RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

Radio-Craft

March
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HUGO GERNSBACK, Editor

How to Make

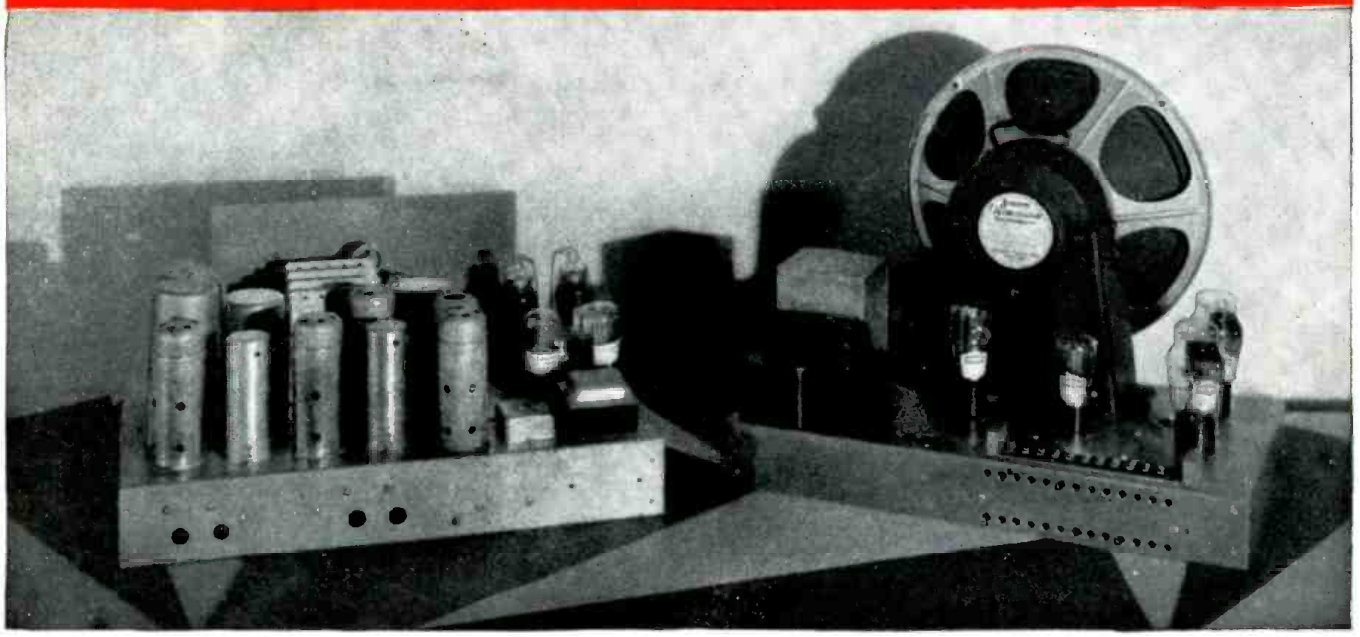
THE PHONOSONE
FOR THE NEAR DEAF

See Page 528

NRA

Re-Wiring "Battery Set" Filaments — A "6F7" Service Oscillator
Electro-Musical "Trombone" — Broadcast Station List — Dynatrons

Whatever You Want in a Radio
WE GUARANTEE IT!



Do you want *actual* daily round-the-world reception? Or 95 stations on the broadcast dial? Or the simplest short-wave tuning of any radio? Or a "down-to-the noise level" sensitivity and the hair line selectivity necessary for championship "stunt" reception? Or the most awe-inspiring tone you've ever heard? Or power enough to fill a cathedral?

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That is possible only because the Explorer comes from the Laboratory of the oldest manufacturer of radios in the world—the Laboratory which gave the radio industry the Multiple-Ganged Condenser, Metal Shielding, Automatic Volume Control, Built-in Power Supply. The Laboratory that pioneered the AC Dynamic Speaker, Wet Electrolitics, and Remote Control. In recent years they have developed Noise Suppression, and hold important patents on these circuits.

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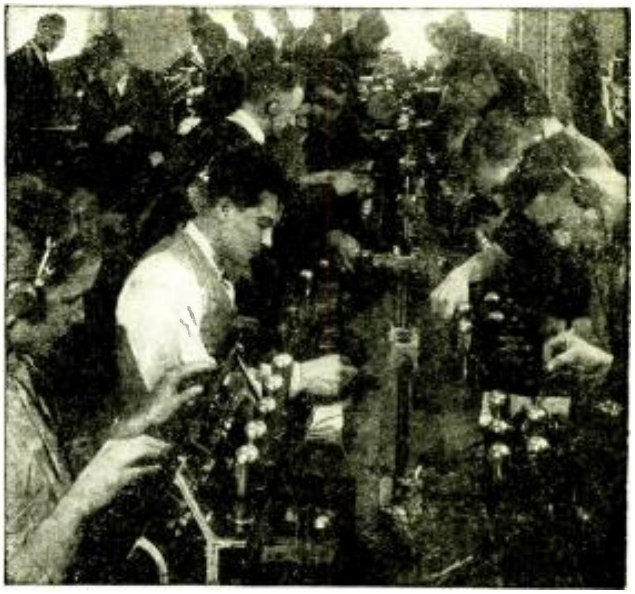
If you who read this advertisement are really interested in your future here is the chance of a life time. Mail the coupon today and I'll give you all the facts.



A scene in the big, busy Radio Shops at Coyne. Here you see fellows working on real Radios—not reading about them from books or lessons. This is THE way to prepare for the big-money field of Radio!

TELEVISION *and* TALKING PICTURES

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Forget pay-cuts—lay-offs—unemployment! Don't be tied down to an untrained man's future. You NEED TRAINING IN A FAST-GROWING MONEY-MAKING TRADE. Here's your chance of a lifetime to get it! Hundreds of opportunities now open in Radio. My sensational offer, explained below, makes it possible for you to START AT ONCE!

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ALL PRACTICAL WORK At COYNE in Chicago

ALL ACTUAL, PRACTICAL WORK. You build radio sets, install and service them. You actually **operate** great Broadcasting equipment. You construct Television Receiving Sets and **actually transmit your own Television programs over our modern Television equipment.** You work on **real** Talking Picture machines and Sound equipment. You learn Wireless Operating on actual Code Practice apparatus. We don't waste time on useless theory. We give you the **practical training you'll need—in 10 short, pleasant weeks.**

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You get Free Employment Service for Life. And don't let lack of money stop you. Many of our students make all or a good part of their living expenses while going to school and if you should need this help just write to me. **Coyne is 33 years old.** Coyne Training is tested—proven beyond all doubt. You can find out everything **absolutely free. Just mail coupon for my big free book!**

H. C. LEWIS, Pres. RADIO DIVISION Founded 1899

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Mail Coupon Today for All the Facts

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Radio Division, Coyne Electrical School
500 S. Paulina St., Dept. 34-8H Chicago, Ill.

Dear Mr. Lewis: Send me your big FREE Book; details of your FREE Employment Service; and tell me all about your special offer of allowing me to pay for training on easy monthly terms after graduation.

Name.....

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City..... *State*.....

Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief
C. W. PALMER, Associate Editor
R. D. WASHBURNE, Technical Editor

CONTENTS OF THE MARCH, 1934, ISSUE

VOLUME V Number 9

IN OUR NEXT FEW ISSUES;

MANY WAYS TO IMPROVE YOUR RECEIVER. There are many thousands of radio receivers in use that have become obsolete simply because later developments have introduced better methods. These sets are not by any means useless. In fact they are probably giving good service at the present time. But there is no reason why they cannot be brought up to date by anyone who is acquainted with the simple details of radio receiver construction. And it is not necessary to have an engineer's degree to follow the easy instructions given in this article telling how many improvements can be made.

ADVANCED METHODS FOR AUTOMOTIVE RADIO NOISE ELIMINATION. An article dealing with completely new and advanced information on the elimination of ignition noises from auto-radio reception. Present methods are unsatisfactory not only to the car owner, and the radio installation man (who still encounters considerable difficulty with certain car models), but also to the auto mechanic as well who many times will find that the "engine trouble" is due to an incorrect or faulty radio installation!

RADIO-CRAFT is published monthly, on the fifth of the month preceding that of date: its subscription price is $2.50 per year. (In Canada and foreign countries, $3.00 a year to cover additional postage.) Entered at the post office at Mt. Morris, Ill., as second-class matter under the act of March 3, 1879.

HUGO GERNSBACK, President I. S. MANHEIMER, Secretary

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I will help You
start a Spare Time or Full Time
Radio Service Business without capital

J. E. SMITH, *President*
National Radio Institute

The man who has directed the Home-Study Training of more men for the Radio industry than any other man in America.

Here are a few examples of the kind of money I train *"my boys"* to make

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"The National Radio Institute put me in a position to make more money than I ever made in good times. I am in the radio service business for myself, where it is possible for me to make from $50 to $75 a week. Service work has increased because people, who in normal times would buy a new Radio, now are contented to have the old one 'pepped up'."—BERNARD COSTA, 150 Franklin St., Brooklyn, N. Y.

Now Owns Own Business

"If I had not taken your Course I would be digging ditches instead of running my own business. One week I made $75 on repairing alone, and this doesn't count sales. If a fellow wants to get into radio, N. R. I. is the starting point."—R. S. Lewis, Modern Radio Service, Pittsfield, Ill.

Averages $80 per Month in Spare Time

"I am getting along well in my Radio work, always being kept very busy. Since enrolling I have averaged around $80 a month working on Radio just part time, since I am still holding down my regular job."—JOHN B. MORISSETTE, 733 Somerville St., Manchester, N. H.

My Free book gives you many more letters of N. R. I. men who have made good in spare time or full time businesses of their own

Free Book Tells How Mail Coupon!

The world-wide use of Radio sets for home entertainment has made many opportunities for you to have a spare-time or full-time Radio business of your own. I give you instructions early in your Course for doing 28 Radio jobs common in almost every neighborhood. Many N. R. I. men make $5, $10, $15 a week extra in spare time almost at once. I show you how to install and service all types of receiving sets. I give you Radio equipment and instructions for conducting experiments, for building circuits and testing equipment, and for making tests that will give you broad, practical Radio experience. Clip the coupon below and get my free 64-page book, "Rich Rewards in Radio"—it gives you a full story of the success of N. R. I. students and graduates, and tells how to start a spare-time or full-time Radio business on money made in spare time while learning.

Many N. R. I. Men Make $5, $10, $15 a Week Extra in Spare Time Almost at Once

Many of the seventeen million sets now in use are only 25 per cent to 40 per cent efficient. I will show you how to cash in on this condition. I will show you the plans and ideas that have enabled many others to make $5, $10, $15 a week in spare time while learning. Ford R. Leary, 1633 Davison Road, Flint, Mich., wrote: "My part-time earnings while taking the N. R. I. Course were $651."

Get Ready Now for a Radio Business of Your Own and for Jobs Like These

Broadcasting stations use engineers, operators, station managers, and pay up to $5,000 a year. Radio manufacturers use testers, inspectors, foremen, engineers, servicemen and buyers, and pay up to $7,500 a year. Radio dealers and jobbers employ hundreds of servicemen, salesmen, managers, and pay up to $5,000 a year. Radio operators on ships enjoy life, see the world, with board and lodging free, and get good pay besides. My book tells you of the opportunities in Radio, Set Servicing, Aircraft Radio, Television, Police Radio, Short Wave, and other fields. Get it.

I Will Train You at Home in Your Spare Time

Hold your job until you're ready for another. Give me only part of your spare time. You do not need a high school or college education. Hundreds with only a common school education have won bigger pay through N. R. I. J. A. Vaughn jumped from $35 to $100 a week. J. E. McLaurine increased his earnings 100 per cent. The National Radio Institute is the Pioneer and World's Largest organization devoted exclusively to training men and young men by Home Study for good jobs in the Radio industry.

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I will give you an agreement to refund every penny of your money if you are not satisfied with my Lessons and Instruction Service when you complete my Training. And I'll not only give you thorough training in Radio principles, practical experience in building and servicing sets, but also Advanced Training in any one of five leading branches of Radio opportunities.

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Mail the coupon for "Rich Rewards in Radio." It's free to any ambitious fellow over 15 years old. It tells you about Radio's spare-time and full-time opportunities; about my training; what others who have taken it are doing and making. Mail coupon now—in an envelope or paste on a 1c post card.

Get my new book It points out what Radio Offers You

J.E.SMITH, Pres.
Dept. 4CX,
National Radio Institute,
Washington, D.C.

SPECIAL Radio Equipment for Broad Practical Experience *Given Without Extra Charge*

My Course is not all theory. I'll show you how to use my special Radio equipment for conducting experiments and building circuits which illustrate important principles used in such well-known sets as Westinghouse, General Electric, Philco, R.C.A., Victor, Majestic, and others. You work out with your own hands many of the things you read in our lesson books. This 50-50 method of training makes learning at home easy, interesting, fascinating, intensely practical. You learn how sets work, why they work, how to make them work.

FREE Radio Servicing Tips

Let me PROVE that my Course is clear, easy to understand and fascinating to study. Send the coupon for a free lesson, "Trouble Shooting in D.C., A.C. and Battery Sets." This interesting lesson gives 132 ways to correct common Radio troubles. I am willing to send this book to prove that you too can master Radio—just as thousands of other fellows have done. Many of them, without even a grammar school education, and no Radio or technical experience, have become Radio experts and now earn two or three times their former pay. Mail the coupon now.

THIS COUPON IS GOOD FOR ONE *FREE* COPY OF MY NEW BOOK — mail it TODAY

J. E. SMITH, *President,*
National Radio Institute, Dept. 4CX,
Washington, D. C.

Dear Mr. Smith: I want to take advantage of your Special Offer. Send me your two books, "Trouble Shooting in D.C., A.C. and Battery Sets" and "Rich Rewards in Radio." I understand this request does not obligate me. (Please print plainly.)

Name ..... *Age* .....

Address .....

City ..... *State* ..... **M**

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Reg. List Price

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Over 2,000 Illustrations
9 x 12 Inches
Flexible, Looseleaf
Leatherette Cover

There's plenty of Servicing Material

in the NEW 1934 Manual

THE necessity of GERNSBACK Manuals in the radio field has been shown by the fact that the total sales of the first three OFFICIAL RADIO SERVICE MANUALS, including the new CONSOLIDATED EDITION, now exceed 80,000 copies. Radio Service Men and others engaged in various branches of radio know the importance of such books, and how they must depend upon them for reliable information. Whether for public-address work, tube information or a circuit diagram, the material needed is certain to be found in one of the OFFICIAL RADIO SERVICE MANUALS.

In preparing this new edition many of the outstanding problems of the Service Men have been considered —methods of servicing, the new equipment constantly needed to cope with new tubes and sets, and the other fields of radio, such as public-address systems, short waves, auto radio and others.

The illustrations in the 1934 Manual are more explicit than before; inasmuch as the diagrams are not limited to the schematic circuit, but other illustrations show the parts layout, positions of trimmers, neutralizers, etc. There are hundreds of new circuits included, and not one from any previous editions of the manuals has been repeated. *This we unconditionally guarantee.*

As in previous years, the 1934 Manual also includes a FREE QUESTION AND ANSWER SERVICE. In each book will be found 25 coupons, which entitle you to free consultation on any radio service topic. These coupons give you a complete mail service—questions on servicing and operating any set or circuit are answered promptly and accurately by the editors. Remember that, at the regular rate of 25c per question which is usually charged by radio magazines, this service alone is worth $6.00. And for the Manual, we charge only $3.50.

It is quite evident that the 1934 Edition of the OFFICIAL RADIO SERVICE MANUAL is a decided improvement over previous volumes.

ORDER YOUR COPIES NOW

It is important to every Radio Service Man and Dealer to get his copy of the 1934 OFFICIAL RADIO SERVICE MANUAL now. The new book will prove itself to be invaluable as those volumes of previous years.

No need to delay sending us your order—the 1934 MANUAL, like its predecessors, is a necessity in your business. We strongly advise you to order your copy today.

GERNSBACK PUBLICATIONS, INC.
96-98 Park Place New York, N. Y.

Contents of the 1934 Manual in Brief

- Diagrams and service notes, more complete than ever before in any MANUAL. Not merely the schematic hook-ups will be found, but chassis drawings showing parts layouts, positions of trimmers, neutralizers, etc.
- Voltage readings for practically all sets, as an aid in checking tubes and wiring.
- All values of intermediate-frequency transformers used in superheterodynes, with the manufacturers' own suggestions as to correct balancing.
- Detailed trouble-shooting suggestions and procedure as outlined by the manufacturers' own engineers—in other words, authentic "dope" right from headquarters.
- Values of all parts indicated directly on all diagrams.
- Section for reference to A.C.-D.C. cigarbox midgets.
- Section for reference to public-address amplifiers.
- Section for reference to short-wave receivers.
- Section for reference to remote-control systems.
- A complete compilation of radio tube data, covering both the old and the many new types.
- Section devoted to test equipment, analyzers, etc., with full diagrams and other valuable information.
- A complete list of American broadcast stations with their frequencies in kilocycles; extremely useful in calibrating and checking test oscillators and in calibrating receivers.
- Free Question and Answer Service, the same as in our last two Manuals.
- No theory; only service information in quickly accessible form.
- Absolutely no duplication of any diagrams; nothing that appeared in any of the previous Manuals will appear in the 1934 MANUAL. This we unconditionally guarantee.
- A handy, easily-consulted master index making it easy for you to find almost anything pertaining to your service problem instantly. This index includes all the diagrams published in all the previous GERNSBACK Manuals, as well as the 1934 diagrams. A big convenience and time saver!

Clip — Mail This Coupon Today

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Gentlemen: Enclosed you will find my remittance of $3.50 for which you are to send me, Postage Prepaid, One Copy of the 1934 OFFICIAL RADIO SERVICE MANUAL. [Send remittance by check or money order; or register letter if it contains cash, currency or unused U. S. Postage stamps.]

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RC-334

Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN
"Takes the Resistance Out of Radio"

Editorial Offices: 96-98 Park Place, New York, N. Y. HUGO GERNSBACK, Editor Vol. V., No. 9, March, 1934

RADIO OPPORTUNITIES

An Editorial by HUGO GERNSBACK

HARDLY a week goes by without some letters reaching me from young men who wish to know if there are still any opportunities in radio.

Most of these correspondents seem to have an idea that since broadcasting is here, and the main radio boom is over, radio has become so well established nothing much further will happen; and that, in fact, it has come down to the level of the butter and egg business.

These letters are always slightly amusing to me because when I think back for three or four years—or for 10 years—when the same sort of letters came in; and when I notice the tremendous progress that has been made in the radio art, I am always amazed that individuals can be found who seem to think that radio offers no further opportunities. This puts me in mind of the case of a Washington Patent Office official who, in the early '70s resigned his position with the Patent Office because he was convinced that nothing much further could be invented. Mind you, this man was an expert in patent matters and had a good technical education. Yet after he quit, to speak of only a few, the telephone, X-ray, automobile, airplane, radio, and hundreds of other most important inventions came along.

It is so with radio. I have often pointed out that the art of radio is constantly expanding, and expanding so fast that even the expert in radio can no longer keep track of all branches. When I say the radio art to-day, I mean—radio broadcasting, point-to-point communication, television, photo-electric appliances, public address, automobile radio, radio telemechanics, radio physics, and dozens of other applications too numerous to list here. Each one of these branches is big to-day; in fact, many of the branches support huge industries at this minute. And yet, I am convinced that the surface has not as yet been scratched. We are still at the very beginning in the radio art. **The great radio inventions have, as yet, not been made.** Many marvelous and undreamt of radio inventions are still to come. In the meanwhile, the art is stepping forward naturally, with new improvements being made every day. You cannot pick up any radio magazine, or a copy of the Patent Gazette without finding dozens of new radio improvements, appliances, and what not.

The trouble with most young men to-day is, when they talk of opportunities in radio, they really do not know their own minds. They think of radio in a vague, incoherent manner. The important fact is to determine in which particular branch of radio you are best qualified. As I said before, the radio art is such a huge thing to-day that there is not a single man alive who could qualify as a radio engineer in all of its branches!

So the important thing to find out is *what you are best fitted for.* You must question yourself about your experience in radio up to now. If you have had no experience, then it becomes necessary to find out what branch you would be most interested in. Would you be more interested in radio broadcasting, or in the short-wave radio field? Would the radio communication field be more attractive to you than airplane radio? These are questions no one can answer for you. Only you, yourself, can answer them.

First of all, you must become well grounded in the fundamentals of electricity; you cannot become a radio expert unless you know electricity. This means book knowledge. After you have mastered the electrical part, you then should get hold of every book, every magazine, and every scrap of printed information that caters to the particular branch of radio in which you are interested. And while there may not be separate books on each branch, most general radio books carry a lot of information on practically every branch of radio in which you may be interested. These books should be in your possession to give you the theoretical knowledge.

After the fundamentals have been mastered, you are now ripe either to take a correspondence school course, of which there are several excellent ones, or to go to a resident radio school, which will teach you both the theoretical as well as manual knowledge. After that, practical knowledge gained in the field, in the laboratory, or in the factory, is essential.

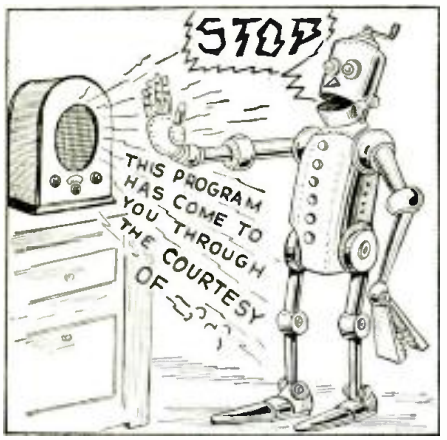
The important thing for young men to-day is *knowledge;* too many have half-baked ideas, and when the opportunity and position come, they are not able to grasp the one and fill the other because they have neither the theoretical nor the practical knowledge. As I have often stated before, what is wanted to-day is expert knowledge. Everybody needs experts.

For these people there is always a golden opportunity, because their number is never very large, and every employer is on the lookout for the man who knows and can convince others of his theoretical and practical knowledge.

And whether you take a job or go into business for yourself, the same principles hold true. Remember, radio opportunities to-day are greater than they were ten years ago and *they will become greater as time goes on.*

But always bear in mind that no matter how much experience you have, remember that you must sell yourself to those who need your services. There are all too many walking cyclopedias in the country to-day who do not get the right position because they have no idea how to present their services to the right firms. This requires a study all by itself. Writing letters to large concerns, asking them for positions, is to-day useless. No attention is paid to them. You must make some other form of contact; you must make what is, technically, called a "presentation." And that means studying the requirements of the particular firm you are interested in; it means studying their product; it means studying their literature. In other words, you must know what the firm is doing and you must know it well. You must also have some inventive ability in order to push yourself ahead. For example, suppose you live in a city in which there is a radio manufacturer, the XYZ Radio Company, making radio sets. By getting hold of a set, either by buying it or by looking it over at the dealer's, perhaps you can think of some improvements. This will give you your opportunity to get in touch with the engineering department or the General Manager. You ask for an interview, not with an idea of getting a position, but showing them something worth-while that you have thought out for them. If the manager or head engineer is impressed by your presentation, employment then often comes as a matter of course.

The RADIO MONTH in



MR. ANTI-BALLYHOO ROBOT
Some sponsors that we could mention have well earned his attention!

A ROBOT TO DELETE NAUSEATING RADIO ADVERTISING

AS if in answer to our plea for less advertising (RADIO-CRAFT, February 1934, page 455) comes news of a new radio robot—a device which automatically takes the "talk" out of radio programs. This device which was developed by Prof. Gleason W. Kenrick of Tufts College, acts whenever there is a quarter of a second silence in the program and keeps the radio set silent for ten seconds.

Prof. Kenrick's robot is a detector and amplifier similar to the automatic volume control devices incorporated in many modern sets. Whenever the "brain" tube's current momentarily drops to zero, a selective relay operates and cuts off reception for a given length of time—ten seconds of silence is an effective antidote for most radio talk.

We wonder what would happen if a fast talker such as Floyd Gibbons tried to beat out the robot, or, unless the device had "brains," how it would discriminate between a speech by the President, and advertising matter!

ARTIST PLUS CONTROL ENGINEER

THE man who sits behind the glass window on one side of a broadcast studio can do more tricks with a singer's voice than a magician with a silk hat, according to Richard Crooks, world-famed tenor of the Metropolitan Opera.

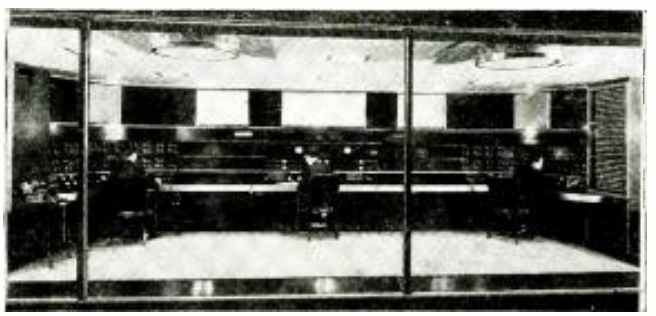
Mr. Crooks says: "For a singer with a smooth voice, the engineer, or control operator as he is called can make a voice of little volume ring with the boom of a Caruso or he can muffle a voice of stupendous proportions. I have seen the man at the controls put the soft pedal on Martinelli to such an extent that he sounded like a lyric tenor.

"Anyone who would achieve success on the air must place himself religiously in the hands of the engineer and have intrinsic faith in his judgment. And it is surprising what a musicianly ear and a general appreciation of crescendo is vested in these men.

"One thing that is deadly to any singer," Mr. Crooks continued, "is a studio hung with draperies as they were not so many years ago. This gives the singer the effect of singing into a blotter with a bag over his head. But that difficulty has been obliterated at Radio City, where sliding panels are employed.

"Speaking of Radio City reminds me that the acoustic engineers have much to learn. One engineer said that there was little difference accoustically between a studio filled with visitors and one that is empty. Another told me there was all the difference in the world."

Shame on the NBC engineers! At least they should get together and stick to one story. It sure creates a bad impression if so famed an artist as Richard Crooks can catch them in such obvious differences of opinion, especially after they have just spent so many thousands of dollars in fitting up their new studios in Radio City.



CONTROL ENGINEERS AT RADIO CITY
"These men can do more tricks with a singer's voice than can a magician with a silk hat."

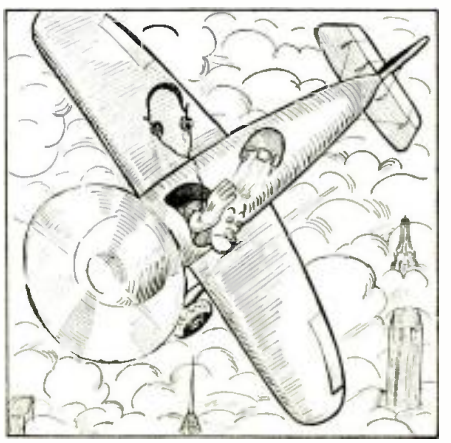
MAIL PLANE LOST WHEN RADIO FAILS

A THICK icy fog settled over northern New Jersey after Dean W. Burford, mail pilot, left the Newark airport for Pittsburgh a few minutes after midnight one day last month.

Burford was gone only a short time when he reported by radiophone that ice was forming on his wings and that he was returning to the field. Then the fog began piling up, and to add to the pilot's difficulties the airport's radio apparatus went out of commission.

Until 4.40 A.M. the plan flew around blindly, many times flying very low over New York City without the pilot even knowing that he was over the great metropolis. Even the great floodlights at the airport which were turned on to guide the lost pilot were of no help.

Finally, the transmitter at the airport was repaired and communication with the plane re-established. By means of the radio beacon a safe landing was made. The value of radio to air flight is well illustrated by this incident.



MAIL PLANE LOST OVER NEW YORK
Which shows just how important the radio beacons are to air navigation.

REVIEW

Radio is now such a vast and diversified art it has become necessary to make a general survey of important monthly developments throughout the field. RADIO-CRAFT analyzes these developments, and presents here a review of those items which are of interest to all.

THE "HUMAN" FORD CAR

OF considerable interest at the recent Ford Motor Car exposition, in the Port of New York Authority building in New York City was a Ford automobile that performed astonishing feats which were both highly entertaining and mysterious to the on-lookers.

It talked, answered questions, started its motor, turned lights on and off, blew its horn, read serial numbers of paper currency, and kidded the audience—although more partial to the fair sex. (Smart work, Henny!)

FATHER HENRY'S TRICK CAR

We wonder how this car will improve the agility of "jaywalkers," and how soon we will find this breed on the roads.

The car was, of course, radio equipped and all the operations performed through remote control. The radio receiver and loudspeaker were so well disguised and hidden that it was impossible to locate them even by a close inspection of the car. Sensitive relays which were operated by the impulses from the radio set, in turn, operated the starter, horn, lights, etc. The car was also equipped to drive and steer itself, in both forward and reverse speeds!

Considerable interest was evidenced by the audience concerning the equipment used and how the car was made to talk and control itself. The owner, Mr. Harry Green of Detroit, Michigan, however, was reluctant to disclose these details, in view of the fact that the car was to be placed on the vaudeville stage. Logically, to reveal these facts would mean to remove the mystery and consequently the interest aroused concerning how all these "tricks" were accomplished.

The reader who is interested in remote control of mechanical objects might refer to the "Radio Robot" which appeared in the August, 1931 issue of RADIO-CRAFT.

THE ELECTRONS ARE WITH US AGAIN

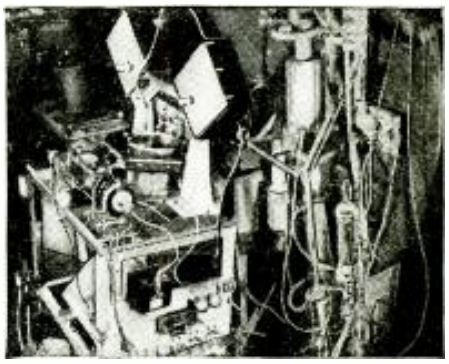
IN the recent sojourns of Commander Settle and his predecessor, high-flying Picard, into the stratosphere, most people have wondered what possible use could be made of the information gained regarding the cosmic rays.

It appears that very definite scientific advances can be made by the use of these rays, as recently revealed in a startling manner by Dr. Robert A. Millikan.

By the use of a Wilson cloud chamber, a complicated device by which cosmic rays can be bombarded upon atoms, Dr. Millikan has made photographs of particles torn from the atoms. These photos revealed in one case, two positive and three negative electrons. Another photo revealed about 26 particles, about half of which were positive and half negative, and all of about the same energies.

Dr. Millikan said: "The indications of the photographs are that these particles were knocked out of the neucleus of the atom itself. These rays (the cosmic rays) are drilling holes through our bodies, from head to heel, and we like it."

Some of our readers may wonder just what this has to do with radio communication, but when it is remembered that the previous theories regarding atomic structure (in which the positively



THE WILSON CLOUD CHAMBER

By means of which Millikan may toss into the discard our books on radio and electrical theory.

charged electrons were supposed to have a mass of some 2,000 times that of the negative particles) form the basis upon which the entire structure of electrical conductance depends, the magnitude of this development becomes apparent. If this basis is incorrect, *the theories upon which radio is based also are incorrect!*

This photographic proof is likely to have some very wide-reaching effects on radio communication.

In commenting further on cosmic rays, indefatigable Dr. Millikan states: "They come from the celestial dome, independent of the positions of the great celestial masses, such as the sun, the stars and the milky way. They are darts of light, that is they cling together for long distances."

AMERICAN VS. BRITISH "RADIO"

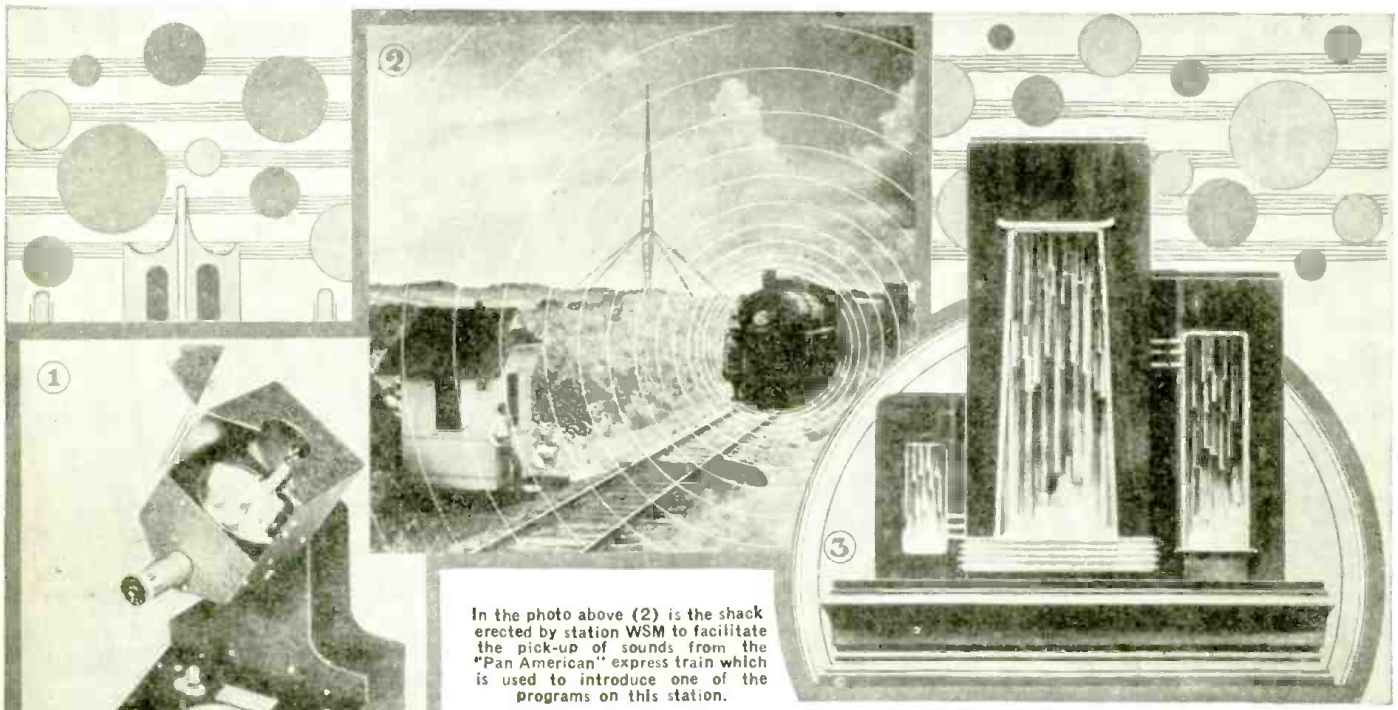
THE National University Extension Association announced a short time ago that it had selected for debating purposes the question whether the United States should adopt the essential features of the British system of radio operation and control. To meet the thousands of requests for material on the topic that poured into the headquarters of the National Association of Broadcasters, this organization has found it necessary to prepare a 191 page book on the subject!

In presenting the negative or American side of the case, Dr. Herman S. Hettinger of the University of Pennsylvania, who prepared this material, stated:

"Adoption by the United States of the essential features of the British system

(*Continued on page* 553)

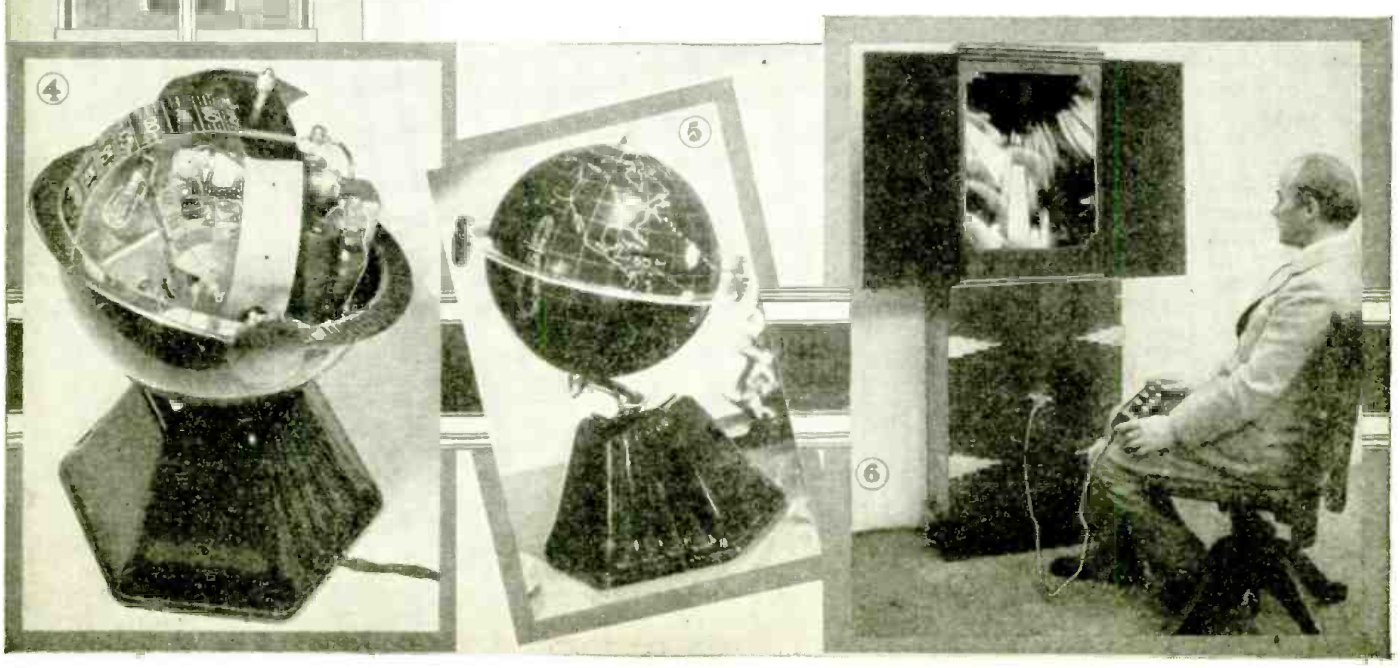
RECENT RADIO DEVELOPMENTS —ILLUSTRATED

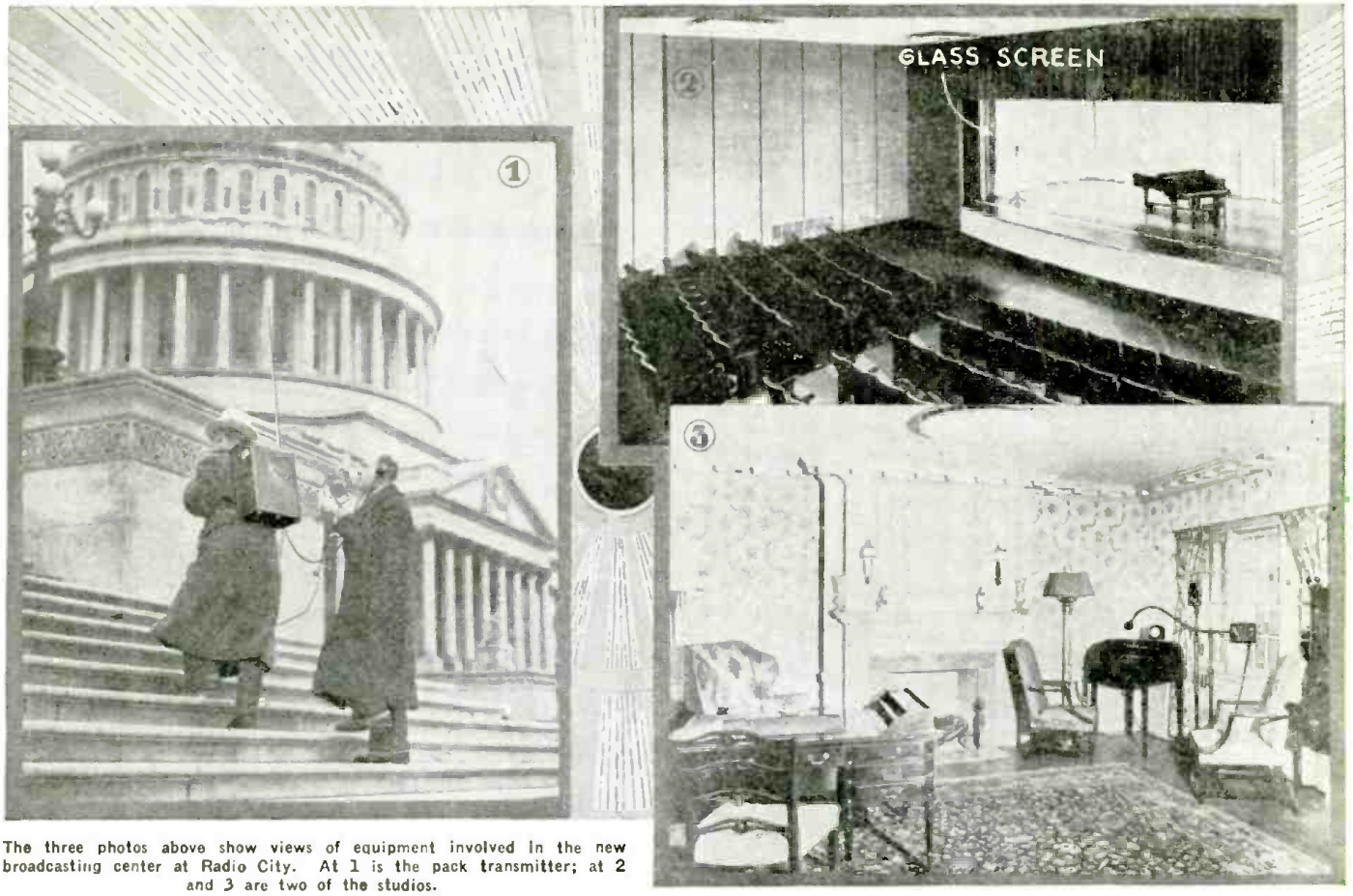


In the photo above (2) is the shack erected by station WSM to facilitate the pick-up of sounds from the "Pan American" express train which is used to introduce one of the programs on this station.

IT IS no longer necessary to leave your watch for a week or more with a jeweler to be regulated; with the stroboscopic timer shown at 1, it can be done in a few minutes! This device checks the balance wheel speed against a standard by methods familiar to television enthusiasts. A novel method of starting a broadcast by the sounds created by an express train is shown at 2. The towers of the broadcast station appear in the background. The resonating tube reproducer shown at 3 operates by sound reflection from a surface of liquid, a method described in RADIO-CRAFT, May, 1930; the "system" shown at 3 is in the $1,000 class! The latest novelty in radio set design is shown at 4 and 5. Photo No. 4 shows the interior of the "radio globe," in which is enclosed a 5 tube A.C.-D.C. receiver. This includes such modern refinements as A.V.C. and a superheterodyne circuit. At 6 is shown an instrument which is attracting some interest with radio listeners. It is a color organ that is capable of over 25 individual colors which drift slowly across the screen like clouds, in an ever-changing array of color. The device plays "color" records, which may be repeated continuously until stopped, or the user can form color combinations of his own by the use of the simple remote control shown in the photo, the beautiful effects produced form a pleasing accompaniment to radio reception.

Photo courtesies: 1—Bell Telephone Labs., 2—Station WSM; 3—Volf Laboratory; 4, 5—Colonial Radio Corp.; 6—Art Institute of Light.





The three photos above show views of equipment involved in the new broadcasting center at Radio City. At 1 is the pack transmitter; at 2 and 3 are two of the studios.

IN THE January, 1934 RADIO-CRAFT, page 393, a photo was shown of the new 150 W. mobile transmitter used as an addition to the service presented by NBC in their new Radio City quarters. This transmitter is in the form of a stream-lined sedan and has a stationary range of approximately 100 miles or a range of 50 miles while in motion. It is to be used for "spot" broadcasts where the use of land telephone lines for the pick-up is not practical. Now, in order to still further expand this service, NBC has announced the "pack" transmitter shown at 1. This small unit, which operates at ultra-high frequencies, is carried as standard equipment with the mobile transmitter and is to be used where the car itself cannot reach the spot of assignment. The case of governmental broadcasts from the Capitol, as shown in the photo, is a typical example of the usefulness of this tiny broadcaster. In most instances, where the pack transmitter is employed, the 150 W. short-wave mobile transmitter is used as a relay station to carry the program to the nearest NBC station (or "outlet," according to the technical terminology).

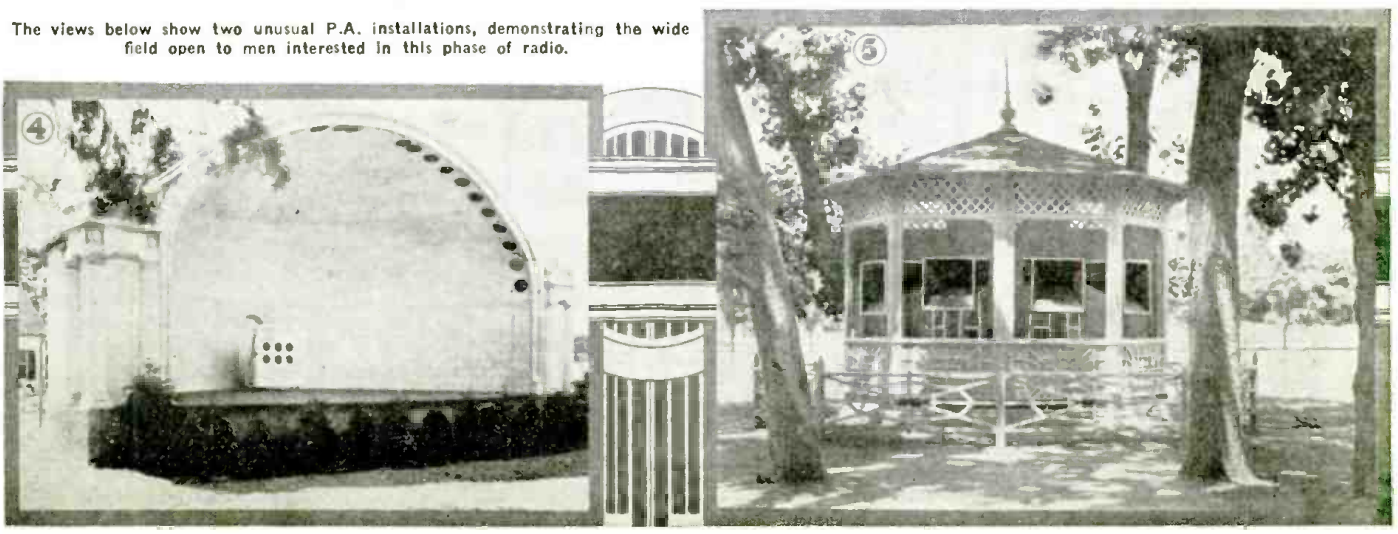
Two additional views of the Radio City installation are shown at 2 and 3. At 2 is the Radio Guild studio which was designed especially for dramatic productions. In contrast to most studios, this one is in the form of a small theatre, with a stage, footlights and 250 permanent upholstered seats. In addition to these conveniences for the dramatic artists, a sliding glass curtain which completely covers the stage, prevents any pick-up of noise other than that desired for the performance. This glass curtain is motor-operated from the control room. The audience in the studio hears the program from 3 concealed reproducers mounted over this stage.

The studio shown at 3 appears more like a well-furnished Georgian drawing-room than a broadcast studio. This is the speakers' studio. The walls above the wainscoat are covered with silk damask, the fireplace and hearth are of marble and all woodwork is painted in ivory. The microphone is inconspicuously located over the small desk at the right of the photo, and certainly should not give anyone "mike fright."

Below, in 4 and 5 are shown two views of unusual P.A. installations. The first, at 4, is installed in a park in New Rochelle, N. Y. It is used to present band music, through the medium of phonograph records, when the usual band is not present. The other, at 5, shows an installation in a bandstand in Chosica, Peru, South America.

Photo courtesies: 1, 2 and 3, NBC; 4 and 5, Wright-DeCoster, Inc.

The views below show two unusual P.A. installations, demonstrating the wide field open to men interested in this phase of radio.



THE LATEST RADIO EQUIPMENT

The short-wave superhet. above has several novel features including a unique dial and individual inductances for each band. (No. 404)

NEW ALL-WAVE SET

The receiver illustrated above, which is adapted for reception of signals from 150 to 18,000 kc. (2,000 to 16.7 meters), employs a superheterodyne circuit with eight of the latest type tubes. (See DATA SHEET No. 109 in this issue.) The dial is an "airplane type," calibrated in kc. and megacycles. The shift from one wave band to another is accomplished by simply turning a knob which brings into use a completely different set of coils for each band. An additional R.F. stage is added to the set on the highest frequency band, to increase the gain.

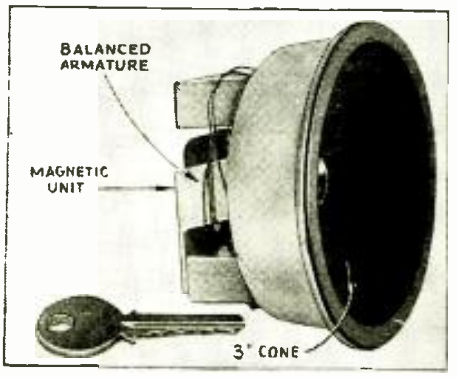
A "DEAF SET"

The hearing aid shown below consists of a two-stage amplifier using "dry-cell" tubes and is adaptable for use with one to ten headsets. Thus, the unit is useful for group operation at home, in theaters, churches, schools, etc. The circuit is shown below, at the right.

Phone adapter for pentode tubes. (No. 406)

HEADPHONE ADAPTER

This item is designed for use with sets having a single output pentode tube such as the 47, PZ, etc., to provide facilities for switching to either phones or reproducer. The feature is its connection into the *screen-grid* circuit of the output tube, by means of the adapter plug shown.



Magnetic-type midget reproducer. (No. 407)

ULTRA-MIDGET SPEAKER

A small reproducer having a cone 3 ins. in diameter, which is especially designed for ultra-small receivers is shown above. The unit is of the magnetic type with a balanced armature.

A studio-type condenser microphone. No. 408)

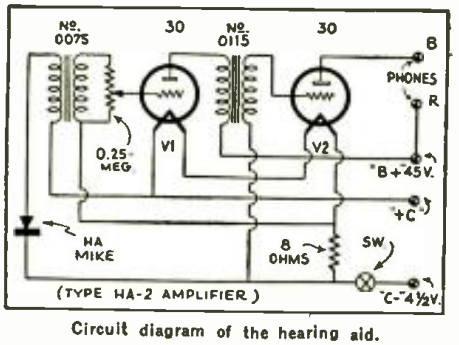
CONDENSER MIKE HEAD

This condenser microphone and head amplifier have been designed for use in broadcasting and recording studies. The amplifier employs two type 30 tubes. The power for these tubes is supplied either by external batteries or a power supply unit. The output level of the mike and amplifier is approximately —30 lb. The output impedance may be reduced from 200 to 50 ohms by strapping terminals in the tube chamber.

METAL-OXIDE RECTIFIER

This rectifier has been specifically designed for use with D.C. milliammeters in converting them to A.C. service. The rectifier has several novel features including complete insulation in bakelite and a new method of making contact with the rectifying film resulting in *fixed resistance* characteristics.

A group-type hearing aid. (No. 405)



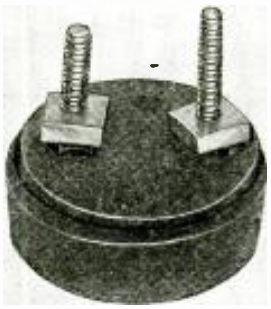
Circuit diagram of the hearing aid.

A metal-oxide rectifier. A metallic film provides contact to the oxide. (No. 409)

Talkies tube-test adapters. (No. 410)

"TALKIES" 50 W. TUBE ADAPTERS

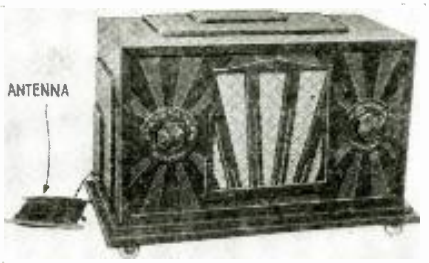
The units above permit 50 W. tubes to be tested in ordinary set analyzers. They are available with different prong arrangements for various analyzers. These adapters facilitate "talkies" repair work.



A fixed crystal detector. (No. 411)

RADIO SPARK PLUGS (right)

These spark plugs take into account the popularity of auto-radio receivers. In addition to the usual spark gap for ignition purposes, a noise-suppressor resistor of approximately 20,000 ohms is mounted inside the porcelain insulator, eliminating the necessity for an external suppressor resistor.

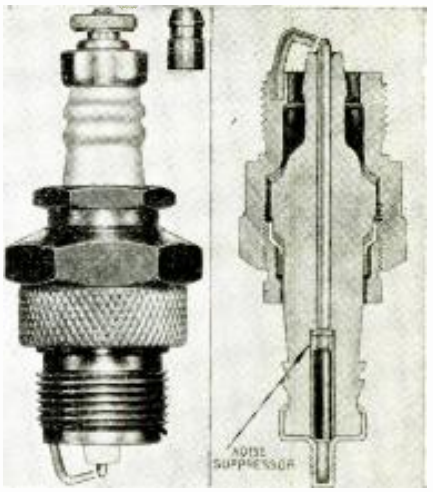


An A.C.-D.C. midget superheterodyne. (No. 412)

FIXED CRYSTAL (left)

The fixed crystal unit shown at the left is mounted in a die-cast housing of small size, finished in crystalline enamel. The crystal (iron pyrites) contact is scientifically adjusted to the most sensitive point.

Crystal detectors are in demand among experimenters for such sets as the Megadyne, etc.

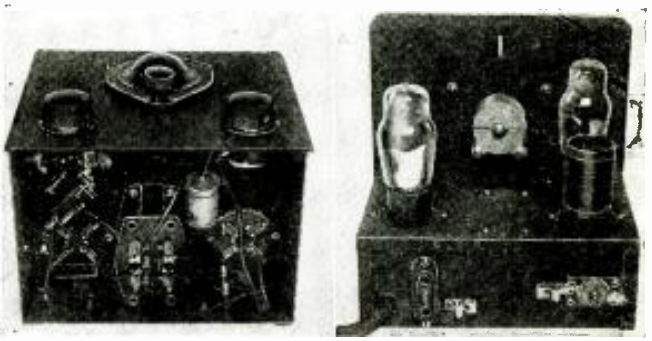


"Suppressed" spark plugs. (No. 413)

A.C.-D.C. RECEIVER (center)

This receiver, shown at No. 412, which uses a superheterodyne type circuit employs five tubes. A 78 is used as first-detector and oscillator; a 78 as I.F. amplifier; a 77 as second-detector; and a 43 as output pentode. A 25Z5 rectifier furnishes both the plate current and the dynamic speaker field current. The I.F. is 456 kc. An important feature is the use of a bypassed "overload" resistor in the second-detector grid circuit, which increases the bias with a strong signal, supplying a type of A.V.C. action.

A "PERFECTED" 2 TUBE SHORT-OR ALL-WAVE KIT SET



Lower and rear views of the 2 tube set. (No. 414)

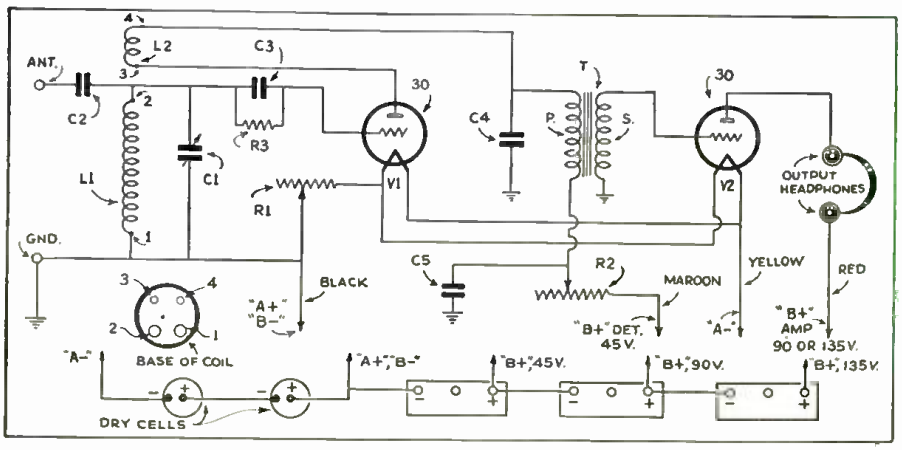
MOST radio sets lay claim to such merits as low cost, extreme sensitivity, or high volume, but the "short-wave" receiver illustrated below establishes priority as a "perfected" set; that is, one in which every single component has been selected as the result of a weeding-out process extending over several years.

Although the wavelength range of this set is generally given as 15 to 200 meters (the "short-wave" range) by the simple addition of two inductance units the range may be extended to 625 meters. Since the latter provision includes the "broadcast" band, "all-wave" operation is secured.

All the components, including the metal panel and subpanel, are available either in kit form or individually.

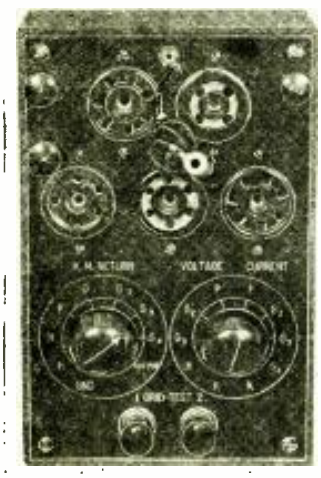
The following tabulation of coil data refers to the use of the "standard" coil form 1 1/16 x 1 3/8 ins. in dia.; the spacing

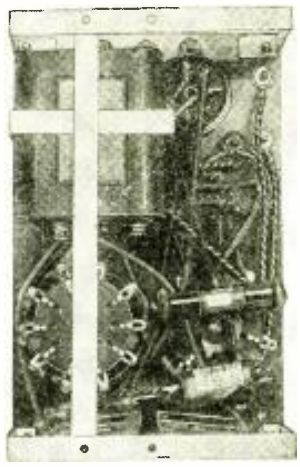
(*Continued on page* 554)



The circuit diagram of the 2 tube short-wave receiver of improved characteristics. The details of battery connections are also shown

A UNIVERSAL ANALYZER AND TUBE CHECKER





Front and rear views of the new test unit (415)

THIRD of three test units, the model 91 analyzer unit, illustrated, is especially designed to be used in the model 90 universal tester described in the October, 1933 issue of RADIO-CRAFT (item No. 145); the model 92 service oscillator is illustrated and described in the February, 1934 issue (item No. 401). The model 91 analyzer unit is available in kit form.

In conjunction with the model 90 universal tester practically all radio measurements may be taken. The switching arrangement, shown in the diagram, makes it possible to read all voltage, current and resistance values without removing the radio set chassis. The feature of the instrument is its low price—less than fifteen dollars. The kit consists of all parts including engraved panel and cast aluminum, black, crystalline-finish case. In addition, a Na-Ald double plug 6 foot analyzer cable with a conductor cord, and 7 to 4, 7 to 6, 7 to 5 and 7 to 7 Na-Ald adapters will be required. The unit is available with a carrying case which will house all three test units mentioned above.

The model 91 analyzer takes care of all type tubes using the 4, 5, 6, or 7 prong socket; the latter accommodates both large- and small-space tubes. The manufacturers call particular attention to the fact that they do not use "composite" or multi-tube sockets, stating their experience has been that such sockets do not stand up under continual use as do single-purpose sockets.

Referring to the diagram, note that the contact arrangement of rotary switch Sw.5 opens the circuit at any point so that resistance values can be read directly from the ohmmeter scale of a model 90 tester; also, it is possible to take readings between contacts of switches Sw.4 and Sw.5.

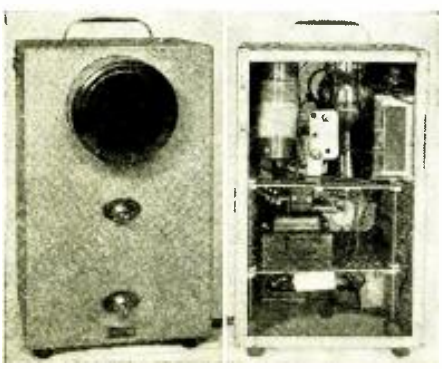
The 90 and 91 units are connected together by means of binding posts—plus to plus, minus to minus. The analyzer cable is plugged into the upper 7 prong socket of the 91 unit. One tube at a time is removed from the set and inserted in the analyzer, using the proper terminal adapter, the analyzer

(*Continued on page* 549)

SOCKET SOUND SYSTEM

An innovation in public address amplifiers is this "socket mike." The device operates completely from the electric light socket, the A.F. output being sent over the same power lines (RADIO-CRAFT, November, 1933), to various outlets.

The socket mike is plugged into an outlet where the sound is to be transmitted from (the reproducer and amplifier unit are at the location where reception is desired). No wires or additional expense for installation is required. The simplicity with which this unit may be installed will please many P.A. men.



This "socket mike" eliminates wiring (416).

A "wide range" microphone (417).

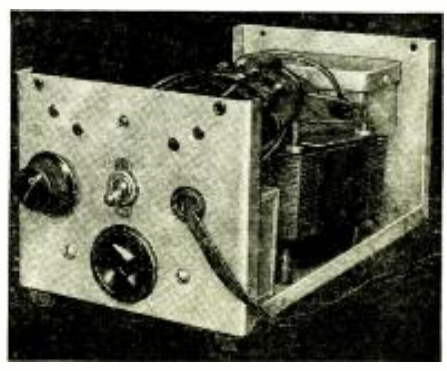
A "TRIAD" CONDENSER MIKE

The microphone above is of the condenser type and has many unusual features. Similarly to present, wide-range sound installations, the microphone is composed of three sub-divisions, each of the units being designed for a definite section of the normal sound spectrum, i. e., bass, treble, and higher frequencies. This unit has further improvements that make it more efficient than the conventional type.

110 VOLT D.C. TO A.C. INVERTER

Here is a long-needed device for attachment to the A.C. operated radio receiver when it is re-located in a D.C. locality. Instead of converting the set so that it will operate from a D.C. source by making inconvenient internal wiring changes this unit may be used to supplying the necessary A.C. power.

This will be found to be more advantageous, particularly when the set is moved back again to where alternating current is available. The inverter, in that case, is simply removed and the set plug is inserted in the light socket without any further expense for rewiring.



An inverter, 110 V. D.C. to A.C (418).

A NEON-TYPE ELECTRO-MUSICAL "TROMBONE"

A musical instrument played by "sliding" the manual; a switch controls staccato effects. This branch of radio is becoming more and more interesting and is attracting many radio experimenters. RADIO-CRAFT is always on the look-out for new electronic instruments. Those who have developed ideas will find it profitable to let us know!

MELCHOR CENTENO V.

Fig. A
The electronic "trombone" being played.

THE photoelectric glow-discharge oscillator, operating at audio frequencies, is well adapted for use in electro-musical instruments. The tonal variations are produced by varying the amount of light which falls on the photoelectric cell of the device. Many practical arrangements are possible for this application.

An experimental form of electro-musical instrument involving the photo-electric glow discharge oscillator is shown in Fig. A. The circuit diagram is illustrated in Fig. 1.

The variations of illumination on the photocell are secured, in this particular instrument, by means of a shutter-like affair which is operated by hand through a lever. The shutter gradually opens or closes a small aperture through which a beam of light passes to a photocell.

A single stage of amplification, provided by a 45 tube, is required to bring the generated oscillations to a good sound level.

A manually-operated switch-key, shown at the top of the box in Fig. A, permits the player to obtain staccato effects. The correct degree of illumination is adjusted by means of a rheostat, the knob of which is located on the left side of the box. This rheostat varies the current through the light-source and thus provides means for tuning the instrument.

Since the photo-*emissive* gas-filled cell is used, it is necessary to operate the light-source by D.C., because A.C. operation of the light-source would introduce modulation in the oscillator's output. If a photo-*conductive* cell were used instead, no such precaution would be necessary, due to the usual electrical inertia of this type of photocell.

The neon tube is a 2 W. type, and without protective resistor. The light-source consists of the lamp and a small hemispherical metallic reflector.

The hand-operated lever of the instrument is shown at the

(*Continued on page* 552)

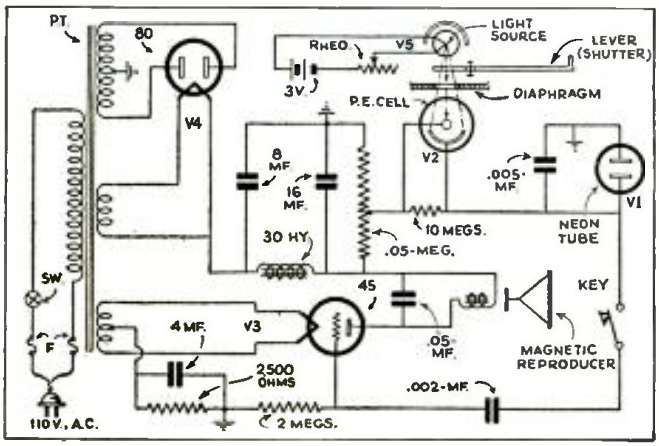


Fig. 1
Schematic circuit of the complete "trombone."

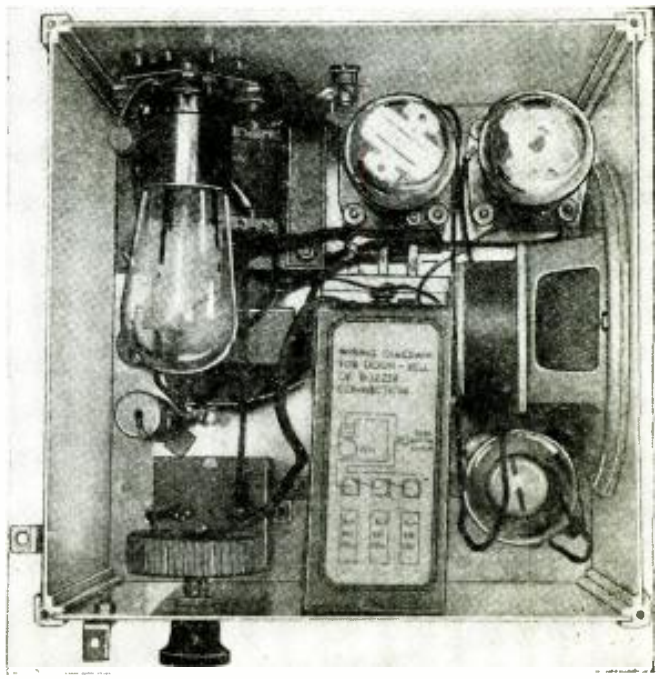


Fig. B
Interior view. Note simplicity of assembly.

INTERNATIONAL RADIO REVIEW

HERE is what the radio experimenter has been wanting for a long time—a semi-technical review of the thousands of new ideas which are continually appearing in overseas publications. Each month there are received at the offices of RADIO-CRAFT hundreds of daily, weekly and monthly magazines originating from every point on the face of the globe.

SINCE the cost of subscribing to each of these would be prohibitive for most radio men, we have arranged with technical translators to prepare for our readers reviews of all the really important, new developments illustrated and described each month in these international radio periodicals.

NOTE that the only available information is that which is published; the experimenter must adapt the ideas to whatever equipment he has on hand.

DELAYED AUTOMATIC GAIN CONTROL

THE title above is the expression used in England to mean the same thing as "delayed A.V.C.," in this country.

The receiver shown in Fig. 1, which appeared in POPULAR WIRELESS, is one of the first circuits that we have seen published using this advanced form of automatic volume control. The duo-diode triode has just appeared on the market, there, and is naturally receiving some interest with set builders.

Regarding the circuit, you will note that it is a T.R.F. arrangement, designed to cover both the broadcast band and the long waves used for broadcasting in Europe. This is accomplished by virtue of the tapped inductances in the aerial and interstage circuits. One plate of the double-diode detector is used for rectification, while the other serves the purpose of varying the bias on the R.F. tubes, both of which are of the variable mu type.

The values of all parts are indicated on the diagram, so that any dyed in the wool experimenters who desire to try this circuit will have little difficulty in changing it over to use American parts.

CATHODE RAY TELEVISION

IN A recent edition of TELEVISION, an English magazine devoted to the science of transmitting and receiving pictures of radio, appears a clear description of how the cathode ray oscillograph tube is applied to scanning.

It will be remembered that the oscillograph tube contains a cathode, around which is placed a shield which is biased with a negative potential to focus the electron stream in a beam. Four flat plates surround the path of this beam—the plates being in two parallel sets, each set at right angles to the other. These two sets of plates serve to move the beam from one place to another on a screen of fluorescent substance on the top of the tube. The electron stream then causes a greenish spot to appear on the screen.

The article in TELEVISION then continues:

The building up of the line screen is accomplished by means of the two electrical circuits shown in Fig. 2. The principle of the circuit is the generation of a "saw-tooth" wave form of voltage, which gives a uniform deflection of the beam in a vertical or horiontal plane.

The condenser C is charged from the "B" battery through the diode, which acts as a variable resistance of constant current characteristics. Across C is the mercury vapor discharge tube, the grid of which is biased to a small negative value. The voltage across C increases uniformly until the striking potential of the discharge tube is reached, when the tube flashes over and discharges the condenser rapidly.

The deflector plates connected across the discharge tube thus have a uniformly increasing voltage applied to them which deflects the beam across the screen. When the condenser discharges the beam returns practically instantaneously to its initial position.

By adjusting the bias on the grids of the discharge tubes, and the filament potential applied to the diodes, the speed of travel of the beam and the rapidity with which it moves in a vertical plane can be adjusted to match the scanning of the television transmitter.

A LOW VOLTAGE PENTODE OSCILLATOR

THE little oscillator described here, which appeared in RADIO WELT magazine, operates satisfactorily with a plate potential of 4 to 9 V.; and consumes such a small amount of current, that it can be supplied from an ordinary "C" battery.

The circuit of the oscillator is shown in Fig. 3. The oscillatory circuit connects the plate to the screen-grid and the plate potential lead is connected to the middle of the inductance coil. A condenser of 200 to 500 mmf. connects the screen-grid which in turn is connected to either

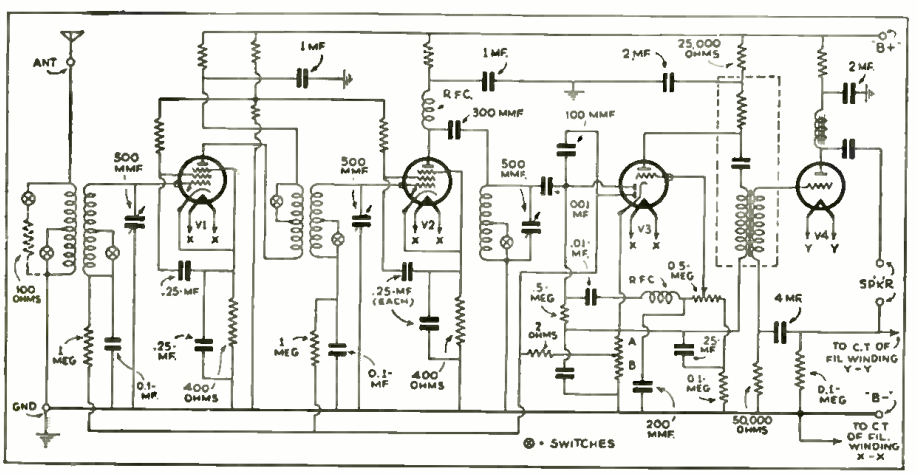


Fig. 1, left
An English version of the duo-diode triode.

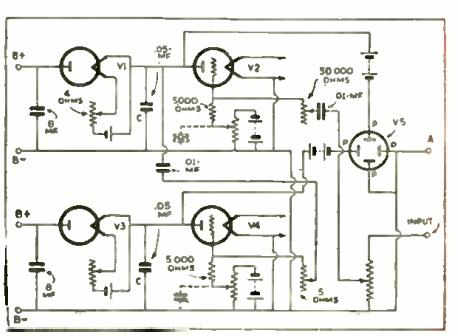


Fig. 2, above
A cathode-ray type of television scanner, using the mercury vapor discharge tube.

the positive or negative end of the filament through a grid-leak of 2 to 3 megs. The oscillator can be considered of the Hartley type, in which the tendency to oscillate is considerably increased by the fact that the generated A.C. voltages are impressed on both screen- and control-grids.

The output, which is small with a plate voltage of 6 V., goes up rapidly, when the plate voltage is raised to 12 V. and higher. Also, the frequency is hardly affected either by the variation of the heating current or by a change of the plate voltage. Thus, the frequency varies less than .02% even when the heating current is reduced from its normal value to a point where the oscillation is at the verge of stopping. Doubling the plate potential has practically no effect on the frequency.

A 3 TUBE SUPERHET. REFLEX

IN THIS set, which appeared in RADIO AMATEUR, an Austrian publication, the use in the first stage of a high-frequency pentode, as a mixer, instead of an ordinary screen-grid tube leads to a larger I.F. output from this stage and permits simplification of the design of the oscillator, on account of the small feed-back effect required with a pentode. A number of additional improvements are introduced through the use of a diode-triode in the second stage. While the diode system of this tube is used for the rectification of the I.F., its amplifying system is used for the amplification of the I.F. and the A.F. That is the reflex feature of the receiver.

Generally, reflex circuits, on account of certain oddities in their operation are not used, particularly in receivers designed for mass production. In this case, however, good results are possible, because the existing conditions are favorable for a satisfactory operation of the tube in a reflex circuit. On account of the considerable power output of the last pentode, the amplitudes of the I.F. currents and the A.F. in the second tube are kept relatively small, so that they can remain on the straight part of the characteristic. The use of a band filter for the transfer of I.F. currents to the diode circuit produces, together with an efficient I.F. transfer, a very weak A.F. coupling. The main advantage of

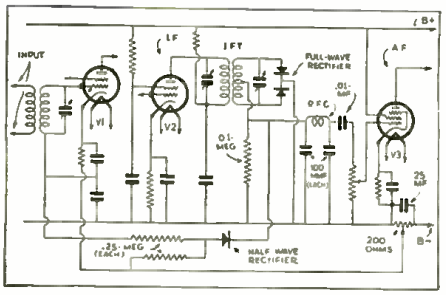


Fig. 6
The use of a dry-disc rectifier for A.V.C.

the reflex circuit is the fact that, without resorting to an extra amplifying stage, an additional band filter for the I.F. is introduced. The number of local selective circuits is thus increased to six, which, naturally, insures a higher selectivity. The drawing in Fig. 4 shows the circuit of the receiver.

CATHODE-RAY TUNING INDICATOR

THE development of superheterodyne receivers to their present high degree of selectivity has necessitated the use of some visual means of tuning to permit a station to be tuned-in "on the nose."

An English answer to this problem is the cathode-ray tuning tube, called the "tunograph" which was featured in a recent issue of WIRELESS WORLD.

An idea of the operation can be gained from the photo, Fig. A, and circuits shown, Fig. 5. It is a miniature cathode-ray oscillograph tube which is connected in the plate circuit of the last I.F. amplifier in the set. Two methods of connecting the tube are shown. The first, Fig. 5A, requires a resistor, R, of 10,000 to 20,000 ohms in series with the last I.F. tube. In this case, a spot of green light appears at the extreme left side of the fluorescent screen, mounted in the upper part of the evacuated glass bulb. Upon tuning in a signal, this spot of light moves to the right.

In the other method of connection, shown in Fig. 5, the tube is connected across the last tuned circuit of the receiver and a dash of light indicates the

(*Continued on page* 554)

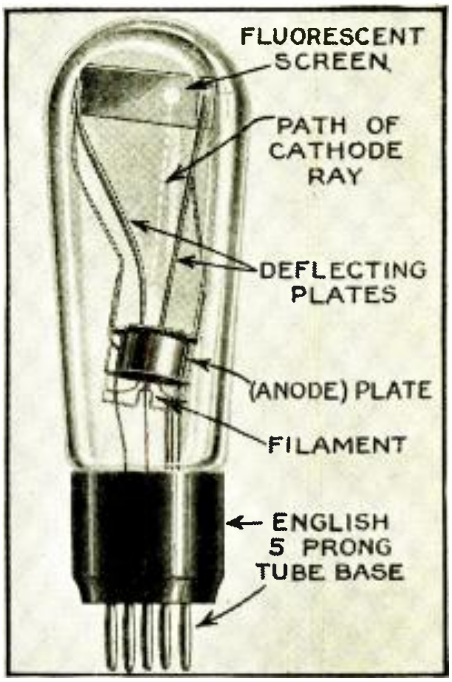


Fig. A
The appearance of the cathode-ray tuning tube showing the deflecting plates and the fluorescent screen on which the beam appears.

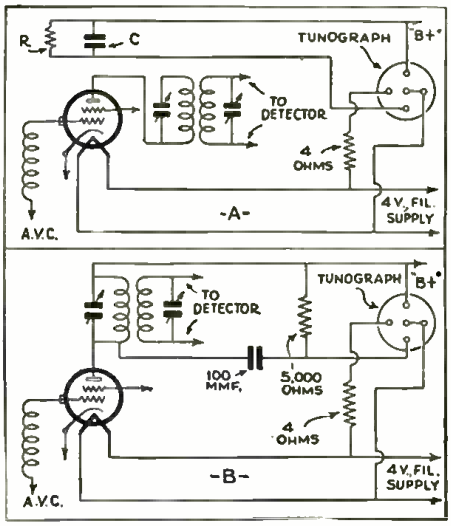


Fig. 5
Two circuits for the cathode-ray tuning tube; that at A, produces a moving spot of light; B, produces a varying band of light.

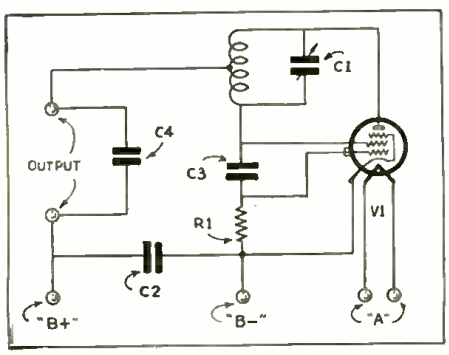


Fig. 3
The circuit of this pentode oscillator supplies almost ideal characteristics; stable frequency and light weight being features.

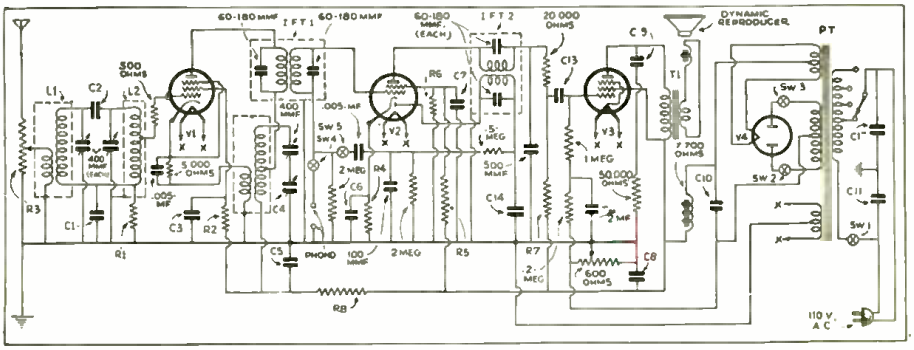


Fig. 4
The reflex action in this set is as follows: the signals after being converted to the intermediate frequency, pass through IFT1, into the screen-grid portion of V2; through IFT2; rectified in diode of V2; amplified at A.F. in screen-grid circuit of V2 and then pass to V3.

HOW TO MAKE THE "PHONOSONE"

Fig. A
"Use your (fore-) head"—for listening!

HUGO GERNSBACK

Through the use of a radio set and a correctly-designed "reproducer," the hard-of-hearing are now enabled to enjoy radio reproduction to the fullest extent. Bone conduction is the "open Sesame"—not sound through the air, but sound through the bone structure of the head. By connecting a phono. pickup or microphone to the radio set, the usefulness of the "Phonosone" is greatly increased; groups may be addressed.

THE hard-of-hearing have good grounds for complaint since the advent of radio, because little is being done to make radio reception available to such individuals.

Of course, when it comes to the *totally* deaf, science cannot do much for them as yet, although the problem does not seem utterly insoluble.

Those, however, who still have their auditory nerves, or vestiges of them, can be made to hear by various artifices. Without wishing to go into the technical, anatomical considerations of the inner ear, let it be understood that *it is not absolutely necessary to make use of the eardrums in hearing!* The vibrations which reach the inner ear do *not* have to go by way of the eardrums.

It was known long ago that the near-deaf could hear through the bones of their head by means of sound conduction. Over a hundred years ago, the deaf composer Beethoven found that, when he held a thin resonant wooden board between his teeth, he could recognize sounds that were conveyed by the vibrations of the wooden board.

This led to the invention of the first *electrical* bone-conduction instrument, developed by myself in the year 1923. It was first described in the November, 1923 issue of SCIENCE AND INVENTION magazine, the name of the instrument being the *Osophone* (Latin, *os*—bone; Greek, *phono*—voice). The invention was patented under date of Dec. 30, 1924 (U. S. Patent No. 1,521,287). The Osophone was nothing but a vibrating electromagnet which carried two hard rubber bit-pieces which were placed between the teeth of the user. The instrument was plugged into the radio set, or used in conjunction with a microphone and an A.F. amplifier; sounds were thus conveyed to the near-deaf. This was a forerunner of a number of bone-conduction instruments, many of which are in use to-day.

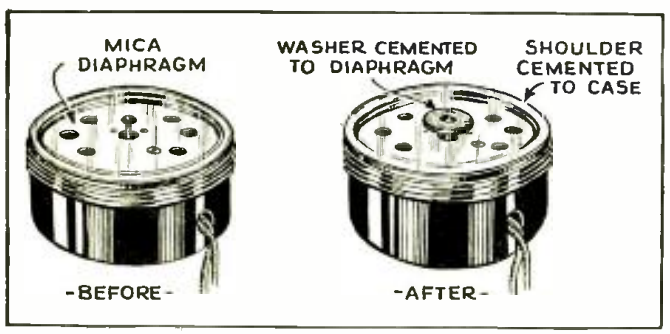


Fig. 1
Details of the "deaf aid" mechanism.

The trouble with most appliances for the deaf to-day is that they are rather expensive, and very often are out of reach of those who cannot afford their high prices. Nor is it always possible, with some of the instruments that are on the market to-day, to get full satisfaction, due to the fact that it is difficult to obtain a sufficient amount of power. Most of the hearing devices on the market now are equipped with a pocket battery, and therefore supply their own current. They are, as a rule, not made to be connected with the radio receiver except indirectly; that is, you must hold the microphone in front of the radio set; then the sounds impinging on the microphone are stepped up and delivered to the receiver (headphone) of the deaf-set, and in this way the near-deaf person hears the radio sounds. This is a roundabout way, of course, and a good deal of energy is lost.

In my experiments with a number of near-deaf people, it was found that in order to really enjoy music, the instrument *must have a considerable amount of power*, in order to transmit sounds satisfactorily, so that the subject can enjoy it.

In designing the present instrument I was mindful of the experimenter and those who are mechanically inclined, so that they can build such an instrument for themselves at low cost.

The Phonosone (*phono*-voice; *os*—bone) is the result of some experiments conducted by myself, and I am certain that the instrument will prove of interest to those of my readers who are mechanically inclined, and who wish to do some of their more unfortunate fellow-men a real service in bringing radio entertainment to them.

The instrument of which I spoke before, i. e., the Osophone, was not practical, for the reason that holding the bit-pieces between the teeth was uncomfortable, and could not be done comfortably for more than ten minutes at one time. The Phonosone, to the contrary, is easy to wear, and does not tire one, even if worn for hours.

FOR THE NEAR DEAF

THE LATEST DEVELOPMENT

Since 1923, when Hugo Gernsback first showed the latent possibilities in the "bone conduction" of sound, as exhibited in connection with his "Osophone," he has carried on experiments and developed instruments for breaking down the wall of silence that — all too often unnecessarily—the years have built around those who are afflicted with various degrees of deafness. The new "Phonosone" described by the author is capable of many practical modifications and applications. This design opens up a lucrative field for those with sufficient initiative to grasp the opportunity which this design presents to radio men.

Fig. B
The "works" of the phonosone.

In order to build the instrument, proceed as follows: select a Baldwin headphone unit, with a *mica* diaphragm, because this is perhaps the easiest type to use. (There are, however, other Baldwin units which have *aluminum* diaphragms; these can be used in the same way, with but little change from the plan given herewith.) It has been found that the Baldwin unit, due to the special anchorage of the armature and diaphragm, gives a greater degree of movement to the diaphragm than other phone units, and that is the reason why I recommend this particular product, which, to my knowledge, is the only one of this type made. The unit can be taken from a pair of headphones, or bought singly. It will be found in most of the catalogs of radio mail-order houses, and many dealers also carry the phones or units in stock. If you use the unit as shown in the illustration—Fig. B, which has a bakelite or hard-rubber case—the first thing to do is to cement the metal unit, which has a shoulder, to the case. For cementing I used Duco cement, which comes in a tube and only costs a few cents. Use a good deal of cement, and, after it has been spread on the rim, press the two parts firmly together. Then weight with books or other heavy weights, and allow it to stand for at least twenty-four hours. After this, the metal unit and the case should be firmly cemented.

If we were to use the unit in this manner, it would be found that the small pin, which projects from the diaphragm, would dig into the skin of the forehead; and, besides, it would kill most of the vibrations, because practically all of the diaphragm would make contact with the forehead. *This is exactly what must be avoided.*

Experiments proved that you need a small support in the center, to keep the rest of the diaphragm clear from the skin, so that only the center, and the rim of the diaphragm, come in contact with the forehead. For that reason, an iron or brass washer, ½-in. in diameter and not more than 1/16-in. thick is cemented, also with Duco cement, to the center on the diaphragm. Do not use wood or fiber. Metal, or if this is not available, hard rubber or bakelite, can be used. Weight the washer with heavy objects and leave it standing for twenty-four hours. The washer is now cemented firmly to the diaphragm. You will note that this assembly extends but little above the outer rim, which is what is wanted. Now a headband is put on, and the instrument is worn as in the photograph, Fig. A, and the cover painting; it will be found that only the center washer and the rim of the unit contact with the forehead. This assures full vibration, without damping the free, normal swing of the diaphragm itself.

The unit is now ready for use. It is comfortable to wear, and can be worn for hours without tiring.

The particular unit described is valuable, because it can take the output of a six- to ten-tube radio set satisfactorily and, though with the large number of tubes there may be some distortion, I, for one, do not think that the individual who is hard of hearing or near-deaf will object to this. He wishes to hear music and sounds, and he will not be overcritical. He also will understand that a unit of this kind, if prepared according to my instructions, will cost very little, and while the quality may not be 100% (as it is from a high-priced, factory-constructed article) I believe that, all in all, he will now enjoy, for the first time, real music.

For those who have their full hearing, and who wish to test the instrument, it is necessary to stop up their ears with both hands, in order to enjoy the music. Those hard-of-hearing, of course, need not do so, as not much outside sound reaches them, anyway.

The unit should *not* be connected to the radio, with the full power turned on, when it is not resting against the forehead. If this precaution is not taken, it will be found that the diaphragm rattles wildly, simply because no work is performed. This rattling ceases immediately when the instrument is applied to the forehead.

A word as to pressure: if too much pressure is developed, by the headband's pressing the unit too tightly against the forehead, the volume is cut down. A little experimentation will be necessary to find the best pressure, which is determined by sliding the unit in its holder back and forward. In a few minutes, the user will easily find the best position.

You may wonder why I picture the instrument as being used on the forehead. To my mind it makes little difference whether you use it on the forehead or you place it above the *mastoid* bone, behind the ear. Different individuals will wish to try different methods, and while, if the instrument is

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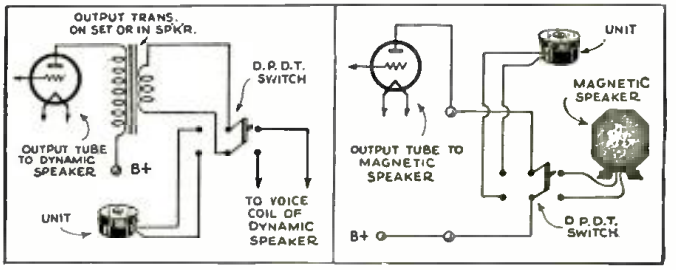

Fig. 2
How to connect the Phonosone to your radio set.

SHORT-CUTS IN RADIO

Hints, "kinks," ideas and suggestions that enable the amateur and professional to save time and money.

FILTER CHOKE SUBSTITUTION

Byron C. Paul

I HAD a model 20 Philco in my shop to be repaired, which would not make a sound. I plugged the adapter of my analyzer in the detector socket and could not get any plate, cathode, or grid readings whatsoever. As I traced the continuity up to the speaker I found the field coil open circuited and the output transformer shot. To determine if that was the only reason why the detector tube showed no voltage, I connected a filter choke to the field-coil terminals (Fig. 1) and found that plate voltage then reached the detector socket. I put a new coupling transformer and field coil in the dynamic speaker and the set worked O.K.

A HOME-MADE TRANSFORMER FLASHER

Ellis H. Disney

THOUSANDS of Balkite model "N" trickle chargers were in use a few years back. Nearly every Service Man has one or more of them in his junk box. One of these, in conjunction with a model T Ford spark-coil, can be made into a flasher capable of repairing burned-out A.F. transformers, reproducers, headphones, etc., as described in the article, "How a Service Man Does It" (RADIO-CRAFT, October 1929).

The rebuilding procedure is as follows: Remove the electrolyte jar from the charger and discard it; clean the rest of the charger thoroughly. Turn the transformer around on the base by prying up the lugs extending down from the bottom of the transformer case through the base; turn the case half way around so that the terminals marked "A," "B" are on the end, as indicated in Fig. 2A, and then push the lugs back into the slots and clinch as before.

By soldering a binding post to each of the contact buttons of the spark coil an easy connection is made.

Drill a hole in the charger base, in the center of the space occupied by the rectifier jar, large enough to hold an extruded fiber washer. Mount the spark-coil on quarter-inch thick spacers and fasten to the base by passing the binding post that is soldered to the bottom contact of the coil through the fiber washer and tighten the nut from the bottom side. Drill a hole in the base, at any convenient place, large enough to pass a wire through to the bottom binding post on the coil, F, in Fig. 2B.

The two leads from the secondary of the spark-coil should be well insulated and provided with small clips with which to grip the A.F. transformer connections, as shown in Fig. 3.

Mount a small knife switch on the transformer case and connect it across transformer posts "A," "B," or the blade and clip may be mounted directly on the posts as illustrated in Fig. 2A.

Audio-frequency transformers may be repaired without removing them from the set by disconnecting the "B" plus lead from the transformer and short-circuiting the secondary winding at the transformer terminals, as shown in the diagram of the completed connections, Fig. 3.

Clip the high-tension leads to the primary of the A.F. transformer and close the switch across "A," "B" for several seconds at a time, with short intervals to keep the coil points from overheating.

I have successfully repaired A.F. transformers, both primary and secondary sides; headphones; and magnetic reproducers by this method of "burning through" the open winding. Another Service Man, to whom I gave this information, reported twenty successful repairs out of twenty-three trials. An average of over eighty per cent.

Of course, when a set is good enough to justify the cost of new transformers that is always the best way to repair it, but many an old battery set that the owner cannot afford to have repaired otherwise can be given a new lease on life with very little expense. *I always explain the process to the customer and let him make the decision* as to whether or not to use this method.

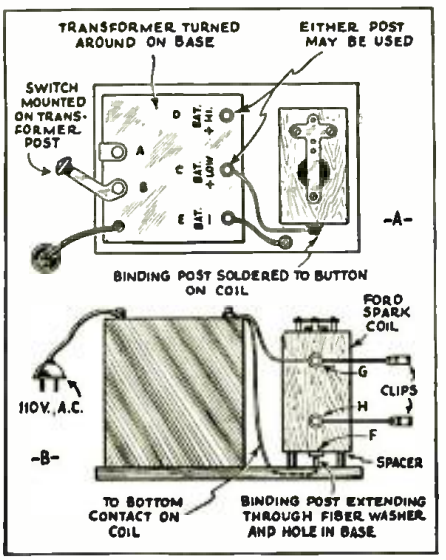

Fig. 2
The apparatus for repairing transformers.

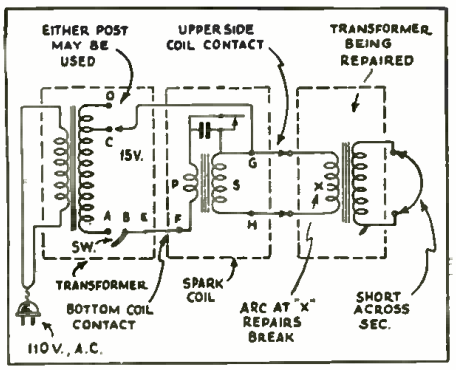

Fig. 1, left
The method of connecting a separate choke.

Fig. 3, above
The wiring of the transformer repair unit.

A LOW-COST CALL SYSTEM

Robert C. Potter

THERE have been many call systems described in past issues of RADIO-CRAFT, but for cheapness and performance the one I built recently, will, I think, "take the cake" since no expensive microphones are required and all

(*Continued on page* 567)

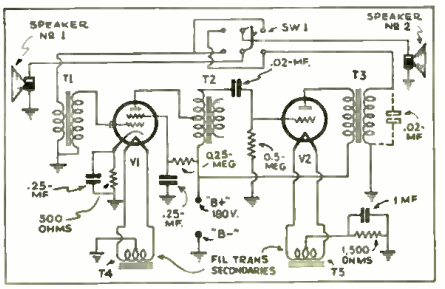

Fig. 4
This two way P.A. system made from junk—box parts has numerous uses in the shop.

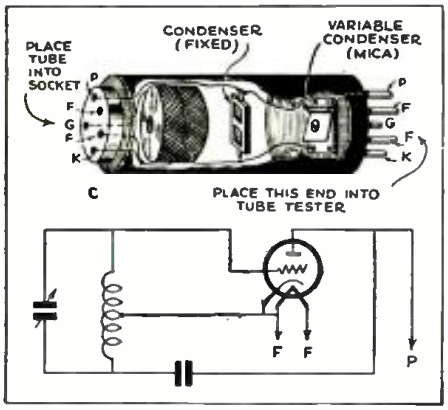

Fig. 5
A simple plug-in oscillator adapter.

A SERVICE OSCILLATOR-TUBE TESTER

C. F. McCann, Jr.

I HAVE noticed in back issues of RADIO-CRAFT that most Service Men have a constant need and use of a simple, inexpensive oscillator that is self-contained; perhaps the description of this little job, that I am using will help some of the fellows.

As it is necessary to always have a tube tester on the job, I constructed this oscillator with the idea of using power from the tester, and it has proven satisfactory for all practical work. In some cases I have simply replaced the oscillator tube of the superheterodyne set with this instrument and find the results have always proven good.

For adjusting superhets., several of these units pre-tuned to different frequencies, for the commonly used intermediate frequencies, will be needed. They are easy to construct, though, and do not take up much space. See Fig. 5 for constructional details.

MULTI-LAYER COIL WINDING

H. G. Holm

HERE is an idea which I have worked out very successfully in my own workshop for winding A.C. power and A.F. transformers; the device illustrated counts the turns and puts them on quickly.

This hookup was first used with an old 12 V. D.C. automobile horn motor and a toy transformer of fairly good amperage (later I changed to 110 V. A.C. by obtaining an old phonograph motor and removing the governor).

As you see from Fig. 7 I use a strip from an old inner tube for a belt to give the correct tension for all windings and an old Stewart speedometer for a turn counter which gives a secondary to a split volt.

I resurrected an old drum dial support for keeping the shaft rigid and an old dial collar, plus a piece of tin and a suitable handle, for turning heavy filament windings.

MEASURING WIRE GAUGE WITH A METER AND BATTERY

Louis B. Sklar

THERE are two instruments on the market manufactured for the purpose of measuring the gauges of wires. One is the *circular disk* type, which is used for quick determination of the wire size. The rim of this instrument has a number of slots of various widths, each one corresponding to the diameter of one of the wire sizes. The slots are marked with the corresponding gauge size.

The other type is the *micrometer caliper* which measures the diameter of wire in mils, and this figure is compared to a table of wire sizes.

TABLE I

Size B. & S.	Ohms per ft.	Size B. & S.	Ohms per ft.	Size B. & S.	Ohms per ft.
1	.000124	16	.00402	31	.130
2	.000156	17	.00506	32	.164
3	.000197	18	.00639	33	.207
4	.000249	19	.00805	34	.261
5.	.000313	20	.0102	35	.329
6	.000395	21	.0128	36	.415
7	.000498	22	.0161	37	.523
8	.000628	23	.0204	38	.660
9	.000792	24	.0257	39	.832
10	.000999	25	.0324	40	1.050
11	.00126	26	.0408	41	1.330
12	.00159	27	.0515	42	1.680
13	.00200	28	.0649	43	2.120
14	.00253	29	.0818	44	2.670
15	.00318	30	.103	45	3.300

Quite often the radio experimenter is confronted with the problem of finding the gauge of a certain size wire. Very few men engaged in radio research or experimenting have such instruments in their tool box, because of their high cost and limited use.

Not long ago the writer had occasion to use one of these two instruments, but not having one in his possession, the idea of using a meter, battery and wire table was conceived. The hook-up is as shown in Fig. 6. The rheostat was adjusted so that the meter gave a full deflection of 1 ma. The next step was to shunt the meter with 30 ft. of the wire of unknown gauge. The new reading on the meter was approximately .1-ma.

This indicated that the current through the shunt was .9-ma. or nine times the current in the meter; thus, the resistance of the shunt was 1/9 of the resistance of the meter, or 3 ohms.

Since thirty feet of wire equals 3 ohms, the resistance of one foot is .1-ohm. A glance at Table I shows immediately that the wire size is No. 30 B.&S. gauge.

A wire table similar to Table I can be found in any electrical handbook, giving the resistance of all wires "per 1,000 ft." The writer has reproduced it, giving the resistance "per foot," for convenience.

Incidentally, the same scheme can be used for other purposes; for instance, to find the internal resistance of any meter, especially meters of very low internal resistance. All you have to do is shunt the meter with a few feet of wire whose resistance is known from the "table." By using the calculations shown above a very accurate indication of the meter's internal resistance will be obtained.

Knowing the resistance of wires, accurate shunt multipliers of 100 or even more can be made. As an illustration, the writer is using as a shunt on a Weston 0-1 ma. milliammeter, No. 40 wire about 3½ ins. long in order to increase the range of the meter to 100 ma.

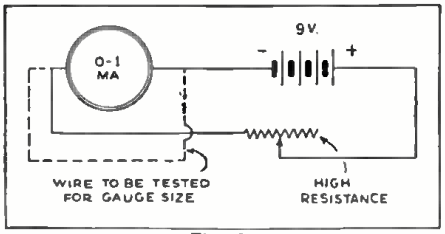

Fig. 6
Measuring wire gauge by resistance method.

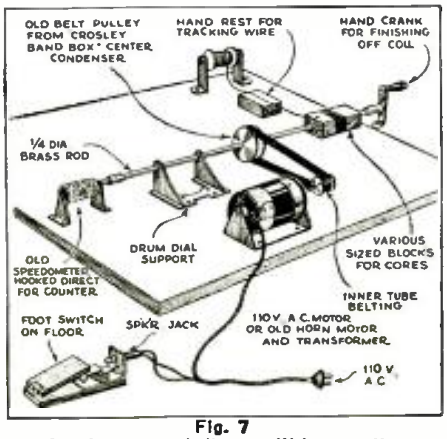

Fig. 7
A set-up for winding multi-layer coils.

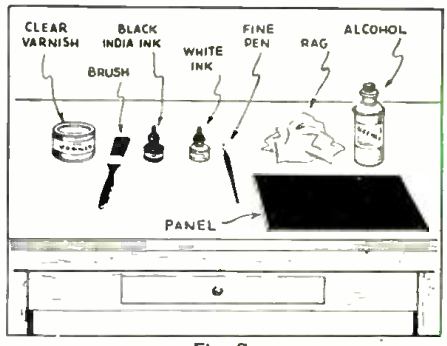

Fig. 8
Materials for engraving your own panels.

MARKING PANELS

F. R. Harris

NO SINGLE factor lends more to the distinguished appearance (and in most cases the usefulness also) of a piece of laboratory apparatus than a nicely engraved panel; and no single factor is to be found less often around the average service and "ham" shop. The reason, of course, is not far to seek. Engraving is a highly skilled art and an accomplishment which is possessed by very few technical men and is hence most gosh-awful expensive, and after one has completed paying for the absolutely necessary "innards," the apparatus is sometimes darn lucky to have a panel!

(*Continued on page* 571)

WIRING "BATTERY SET" FILAMENTS

FOR "AIRCELL" OPERATION

E. E. HORINE*

Whether you are interested in battery sets from the standpoint of constructing or experimenting with them, or if you actually intend to make a profit by their use, you cannot afford to miss reading this article. It covers in a complete manner the use of the aircell, first described in the April, 1931 issue of RADIO-CRAFT, page 594, showing different receiver filament circuits for best results.

A NEW and improved kind of battery operated set, differing in several important respects from the battery receiver as it was known before the "A.C. days," may now be built for amateur or commercial purposes.

The principle difference between this new, or "aircell" receiver and a conventional battery set is in the filament circuit. This difference overcomes the shortcomings and the hazards inherent in old battery receivers and makes the aircell receiver truly practical for use, in unwired homes, by non-technical people. Overcoming the impractical nature of the battery set has been made possible by the development of the new aircell "A" battery, which, unlike all other practical forms of primary batteries, delivers its output at approximately constant voltage.

Figure 1, plotted to scale, shows the essential difference between the aircell "A" Battery and an "A" battery made up of a bank of dry cells. To obtain these curves, a large dry "A" pack, consisting of 16, "6 in." dry cells, and an aircell battery were discharged at a drain of 600 ma. (0.6-A.) four hours per day, until the battery voltage fell to 1.8 V.

The dry battery started off at an initial voltage of 3.12 V. and thereafter exhibited the characteristic voltage decline until, at 367 hours, the voltage was down to 1.8 V. 367 hours at 0.6-A. is an output of 220 ampere-hours, and since the battery consisted of 8 sets of cells connected in parallel, this is equivalent to 27½ ampere-hours per cell, a fairly good output for a 6 in. cell discharged in this manner.

The aircell battery started off at an initial voltage of 2.53 V. and when it had delivered its rated output of 600 ampere-hours (1000 hours at 0.6-A.) the voltage had fallen only to 2.22, a drop of only 0.31-V. in 1000 hours of use as compared to a drop of 1.41 V. in 367 hours for the dry "A" pack.

Inasmuch as tube filaments must be operated at practically constant voltage, some form of voltage regulator is essential when a dry cell "A" battery is employed. In the old days, before the constant-voltage aircell battery was developed, the universal practice was to equip battery sets with a filament rheostat to function as the voltage regulator.

A "Dry Cell" Circuit

Figure 2 shows the essentials of the filament circuit of a conventional set built around dry cell tubes (type 99). The tubes had to be operated at, or very close to, 3.0 V., which called for an "A" battery of an appropriate number of cells connected 3 in series, so they could be worked down to at least as low as 1.0 V. per cell. The initial voltage of such a battery nominally is 4.5 V., so that, in the beginning, the user had 50% more voltage at his disposal than the tubes could stand. His task was to manipulate his rheostat so that no more than 3 V. could get through to the tubes, no matter what his battery voltage might be. This was asking too much of the non-technical user. He just couldn't do it. The natural tendency was to over-voltage the tubes, since turning on more power made the set "play" louder, but this tendency naturally ruined the tubes. The result of trying to sell and service dry battery sets was that the dry cell tube got the reputation of being delicate, fragile, short-lived and generally unsuited for practical use, and because of this, the dry battery set had to be abandoned by the Industry. It was a complete commercial failure.

The truth of the matter was that *the dry cell tube was all right!* It would last as long, and perform as well as the

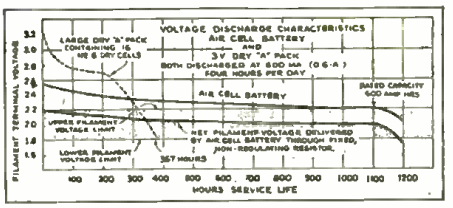

Fig. 1
A comparison of dry cells and aircells.

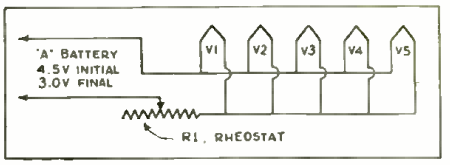

Fig. 2
The conventional battery filament wiring.

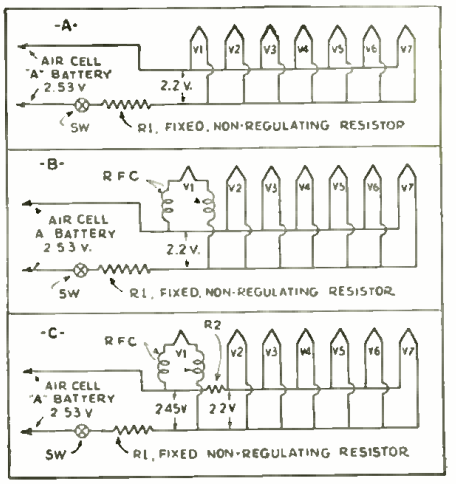

Fig. 3
Filament connections for aircell use.

huskier storage battery tubes *when burned at constant voltage*, but this *essential* of constant filament voltage could not be realized with a variable voltage battery working through a rheostat. The *rheostat* made rural radio impractical, not the tubes.

The aircell battery overcomes this one barrier to practical rural radio by making the rheostat unnecessary. As shown in Fig. 1, a fixed, non-regulating resistor is all that is needed to insure correct filament voltage at all times, never too high to cause the damage, never too low to cause weak reception.

The outstanding feature which characterizes the aircell receiver and which keeps it from being "just another battery set," is that it has no rheostat or voltage regulator of any kind. Instead, a small, fixed resistor of correct value, incapable of adjustment and usually located where it can't easily be tampered with, takes care of what used to be the most difficult phase of battery receiver design, the problem of how to reconcile the variable voltage output of the "A" battery and the constant voltage input of the tubes.

The initial working voltage of the aircell battery is 2.53 V. This is higher than the voltage of a single storage cell, and lower than that of two dry cells connected in series. Because of this, there were no tubes available with which the battery could work, and it

(*Continued on page* 551)

* Sales Engineer, National Carbon Co., Inc.

HOW TO MAKE A SELECTOR UNIT

FOR VOLTAGE OR RESISTANCE ANALYZING

The sad experience of many Service Men who purchased servicing instruments, only to discover that they had become obsolete with the last influx of new tubes, can be alleviated by this Selector which makes them useful for even the latest types of receivers.

C. W. PALMER

THERE are many thousands of Service Men who are trying to struggle along with set analyzers having test plugs with only 4 or 5 prongs, or with simply an ohmmeter. These Service Men are hopelessly involved when trying to check the circuits of a modern radio receiver having 6 or 7 prong sockets.

In fact, there are about forty different tube base wiring arrangements for tubes having from 4 to 7 prongs. In other words, there is absolutely no uniformity as to the location of various tube elements on the base. Thus, a Service Man without one of the latest set testers must refer to a tube base diagram to determine the location of each tube element at a socket; a process that consumes much valuable time.

The Test Position Chart

To overcome this difficulty, the test unit adapter and special tabulation described here, have been originated. The nucleus of the instrument is the test position chart which has been tabulated after considerable correspondence with the various tube manufacturers. It contains the test positions for over 105 tubes, going back to the earliest and including the very latest types of tubes.

The adapter itself consists of a multi-pole switch, a cable, an analyzer plug with various adapters permitting it to be plugged into any tube socket, as well as clips and a test prod. All these parts are housed in a small metal box, as shown in Figs. A and B; on the front of the instrument is the special chart. The result is that an analyzing instrument is produced in combination with either an old type set analyzer or an ohmmeter, which will test receivers using the latest types of tubes, without the necessity of referring to complicated and insufficient tube base diagrams and similar data.

In the instrument as shown, the box is sufficiently large so that the analyzer plug, the cable and the 4-, 5- and 6-prong adapters fit inside (the bottom of the box being removable).

The Operation of the Unit

For resistance analysis of receiver defects, the Selector Unit is adapted for use with any ohmmeter. The test prods of the ohmmeter are simply inserted in the two pin jacks on the side of the unit.

Most ohmmeters require that the battery voltage be adjusted from time to time, so that the indicator on the instrument will deflect full scale. The usual procedure is to short the ohmmeter leads together when this adjustment is needed. To make removal of the ohmmeter connections unnecessary, the No. 12 position on the switch directly shorts the ohm-

(*Continued on page* 570)

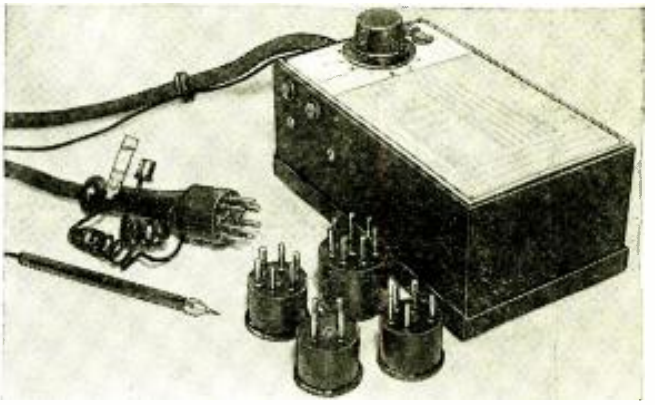

Fig. A

The appearance of the selector and adapters.

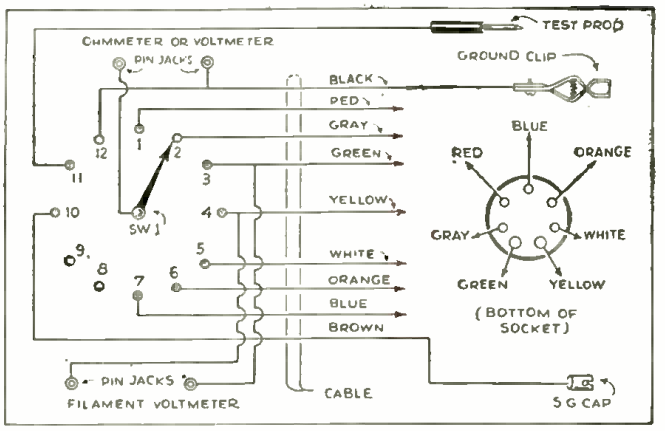

Fig. 1

The circuit diagram of the complete selector.

TABLE I

Base	Type Tube	1	2	3	4	5	6	7	8	9	10
4	100A, 01A, 10, 12A, WX12, 20, 26, 30, 31, 40, 45, 50, 71A, X33, 183, 483, 864, 2A3	CG	P	F	F						
	5Z3, 80, 82, 83, AF, AG	P1	P2	F	F						
4	81	o	P	F	F						
4	BA, BH	o	K	P	P						
4	BR	o	o	K	P						
4	1V, 12Z3, KR1	K	P	H	H						
4	22, 32, 34	SG	P	F	F						CG
5	33, 47, LA, PZ, GA, 6A4	CG	P	F	F	SG					
5	46, 49, 52	CG	P	F	F	G2					
5	27, 37, 56, 76, 485	CG	P	H	H	K					
5	15, 24A, 35, 36, 38, 39, 44, 51,	SG	P	H	H	K					CG
5	84, G2, G2S, G4, G4S, 6Z4	P	P	H	H	K					
5	Wund A	P	CG	H	H	CG					K
5	TT2J5	P1	P2	H	H	K					CG
6	57, 58, 77, 78, 6C6, 6D5	SG	P	H	H	K	SU				CG
6	55, 75, 85, 2A6	DP	P	H	H	K	DP				CG
6	83	G2	P	H	H	K	G3				G1
6	25Z5	K1	P1	H	H	P2	K2				
6	2A5, 18, 41, 42, 43, 48, PA	SG	P	H	H	K	CG				
6	79	CG2	P2	H	H	P1	K				CG1
6	6Z5	P1	H	H	H	P2	K				
6	Wund A Auto, 90, 92	CG	P	H	H	K	CG				
6	TT2J1	CG1	P2	−H	+H	K	P1				
6	1A6	G2	P	F	F	G3-5	G1				G4
6	19	CG1	P1	F	F	P2	CG2				
7	59, PZH	G2	P	H	H	K	G3	G1			
7	2A7, 6A7	G3-5	P	H	H	K	G1	G2			G4
7	2B7, 6B7	SG	P	H	H	K	DP	DP			CG
7	53	CG1	P1	H	H	P2	CG2	K			
7	G59b	G2	P	H	H	o	G3	G1			
7	G6C7	SS	P	H	H	K	DP	DP			CG
7	G6E7, G6D7	SG	P	H	H	K	SS	SU			CG
7	12Z5	K1	P1	H	H	P2	K2	H			
7	12A5	G2	P	H	H	He	K-G3	G1			

STATICHECKER TUBE BASE CHART

HOW TO MAKE AN A. C.—D. C.

"6F7" SERVICE OSCILLATOR

The advantages of this service oscillator over previous units are as follows: it is compact and can be included in the service kit; it is universally operated from A.C. or D.C. lines; it is light in weight; it covers all popular I.F., broadcast and many of the short waves; it provides substantially pure A.F. modulation; it provides complete control of both the R.F. and A.F. outputs; and finally the output is arranged to be coupled to any circuit, either grid or plate of a vacuum tube. The author has calibrated the attenuator.

F. R. HARRIS

THE service oscillator has been one of the perennial problems of the radio technician. All types, from the single tube, self-modulated, battery-driven job to the multi-tube, all-electric (fearfully and wonderfully made) contraption, with provision for controlling everything necessary and unnecessary, have been, on occasion, presented. The simple units bad the advantage of extreme portability and low cost, but were strictly limited in their application. The big jobs, on the other hand, would do everything but were complicated and expensive. Of course, they also were portable—with the aid of two men and a horse!

In designing the oscillator presented herewith these extremes were kept in mind and an effort was made to design a piece of apparatus capable of as many as possible of the applications of the elaborate layouts while at the same time preserving the simplicity, low cost and portability of the simpler outfits. After a great deal of experimental work, the author is of the opinion that he has achieved this happy medium in the design presented for your approval.

Design Considerations

The objects to be attained were set forth at the start of the experimental work (covering several months) as follows:

First, it must be compact to be included in the portable service kit.

Second, it must be line-operated to avoid the space and weight requirements of batteries; and it must operate on both A.C. and D.C. lines.

Third, it must cover all the I.F., broadcast and as much as possible of the short-wave spectrum; and must provide all these both modulated and unmodulated.

Fourth, it must provide as nearly as possible pure A.F. for the testing of P.A. and other audio equipment.

Fifth, the output at both R.F. and A.F. must be controllable and capable of calibration.

Sixth, the output must be so arranged as to make impossible a short in the device being tested, whether it be fed into grid, plate or regular input circuits.

That the first of these objects was attained is shown by the fact that the entire oscillator and power supply assembly fits in an aluminum box 4½ x 6¼ x 5½ ins. deep. However, no specific details or drawings are given as to the construction of this case since it is assumed that every person building one will have different space requirements to meet and therefore such details would be of little use to the average builder. The photographs show how the layout was made in this case, a little juggling of parts will enable you to put them into the space you have available. One point in particular works to the end of compactness in this case; unlike a receiver, extreme precautions against feed back need not be observed since it is already an oscillator and a little feedback more or less will make no practical difference.

The second point is gained by the use of the 6 V. type of tubes with the filaments in series and a 25Z5 as a rectifier for A.C. use. While on this point it might be well to forestall questions by clearing up one point. The Wunderlich tube used, requires a filament current of .4-A. while the other two require .3-A. However, if the current is adjusted to .35-A. it will not overload the two tubes and will be very slightly under that required by the Wunderlich. In fact, this will be an advantage as the stability of any oscillator is improved by operating the cathode at as low a temperature as possible and the sensitivity

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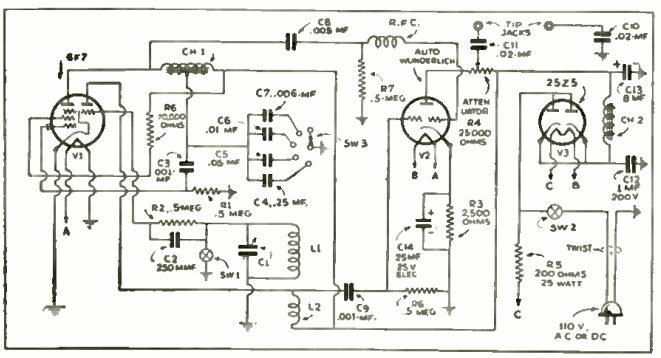

Fig. 1
The circuit of the entire oscillator unit.

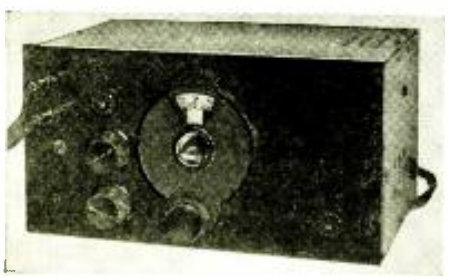

Fig. A, above
The panel with its tuning and output controls.

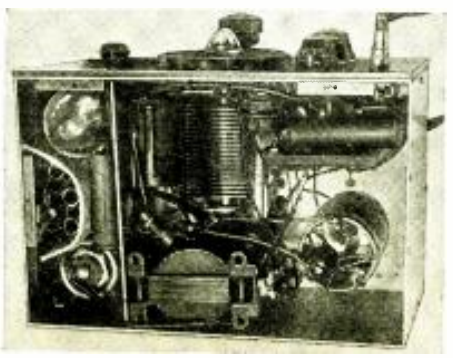

Fig. B, right
The interior, showing the layout of parts. A veritable portable laboratory instrument.

Fig. C
The appearance of the oscillator from the back. Note that two tubes are horizontal.

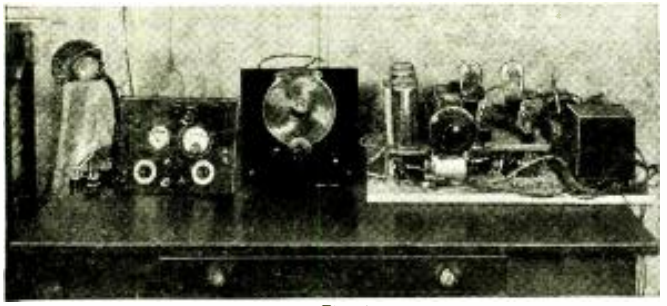

Fig. A
A service application: aligning a T.R.F. chassis.

FACTS ABOUT DYNATRON OPERATION

PART I

C. M. DELANO

The RADIO EXPERIMENTER, that is, the man who is always on the look-out for new things to improve radio reception and allied subjects, will be pleased to learn about the many applications that can be worked out for this new system of operation. Do you know that oscillators, detectors, amplifiers, and test equipment of all sorts may be designed around vacuum tubes of nearly all types employed in a "dynatron" connection—that is, with the grid at a higher voltage than the plate? In the concluding chapter the author furnishes twenty bibliographical references, in connection with the many experiments he describes. Experimenters are requested to report the results they secure.

VACUUM tubes are designed and constructed for many purposes and are made in many types and sizes. In general, a given type of tube serves a single purpose, though it may serve a group of purposes; as is the case with the "general service" tube which may be used as an amplifier, detector, or oscillator by varying the operating conditions imposed upon the circuit of which the tube elements are a part. Usually the operating conditions in the tube circuit are controlled to a greater or less extent by varying the voltages applied to the plate and the control-grid (and also the screen-grid, provided the tube in question has such an element). These controlling factors determine, as a rule, whether the tube is to function as a detector, amplifier or oscillator; and also the extent to which the particular function desired is to be carried.

The "Dynatron" Action

Under certain governing conditions, a given tube may be expected to do certain things in a fairly orthodox manner, as determined through the medium of investigations carried on for many years. It has been found that certain vacuum tubes, when caused to function with unusual biasing potentials, will operate under conditions that give results decidedly different from the ordinary run of vacuum tube characteristics.

Among this number of rather unusual indications is an interesting one known as "dynatron operation." In addition to being interesting, *this peculiar mode of operation has practical value* and may be put to good use by the experimenter and Service Man.

It is the purpose of this article to explain some of the properties and principles of dynatron tube operation and to indicate some of the practical uses to which it may be put; keeping in mind the fact that there are certain limitations to the practical application of the principle.

The Theory of Operation

To effect a reasonably clear understanding of the subject, consider for the time being the ordinary general-purpose type of radio receiving tube having three elements used in a single tube circuit, as, for instance in the common, one-tube receiver hook-up; the filament, being heated, liberates electrons which move in the direction of the field set up inside the tube. Surrounding the filament is the grid, which may be in the form of a helix or cylinder of wire gauze. Surrounding the grid, in turn, is the plate, which, commonly, is made of sheet metal; as the electrons fly from the filament they pass through the grid and bombard the plate. This electron stream completes or closes the electrical circuit, thus permitting plate current to pass from plate to filament, as shown in Fig. 1. The grid, being interposed between these two elements, tends to restrict the flow of electrons (due to change in intensity—of the electrostatic field—which the grid is capable of producing) and thus, the amount of current passing in the circuit. This plate current, energizing as it does, the components of the output circuit, controls the volume with which the signal is heard in the receiver. The conditions discussed refer to Fig. 1.

With the foregoing action (commonly referred to as the "valve" action) of the radio tube in mind, let us rewire our circuit somewhat and employ our apparatus for the purpose of conducting an experiment. Assume that we have a tube, say of the 01A type, with the filament heated by a battery and that we have 90 V. of "B" battery available. Instead of connecting our 90 V. of potential supply to the plate, connect the plate to the 22½ V. tap and connect the 90

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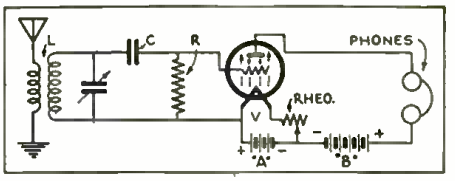

Fig. 1
A one tube circuit showing electron flow.

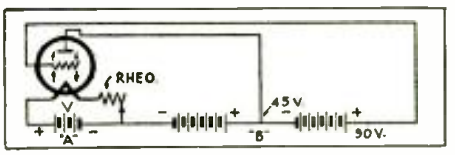

Fig. 2
Compare the electron flow with that of Fig. 1.

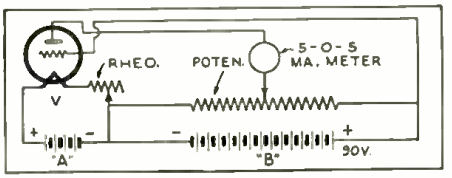

Fig. 3
An experiment to show the dynatron action.

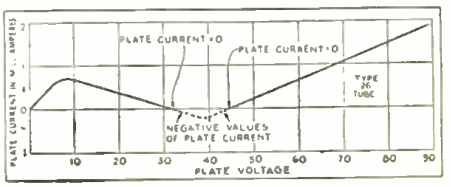

Fig. 4
Plate current changes in dynatron operation.

HOW TO SELECT P. A. EQUIPMENT

Do you know how to select the correct power amplifiers and reproducers for any type of sound installation? The important fundamentals are discussed, in simple language, by the author. P.A. workers will find this comprehensive article a useful reference.

CLIFFORD E. DENTON*

THERE are three common sources from which sound in the form of varying electrical impulses can be obtained. First, the output of a radio set; second, the microphone; and last, from phonograph recordings.

Therefore, one of the first things that a purchaser of sound equipment must know is which one of the above stated sources or combinations is to be used in conjunction with the amplifying equipment. Having decided upon the method of sound production to be used, then one is in a position to select the necessary associated equipment so that the correct results can be obtained.

Choice of Mixing System

In general, a mixing system consists of a series of volume controls so arranged that the incoming electrical impulse, whether it be from a radio set, a microphone or a phonograph record, can be correctly fed into the main amplifying system with a minimum loss in energy, and a minimum degree of frequency discrimination.

In poorly-designed mixing systems the loss in signal strength may be so great as to necessitate additional amplification to bring the signal back to a level where it would be usable. In general, poor mixing systems have the very disagreeable feature of frequency discrimination. By this is meant, that the volume control governing the particular circuit in operation may cause a loss in the high-frequency response at the low-volume level setting. Then again, there may be a loss in the low-frequency response at the high-volume level setting. The ideal mixing system would use volume controls of such electrical characteristics that there would be no discrimination in the range of sound frequencies being transmitted from the minimum to the maximum setting of the control.

In the view above is illustrated a practical application of the principles discussed by Mr. Denton. This sound system, an installation on the boardwalk, Long Beach, New York, is designed to "address" a promenading public totalling 725,000 each week!

A mixing system should be so designed and operated that it will supply to the input system of the power amplifier, a level of sound which is constant in value whether it be from a radio set, microphone or phonograph record. This is an important consideration, as the modern radio set is capable of far greater output than that which can be obtained from the best phonograph recording and all those who have had experience with microphones know that it is impossible to build microphones that have the same signal output as that which can be obtained from the modern electrical recording.

Care should be taken in the selection of a mixing system because it is the bottle neck through which the source of sound is transmitted to the amplifier. If the mixing system is poor, it is impossible to obtain satisfactory results from the amplifiers or speakers, regardless of excellence or cost.

Amplifiers

It is not the purpose of this article to express opinion as to the merits of a particular type of amplifier or circuit, but there are a few things that stand out as definite facts which were determined only after many years of constant research and develoment.

First, that push-pull amplification offers the maximum in results and the minimum in frequency discrimination.

Second, that class A operation of modern tubes in the voltage amplifier and power stages results in a high degree of efficiency and a minimum of distortion. The younger but bigger brother to class A tube circuits is now known as A Prime, and this rather recent development has brought the operating efficiency of tubes used in the last power stage in the modern amplifier to the point where even the novice can readily detect the superior quality of this new output system.

Sound Distribution System

The word "loudspeaker" is meaningless, and a more accurate term should be employed so that the proper understanding of a sound distribution system may be recognized even by a layman.

We are all familiar with the dynamic, cone-type reproducers which are generally mounted on baffles; or, as is the modern trend, the use of these units in large horns. Both of these methods of reproducer "loading" are quite satisfactory and fill their respective needs very well. When dynamic reproducers of the cone type are used in rather small rooms a baffle made up with acousti-celotex or some similar material is generally very satisfactory. However, in cases

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A COMBINATION P. A. AMPLIFIER AND BROADCAST TUNER

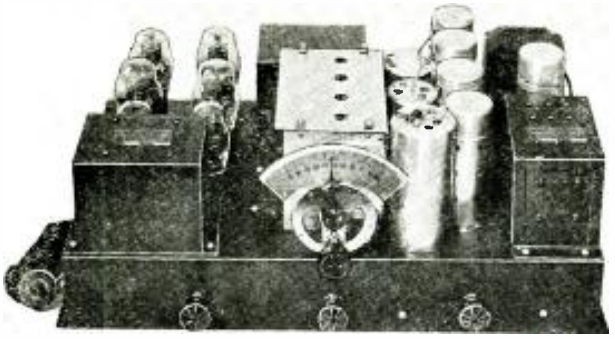


Fig. A
The appearance of the receiver and P.A. unit.

PART I

The A.C.-D.C. radio receiver has made an impression on the radio industry that will not soon be forgotten. And now we have a P.A. system combined with an efficient superhet. that works on the same idea. In Part I, the receiver details are given.

LEON J. LITTMANN*

THE combined radio and P.A. system described here may be operated from any 110 V. D.C. or 110 V. A.C. 25-60 cycle power line, without having to snap any switches, and without circuit changes of any kind. In fact, it may be operated from 220-240 V. lines by simply employing a series resistor of 165 ohms (85 W. rating), which method is not advisable for systems employing power transformers. It can also be operated from a 6 V. battery or a 32 V. D.C. power source with the aid of a vibrator and transformer type power unit, provided the heater circuits of the tubes are wired in parallel or in a corresponding series-parallel arrangement (shown in Fig. 2).

In any one of the above modes of operation, the full undistorted power output of 7½ W. may be obtained, whether it be operated as a receiver or as a P.A. amplifier.

Enough information is given in this article to enable anyone to successfully build and operate this universal system in a totally foolproof and relatively simple manner, without requiring much practical or theoretical knowledge. All R.F., I.F., and A.F. components are fully identified, and separately housed and shielded. This eliminates all stray couplings and resulting undesirable feedback effects.

The complete system is mounted on a chassis measuring 10 x 18 in. and con-

(*Continued on page* 556)

* Chief Engineer, Coast-to-Coast Radio Corporation.

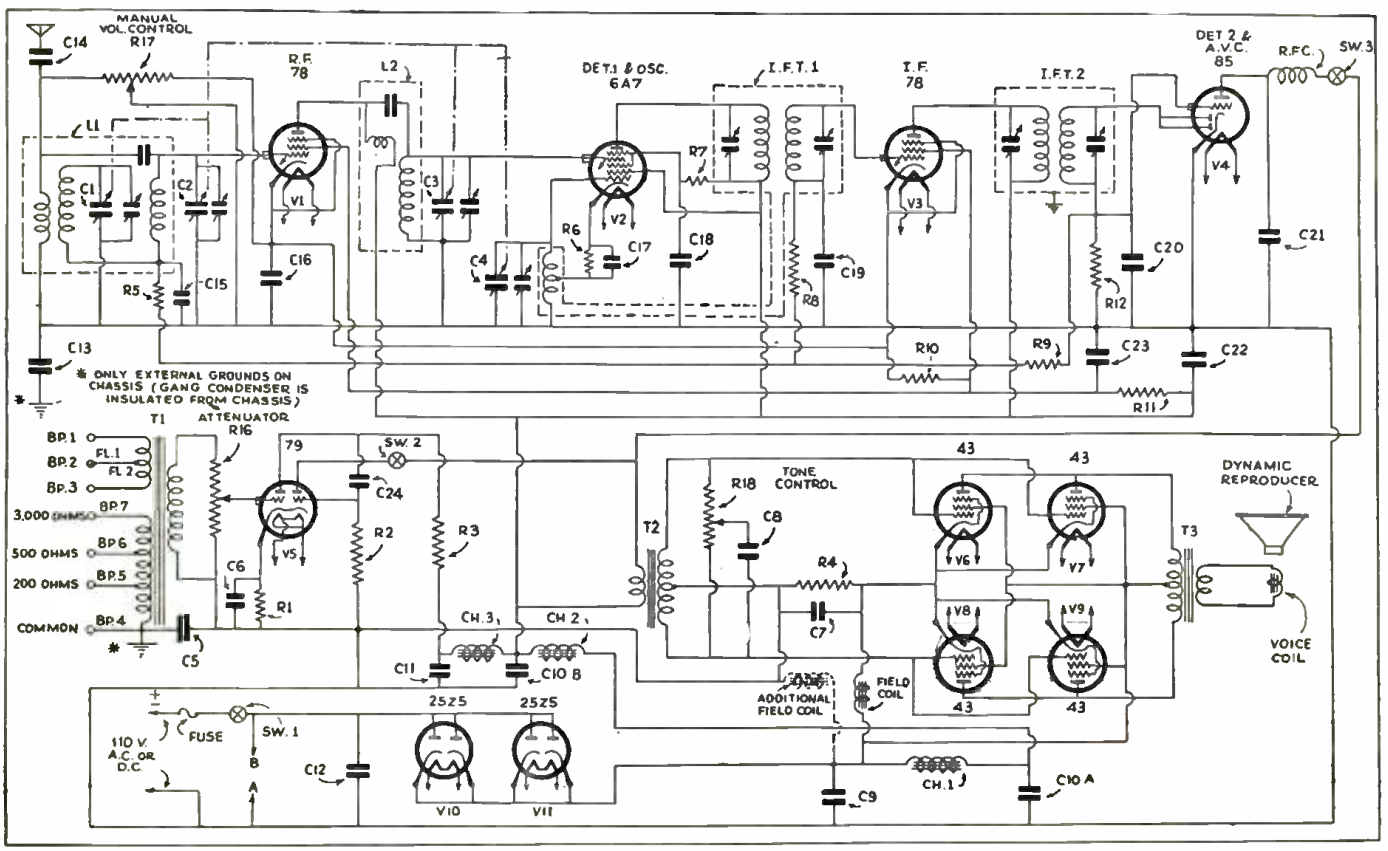


Fig. 1
The wiring of the combined unit. Switches Sw.3 change the circuit from P.A. to radio reception. In the latter, V5 is omitted.

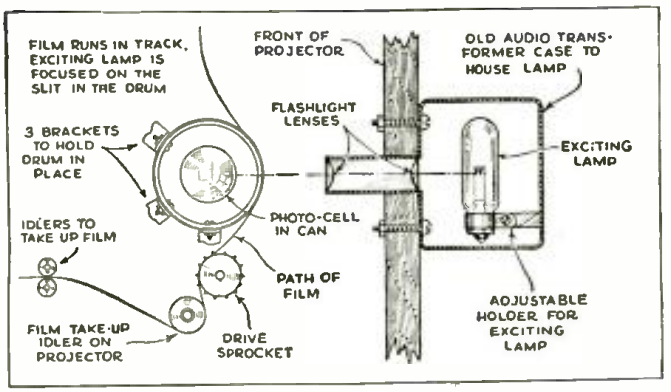


Fig. 3
The operation of the sound head in detail.

HOW TO MAKE AN INEXPENSIVE "TALKIES" SOUND HEAD

LEWIS C. COOK

Fig. A
The appearance of the P.E. cell and exciter lamp.

Fig. B
The two units which make up the P.E. cell assembly.

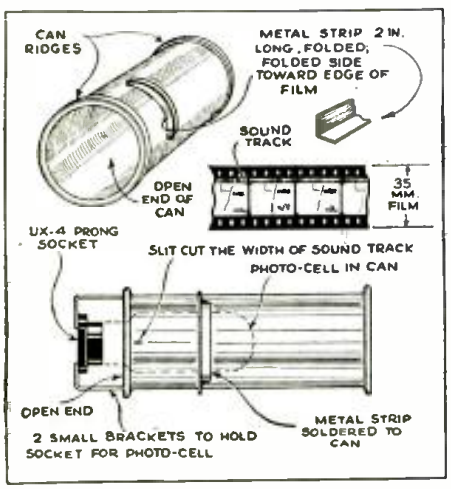


Fig. 2
The P.E. cell unit showing the "light slit."

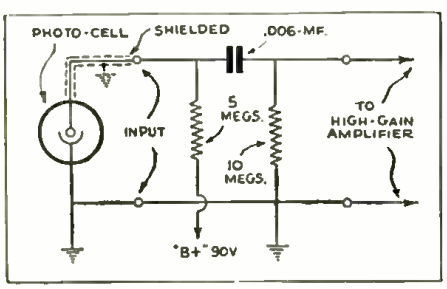


Fig. 4
The hook-up of the P.E. cell to the amplifier.

RADIO engineers and experimenters will find a very profitable field in building a sound head which can be used with standard motion picture projectors. The following sound head was built for a portable projector, converting an old, "silent" 35 millimeter device into a "sound" type for reproducing sound on film.

The sound head shown in Figs. A, B and C, was built for a little over ten dollars! When used with a high-gain amplifier and one speaker, excellent results were obtained. The writer, to date, has built *five* of these sound heads and results are equal to that secured from many high-priced installations.

The sound head described here was designed to operate with any or all standard makes of portable 35 millimeter projectors. The universal motor usually found in projectors is not used as a power source, as it is generally known that this type of motor is not dependable for the uniform drive required in true reproduction of sound without waver or other distortion. By removing this motor and purchasing a synchronous motor from a motion picture supply house for a price of about five dollars, the problem of correct speed (90 feet of film passing through the projector sound head drum per minute) is solved.

Now for the construction of the sound head. The parts necessary are as follows: One motion picture feed sprocket and shaft and a 2 in. pulley. These parts can be obtained from any motion picture supply house or theatre for a few cents: one small tin can 3½ x 2½ ins. in diameter; four small iron angles; two small flashlight lenses with a small metal tube about 3½ ins. long to hold the two lenses; one exciter lamp 8½ V. A.C.; one photoelectric cell; one 4 prong socket; one 5 meg. resistor; one 10 meg. resistor; and a .006-mf. condenser, to couple the photoelectric cell to the input of the amplifier. A transformer was wound to supply the exciter lamp with 8½ V. A.C. at 3 A.

Figure 1 is a schematic plan of the can, which is now called the film drum. Cut a small piece of tin 2 ins. long and ¼-in. wide. Fold it lengthwise to form a right-angle and solder it on the can just the width of the film from the open end of the can, so the film will be guided smoothly through the track. Now, by holding a piece of sound film in place on the track of the film drum at about the middle, mark the width of the track.

(*Continued on page* 568)

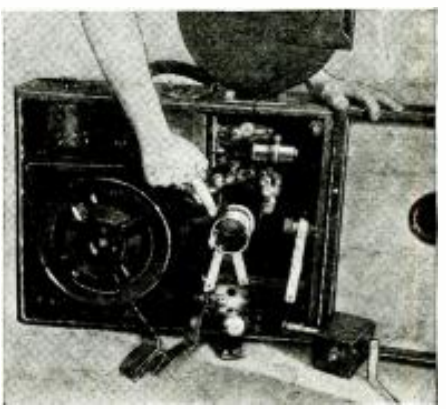


Fig. C
The cell ready to be mounted in its "can." Note its relation to other projector mechanism.

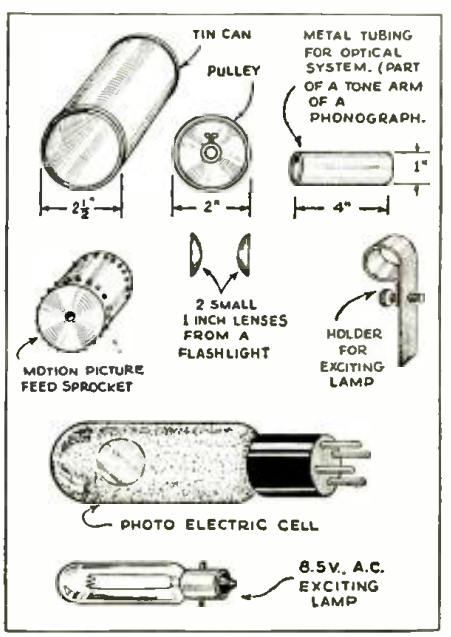


Fig. 1
Details of the assembly of the sound head.

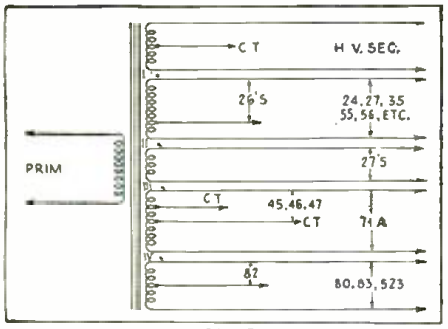


Fig. 1
The windings of the "universal" transformer.

HOW TO INSTALL "REPLACEMENT" TRANSFORMERS

Do you know the factors which govern the replacement of power transformers in sets? Mr. Cole explains them.

G. McL. COLE*

RECENTLY it was shown (RADIO-CRAFT, November 1933, page 266) that a single transformer of correct design could readily handle many different types of sets with just about every combination of tubes now in use (Fig. 1). Four multi-tap transformers of this type replace defective units of these various set types in sizes from 4 to 10 tubes. Notice that each of the transformers supplies correct voltages to 1.5 V. 26's, 2.5 V. 24's, 2.5 V. 45's, 2.5 V. 82's, or 5 V. 80's. Also that by using *series combinations* of the filament windings it supplies the 6.3 V. heaters of either 6.3 V. power tubes or the new 2A3, 2A5 or 2B6 power tubes. In either case, the 2.5 V. 82, or the 5.0 V. 80, 83, or 5Z3, may be used. There is one class of tubes, however, whose conditions cannot be met with these four units. This refers to the types 10 or 50 power tubes, and the 81 rectifier tubes.

The 10 type tubes require high voltage at high current drain such that the normal A.C. plate voltage of the secondary is 1,400 V. at about 150 ma. drain—105 W. in the high voltage circuit alone! The usual 10 tube set using 24's, 27's, 47's, and an 80 rectifier only drains about 105 W. for plate power, filament supply—*everything*. While the four transformers could readily have been extended to include the 10 and 81 tubes as well as the 24, 27, etc., for which they are intended, why penalize, say, a 6 or 7 tube set with a much-too-large transformer for the sake of "super-super" universality? No, it was better to draw the line and make one transformer to supply power to all such sets and amplifiers. Figure 2 shows the general circuit diagram of the "high voltage" transformer. Let us list some of the

(*Continued on page* 559)

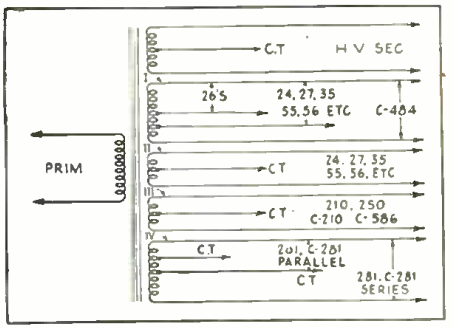


Fig. 2
The "high-voltage" replacement transformer.

* Chief Engineer, General Transformer Corp.

SERVICING THE "TALKIES"

In this installment, the author concludes the discussion of the psychology of the projectionist and how he is best "handled."

PART V

AARON NADELL

ASIDE from sound, the projectionist has always been required to know enough about electricity to handle his arc-lamp circuits intelligently, and to care for his projector drive motor and for his arc-lamp generator or rectifier. He is sufficiently familiar with optical science to prescribe the lenses needed for any size of screen or for any distance of "throw." He is commonly a good mechanic, capable of keeping his projector gearing system in good working order and of repairing it when necessary. In many localities his competence in all three fields is tested by a licensing examination prescribed by law, and of recent days questions relating to sound apparatus have been added to many of these examinations.

The addition of sound, with its vacuum tube circuits and more delicate electrical requirements, found many projectionists who had built their own radio receivers during the days when that sport was popular, some projectionists who were radio amateurs, here and there a graduate electrical engineer of a projection room, but the bulk of the craft were men who had to make, and have made, fairly strenuous but highly successful efforts to adapt their pre-existing electrical knowledge to the requirements of audio amplifiers.

The average projectionist of the present day is quite competent to repair all the more ordinary troubles of his own sound equipment. He will, moreover, be likely to know more than the average radio man about certain types of trouble, hums, noises or flutter, which are commoner to sound equipment than to "radios" or (as, in the case of flutter) impossible in any radio except a radio-phonograph combination. Nevertheless, there are at least four ways in which the radio man can be of great help to him in repair work.

1. Repairing trouble is the exception and not the rule with a projectionist. The radio man, *if he knows the circuit*, will probably do a far faster job. And with an audience waiting, time is of vital importance.

2. The projectionist has little testing apparatus, often not even a voltmeter. He has little experience in using test kits. The radio man, who can provide both the tester and experience in using it, will not only find some troubles faster, he will also uncover obscurer defects and causes of trouble that the projectionist working by rule of thumb may have great difficulty in locating.

(*Continued on page* 564)

BROADCAST STATIONS OF THE U. S.

A list of all the broadcast stations in the U. S. as licensed by the Federal Radio Commission and brought up to date to December 22, 1933. Abbreviations: T, location of transmitter; C. P., construction permit authorized; LS, power until local sunset.

Call Letters	Location	Power (watts)	Freq. (kc.)	Wave-length (meters)
KABC	San Antonio, Tex.	100	1420	211.3
KALE	Portland, Ore.	500	1300	230.8
KARK	Little Rock, Ark.	250	890	337.1
KASA	Elk City, Okla.	100	1210	247.9
KBPS	Portland, Ore.	100	1420	211.3
KBTM	Paragould, Ark.	100	1200	250
	C.P.T-Jonesboro			
KCMC	Texarkana, Ark.	100	1420	211.3
KCRC	Enid, Okla.	100	1370	219
KCRJ	Jerome, Ariz.	100	1310	229
KDB	Santa Barbara, Calif.	100	1500	200
KDFN	Casper, Wyo.	500	1440	208.3
KDKA	Pittsburgh, Pa.	50kw	980	306
	T-Saxonburg			
KDLR	Devils Lake, N. D.	100	1210	247.9
KDYL	Salt Lake City, Utah.	1kw	1290	232.6
KECA	Los Angeles, Calif.	1kw	1430	209.8
KEIW	Burbank, Calif.			
KELW	Burbank, Calif.	500	780	385
KERN	Bakersfield, Calif.	100	1200	250
KEX	Portland, Ore.	5kw	1180	254.2
KFAB	Lincoln, Nebr.	5kw	770	390
KFAC	Los Angeles, Calif.	1kw	1300	230.8
KFBB	Great Falls, Mont.	1kw	1280	234.4
KFBI	Abilene, Kans.	5kw	1050	285.7
	T-Milford			
KFBK	Sacramento, Calif.	100	1310	229
KFBL	Everett, Wash.	50	1370	219
KFDM	Beaumont, Texas.	500	560	536
KFDY	Brookings, S. D.	1kw	550	545
KFEL	Denver, Colo.	500	920	326
	T-Edgewater			
KFEQ	St. Joseph, Mo.	2½kw	680	441
KFGQ	Boone, Iowa.	100	1310	229
KFH	Wichita, Kans.	1kw	1300	230.8
KFI	Los Angeles, Calif.	50kw	640	469
	T-Buena Park			
KFIO	Spokane, Wash.	100	1120	267.9
KFIZ	Fond du Lac, Wis.	100	1420	211.3
KFJB	Marshalltown, Iowa.	100	1200	250
KFJI	Klamath Falls, Ore.	100	1210	247.9
KFJM	Grand Forks, N. D.	100	1370	219
KFJR	Portland, Ore.	500	1300	230.8
KFJZ	Forth Worth, Tex.	100	1370	219
KFKA	Greeley, Colo.	500	880	341
KFKU	Lawrence, Kan.	500	1220	245.9
	T-Tonganoxie			
KFLV	Rockford, Ill.	500	1410	212.8
KFNF	Shenandoah, Iowa.	500	890	337
KFOR	Lincoln, Nebr.	100	1210	247.9
KFOX	Long Beach, Calif.	1kw	1250	240
KFPL	Dublin, Tex.	100	1310	229
KFPM	Greenville, Tex.	15	1310	229
KFPW	Ft. Smith, Ark.	100	1210	247.9
KFPY	Spokane, Wash.	1kw	1340	223.9
KFQD	Anchorage, Alaska.	250	600	500
KFRC	San Francisco, Calif.	1kw	610	492
KFRU	Columbia, Mo.	500	630	476
KFSD	San Diego, Calif.	1kw	600	500
KFSG	Los Angeles, Calif.	500	1120	267.9
KFUO	Clayton, Mo.	500	550	545
KFVD	Los Angeles, Calif.	250	1000	300
KFVS	Cape Girardeau, Mo.	100	1210	247.9
KFWB	Hollywood, Calif.	1kw	950	316
KFWF	St. Louis, Mo.	100	1200	250
KFWI	San Francisco, Calif.	500	930	323
KFXD	Nampa, Idaho	100	1200	250
KFXF	Denver, Colo.	500	920	326
KFXJ	Grand Junction, Colo.	100	1200	250
KFXM	San Bernardino, Calif.	100	1210	247.9
KFXR	Oklahoma City, Okla.	100	1310	229
KFYO	Lubbock, Tex.	100	1310	229
KFYR	Bismarck, N. D.	1kw	550	545
KGA	Spokane, Wash.	5kw	1470	204.1
KGAR	Tucson, Ariz.	100	1370	219
KGB	San Diego, Calif.	1kw	1330	225.6
KGBU	Ketchikan, Alaska.	500	900	333
KGBX	Springfield, Mo.	100	1310	229
KGBZ	York, Nebr.	500	930	323
KGCA	Decorah, Iowa.	100	1270	236.2
KGCR	Watertown, S. D.	100	1210	247.9
KGCU	Mandan, N. D.	250	1240	241.9
KGCX	Wolf Point, Mont.	100	1310	229
KGDE	Fergus Falls, Minn.	100	1200	250
KGDM	Stockton, Calif.	250	1100	272.7
KGDY	Huron, S. D.	250	1340	223.9
KGEK	Yuma, Colo.	100	1200	250
KGER	Long Beach, Calif.	1kw	1360	220.6
KGEZ	Kalispell, Mont.	100	1310	229
KGFF	Shawnee, Okla.	100	1420	211.3
KGFG	Oklahoma City, Okla.	100	1370	219
KGFI	Corpus Christi, Tex.	100	1500	200
KGFJ	Los Angeles, Calif.	100	1200	250
KGFK	Moorhead, Minn.	100	1500	200
KGFL	Raton, N. Mex.	100	1370	219
	T-Roswell			
KGFW	Kearney, Nebr.	100	1310	229
KGFX	Pierre, S. D.	200	630	476
KGGC	San Francisco, Calif.	100	1420	211.3
KGGF	Coffeyville, Kans.	500	1010	297
	T-S. Coffeyville, Okla.			
KGGM	Albuquerque, N. M.	250	1230	243.9
KGHF	Pueblo, Colo.	250	1320	227.3
KGHI	Little Rock, Ark.	100	1200	250
KGHL	Billings, Mont.	1kw	950	316
KGIR	Butte, Mont.	500	1360	220.6
KGIW	Trinidad, Colo.	100	1420	211.3
	T-Alamosa			
KGIX	Las Vegas, Nev.	100	1420	211.3
KGIZ	Springfield, Mo.	100	1500	200
KGKB	Tyler, Tex.	100	1500	200
KGKL	San Angelo, Tex.	100	1370	219
KGKO	Wichita Falls, Tex.	250	570	526
KGKY	Scottsbluff, Nebr.	100	1500	200
KGMB	Honolulu, Hawaii	250	1320	227.3
KGNF	North Platte, Nebr.	500	1430	209.8
KGNO	Dodge City, Kans.	250	1340	223.9
KGO	San Francisco, Calif.	7½kw	790	380
	T-Oakland			
KGRS	Amarillo, Tex.	1kw	1410	212.8
KGU	Honolulu, Hawaii	2½kw	750	400
KGVO	Missoula, Mont.	100	1200	250
KGW	Portland, Ore.	1kw	620	484
	T-Faloma			
KGY	Olympia, Wash.	100	1210	247.9
KHJ	Los Angeles, Calif.	1kw	900	333
KHQ	Spokane, Wash.	1kw	590	509
KICA	Clovis, N. M.	100	1370	219
KICK	Carter Lake, Iowa.	100	1420	211.3
KID	Idaho Falls, Idaho.	250	1320	227.3
KIDO	Boise, Idaho.	1kw	1350	222.2
KIDW	Lamar, Colo.	100	1420	211.3
KIEM	Eureka, Calif.	100	1210	247.9
KIEV	Glendale, Calif.	100	850	353
KIFH	Juneau, Alaska.	100	1310	229
KIGY	Lowell, Ariz.	100	1200	250
KIT	Yakima, Wash.	100	1310	229
KJBS	San Francisco, Calif.	100	1070	280.4
KJR	Seattle, Wash.	5kw	970	309
KLCN	Blytheville, Ark.	100	1290	232.6
KLO	Ogden, Utah.	500	1400	214.3
KLPM	Minot, N. D.	250	1240	241.9
KLRA	Little Rock, Ark.	1kw	1390	215.8
KLS	Oakland, Calif.	250	1440	208.3
KLUF	Galveston, Tex.	100	1370	219
KLX	Oakland, Calif.	1kw	880	341
KLZ	Denver, Colo.	1kw	560	536
KMA	Shenandoah, Iowa.	500	930	323
KMAC	San Antonio, Tex.	100	1370	219
KMBC	Kansas City, Mo.	1kw	950	316
	T-Independence			
KMED	Medford, Ore.	100	1310	229
KMJ	Fresno, Calif.	500	580	517
KMLB	Monroe, La.	100	1200	250
KMMJ	Clay Center, Neb.	1kw	740	405
KMO	Tacoma, Wash.	250	1330	225.6
KMOX	St. Louis, Mo.	50kw	1090	275.2
KMPC	Beverly Hills, Calif.	500	710	423
KMTR	Los Angeles, Calif.	500	570	526
KNOW	Austin, Tex.	100	1500	200
KNX	Los Angeles, Calif.	25kw	1050	285.7
KOA	Denver, Colo.	12½kw	830	361
KOAC	Corvallis, Ore.	1kw	550	545
KOB	Albuquerque, N. M.	10kw	1180	254.2
KOH	Reno, Nev.	500	1380	217.4
KOIL	Councils Bluffs, Iowa.	1kw	1260	238.1
KOIN	Portland, Ore.	1kw	940	319
KOL	Seattle, Wash.	1kw	1270	236.2
KOMA	Oklahoma City, Okla.	5kw	1480	202.7
KOMO	Seattle, Wash.	1kw	920	326
KONO	San Antonio, Tex.	100	1370	219
KOOS	Marshfield, Ore.	100	1370	219
KORE	Eugene, Ore.	100	1420	211.3
KOY	Phoenix, Ariz.	1kw-LS	1390	215.8
KPCB	Seattle, Wash.	100	650	462
KPJM	Prescott, Ariz.	100	1500	200
KPO	San Francisco, Calif.	5kw	680	441
	T-Near Belmont	C.P.50kw		
KPOF	Denver, Colo.	500	880	341
KPPC	Pasadena, Calif.	50	1210	247.9
KPQ	Wenatchee, Wash.	100kw	1500	200
KPRC	Houston, Tex.	1kw	920	326
	T-Sugarland	2½kw-LS		
KQV	Pittsburgh, Pa.	500	1380	217.4
KQW	San Jose, Calif.	500	1010	297
KRE	Berkeley, Calif.	100	1370	219
KREG	Santa Ana, Calif.	100	1500	200
KRGV	Harlingen, Tex.	500	1260	238.1
KRKD	Los Angeles, Calif.	500	1120	267.9
KRLD	Dallas, Tex.	10kw	1040	288.5
KRMD	Shreveport, La.	100	1310	229
KROW	Oakland, Calif.	500	930	323
	T-Oakland	1kw-LS		
KRSC	Seattle, Wash.	100	1120	267.9
KSAC	Manhattan, Kans.	500	580	517
KSCJ	Sioux City, Iowa.	1kw	1330	225.6
KSD	St. Louis, Mo.	500	550	545
KSEI	Pocatello, Idaho.	250	900	333
KSL	Salt Lake City, Utah.	50kw	1130	265.5
	T-Saltair			
KSO	Des Moines, Iowa.	100	1370	219
KSOO	Sioux Falls, S. D.	1kw	1110	270.3
KSTP	St. Paul, Minn.	15kw-LS	1460	205.5
	T-Radio Center			
KSUN	Lowell, Ariz.	100-LS	1200	250
KTAB	San Francisco, Calif.	1kw	560	536
	T-Oakland			
KTAR	Phoenix, Ariz.	500	620	484
KTAT	Fort Worth, Tex.	1kw	1240	241.9
	T-Birdville			
KTBS	Shreveport, La.	1kw	1450	206.9
KTFI	Twin Falls, Idaho.	1kw-LS	1240	241.9
KTHS	Hot Sp. Nat. Pk, Ark.	10kw	1040	288.5
KTM	Los Angeles, Calif.	500	780	385
	T-Santa Monica.	1kw-LS		
KTRH	Houston, Tex.	1kw	1120	267.9
KTSA	San Antonio, Tex.	1kw	1290	232.6
KTSM	El Paso, Tex.	100	1310	229
KTUL	Chickasha, Okla.	250	1400	214.3
KTW	Seattle, Wash.	1kw	1220	245.9
KUJ	Walla Walla, Wash.	100	1370	219
KUMA	Yuma, Ariz.	100	1420	211.3
KUOA	Fayetteville, Ark.	500	1260	238.1
	T-Mt. Sequoyah			
KUSD	Vermillion, S. D.	500	890	337
KVI	Tacoma, Wash.	500	570	526
	T-Des Moines			
KVL	Seattle, Wash.	100	1370	219
KVOA	Tucson, Ariz.	500	1260	238.1
KVOO	Tulsa, Okla.	25kw	1140	263.2
KVOR	Colorado Spgs., Colo.	1kw	1270	236.2
KVOS	Bellingham, Wash.	100	1200	250
KWCR	Cedar Rapids, Iowa.	100	1420	211.3
KWEA	Shreveport, La.	100	1210	247.9
KWFV	Hilo, Hawaii	100	1210	247.9
KWG	Stockton, Cal.	100	1200	250
KWJJ	Portland, Ore.	500	1060	283
KWK	St. Louis, Mo.	1kw	1350	222.2
	T-Kirkwood			
KWKC	Kansas City, Mo.	100	1370	219
KWKH	Shreveport, La.	10kw	850	353
	T-Kennonwood			
KWLC	Decorah, Iowa.	100	1270	236.2
KWSC	Pullman, Wash.	1kw	1220	245.9
KWWG	Brownsville, Tex.	500	1260	238.1
KXA	Seattle, Wash.	250	760	395
KXL	Portland, Ore.	100	1420	211.3
KXO	El Centro, Calif.	100	1500	200
KXRO	Aberdeen, Wash.	100	1310	229
KXYZ	Houston, Tex.	250	1440	208.3
KYA	San Francisco, Calif.	1kw	1230	243.9
KYW	Chicago, Ill.	10kw	1020	294.1
	C.P. Philadelphia, Pa.			
WAAB	Boston, Mass.	500	1410	212.8
	T-Quincy			
WAAF	Chicago, Ill.	500	920	326
WAAM	Newark, N. J.	1kw	1250	240
WAAT	Jersey City, N. J.	500	940	319
WAAW	Omaha, Neb.	500	660	455
WABC-WBOQ	New York, N. Y.	50kw	860	349
	T-Wayne, N. J.			

Call Letters	Location	Power (watts)	Freq. (kc.)	Wave-length (meters)
WABI	Bangor, Maine	100	1200	250
WACO	Waco, Tex.	100	1420	211.3
WADC	Tallmadge, Ohio	1kw	1320	227.3
WAGM	Presque Isle, Maine	100	1420	211.3
WAIU	Columbus, Ohio	500	640	469
WALR	Zanesville, Ohio	100	1210	247.9
WAMC	Anniston, Ala.	100	1420	211.3
WAML	Laurel, Miss.	100	1310	229
WAPI	Birmingham, Ala.	5kw	1140	263.2
WARD	Long Island Cy, N. Y.	500	1400	214.3
WASH	Grand Rapids, Mich.	500	1270	236.2
WAVE	Hopkinsville, Ky.	1kw	940	319
WAWZ	Zarephath, N. J.	250	1350	222.2
WAZL	Hazelton, Pa.	100	1420	211.3
WBAA	W. Lafayette, Ind.	1kw-LS	1400	214.3
WBAK	Harrisburg, Pa.	1kw	1430	209.8
WBAL	Baltimore, Md. T-Pikeville, Md.	10kw	1060	283
WBAP	Fort Worth, Tex. T-Grapevine	50kw	800	375
WBAX	Wilkes-Barre, Pa. T-Plains Twp.	100	1210	247.9
WBBL	Richmond, Va.	100	1210	247.9
WBBM	Chicago, Ill. T-Glenview	25kw	770	390
WBBR	Brooklyn, N. Y. T-Rossville	1kw	1300	230.8
WBBX	New Orleans, La.	100	1200	250
WBBZ	Ponca City, Okla.	100	1200	250
WBCM	Bay City, Mich. T-Hampton Twp.	500	1410	212.8
WBEN	Buffalo, N. Y. T-Martinsville	1kw	900	333
WBEO	Marquette, Mich.	100	1310	229
WBHS	Huntsville, Ala.	100	1200	250
WBIG	Greensboro, N. C	500	1440	208.3
WBNX	New York, N. Y. T-Cliffside, N. J.	250	1350	222.2
WBOQ	(See WABC-WBOQ)			
WBOW	Terre Haute, Ind.	100	1310	229
WBRC	Birmingham, Ala.	500	930	323
WBRE	Wilkes-Barre, Pa.	100	1310	229
WBSO	Needham, Mass.	500	920	326
WBT	Charlotte, N. C.	50kw	1080	277.8
WBTM	Danville, Va.	100	1370	219
WBZ	Boston, Mass. T-Millis Twp.	50kw	990	303
WBZA	Boston, Mass. T-East Springfield	1kw	990	303
WCAC	Storrs, Conn.	250	600	500
WCAD	Canton, N. Y.	500	1220	245.9
WCAE	Pittsburgh, Pa.	1kw	1220	245.9
WCAH	Columbus, Ohio.	500	1430	209.8
WCAL	Northfield, Minn.	1kw	1250	240
WCAM	Camden, N. J.	500	1280	234.4
WCAO	Baltimore, Md.	250	600	500
WCAP	Asbury Park, N. J. T-Whitesville	500	1280	234.4
WCAT	Rapid City, S. D.	100	1200	250
WCAU	Philadelphia, Pa. T-Newton, Square Co.	50kw	1170	256.4
WCAX	Burlington, Vt.	100	1200	250
WCAZ	Carthage, Ill.	50	1070	280.4
WCBA	Allentown, Pa.	250	1440	208.3
WCBD	Zion, Ill.	5kw	1080	277.8
WCBM	Baltimore, Md.	100	1370	219
WCBS	Springfield, Ill.	100	1210	247.9
WCCO	Minneapolis, Minn. T-Anoka	50kw	810	370
WCDA	New York, N. Y. T-Cliffside, N. J.	250	1350	222.2
WCFL	Chicago, Ill.	1½kw	970	309
WCKY	Covington, Ky. T-Crescent Springs	5kw	1490	201.3
WCLO	Janesville, Wis.	100	1200	250
WCLS	Joliet, Ill.	100	1310	229
WCNW	Brooklyn, N. Y.	100	1500	200
WCOA	Pensacola, Fla.	500	1340	223.9
WCOC	Meridian, Miss.	500	880	341
WCRW	Chicago, Ill.	100	1210	247.9
WCSC	Charleston, S. C.	500	1360	220.6
WCSH	Portland, Me. T-Scarboro	1kw	940	319
WDAE	Tampa, Fla.	1kw	1220	245.9
WDAF	Kansas City, Mo.	1kw	610	492
WDAG	Amarillo, Tex.	1kw	1410	212.8
WDAH	El Paso, Tex.	100	1310	229
WDAS	Philadelphia, Pa.	100	1370	219
WDAY	Fargo, N. D. T-West Fargo	1kw	940	319
WDBJ	Roanoke, Va.	500-LS	930	323
WDBO	Orlando, Fla.	250	580	517
WDEL	Wilmington, Del.	250	1120	267.9
WDEV	Waterbury, Vt.	500	550	545
WDGY	Minneapolis, Minn.	1kw	1180	254.2
WDOD	Chattanooga, Tenn. T-Brainerd	1kw 2½kw-LS	1280	234.4
WDRC	Hartford, Conn. T-Bloomfield	1kw	1330	225.6
WDSU	New Orleans, La. T-Gretna	1kw	1250	240
WDZ	Tuscola, Ill.	100	1070	280.4
WEAF	New York, N. Y. T-Bellmore	50kw	660	455
WEAN	Providence, R. I.	250	780	385
WEBC	Superior, Wis.	1kw	1290	232.6
WEBQ	Harrisburg, Ill.	100	1210	247.9
WEBR	Buffalo, N. Y.	100	1310	229
WEDC	Chicago, Ill.	100	1210	247.9
WEED	Greenville, N. C.	100	1420	211.3
WEEI	Boston, Mass. T-Weymouth	1kw	590	509
WEEU	Reading, Pa.	1kw	830	361
WEHC	Charlottesville, Va.	500	1350	222.2
WEHS	Cicero, Ill.	100	1420	211.3
WELL	Battle Creek, Mich.	50	1420	211.3
WENC	Americus, Ga.	100	1420	211.3
WENR	Chicago, Ill. T-Downers Grove	50kw	870	345
WESG	Elmira, N. Y. T-Ithaca	1kw	1040	288.5
WEVD	New York, N. Y. T-Brooklyn	500	1300	230.8
WEW	St. Louis, Mo.	1kw	760	395
WEXL	Royal Oak, Mich.	50	1310	229
WFAA	Dallas, Tex. T-Grapevine	50kw	800	375
WFAB	New York, N. Y. T-Carlstadt, N. J.	1kw	1300	230.8
WFAM	South Bend, Ind.	100	1200	250
WFAS	White Plains, N. Y.	100	1210	247.9
WFBC	Greenville, S. C.	100	1200	250
WFBE	Cincinnati, Ohio.	100	1200	250
WFBG	Altoona, Pa.	100	1310	229
WFBL	Syracuse, N. Y. T-Collamer	1kw 2½kw-LS	1360	220.6
WFBM	Indianapolis, Ind.	1kw	1230	243.9
WFBR	Baltimore, Md.	500	1270	236.2
WFDF	Flint, Mich.	100	1310	229
WFDV	Rome, Ga.	100	1500	200
WFEA	Manchester, N. H.	500	1430	209.8
WFI	Philadelphia, Pa.	500	560	536
WFLA-WSUN	Clearwater, Fla.	250	620	484
WFQD	Anchorage, Alaska		600	500
WGAL	Lancaster, Pa.	100	1310	229
WGAR	Cleveland, Ohio. T-Cuyahoga Heights	500 1kw-LS	1450	206.9
WGBB	Freeport, N. Y.	100	1210	247.9
WGBF	Evansville, Ind.	500	630	476
WGBI	Scranton, Pa.	250	880	341
WGCM	Mississippi City, Miss.	250-LS	1210	247.9
WGCP	Newark, N. J.	C.P. 1kw	1250	240
WGES	Chicago, Ill.	500	1360	220.6
WGH	Newport News, Va.	100	1310	229
WGL	Ft. Wayne, Ind.	100	1370	219
WGLC	Hudson Falls, N. Y.	100	1370	219
WGN	Chicago, Ill. T-Elgin	C.P. 50kw	720	417
WGNY	Chester Twsp., N. Y.	100	1210	247.9
WGR	Buffalo, N. Y. T-Amherst Twp.	1kw	550	545
WGST	Atlanta, Ga.	250	890	337
WGY	Schenectady, N. Y. T-South Schenectady	50kw	790	380
WHA	Madison, Wis.	1kw	940	319
WHAD	Milwaukee, Wis.	250	1120	267.9
WHAM	Rochester, N. Y. T-Victor Twp.	5kw C.P. 50kw	1150	260.9
WHAS	Louisville, Ky. T-Jeffersontown	50kw	820	366
WHAT	Philadelphia, Pa	100	1310	229
WHAZ	Troy, N. Y.	500	1300	230.8
WHB	Kansas City, Mo. T-North Kansas City	500	860	349
WHBC	Canton, Ohio.	100	1200	250
WHBD	Mt. Orab, Ohio.	100	1370	219
WHBF	Rock Island, Ill.	100	1210	247.9
WHBL	Sheboygan, Wis.	500	1410	212.8
WHBQ	Memphis, Tenn.	100	1370	219
WHBU	Anderson, Ind.	100	1210	247.9
WHBY	Green Bay, Wis. T-West De Pere	100	1200	250
WHDF	Calumet, Mich.	100	1370	219
WHDH	Boston, Mass. T-Saugus	1kw	830	361
WHDL	Tupper Lake, N. Y.	100	1420	211.3
WHEB	Portsmouth, N. H. T-Newington	250	740	405
WHEC	Rochester, N. Y.	500	1440	208.3
WHEF	Kosciusko, Miss.	100	1500	200
WHET	Troy, Ala. C.P. T-Dothan	100	1370	219
WHFC	Cicero, Ill.	100	1420	211.3
WHIS	Bluefield, W. Va.	250	1410	212.8
WHK	Cleveland, Ohio. T-Seven Hills	1kw 2½kw-LS	1390	215.8
WHN	New York, N. Y.	250	1010	297
WHOM	Jersey City, N. J.	250	1450	206.9
WHP	Harrisburg, Pa. T-Lemoyne	500 1kw-LS	1430	209.8
WIAS	Ottumwa, Iowa	100	1310	229
WIBA	Madison, Wis.	500	1280	234.4
WIBG	Glenside, Pa. T-Elkins Park	100	970	309
WIBM	Jackson, Mich.	100	1370	219
WIBU	Poynette, Wis.	100	1210	247.9
WIBW	Topeka, Kans.	1kw	580	517
WIBX	Utica, N. Y.	100	1200	250
WICC	Bridgeport, Conn. T-Bridgeport	250 500-LS	600	500
WIL	St. Louis, Mo.	100	1200	250
WILL	Urbana, Ill.	1kw-LS	890	337
WILM	Wilmington, Del. T-Edge Moor	100	1420	211.3
WIND	Gary, Ind.	1kw	560	536
WINS	New York, N. Y. T-Carlstadt, N. J.	500	1180	254.2
WIOD-WMBF	Miami, Fla. T-Miami Beach	1kw	1300	230.8
WIP	Philadelphia, Pa.	500	610	492
WIS	Columbia, S. C.	500	1010	297
WISN	Milwaukee, Wis.	250	1120	267.9
WJAC	Johnstown, Pa.	100	1310	229
WJAG	Norfolk, Nebr.	1kw	1060	283
WJAR	Providence, R. I.	250	890	337
WJAS	Pittsburgh, Pa. T-No. Fayette, Twp.	1kw 2½kw-LS	1290	232.6
WJAX	Jacksonville, Fla.	1kw	900	333
WJAY	Cleveland, Ohio.	500	610	492
WJBC	La Salle, Ill.	100	1200	250
WJBI	Red Bank, N. J.	100	1210	247.9
WJBK	Detroit, Mich. T-Highland Park	100	1370	219
WJBL	Decatur, Ill.	100	1200	250
WJBO	New Orleans, La. C.P. Baton Rouge	100	1420	211.3
WJBW	New Orleans, La.	100	1200	250
WJBY	Gadsden, Ala.	100	1210	247.9
WJDX	Jackson, Miss.	1kw	1270	236.2
WJEJ	Hagerstown, Md.	100	1210	247.9
WJEM	Tupelo, Miss.	500	990	303
WJJD	Mooseheart, Ill.	120kw	1130	265.5
WJMS	Ironwood, Mich.	100	1420	211.3
WJR	Detroit, Mich. C.P.T-Detroit	10kw	750	400
WJSV	Alexandria, Va.	10kw	1460	205.5
WJTL	Oglethorpe Univ., Ga.	100	1370	219
WJW	Akron, Ohio.	100	1210	247.9
WJZ	New York, N. Y. T-Bound Brook, N. J.	50kw	760	395
WKAQ	San Juan, P. R.	1kw	1246	241.9
WKAR	E. Lansing, Mich.	1kw	1040	288.5
WKBB	Joliet, Ill. T-E. Dubuque	100	1500	200
WKBC	Birmingham, Ala.	100	1310	229
WKBF	Indianapolis, Ind. T-Nr. Indianapolis	500	1400	214.3
WKBH	La Crosse, Wis.	1kw	1380	217.4
WKBI	Cicero, Ill.	100	1420	211.3
WKBN	Youngstown, Ohio.	500	570	526
WKBO	Harrisburg, Pa.	100	1200	250
WKRV	Connersville, Ind.	100	1500	200
WKBW	Buffalo, N. Y. T-Amherst Twp.	5kw	1480	202.7
WKBZ	Ludington, Mich.	100	1500	200
WKEU	La Grange, Ga.	100	1500	200
WKFI	Greenville, Miss. C.P. T-Greenwood	100	1210	247.9
WKJC	Lancaster, Pa.	100	1200	200
WKOK	Sunbury, Pa.	100	1210	247.9
WKRC	Cincinnati, Ohio.	500	550	545
WKY	Oklahoma City, Okla.	1kw	900	333
WKZO	Kalamazoo, Mich.	1kw	590	509
WLAC	Nashville, Tenn.	5kw	1470	204.1
WLAP	Louisville, Ky.	100	1200	250
WLB	Minneapolis, Minn. T-St. Paul	1kw	1250	240
WLBC	Muncie, Ind.	C.P.100-LS	1310	229
WLBF	Kansas City, Kans.	100	1420	211.3
WLBL	Stevens Point, Wis. T-Nr. Ellis	2½kw	900	333
WLBW	Erie, Pa. T-Summit Township	500 1kw-LS	1260	238.1
WLBZ	Bangor, Me.	500	620	484
WLCI	Ithaca, N. Y.	50	1210	247.9
WLEU	Erie, Pa.	100	1420	211.3
WLEY	Lexington, Mass.	100	1370	219
WLIT	Philadelphia, Pa.	500	560	536
WLOE	Boston, Mass. T-Chelsea	100 250-LS	1500	200
WLS	Chicago, Ill. T-Downers Grove	50kw	870	345

Call Letters	Location	Power (watts)	Freq. (kc.)	Wave-length
WLVA	Lynchburg, Va.	100	1370	219
WLW	Cincinnati, Ohio. T-Mason	50kw c.p. 500 kw	700	429
WLWL	New York, N. Y. T-Kearny, N. J.	5kw	1100	272.7
WMAC	(See WSYR-WMAC)			
WMAL	Washington, D. C.	250	630	476
WMAQ	Chicago, Ill. T-Addison	5kw	670	448
WMAS	Springfield, Mass.	100	1420	211.3
WMAZ	Macon, Ga.	500	1180	254.2
WMBC	Detroit, Mich.	100	1420	211.3
WMBD	Peoria, Ill. T-Peoria Heights	500 1kw-LS	1440	208.3
WMBF	(See WIOD-WMBF)			
WMBG	Richmond, Va.	100	1210	247.9
WMBH	Joplin, Mo.	100	1420	211.3
WMBI	Chicago, Ill. T-Addison	5kw	1080	277.8
WMBO	Auburn, N. Y.	100	1310	229
WMBQ	Brooklyn, N. Y.	100	1500	200
WMBR	Tampa, Fla. C.P. Jacksonville, Fla.	100	1370	219
WMC	Memphis, Tenn. T-Bartlett	500 1kw-LS	780	385
WMCA	New York, N. Y. T-Flushing	500	570	526
WMMN	Fairmont, W. Va.	250	890	337
WMPC	Lapeer, Mich.	100	1500	200
WMSG	New York, N. Y.	250	1350	222.2
WMT	Waterloo, Iowa.	500	600	500
WNAC	Boston, Mass. T-Quincy	1kw	1230	243.9
WNAD	Norman, Okla.	500	1010	297
WNAX	Yankton, S. D.	2½kw-LS	570	526
WNBF	Binghamton, N. Y.	100	1500	200
WNBH	New Bedford, Mass. T-Fairhaven	100 250-LS	1310	229
WNBO	Silverhaven, Pa.	100	1200	250
WNBR	Memphis, Tenn.	500	1430	209.8
WNB	Carbondale, Pa.	10	1200	250
WNBX	Springfield, Vt.	250	1260	238.1
WNBZ	Saranac Lake, N. Y.	50	1290	232.6
WNOX	Knoxville, Tenn.	2kw-LS	560	536
WNRA	MuscleShoalsCity,Ala	100	1420	211.3
WNYC	New York, N. Y.	500	810	370
WOAI	San Antonio, Tex. T-Selma	50kw	1190	252.1
WOBU	Charleston, W. Va.	250	580	517
WOC	Mitchellville, Iowa.	50kw	1000	300
WOCL	Jamestown, N. Y.	50	1210	247.9
WODA	Carlstadt, N. J.	2½kw-LS	1250	240
WODX	Mobile, Ala. T-Springhill	500	1410	212.8
WOI	Ames, Iowa.	5kw	640	469
WOKO	Albany, N. Y.	500	1440	208.3
WOL	Washington, D. C.	100	1310	229
WOMT	Manitowoc, Wis.	100	1210	247.9
WOOD	Grand Rapids, Mich.	500	1270	236.2
WOPI	Bristol, Tenn.	100	1500	200
WOQ	Kansas City, Mo.	1kw	1300	230.8
WOR	Newark, N. J. T-Kearny	5kw C.P. 50kw	710	423
WORC	Worcester, Mass. T-Auburn	500	1280	234.4
WORK	York, Pa. T-W. Manchester	1kw	1000	300
WOS	Jefferson City, Mo.	500	630	476
WOSU	Columbus, Ohio.	750	570	526
WOV	New York, N. Y. T-Secaucus, N. J.	1kw	1130	265.5
WOW	Omaha, Nebr.	1kw	590	509
WOWO	Ft. Wayne, Ind.	10kw	1160	258.6
WPAD	Paducah, Ky.	100	1420	211.3
WPAP	(See WQAO-WPAP)			
WPCH	New York, N. Y. T-Flushing	500	570	526
WPEN	Philadelphia, Pa.	C.P. 500	920	326
WPFB	Hattiesburg, Miss.	100	1370	219
WPG	Atlantic City, N. J.	5kw	1100	272.7
WPHR	Petersburg, Va. T-Ettrick	100	1200	250
WPRO	Providence, R. I. T-Providence	100	1210	247.9
WPTF	Raleigh, N. C.	1kw	680	441
WQAM	Miami, Fla.	1kw	560	536
WQAN	Scranton, Pa.	250	880	341
WQAO-	New York, N. Y.	250	1010	297
WPAP	T-Cliffside, N. J.			
WQBC	Vicksburg, Miss.	500	1360	220.6
WQDM	St. Albans, Vt.	100	1370	219
WQDX	Thomasville, Ga.	100	1210	247.9
WRAK	Williamsport, Pa.	100	1370	219
WRAM	Wilmington, N. C.	100	1370	219
WRAW	Reading, Pa.	100	1310	229
WRAX	Philadelphia, Pa.	C.P. 500	920	326
WRBL	Columbus, Ga.	100	1200	250
WRBX	Roanoke, Va.	250	1110	212.8
WRC	Washington, D. C.	500	950	316
WRDO	Augusta, Me.	100	1370	219
WRDW	Augusta, Ga.	100	1500	200
WREC	Memphis, Tenn. T-Whitehaven	500 1kw-LS	600	500
WREN	Lawrence, Kans. T-Tonganoxie	1kw	1220	245.9
WRHM	Minneapolis, Minn. T-Fridley	1kw	1250	240
WRJN	Racine, Wis.	100	1370	219
WRNY	New York, N. Y. T-Coytesville, N. J.	250	1010	297
WROL	Knoxvile, Tenn.	100	1310	229
WRR	Dallas, Tex.	500	1280	234.4
WRUF	Gainesville, Fla.	5kw	830	361
WRVA	Richmond, Va. T-Mechanicsville	5kw	1110	270.3
WSAI	Cincinnati, Ohio. T-Mason	500 2½kw-LS	1330	225.6
WSAJ	Grove City, Pa.	100	1310	229
WSAN	Allentown, Pa.	250	1440	208.3
WSAR	Fall River, Mass.	250	1450	206.9
WSAZ	Huntington, W. Va.	500	580	517
WSB	Atlanta, Ga.	50kw	740	405
WSBC	Chicago, Ill.	100	1210	247.9
WSBT	South Bend, Ind.	500	1230	243.9
WSEN	Columbus, Ohio.	100	1210	247.9
WSFA	Montgomery, Ala.	500	1410	212.8
WSIX	Springfield, Tenn.	100	1210	247.9
WSJS	Winston-Salem, N. C.	100	1310	229
WSM	Nashville, Tenn. T-Franklin	50kw	650	462
WSMB	New Orleans, La. C.P. T-Algiers	500	1320	227.3
WSMK	Dayton, Ohio.	200	1380	217.4
WSOC	Charlotte, N. C.	100	1210	247.9
WSPA	Spartanburg, S. C.	100	1420	211.3
WSPD	Toledo, Ohio.	1kw	1340	223.9
WSUI	Iowa City, Iowa.	500	880	341
WSUN	(See WFLA-WSUN)			
WSVS	Buffalo, N. Y.	50	1370	219
WSYB	Rutland, Vt.	100	1500	200
WSYR-	Syracuse, N. Y.	250	570	526
WSYU				
WTAD	Quincy, Ill.	500	1440	208.3
WTAG	Worcester, Mass.	500-LS	580	517
WTAM	Cleveland, Ohio. T-Brecksville Village	50kw	1070	280.4
WTAQ	Eau Claire, Wis. T-Twp. of Washington	1kw	1330	225.6
WTAR	Norfolk, Va.	500	780	385
WTAW	College Station, Tex.	500	1120	267.9
WTAX	Springfield, Ill.	100	1210	247.9
WTBO	Cumberland, Md.	100	1420	211.3
WTEL	Philadelphia, Pa.	100	1310	229
WTFI	Athens, Ga.	500	1450	206.9
WTIC	Hartford, Conn. T-Avon	50kw	1060	283
WTJS	Jackson, Tenn.	100	1310	229
WTMJ	Milwaukee, Wis. T-Waukesha	1kw 2½kw-LS	620	484
WTNJ	Trenton, N. J.	500	1280	234.4
WTOC	Savannah, Ga.	500	1260	238.1
WTRC	Elkhart, Ind.	100-LS	1310	229
WVFW	Brooklyn, N. Y.	500	1400	214.3
WWAE	Hammond, Ind.	100	1200	250
WWJ	Detroit, Mich.	1kw	920	326
WWL	New Orleans, La. T-Kenner	10kw	850	353
WWNC	Asheville, N. C.	1kw	570	526
WWRL	Woodside, N. J.	100	1500	200
WWSW	Pittsburgh, Pa. T-Wilkinsburg	100 250-LS	1500	200
WWVA	Wheeling, W. Va.	5kw	1160	258.6
WXYZ	Detroit, Mich.	1kw	1240	241.9

POLICE STATIONS (Alphabetically by Call Letters)

Call Letters	Location	Freq. (kc.)
KGHO	Des Moines, Iowa	1534
KGJX	Pasadena, Calif.	1712
KGOZ	Cedar Rapids, Iowa	2470
KGPA	Seattle, Wash.	2414
KGPB	Minneapolis, Minn.	2430
KGPC	St. Louis, Mo.	1712
KGPD	San Francisco, Calif.	2470
KGPE	Kansas City, Mo.	2422
KGPG	Vallejo, Calif.	2422
KGPH	Oklahoma City, Okla.	2450
KGPI	Omaha, Neb.	2470
KGPJ	Beaumont, Tex.	1712
KGPK	Sioux City, Ia.	2470
KGPL	Los Angeles, Calif.	1712
KGPM	San Jose, Calif.	2470
KGPN	Davenport, Iowa	2470
KGPO	Tulsa, Okla.	2450
KGPP	Portland, Ore.	2442
KGPQ	Honolulu, T. H.	2450
KGPR	Fort Worth, Tex.	1712
KGPS	Bakersfield, Calif.	2414
KGPW	Salt Lake City, Utah	2470
KGPX	Denver, Colo.	2442
KGPY	Baton Rouge, La.	1574
KGPZ	Wichita, Kans.	2450
KGZA	Fresno, Calif.	2414
KGZB	Houston, Tex.	1712
KGZC	Topeka, Kans.	2442
KGZD	San Diego, Calif.	2430
KGZE	San Antonio, Tex.	2506
KGZF	Chanute, Kans.	2450
KGZG	Des Moines, Ia.	2470
KGZH	Klamath Falls, Ore.	2442
KGZI	Wichita Falls, Tex.	1712
KGZJ	Phoenix, Ariz.	2430
KGZL	Shreveport, La.	1712
KGZM	El Paso, Tex.	2414
KGZN	Tacoma, Wash.	2414
KGZO	Santa Barbara, Calif.	2414
KGZP	Coffeyville, Kans.	2450
KGZQ	Waco, Tex.	1712
KGZR	Salem, Ore.	2442
KGZS	McAlester, Okla.	2450
KIDA	Seattle, Wash.	1574
KSW	Berkeley, Calif.	2422
KVP	Dallas, Tex.	1712
W2XCI	W. Trenton, N. J.	60000
W2XCJ	Bayonne, N. J.	44600
WBA	Harrisburg, Pa.	257
WBR	Butler, Pa.	257
WCK	Belle Island, Mich.	2414
WDX	Wyoming, Pa.	257
WEY	Boston, Mass.	1558
WKDT	Detroit, Mich.	1558
WKDU	Cincinnati, Ohio.	1712
WMB	Reading, Pa.	257
WMDZ	Indianapolis, Ind.	2442
WMJ	Buffalo, N. Y.	2422
WMO	Highland Park, Mich.	2414
WMP	Framingham, Mass.	1574
WNDA	Miami, Fla.	2442
WPDA	Tulare, Calif.	2414
WPDB	Chicago, Ill.	1712
WPDC	Chicago, Ill.	1712
WPDD	Chicago, Ill.	1712
WPDE	Louisville, Ky.	2442
WPDF	Flint, Mich.	2442
WPDG	Youngstown, Ohio.	2458
WPDH	Richmond, Ind.	2442
WPDI	Columbus, Ohio.	2430
WPDJ	Passaic, N. J.	2416
WPDK	Milwaukee, Wis.	2450
WPDL	Lansing, Mich.	2442
WPDM	Dayton, Ohio.	2430
WPDN	Auburn, N. Y.	2458
WPDO	Akron, Ohio.	2458
WPDP	Philadelphia, Pa.	2470
WPDR	Rochester, N. Y.	2458
WPDS	St. Paul, Minn.	2430
WPDT	Kokomo, Ind.	2470
WPDU	Pittsburgh, Pa.	1712
WPDV	Charlotte, N. C.	2458
WPDW	Washington, D. C.	2422
WPDX	Detroit, Mich.	2414
WPDY	Atlanta, Ga.	2414
WPDZ	Fort Wayne, Ind.	2470
WPEA	Syracuse, N. Y.	2458
WPEB	Grand Rapids, Mich.	2442
WPEC	Memphis, Tenn.	2470
WPED	Arlington, Mass.	1712
WPEE	Brooklyn, N. Y.	2450
WPEF	New York, N. Y.	2450
WPEG	New York, N. Y.	2450
WPEH	Somerville, Mass.	1712
WPEI	E. Providence, R. I.	1712
WPEJ	Brookline, Mass.	1712
WPEK	New Orleans, La.	2430
WPEL	W. Bridgewater, Mass.	1574
WPEM	Woonsocket, R. I.	2470
WPEP	Arlington, Mass.	1712
WPEQ	Baton Rouge, La.	1574
WPES	Saginaw, Mich.	2442
WPET	Lexington, Mass.	1712
WPEW	Northampton, Mass.	1574
WPEY	Chattanooga, Tenn.	2470
WPEZ	Framingham, Mass.	1574
WPFA	Newton, Mass.	1712
WPFC	Muskegon, Mich.	2442
WPFD	Highland Park, Ill.	2430
WPFE	Reading, Pa.	2442
WPFF	Toms River, N. J.	2430
WPFG	Jacksonville, Fla.	2442
WPFH	Baltimore, Md.	2414
WPFI	Columbus, Ga.	2414
WPFJ	Hammond, Ind.	1712
WPFK	Hackensack, N. J.	2430
WPFL	Gary, Ind.	2470
WPFM	Birmingham, Ala.	2414
WPFN	Fairhaven, Mass.	1712
WPFO	Knoxville, Tenn.	2470
WPFP	Clarksburg, W. Va.	2414
WPFQ	Swathmore, Pa.	2470
WPFR	Johnson City, Tenn.	2470
WPFS	Asheville, N. C.	2458
WPFT	Lakeland, Fla.	2442
WPFU	Portland, Me.	2422
WPFV	Pawtucket, R. I.	2470
WPFW	Mt. Pleasant, N. Y.	2414
WPFX	Palm Beach, Fla.	2442
WPFY	Yonkers, N. Y.	2414
WRDH	Cleveland, Ohio.	2458
WRDQ	Toledo, Ohio.	2470
WRDR	Grosse Point Village, Mich.	2414
WRDS	East Lansing, Mich.	1574

READERS' DEPARTMENT

A department in which the reader may exchange thoughts and ideas with other readers.

THE PENTODE AND QUALITY —A SLAP AT POOR DESIGNS

Editor, RADIO-CRAFT:

Please give us an article on the "rottenness" of half the radio receivers on sale today. I mean the midgets and any set containing pentode tubes.

I'm anxious to buy a nice, "round-toned" set, but every one I hear has a strained, metallic, yes, even a sort of asthmatic tone—nothing like the tone we used to get from the old 45 type tubes. Pentodes afford more volume with fewer tubes—yes; but is that anything to brag about?

Stromberg-Carlson doesn't fall for pentodes. At first, I wondered why. Now I *know*. (Well, well—Mr. Gordon must have read the article, "Why Stromberg-Carlson Sticks to Class A," in the August, 1933 issue of RADIO-CRAFT, page 123.—*Technical Editor*) They know what's good for 'em and they have a reputation to sustain.

I can't see why a decent-sized mantel set can't be made to give good tone quality. Why use pentodes at all? And if so, is there no way of getting a rounded tone from them?

Some of the 1931 console sets being almost given away today are marvelous compared with the 1933 receivers containing pentodes. Maybe it's regeneration that spoils the tone. (This is true to a considerable extent, ordinarily.—*T. E.*)

The "three-tubes-in-one" idea is all poppycock; simply a delusion and a snare.

GEORGE GORDON,
11 *Jerome Street*,
Rahway, N. J.

The Editor is inclined to agree with Mr. Gordon regarding the quality of receivers using pentode output tubes. While, theoretically the output pentode is capable of high-quality reproduction, the practical factors entering the situation usually over-power this possibility. The impedance of the transformer or other form of load into which the pentode feeds *must be closely adjusted to the optimum value for the tube*, with the applied potentials, as clearly described in the article, "How to Use Pentodes," Part III, in the October, 1931 issue of RADIO-CRAFT, page 227. And this load impedance value is really critical — otherwise, harmonics are amplified out of all proportion to the fundamental tones and new harmonics are generated in the tube circuit.

To prevent this action, individual laboratory matching of the tube and load is required—which is certainly not done in most factory production lines. Theoretical results are seldom realized in practice.

Of the present-day sets, we have yet to hear one with pentode output tubes that could rival a well-designed, class A amplifier using triodes.—*Editor*

5 METER BROADCASTING —COMMENTS BY AN "OLD TIMER"

Editor, RADIO-CRAFT:

I have read your publications for the past ten years and know the part you play in the advancement of many phases of radio.

Your statement in the Editorial (RADIO-CRAFT, September 1933) on "Our Changing Radio" is very true as everyone knows and another change I would like to see is the addition of 5 meter converters on B.C.L. receivers; and the licensing of 5 meter broadcast stations.

There is no doubt that many towns and small cities would welcome the chance to have a local broadcast station. If the broadcast band wasn't as limited as it is, many new stations would "get on the air," as the number of applications received by the F.R.C. shows. Many stations of low power are not interested in reaching listeners outside of their city and its outskirts.

Five meters could very well be adapted to their purpose and as interference would not set up, all these stations could operate *on the same frequency*—and without a doubt the F.R.C. can spare 20 kc. or so in this region.

Receivers with 5 meter converters would not necessarily have to be tuned to receive these stations, as the frequency could be set. This would simplify the manufacture.

The introduction of 5 meter broadcasting would create a new era for the industry and another reason why those homes without a radio set should get one.

JOHN L. GERSHRY,
R-4, Lake Ariel,
Penna.

The facts mentioned by Mr. Gershry have been first recognized by those interested in supplying police equipment. Licenses have already been issued for experimental operation. Soon other interests will be clamoring for these, and lower, wavelengths.—*Technical Editor*

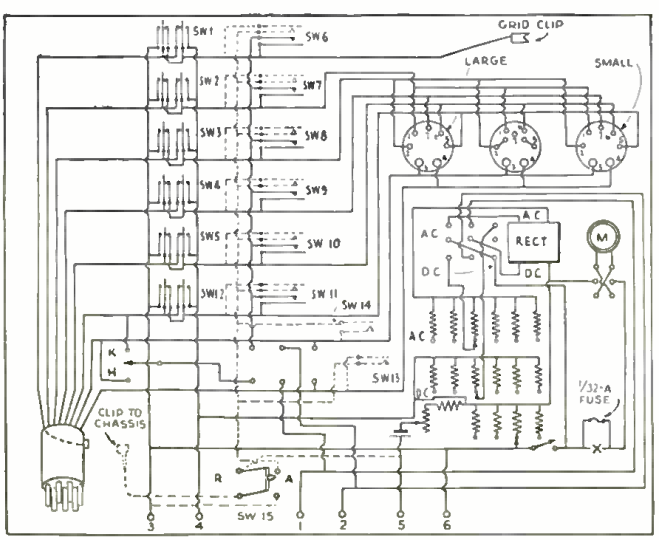


Fig. 1
Adapting the "Universal Analyzer" for resistance analysis. The circuit changes are indicated by dotted lines.

"UNIVERSAL ANALYZER" CHANGES FOR RESISTANCE TESTS

Editor, RADIO-CRAFT:

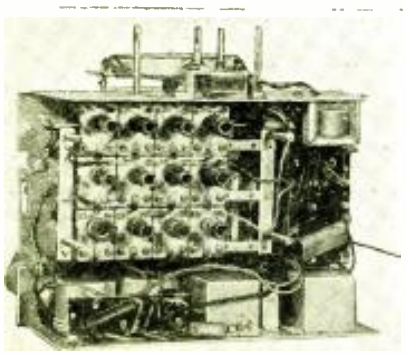
Many who constructed the RADIO-CRAFT Universal Analyzer which was described in the September, 1932 issue on page 138, which for voltage measurement used double-pole push button switches, can very conveniently make the improved RADIO-CRAFT analyzer in the October, 1933 issue.

While this analyzer uses single-contact push button switches for the voltage measurement, the old double-pole push button switches may be used in the improved analyzer with an additional D.P.S.T. toggle switch Sw.14, two single contact push button switches

(*Continued on page* 554)

G. E. MODEL K-80, 16.7 TO 2,000 METER, 8 TUBE ALL-WAVE SUPER.

(This chassis is used in the models K-80-X and K-85 receivers. Incorporates T.R.F. ahead of the first-detector; A.V.C.; class "B" A.F.; full-vision, illuminated, frequency-calibrated, aircraft-type vernier dial; tone control; 110 V. or 220 V. operation on 25 to 60 cycles.)



A bottom view of the G.E. model K-80. Note the 15 coils employed for all-wave reception.

That short-wave reception is here to stay as a practical branch of radio operation is an undisputed *fact*. Efficient short-wave reception has been realized only through the construction of high-power sets. The latest, most advanced engineering have been incorporated in the receiver design that is the subject of this Data Sheet; not only short-, but all-wave operation have been efficiently obtained.

The power rating of this set is 110 W.; undistorted output, 6 W. The ranges are as follows: selector switch position D, 16.7-37.5 meters; C, 30-77; B, 77-200; A, 200-555; and X, 732-2,000. This receiver is available with or without band X.

Except where otherwise indicated the directions apply only to bands X, A, B and C; for band D an additional R.F. circuit is utilized to increase the sensitivity and image-frequency selectivity, and to reduce the interference caused by tube hiss, and 445 kc. signals or static. The I.F. of 445 kc. gives an especially good frequency ratio and makes easier the alignment of the set oscillator at the higher frequency bands. There are 15 coils in the coil assembly. Following are the tube operating voltages at a line potential of 120 V.; voltages are measured from tube element to cathode.

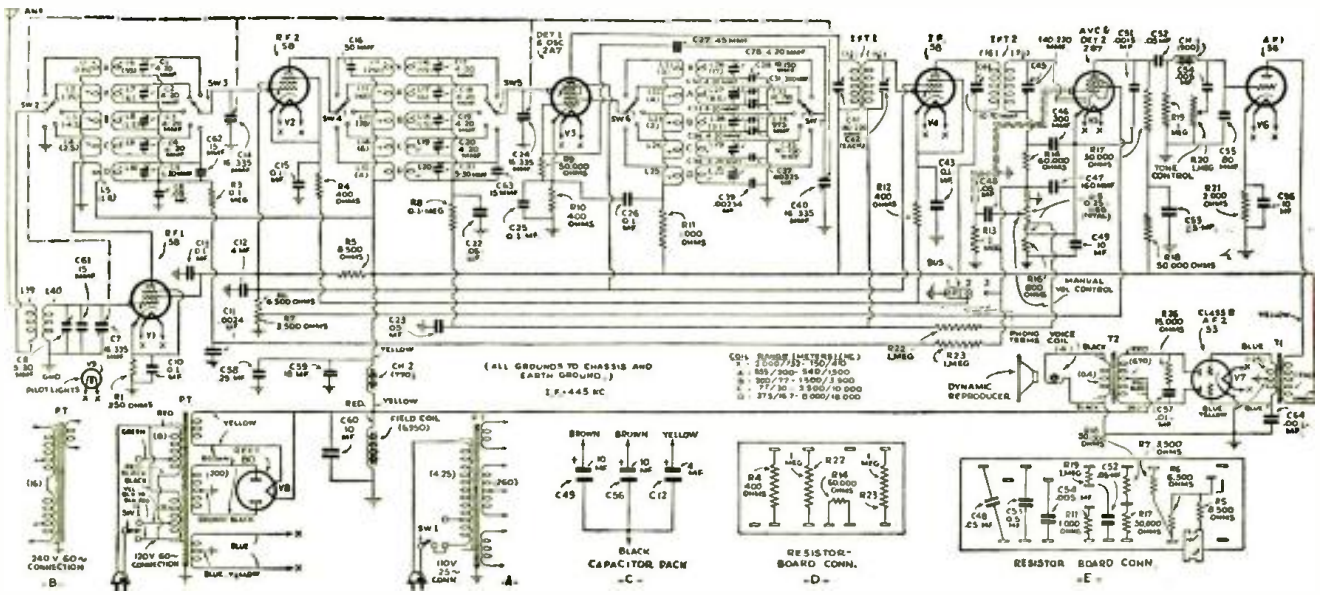
Tube Type	Plate Volts	C.-G. Volts	S.-G. Volts	Plate Ma.
V1	255	**2.0	100	6
V2	255	**2	100	6
V3	250	**2½	100	*5
V4	255	**2	100	6
V5	105	**1½	35	1½
V6	245	**12		6
V7	300	0		36

* Voltages and current readings apply to the detector portion; ** cannot be measured because of the high resistance of the circuits. Tube V8 measures 640 V., plate-to-plate; plate current is 130 ma. per plate. This receiver introduces to the Service Man the use of a particular type of "tuning wand." One end of the wand consists of a brass cylinder which when inserted in a coil reduces its effective inductance; the other end contains a special, finely-divided iron (suitable for use at radio frequencies) which, when inserted in a coil, raises its effective inductance. To use this "tuning wand" the signal is first tuned in at the frequency at which a check is desired on alignment. The wand is then inserted *slowly* in the antenna and R.F. transformers, using first one end and then the other of the wand. Unless the alignment is perfect, the output meter reading will be increased to a peak for a critical position of the wand in the coil. The end of the wand required will indicate whether the "coil" is high or low in resonance. Alignment at the H.F. end of a tuning range is accomplished by the use of the trimming condensers.

If alignment correction is required at the L.F. end of a tuning range, it may be accomplished by sliding the end winding of the R.F. transformer. The turn furthest from the trimmer panel is pushed forward to increase the inductance and further away to decrease it. On band D coils the last two or three turns may be pushed in a similar manner to obtain the correct inductance value. Note that this adjustment *should not be attempted* unless a quite appreciable improvement, as indicated by the use of the tuning wand, will result.

Magnetic pickup connections are provided on a terminal board at the rear of the chassis.

The output of the service oscillator should be set at the minimum value necessary to obtain a deflection of the output meter when the volume control is at its maximum position. The output posts of the service oscillator should be connected to the antenna and ground for the R.F. and oscillator adjustments; and between the first-detector control-grid and ground for the I.F. settings. Make all adjustments for a maximum deflection of the output meter. The recommended antenna system has a length of 25 to 75 feet, including lead-in and ground wire. The black lead of the chassis connects to the antenna, the yellow lead to ground. The power switch and tone control are ganged.



Schematic circuit diagram of the G.E. model K-80 all-wave superheterodyne receiver. A wave-change switch selects the correct coil for the desired reception band.

THE MAJESTIC MODEL 460 CHASSIS 6 TUBE SUPERHETERODYNE

(Models 461 and 463 receivers with type G-24-C reproducer; also set models 67, 68, 196, 666, 776, 886, left, in views below and 996, right, in views below. Includes delayed A.V.C., police-call reception, improved pre-selector system, flat sensitivity, tone control, line noise filter and new tubes, although the circuit used in this receiver is in general of conventional type. Modernistic cabinets.

The improved pre-selector circuit gives a greater image attenuation and greater stage gain resulting in a much lower percentage of noise for a given output level. Very careful design is carried out to insure excellent I.F. response.

The new A.V.C. circuit follows the modern trend of having an improved overload and A.V.C. action, but without the customary disadvantages of the more conventional circuits. This is accomplished by utilizing one diode plate for A.F. development only, and the other for A.V.C. voltage only. It is, therefore, possible to design an A.F. circuit and an A.V.C. circuit of optimum constants without any sacrifice of one to aid the other as has been the case in previous receivers. The result of this is a much greater power output for very weak, as well as strong, signals and a very constant output level over an extremely wide range of signal inputs, which of course effectively overcomes fading.

The use of a type 2A7S pentagrid converter results in a very flat sensitivity over the band covered: and makes it possible to control this stage with the A.V.C. voltage.

To align the receiver, adjust the volume control to maximum, supply a service oscillator frequency of 175 kc. to the control-grid of V2, and adjust the trimmers of I.F.T.1 and I.F.T.2 for maximum sensitivity. Finally, set the gang condenser at minimum capacity: be sure and supply a service oscillator frequency of 1,730 kc. to the input of the receiver and align the trimmers in shunt to the gang condenser sections. When correctly aligned, the sensitivity should be 10 microvolts or less at 100 milliwatts output with 30 per cent modulation.

Following are the tube voltages:

Tube Type	Plate Volts	S.G. Volts	Cath. Volts
V1	260	92	4.2
V2	260	92	4.2
V2	92	——	4.2
V3	260	92	4.2
V4	*	——	——
V4	65	——	23
V5	243	260	15

* Actual voltage at plate of tube. This reading will be much lower when a low resistance voltmeter is used, due to the drop across R3.

The first row of figures for V2 is for the modulator section; second row, the oscillator. The first row of figures for V4 refers to the second-detector section of the tube; second row, the first A.F. Filament to ground potential of V6 is 300 V., D.C.; line voltage, 115 V., A.C.; volume control in maximum position.

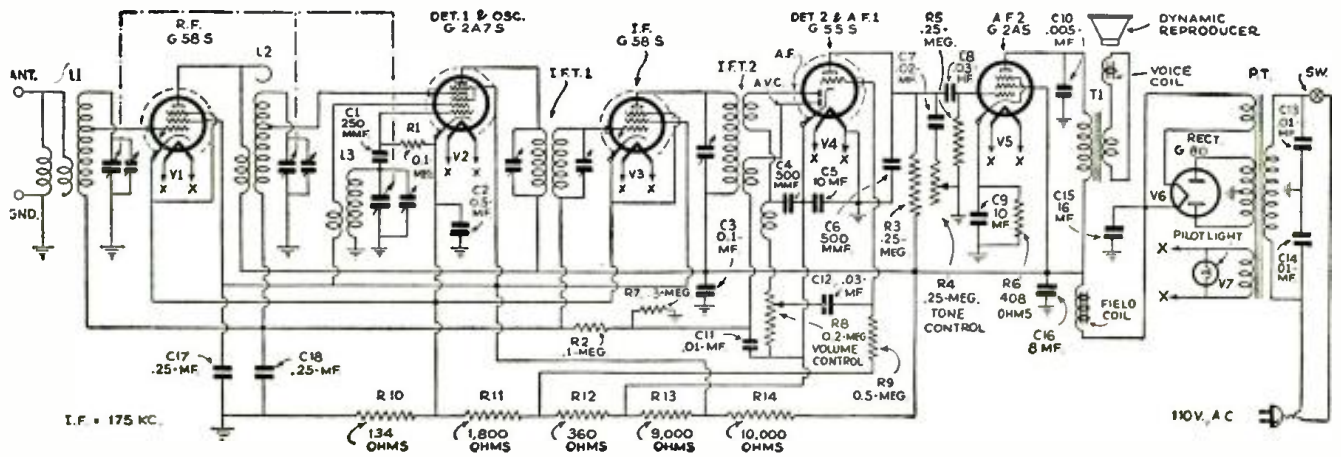
Resistance values, in ohms, for the inductances are as follows: L1 primary, 22.16; secondary, total, 5.38. Coil L2 primary, 146; secondary, 4.15. Coil L3 primary, 2.7; secondary, 2.13. Coil I.F.T.1 primary, 125; secondary, 122. I.F.T.2 primary, 148; A.F. secondary, 69.3; A.V.C. secondary, 68.3. Transformer T1 primary, 500. Field coil, 1,070. Each side of P.T. high-voltage secondary, 360.

The chassis-wiring color code referred to in radio service sheet No. 101, November, 1933 issue of RADIO-CRAFT, is followed in this receiver. Also, the same condenser color code is used. The resistor code is the standard one in which the body color represents the first figure of the resistance value; the end, the second figure of the resistance value; and, the dot, the number of ciphers following the first two figures.

This circuit is used in the model 463 Century Six ultra-midget set having a side panel of lacewood. The model 461 Master Six set is of matched butt walnut, with the controls on either side of a central, vertical decoration. The model 196 Gothic receiver has a "church window" patterned midget cabinet; and the controls are central and close together on a chromium finished dual scale. More pretentious are the floor models. These include the model 666 Ritz, a modernistic cabinet with central panels and sides of striped walnut, and pilasters of dark walnut. Also, the model 886 Park Avenue, a modernistic console of red and white birch finished in natural and ebony. Another model is the 776 Lido, a console cabinet with five different tones of wood from natural to ebony. Still other sets using this chassis include the model 67 Barclay. Its large console is in modified period design, in an over-all finish of brown walnut with a central panel of walnut. Also, the model 68 Plaza, a console cabinet in all-over walnut finish and central panel of matched butt walnut with overlay of lacewood. (The model 69 receiver, of which no record can be obtained at the moment of writing, is also said to be included in this series.)

Left, model 886 modernistic cabinet set. Right, model 996 with built-in bookcase.

The three dots on a mica condenser indicate its capacity and the two colored dots, its D.C. working voltage. On condensers having three dots on one side and two on the other, the designations are to be read with the capacity rating (3 dots) at the bottom, while on condensers having all five dots on one side the designations are to be read with the capacity rating on the top. Capacity: referring to the "figure code," the first color indicates the first digit of the capacity expressed in mmf. The second color indicates the second digit of the capacity expressed in mmf. The third color indicates the number of ciphers following the second digit of the capacity. As an example, a red, green and brown dot combination would indicate a capacity of 250 mmf.; and brown, black and red, .001-mf. Voltage: the first colored dot indicates multiples of 100 V., and the second one, multiples of 10 V. An example is orange and green dots, 350 V.; and, blue and black dots, 600 V.



THE ANALYSIS OF RADIO RECEIVER SYMPTOMS

OPERATING NOTES

BERTRAM M. FREED

WHAT THIS DEPARTMENT IS FOR

It is conducted especially for the professional Service Man. In it will be found the most unusual troubles encountered in radio service work, written in a practical manner, by Service Men for you.

Have you, as a professional man, encountered any unusual or interesting Service Kinks that may help your fellow workers? If so, let us have them. They will be paid for, upon publication, at regular space rates.

RCA-VICTOR R11, RE-18, RE-19, R-21, RAE 26

IN the June, 1933 issue of RADIO-CRAFT, mention was made by one contributor that the cure for distortion at any volume level on the RCA-Victor models R-11, RE-18, RE-19, R-21, RAE-26, and equivalent Westinghouse and General Electric receivers, was to throw the adjustment trimmers on the tuning gang slightly off one way or the other. This is absolutely incorrect and should never be attempted, for not only will it fail to accomplish the desired results, but will throw the calibration of the receiver off, because of disturbance of the oscillator trimmer; and reduce the sensitivity greatly, particularly at the high frequencies.

(Only in exceptional cases is it expedient to throw a circuit off tune; in general, it is poor practice.—*Tech. Ed.*)

With these receivers, distortion at any volume level is due to a defective voltage dividing system. The screen-grid voltage on the R.F., first-detector and I.F. tubes will be found much higher than the correct potential of 70-75 V. If a point-to-point resistance measurement is made between the plate and screen-grid, and screen-grid and cathode of the I.F. tube, an indication of the real trouble will be found. In the R-11, RE-18, R-21 and RAE-26 models, the reading obtained with the ohmmeter from plate to screen-grid should be approximately 19,000 ohms; the value being about 8,000 ohms for the RE-19. This is shown in Fig. 1.

Because of the heavy current passing through the screen-grid voltage drop resistor, a 2 W. "carbon" unit, the resistor carbonizes *and becomes* GREATLY REDUCED *in value*, in some cases as low as 1000 ohms but in most cases about 3,000 ohms. When this occurs, the unit connected from screen-grid to cathode often carbonizes at the same time, because of the additional stress placed upon it.

An explanation for this change in the value may be of some interest. A carbon resistor unit is usually composed of minute carbon particles *thoroughly mixed with equally minute particles of an insulating material*, such as bakelite and, by the aid of a binder, formed under heavy pressure. The quantity of carbon or insulating particles determines the resistance. When the current passing through the resistor is greater than its watts rating, many of the bakelite particles burn or carbonize, thus resulting in a unit of *reduced* value.

Remedy for the condition described is replacement of the large screen resistor unit A with one of higher current rating, preferably wire-wound, to keep within the physical limits. Resistor B from screen-grid to cathode should be replaced also, if it has changed in value.

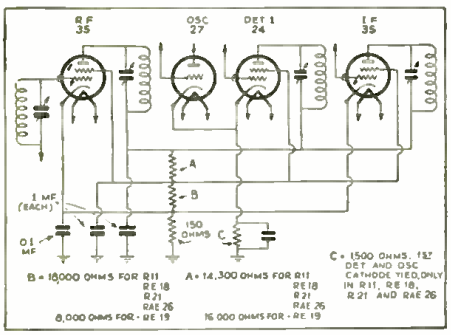
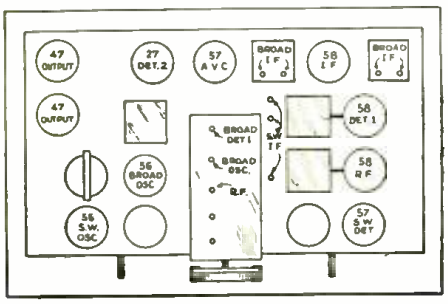


Fig. 1
Resistance values for various models.



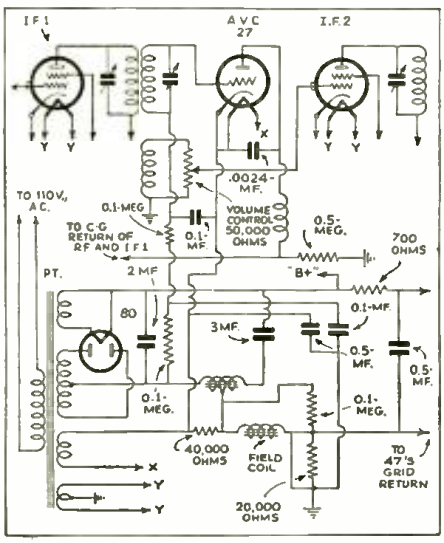


Fig. 2, left
The trimmers in the Stewart-Warner set. Detuning reduces image-frequency reception.

Fig. 3, above
The A.V.C. circuit of the model R-55.

STEWART-WARNER 105 SERIES

THIS SERIES of Stewart-Warner comprising models 50 to 59 is an 11 tube all-wave receiver employing a double superheterodyne circuit with 4 tuning ranges. When this receiver is installed in a locality where a powerful broadcasting station is transmitting on a frequency of 1,500 kc. it may be noted that this station will be received all over the short-wave tuning ranges. This is due to the fact that the short-wave intermediate frequency is set at 1,525 kc.—entirely too close to the broadcast band. If the district distributor is notified of this condition, instructions will be given to realign the short-wave I.F. trimmers at 1,525 kc. but in every instance this failed to produce the desired results. After a great deal of trial and experimentation it was found that after the short-wave I.F. had been realigned at 1.525 kc. to maximum output, it was necessary to throw the alignment out, by giving the middle trimmer a ¼- to ½-turn to the left (loosening the adjusting screw) while the interfering station, which may be even a nearby powerful broadcaster at 1,400 to 1,450 kc. is heard on any one of the short-wave bands. Of course, the *harmonics* of these interfering stations may be heard on the short-wave band, but *this is normal.*

Often, this receiver is very weak with the local-distance switch in the local position. Although the purpose of this switch is to eliminate noise while tuning from station to station, it is also possible to obtain greater response by realigning the broadcast gang trimmers, with the switch in the local position. A diagram showing the position of the trimmers is illustrated in Fig. 2.

(*Continued on page* 560)

RADIO-CRAFT'S INFORMATION BUREAU

SPECIAL NOTICE TO CORRESPONDENTS: Ask as many questions as you like, but please observe these rules:

Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. List each question. Be SURE to sign your name AND address.

Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.

Replies, magazines, etc., cannot be sent C. O. D.

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question; answers are subject to subsequent publication, if considered of exceptional interest.

Other inquiries must be marked "For Publication."

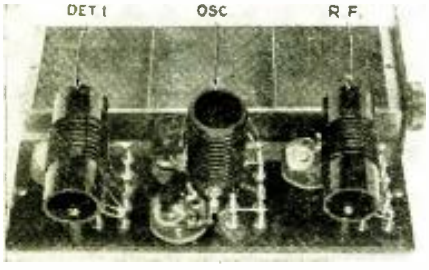


Fig. Q.245

Interior of the "drawer coil" unit.

ALL-PURPOSE PENTODE

(239) Mr. Bernard Little, Jeanette, Pa.

(Q.) In reviewing the March, 1932 issue of RADIO-CRAFT, I note an all-purpose pentode in which the commercial identification number is not given. In other words I do not know whether it is a 57, 37, etc.

In comparing its characteristics with the 24, I am tempted to replace the latter tubes in an Atwater Kent model 60.

Will such a step require a change in the circuit? Or can it be substituted as conveniently as the type 56 for the 27, without serious distortion and with benefits to gain?

(A.) The tube that Mr. Little mentions is now known as the type 46—a power output pentode. The characteristics of this tube were given in the article and it is evident that Mr. Little mis-interpreted them in suggesting that they might be used in R.F. or detector circuits. This tube is specifically designed as an output pentode.

DYNAMIC SPEAKER FOR "RADIOLAMP"

(240) Mr. Marvin Lehnert, Milwaukee, Wis.

(Q.) I constructed the receiver described in the May, 1933 issue of RADIO-CRAFT, on page 648. This set works very fine and I am well pleased with it. I have a small dynamic reproducer which I would like to use with it, but I don't know how to supply the field current. The field coil is 1,260 ohms.

I have tried several methods, but I either excite it too little or too much and it becomes hot. Placing it instead of the filter choke does not excite it enough and when it is connected across the "B" supply the field coil becomes hot. Can you give me any information about this?

(A.) The power circuit of the Radiolamp set you built has not been designed to supply the field coil of a dynamic reproducer. If you are using the set on a 110 V. D.C. line, then merely connect the field coil directly across the 110 V. If you are using the set on an A.C. line, then you must build a small rectifier system and connect the output directly to the dynamic speaker. The pattern of the power supply unit for the Radiolamp can be followed exactly, substituting a resistance of 225 ohms for the 40 W. lamp and the other filaments of the receiver. A single 8 mf. electrolytic condenser across the output will be sufficient filtering.

PROSECUTION FOR "BLOOPING" SETS

(241) Mr. J. Alinsky, Jr., Shenandoah, Pa.

(Q.) I am writing to you for some aid in answering a question brought up by a few of my friends. I would appreciate an answer if convenient. The question is as follows:

Is there any law in the United States regulations by which it is possible to arrest or stop a person from operating a receiving set which oscillates, such as the old-time, one tube regenerative type?

(A.) There is no law at the present time to stop a person from operating a receiving set, the circuit of which oscillates, unless the set becomes a nuisance and disturbs people. In the latter case, there are ordinances in numerous cities, towns and communities which necessitate the correct shielding and filtering of any electrical appliances that cause interference in radio receivers. Radiating radio receivers, as well as other electrical devices, would naturally come under this classification.

OVERHEATING RESISTORS IN A.C.-D.C. RECEIVERS

(242) Mr. Julian Lorenz, Washington, D. C.

(Q.) What can be done about cooling off the resistors in an A.C.-D.C. compact "personal" receiver? The resistor is placed near a paraffin-covered condenser which smokes whenever the set is run for two programs, or about an hour and a half. Will this affect the condenser?

(A.) It certainly is not correct for the condenser to smoke, as you mention. Possibly there is a short circuit in the set that causes the "bleeder" resistor to overheat. We would suggest that you check the values of all resistors in the set and if possible also check the condensers to determine if any of the components are faulty, or of incorrect value.

If the set is found to be in perfect condition, except for the overheated condenser, we suggest that you obtain a piece of sheet asbestos and wrap it around the condenser, to deflect some of the heat from the resistor. This will probably eliminate the trouble. Another expedient would be to use a "power cord," mentioned in past RADIO-CRAFT Data Sheets, selecting for the series resistor in the cord a value which is correct for the particular set.

PIANOTRON WIRING (A CORRECTION)

(243) Mr. Jack West, Oradell, N. J.

(Q.) In checking over the wiring of the Pianotron which appeared in the January, 1934 issue of RADIO-CRAFT, I find that the tuned circuit of the 1A6 tube, L2, C6, is not completed to ground. As I am thinking of building one of these instruments, I naturally want to be sure that the circuit is correct. Can you advise me?

(A.) On this page is shown a portion of the circuit of the Pianotron (Fig. Q.243), showing the addition of the wire that you mention. While this wire should be in place, the Pianotron will work quite well without it, as the grid circuit of the triode section of the 1A6 is completed through resistor R4.

The missing wire does not complete the tuned circuit as you say, as this oscillatory circuit is complete between coil L2 and condenser C6, whether this coil and condenser combination is connected to any other circuit or not.

POWER TRANSFORMER DATA

(244) Mr. Morris Hashmall, New York, N. Y.

(Q.1) I would appreciate it if you will send me the following information regarding the RADIO-CRAFT A.C. Pentode Portable receiver. In the reference data, you specify a power transformer with a 400 V. C.T. secondary. Does this mean 400 V. on each side of the center-tap, or 200 V. on each side?

(A.1) The power transformer in the A.C. Pentode Portable has a 400 V. secondary, with a center-tap. In other words, it has 200 V. on each side of the tap.

(Q.2) What are the plate and screen-grid voltages on the detector and the output tube, in the same set?

(A.2) The voltages supplied to the 24 and the 47 were not measured at the time that the set was available, so we cannot give this information with any great deal of accuracy. If you use the parts specified, however, all voltages should be correct.

COILS FOR THE NOVEL 9 TUBE ALL-WAVE SUPER.

(245) Mr. Ronald Moses, Buffalo, N. Y.

(Q.) In the February, 1934 issue of RADIO-CRAFT, which I have just finished reading, a set using drawer-type coils is described. This set is called the Novel 9 Tube All-Wave "Super." However, I do not find details for the coils used in this receiver. Can you supply this information?

(A.) The appearance of one of the coil drawers for this receiver is shown in Fig. Q.245. It will be noticed that the coil forms are mounted at right angles, in such a position that the wires to the contacts are extremely short. The copper shield that makes up the drawer is divided into three compartments, to further prevent interaction between the inductances.

Below are the details of turns, coil sizes, etc., for the entire group of coils, covering wavelengths of 540 to 14 meters.

Coil Data

Coil A—90 to 200 Meters

R.F. and Detector coils—53 turns No. 24 enamel wire, close wound, tapped at 33 turns for band spread. Wound on 1 3/16 in. form.

Oscillator coil—55 turns No. 24 enamel wire, close wound, tapped at 5 turns for cathode and 20 turns for band spread. —1 3/16 in. form.

(*Continued on page* 558)

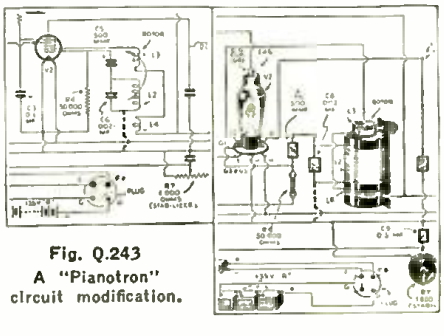


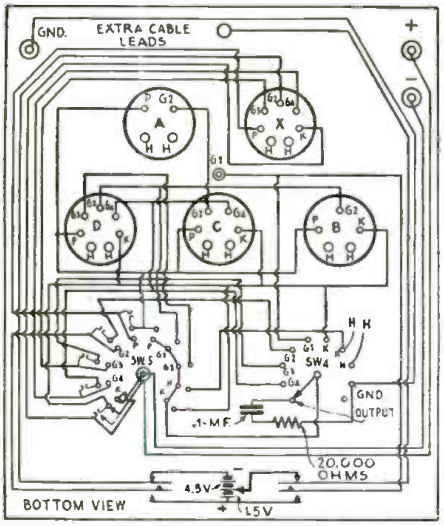
Fig. Q.243

A "Pianotron" circuit modification.

LATEST IN RADIO

UNIVERSAL ANALYZER

(*Continued from page 524*)



Schematic circuit of the analyzer

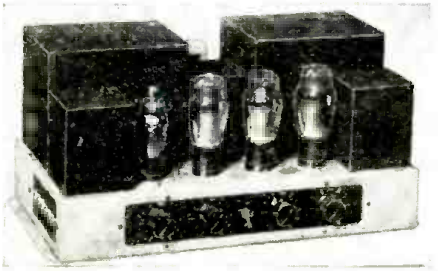
cable is plugged into the set in place of the tube. With power turned on in the set under test, the voltage between any of the elements of the tube and ground, or cathode, or between the elements themselves, may be measured by varying the positions of the two rotary switches, Sw.4 and Sw.5. Current readings are made by setting switch Sw.5 to the desired point and setting the 90 tester for current of the desired range. An additional feature is the determination of A.F. output directly by setting Sw.5 to Plate and Sw.4 to Output. This is useful in aligning work. Resistance measurements can be made by setting the 90 unit to resistance measurement.

SINGLE UNIT AMPLIFIER OR DRIVER

The unit shown below is a flexible, 2 stage, high-gain amplifier for P.A. work. It employs the class A system, with two 57 tubes in the first stage, and two 59's in the second, both stages being in push-pull. The power output of the amplifier is 3.2 W. and the gain is 65 db. at 1000 cycles. The power consumption is rated at 85 W. This amplifier is unusually flexible in its input requirements, being adaptable for carbon or condenser mikes; low- or high-impedance phono. pickups; or the plate of a triode detector for radio amplification. The output is adjustable for 4, 9 and 15 ohms to feed directly into the voice coils of dynamic speakers and a 500 ohm winding is also provided for remote line work.

This amplifier is designed for use either as a low-power P.A. amplifier or as a driver of a power stage for high power outputs. It has a self-contained microphone current supply with a current control thus eliminating the need for mike batteries.

(*Continued on page 566*)



An extremely flexible amplifier (419).

MAKING A 6F7 SERVICE OSCILLATOR

(*Continued on page* 534)

to line voltage fluctuations decreases rapidly with the temperature.

While on the subject of line voltage fluctuations, remember that frequency of oscillation is governed not only by the constants of the tuned circuit but also to some extent by the plate voltage. The service kit for which this particular job was built includes a line voltage adjustment as part of the tube test panel. If there is no such adjustment in your service kit it might be well. If you desire the greatest accuracy, to include one in the oscillator itself.

An answer to the third point was first sought in the use of separate coils covering each frequency band but the space required for these coils and the associated multi-point switch defeated entirely the object of compactness so it was abandoned in favor of a single, low-frequency coil and the oscillator so designed as to be as rich as possible in harmonics by biasing the amplifier tube somewhat below the straight portion of its curve.

A position is provided on the A.F. switch which completely stops A.F. oscillation and so provides the desired, modulated-unmodulated service.

The fourth point is solved by the inclusion of a shorting switch across the R.F. tuning condenser which stops R.F. oscillation and provides pure A.F.; and the use of a 5 point tuning switch cutting in various condensers across the plate portion of the A.F. oscillator inductance, the last of which is large enough to completely stop oscillation.

A potentiometer in the plate of the amplifier tube solves the fifth problem since the entire output is taken across this potentiometer acting as a voltage divider. The addition of a scale on the panel will allow this output to be compared with any available standard and definitely calibrated.

The final point is answered by completely isolating the output circuit with reference to D.C. by means of condensers.

The Circuit

Reference to the diagram will show the simplicity of the circuit. Rectification for A.C. use is accomplished by the application of the 25Z5 tube. The rectified current is put through a single-section filter consisting of the 1 mf. paper condenser, C12, the 15 hy. choke, L4, and the 8 mf. electrolytic condenser C13. Due to the very small current drain of the entire outfit, this simple filter is amply sufficient to insure freedom from 60 cycle modulation. The first filter condenser is made small to decrease the voltage difference of A.C. compared with D.C. operation.

The oscillator proper consists of a type 6F7 tube, which is a pentode and triode contained in the same bulb. The pentode section is used as an A.F. oscillator while the triode functions as an independent R.F. oscillator. Either frequency may be varied at will without causing the least variation in the other.

The oscillating voltages so developed are fed into the two grids of a Wunderlich tube which functions as a modulator tube and the modulated output from the plate of this tube is fed into the potentiometer, R4, acting as a load resistor.

A word about this tube may not be amiss for those who may perhaps not be familiar with it. It contains a heater, a cathode, two coplanar grids and a plate. The novelty and usefulness of this tube lies in the use of these coplanar grids—which term simply means that the two grids are wound over the same supports, in the same plane and are *exactly* identical; so identical that if a positive voltage is applied to one grid and an equal negative voltage to the other, *there will be no change in plate current.*

There is, however, considerable capacity between these two grids and for that reason the R.F. choke L5 is included in the A.F. grid lead to prevent the leakage of R.F., especially at the higher frequencies, back through the rather effective R.F. ground formed by this circuit.

The coupling condensers C8 and C9 are about the only really critical values in the circuit. If they are made too large, there will be a tuning effect of the A.F. on the R.F., and vice-versa. On the other hand, if made too small there will be frequency discrimination in regard to transfer of energy to the output tube. The values shown seem to be about the happy medium, though if you wish, you can indulge in experiment on this score. Condenser C8, of course, controls the percentage of modulation of the R.F. output.

Radio frequency variation is obtained in the usual manner through the tuning condenser C1, while variation of audio tone is achieved through the use of a tapped switch placing various values of capacity across the plate section of the A.F. inductance L3. The .25-mf. condenser was sufficient with the inductance used in the original model to stop oscillation entirely and the other values gave a variation from an extremely high to a very low note. These, also, are subject to variation and depend on the A.F. inductance used, though the values shown should be satisfactory with the average inductance.

Building

Very little need be said on this subject as the average builder of a circuit of this type will be an experienced constructor and will know exactly how to go about it. The main point that may be stressed is that everything must be fastened down solidly, especially the wiring of the tuned circuits or you will be troubled with instability and modulation due to the vibration of thin wires.

The R.F. coil consists of 360 turns, random-wound over a space of 1⅛ ins. on a 1⅝-ins. dia. tube for the tuned portion; and 250 turns wound in a ⅞-in. space and removed about ¼-in. from the primary, of No. 34 D.C.C. wire. The size wire is not critical but it had better be double cotton.

The center-tapped output choke specified is the old fashioned R.C.A. job which was used in some of the earlier battery models and which is available from many of the mail order houses. The inductance of this coil is sufficiently low so that a very high A.F. is readily obtained.

Don't forget to provide plenty of ventilation in the rectifier section as considerable heat is developed in the tube filament dropping resistor. The original model has the resistor mounted on the end wall with holes at bottom and top and a chimney inside made of asbestos paper.

Calibration

After the unit is built, there remains the problem of calibration of both audio and radio frequencies.

The A.F. may be very simply calibrated by comparing the tone with a piano keyboard. Almost any physics text book will have a chart showing the physical pitch of the various keys.

Radio frequency calibration is nearly as simple, but requires the use of a calibrated receiver. Most modern receivers are calibrated directly in kc., check this calibration against several stations of known frequency scattered over the dial. If your receiver is not calibrated this will first have to be done, drawing a curve of dial settings against frequency. Now connect the output of the oscillator to the receiver with the shielded lead and start the oscillator delivering a modulated R.F. signal. Turning the dial of the receiver will result in a number of response points being observed. *The difference in kc. between any two of these points is the fundamental frequency of the oscillator at that setting.* It should be around 100 kc. with the coil specified but this need not be accurate. All that is necessary is that it be below 130 kc. which is about the lowest frequency used in any modern I.F. amplifier. A repetition of this procedure with different oscillator dial settings will result in sufficient points being determined to draw a proper curve.

Calibration of the *intensity* of output is also very useful. Most of us engaged in service work have several "standard" stations that we use in judging the performance of a receiver. This is all very well as long as we are in the shop but in the field we are sometimes lost. By using a D.P.D.T. switch to connect the receiver alternately to antenna and oscillator we may compare the oscillator with these stations. Marking the position of these points on the panel gives us a very excellent empirical standard which we may always have available.

This same "stunt" may be used to calibrate the A.F. output by comparing the oscillator with a microphone, a phonograph pickup and the like. But be sure that this comparison is made at the same frequency, or it will be meaningless.

List of Parts

One Hammarlund midget tuning condenser, type MC325-M, C1;
One R.F. choke, 85 mhy, L5;
One bakelite tube, 1⅝ in. dia. x 3 ins. long;
Four I.R.C. ½-meg., ½-W. resistors, R1, R2, R6, R7;
One Lynch 2,500 ohm, 1 W. resistor, R3;
One Lynch 70,000 ohm, ½-W. resistor, R6;
One Lynch 200 ohm, 25 W. resistor, R5;
One Centralab potentiometer, tapered, 25,000 ohms, type sample No. 1866, R4;
One Polymet mica condenser, 250 mmf, C2;
Two Polymet mica condensers, .001-mf, C3, C9;
One Polymet mica condenser, .005-mf, C8;
Two Aerovox paper condensers, .02-mf., 600 V., C10, C11;
One Aerovox paper condenser, .006-mf., 200 V., C7;
One Aerovox paper condenser, .01-mf., 200 V., C6;
One Aerovox paper condenser, .05-mf., 200 V., C5;
One Aerovox paper condenser, .25-mf., 200 V., C4;
One Aerovox paper condenser, 1 mf., 200 V., C12;
One Aerovox electrolytic condenser, type V8, 8 mf., 450 V., C 13;
One Aerovox electrolytic condenser, 25 mf., 25 V., C14;
One Universal midget 30 hy. choke, L4;
One R.C.A. output choke, as specified, L3;
One 5 point switch, S3;
Two midget fixture-type switches, S1, S2;
One Na-Ald 5 prong socket for V1;
One Na-Ald 7 prong socket for V2;
One Na-Ald 6 prong socket for V3;
One RCA type 25Z5 tube, V1;
One RCA type 6F7 tube, V2;
One Auto-Wunderlich type tube, V3;
Two tip jacks;
Two tip jack plugs;
Two Pee Wee clips;
Necessary hardware, aluminum for box, wire, length of shielded wire for output cable, cord and plug for power cable.

REWIRING FILAMENTS FOR THE "AIRCELL"

(*Continued from page 532*)

became necessary to develop a line of "aircell tubes" to match the battery. These tubes sometimes are called 2 V. tubes.

Being intended to be operated only by the aircell battery, which, in a correctly designed filament circuit can't possibly over-voltage the tubes, it was not necessary to have as wide a margin of safety in the filaments against accidental over-voltage as had been the case with dry cell tubes. Because of this, aircell tubes operate on much less filament *power* than the original dry cell tubes. While this makes them even more vulnerable to over-voltage than the dry cell tubes, the hazard of over-voltage is absent in an aircell receiver, and the resulting decrease in battery drain fully justified taking the tube out of the dry battery class.

Although sometimes referred to as "2-V." tubes, this reference is not correct. Actually, the tubes are designed to draw their rated filament current at 2.10 V.; one make is "centered" at 2.15 V. The upper safe limit is 2.20 V., and the lower limit of satisfactory operation is 1.80 V. Anything over 2.20 V. will damage the tubes and anything under 1.80 V. will cause weak reception; or, in the case of tubes which have been used several hundred hours, complete loss of reception. Figure 1 shows how well the filament characteristics of the "aircell tube" have been matched with the voltage characteristics of the "aircell battery."

"Aircell" Circuits

Figure 3A shows the simplest kind of filament circuit layout for an aircell receiver.

All tube filaments are connected in parallel across the filament bus (parallel line), the circuit being completed through the fixed resistor and the on-off switch.

The resistor is calculated as follows: first, calculate the total filament current which will flow when 2.20 V. are impressed on the tubes. Remembering that the tubes draw their rated current at 2.10 V., it will be sufficiently accurate to apply Ohm's law to find out what it will be at 2.20 V. The battery voltage being 2.53 V., it is necessary to have enough resistance in the circuit to produce a drop of 0.33-V. Knowing the current to be carried, the amount of resistance required can be calculated. This is not the value of the resistor, however; it is the *total* resistance needed, and the total is usually made up of three main elements—the leads, the switch and the resistor, itself. To get the value of the resistor, it is necessary to know the resistance of the leads and switch, and subtract it from the total resistance required.

This part of the circuit must be designed and manufactured with considerable precision. From Fig. 1 it can be seen that if the resistor is too large, the tubes will be undervoltaged from the start, and that the net filament voltage may fall to 1.80 V. before the aircell battery can have delivered its rated life. This would cause complaints of short battery life. On the other hand, if the resistor is too small, the tubes will be overvoltaged, and this would cause complaints of short tube life. The lee-way between too much and too little resistance is quite narrow.

Figure 3B shows a more complex and, at present, the most common type of aircell receiver filament circuit. The main point of interest from a design standpoint is the presence of choke and coupling coils in the filament legs of one of the tubes.

These coils usually have considerable resistance, amounting in some cases to as much as 4 ohms. The tube usually associated with these coils is the 1A6, having a 60 ma. filament. If operated at 2.20 V. initially, it will draw 62.8 ma., and this current flowing through 4 ohms will produce a drop of 0.25-V. If we were to lay out the circuit as in Fig. 3B, and provide a resistor to produce a drop of 0.33-V., leaving the required 2.20 V. across the filament bus, the 1A6 will have only 1.95 V., since 0.25-V. is lost in the coils. This means that it would reach the lower 1.80 V. limit after only about 300 or 350 ampere-hours had been delivered by the aircell battery, which would be wholly unsatisfactory to the user.

It would be equally bad to reduce the main resistor enough to raise the voltage on the 1A6 to 2.20 V., since this would over-voltage all the other tubes to the extent of 0.25-V., or approximately 12% over their rated voltage. The resulting short tube life would be as bad, if not worse than the short battery life resulting from under-voltaging the 1A6.

Figure 3C shows how this problem is being handled by aircell receiver manufacturers. Since the coils in the filament legs of the 1A6 absorb 0.25-V., a second resistor, R2, is inserted in the circuit between the 1A6 and the rest of the tubes, designed to produce the same drop. Then the main resistor is designed to produce the rest of the required drop of 0.33-V., or 0.08 V. In this way, the net voltage at the filament terminals of all tubes is the same, 2.20 V., insuring maximum life both of the tubes and of the "A" battery.

The figures just used apply only when the combined resistance of the choke and coupling coils is 4 ohms. The procedure for other coil resistances is the same, however. The supplementary resistor, R2, is designed to produce the same voltage drop as the coils, and the main resistor makes up the rest of the required 0.33-V. drop.

Alternative Ideas

A few aircell receiver manufacturers feel that it is desirable to make it possible for their customers to exercise a choice in the matter of "A" batteries, so that a dry "A" pack may be used if desired. In such cases, a rheostat is provided, with a separate "A" battery lead, including the rheostat, bypassing the fixed resistor. In such cases, that part of the circuit intended for dry "A" battery operation becomes essentially the same as Fig. 2, with the voltage constants changed.

The "A" battery voltage is 3.0 V. initial and 2.0 V. final. The rheostat must be manipulated to keep the tube voltage reasonably close to 2 volts. All the elements of risk that caused the failure of the old dry battery sets are present in this setup. The user still has 50% more voltage at his disposal than the tubes can stand; it is still up to him to adjust the rheostat in accordance with the shape of the dry battery voltage discharge curve, an operation calling for more technical knowledge and skill than the ordinary man possesses; the tubes themselves are even more vulnerable to over-voltage than was the case in the past, which increases the hazards incident to dry battery operation, all of which strongly indicates that such practice should be discouraged.

●

AN ELECTRO-MUSICAL "TROMBONE"

(*Continued from page* 525)

left of Fig. A. The outer extremity of the lever moves over a wooden circular arc, on which are marked the tonal intervals.

The instrument possesses an agreeable timbre. Its musical range is easily adjusted to cover two octaves, nearly the same range as the bass voice. By increasing the current through the light-source, this range can be increased to a considerable degree, but the intervals on the arc become too crowded for facility of operation.

The instrument could be improved by providing means for adjusting the volume of the generated tones. As it is, there is only one volume level. Another improvement would consist in the A.C. operation of the light-source. The first improvement may be attained by connecting two or more "staccato" keys in the loudspeaker circuit, one key for each desired volume level. The second improvement may be accomplished, as previously explained, by the use of a photo-conductive cell.

Other improvements could be made regarding the quality of the sound generated by the instrument. Suitable A.F. filters or additional photo-electric glow-discharge oscillators may be used so as to enhance or suppress certain harmonics and, thereby, change the timbre of the sounds.

Many other electro-musical instruments can be devised along the same lines of the experimental form described. (The unit illustrated was built up to satisfy the demands of patent specifications; and to demonstrate the principle involved.—*Technical Editor*)

List of Parts

Three - prong sockets;
One midget magnetic reproducer;
One RCA type 80 tube;
One RCA type 45 tube;
One RCA photoelectric cell;
One 2 W., S-14 bulb, neon glow lamp, without protective resistor;
One incandescent lamp, type 14, 2.5 V., .3-A.;
One Polymet mica condenser, .005-mf.;
One General Transformer 30 hy. choke coil;
One Aerovox paper condenser, 0.05-mf.;
One Lynch adjustable resistor, 50,000 ohms, 10 W.;
One Aerovox electrolytic, multiple-section condenser, 4-8 mf., 500 V.;
One Precision resistor, 10 megohms, 1 W.;
One Precision resistor, 2 megs., 1 W.;
One Precision resistor, 2,500 ohms, 10 W.;
One rheostat, 2 ohms, 1 W.;
One Polymet bypass condenser, 4 mf.;
One Polymet mica condenser, .002-mf.;
Two medium-size dry cells, 1.5 V.;
One General Transformer power transformer, 400 V., 25 ma., C.T.; 2.5 V., 3.5 A., C.T.; and 5 V., 2 A.;
One toggle switch;
One flashlight reflector, small size;
One Blan aluminum box, 8 x 8 x 6 ins.;
One wooden arc, ¼-in. thick, 11 in. outer radius, 10 in. inner radius;
One aluminum box, 3 x 2 x 1 in., for exciter-lamp housing;
One plug and cable, 110 V.;
One double-contact, bayonet-base socket, for the neon tube;
One S.P.S.T. switch;
Two 0.5-A. fuses;
Angle brackets, wire and hardware.

THE RADIO MONTH IN REVIEW

(*Continued from page* 519)

of radio operation and control, would entail on the part of the American people a willingness to take the following three steps.

"First, they would have to be willing to completely scrap the present American structure and to create, under the Federal Government, a public, non-profit monopoly for the purpose of owning and operating all of the broadcasting facilities of the country.

"Second, they would have to be willing to subject this new broadcasting system to regulation by a government agent, whose authority would extend to the point of possessing a complete censorship over programs. In Great Britain the General Post Office possesses this power.

"Third, they would have to be willing to support the new system by means of taxation and not by paid advertising.

"The broadcasting problems of the United States are vastly different from those of a small country, of only 94,000 square miles, in which there are slightly more than 4,000,000 sets. According to the B.B.C. Yearbook, *three of the British stations are able to serve 75 per cent of all British listeners.*

"Contrast this to the American problems. Here there is an area of more than 3,000,000 square miles to be served—an area thirty-two times that of the United Kingdom. In it are located more than 17,000,000 receiving sets—not highly concentrated as in Great Britain—but scattered far and wide."

According to Doc Hettinger's statements, Uncle Sam would not find John Bull's methods at all to his liking.

However, past experience has indicated that debates such as this one result in steps being taken to follow the better course that these controversies bring to light. Therefore, the conclusions of this debate, in the thousands of high schools throughout the country, should result in improved radio broadcast programs.

PERCENTAGE OF PROGRAMS OF VARIOUS TYPES

PERCENTAGE OF B.B.C. PROGRAMS

Type of Program	% of Total Hours National	% of Total Hours Regional
Serious music	21.4	22.2
Light music	18.3	34.8
Variety music	4.1	4.7
Dance bands	10.5	19.7
Gramophone records	4.5	2.0
Total music	58.8	83.4
Drama	1.9	1.7
Talks and readings	9.0	1.6
Schools: education	2.8	...
Adult education	2.2	3.1
News and running comments	9.2	8.6
Religious services	5.5	1.1
Appeals	0.2	0.2
Children's hour	5.6	...
Special transmission	0.4	0.1
Pictures	4.4	0.2
Total	100.0	100.0

PERCENTAGE OF NBC AND COLUMBIA PROGRAMS

Type of Program	Sun., Nov. 6	Wed. Nov. 9
Classical music	16.4	6.6
Semi-classical music	19.0	14.0
Folk music and ballads	3.0	1.5
Variety music	3.4	1.5
Popular music	26.5	37.5
Total music	68.3	61.1
Children's programs	2.4	3.5
Comedy broadcasts	2.0	4.6
Other dramatic programs	7.4	8.0
Adult educational programs	3.4	3.6
Children's educat. programs	...	1.0
Farm programs	...	1.5
International rebroadcasts	1.0	1.0
News, m'k't, w'ther reports	...	1.0
Religious broadcasts	7.0	0.6
Sports broadcasts	...	...
Special pub. interest features	1.0	0.6
Women's feature programs	7.5	10.0
Variety programs	...	3.5
Total programs	100.0	100.0

INTERNATIONAL RADIO REVIEW

(*Continued from page* 527)

presence of a signal. The length of the line shows the strength of signal.

It is of interest to Service Men and experimenters to note that this simple little cathode-ray tube has many other uses besides its prime application as a tuning indicator. It can be used to align the circuits of I.F. amplifiers; for simple wave-form analysis of A.F. amplifiers; for high-frequency voltage measurement (as an A.C. voltmeter) and many other uses that will suggest themselves to the technical man.

DELAYED A.V.C. WITH A CRYSTAL

UP TO this time, the introduction of A.V.C. to "straight" sets using grid detection has necessitated complicated and costly alterations.

The system shown in Fig. 6 eliminates this difficulty by the application of dry-disc rectifiers, available in Europe for detecting purposes. The circuit shown, employs two of these rectifiers, one a full-wave unit which acts as the second-detector, and the other a half-wave unit as the A.V.C.

The A.V.C. rectifier is simply connected in the detector bypass circuit and the D.C. at the output is used, after passing through a suitable filter, for controlling the bias applied to the variable-mu tube.

The second-detector of the receiver is replaced by a crystal (as explained above) of the full-wave type to give an equivalent of double-diode detection. The crystal units operate on the principle of the dry-disc metal rectifiers used for converting D.C. milliammeters into A.C. meters. These R.F. detectors have been especially designed for the detection of high-frequency currents, though and have a very small internal capacity. They are sold in Europe under the trade name of Westector.

The use of crystals for the purpose of detection and A.V.C. in large receivers has the advantage of reducing the number of tubes required to give the desired results. However, as we have pointed out before (RADIO-CRAFT, January 1934, page 418), ordinary crystals cannot be used, as the voltages developed in sensitive superhets, would burn the contact and disrupt detection. Special rectifiers of the type mentioned are necessary. They cannot be obtained in the U. S. at this time.

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READERS' DEPARTMENT

(*Continued from page* 543)

Sw.12 and Sw.13, to make this a *resistance analyzer* without interrupting any other use of the analyzer. The connections are shown in Fig. 1. The analyzer can be plugged in, and all current and voltage tests made in the usual manner; or the radio set power cord may be disconnected and a resistance measurement made from the same plug.

All that is necessary to make the resistance measurement is to turn the A.C.-O-D.C. switch to the off position, connect a clip to the set chassis, turn Sw.14 to the R position, and the I.—E. switch to the I position; press push buttons Nos. 6 to 13 to measure resistance from any connection of the tube socket to the chassis of the set.

In making resistance tests, be sure the set is disconnected from any source of power. A 1/32-A. fuse is added in the meter circuit to protect the meter against any error in using the tester. For instance, making a voltage test with the clip to chassis and Sw.14 in the R position, will cause damage to the meter. Be sure Sw.14 is in the A position, and that the clip is disconnected, when using the analyzer for other than resistance measurements.

R. L. DAWSON,
1015 *Knight Street,*
Lynchburg, Va.

CHEAP, EFFECTIVE ADVERTISING

Editor, RADIO-CRAFT:

I am describing below a form of advertising which I believe to be one of the cheapest, as well as one of the most effective to insure "repeat" business.

I had a large quantity of business cards on hand, as well as having an old paper punch of the variety used to punch holes in paper for use on a "ring-board" (similar to a clasp-board). I punched a quantity of the cards at the end, reinforced the hole with a gummed reinforcement on each side, supplied it with a string, and Presto! I had a first class tag. Total cost 5 cents per 100!

I tie one of these to the cord of each radio set leaving my service bench. These are not often torn off, if they are tied up close to the chassis.

Now here is what invariably happens when something goes "haywire" with the radio in the home (long after the regular advertising is mislaid and forgotten): there is usually at least one curious man in each household who will turn the receiver around to see if the tubes are all burning. If not, he usually buys new tubes, which may or may not correct the trouble, but if it does not, he usually calls the first radio man he can think of—and that's where the tag does its bit. To my way of thinking, all the radio service advertising in the world does no good if the service is not needed, or rather I should say, if the owner *thinks* he doesn't need service. But when the radio "quits," that's when advertising about service is really needed, and Mr. Tag does his stuff just then.

I also find it comparatively easier to go up to a stranger and ask him to tie one of these tags on his radio than to hand him a card and tell him I'd like to service his "radio," because the chances that he needs service at that particular time are nil, whereas it is only human nature to tie any kind of tag to something. A little understanding of this human nature is the thing that puts it across. A business card is often thrown away when the dry-cleaner comes around at cleaning time and the "old man's" pockets are emptied!

HARRY L. KAGAMASTER,
107 W. *Market St.,*
Akron, Ohio.

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LATEST IN RADIO

(*Continued from page* 523)

between L1 and L2, in fractions of an inch, is given at X.

W.L. Range	Coil L1	Turns L2	X for L1-L2	Wire Size
15- 23	3¾	5¾	1/8-in.	No. 28 D.S.C.
23- 45	6¾	5¾	1/8-in.	No. 28 D.S.C.
45-115	15¾	6¾	1/8-in.	No. 28 D.S.C.
115-200	38¾	9¾	1/8-in.	No. 29 D.S.C.
195-400	75¾	10¾	1/8-in.	No. 38 S.S.C.
340-625	174¾	25¾	1/8-in.	No. 38 S.S.C.

A List of Parts is given for those who may want to select individual items to complete an instrument incorporating the circuit of this most successful of 2 tube receivers, which uses plug-in coils.

List of Parts

One Hammarlund variable condenser, 140 mmf.;
One A.F. transformer, 3 to 1 ratio;
One tuning dial;
One 4 wire battery cable;
One Centralab potentiometer, 50,000 ohms;
One rheostat, 10 to 30 ohms;
Three Na-Ald UX type wafer sockets;
Two RCA type 30 tubes;
One Aerovox bypass condenser, .25-mf., 200 V.;
One twin phone jack;
One Hammarlund antenna equalizing condenser, 100 mmf.;
One Lynch resistor, 5 megs.;
Two molded mica condensers, 100 mmf.;
One Harrison metal panel, 7½ x 7 ins. high;
One Harrison metal subpanel, 7½ x 5 x 2½ ins. deep;
Two knobs;
Four coils or coil forms, or one kit of Harrison coils;
Miscellaneous hardware, wire, etc.

Selecting P.A. Equipment

(Continued from page 536)

where the sound output has to be distributed over considerable distances it is wiser to use a horn for that purpose.

The second type of dynamic unit that is available is of the small-diaphragm type. These units, of course, can be used on horns only and are excellent for their purpose of sound distribution in any given direction. An interesting example of their use is at airports, where the sound has to be carried out across the field for a distance of a quarter of a mile, or more. In that case it is necessary to confine every available bit of energy to a concentrated field so that the maximum distance coverage can be obtained.

The modern tendency is to use two or more reproducers so that a wider range of frequencies can be obtained. This will result in combinations, of horn and baffle type reproducers, which reproducers should be of vital interest to all sound equipment users.

In the average installation, the writer has noted that the tendency is to use as few reproducers as possible and run them at a point where they are badly overloaded. This results in poor quality and should be avoided. If it is necessary to push the reproducers for a given coverage, it is wiser to use additional reproducers well placed, and work them all at reasonable volume. This will result in better quality output and longer active life for the reproducers themselves.

Power Required

While the exception will prove the rule, the following statements have worked out very well in practice, and should be quite satisfactory for use as a guide in the selection of a number of reproducer units to be employed for satisfactory operation. If, to fulfill any of these requirements, it becomes necessary to overload the reproducer (or reproducers), it is recommended that an additional reproducer be used so as to keep the reproducer-working-level below the point at which distortion would be generated by the reproducers themselves. In a room seating 500 persons or less, one dynamic reproducer would generally be satisfactory. In rooms seating up to 1,000 persons, two dynamic reproducers should give excellent sound coverage. In auditoriums seating up to 2,000 people, three or four dynamic reproducers can be used very efficiently—with the choice in favor of the fourth reproducer for most satisfactory results.

In all calculations involving the amount of power necessary for a given operating condition, the following figures can be used as a rough, but very satisfactory, check to determine the maximum amount of power necessary.

The reference level to which the succeeding figures are based is zero level, or a power of .006-milliwatt. For headsets, allow approximately .0004-watt per unit. For hotel guest rooms allow .048-watt per speaker. For offices, average-size living rooms, small reception rooms, etc., allow about .15-watt. In school class rooms, club rooms, lobbies of hotels, hospital wards, card-rooms, large living rooms or libraries, allow about 0.3-watt. Rooms seating up to 500 people, allow about 3 watts. From this point on it would be wise to use more than one reproducer and divide the load between two units for most satisfactory operation.

Rooms capable of seating up to 1,000 people use about 6 watts. In rooms with a seating capacity of 1,500 persons, or over, use about 10 watts. This necessitates the use of at least two reproducers; and in instances where the rooms are very noisy it would be wise to use four reproducers carefully placed to give the maximum coverage.

One should always bear in mind that a large room of equal capacity in cubic feet, in which there is a low noise level, requires less power than would be necessary in a room of equal size which was used as a dance hall or a roller skating rink (for example).

In general, when reproducers are to be used in the open air, or in places such as ice skating rinks, it would be advisable to use the horn-type speakers, so that the correct sound coverage can be obtained with the minimum amount of power. The reproducers recommended for use under the conditions stated in the first part of this section can be of the dynamic cone type with a suitable baffle for the best average operation.

Adequate Coverage

While experience in the selection of the required material for a given installation cannot be obtained over night, the above-mentioned figures will enable the newcomer in the sound game to choose equipment that will be applicable to his needs.

There is nothing quite so exasperating as to have a sound system that is very satisfactory insofar as frequency response is concerned, but lacking in the necessary power to satisfactorily fulfill the conditions imposed upon the equipment by the room or space to be covered by sound. Therefore, *it is always advisable to select equipment which will supply more sound energy than actually required for the occasion.* Be on the safe side and select equipment which is capable of giving you the frequency response that you desire and still be able to deliver more power upon demand, so that the unexpected conditions which often arise in sound work can be overcome with smoothness and efficiency. (The relation of watts power to decibel, or "db." ratings is given in RADIO-CRAFT—November, 1931, Information Bureau.—*Technical Editor*)

The author will be glad to assist designers and builders of sound equipment, who have individual questions or problems.

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*Chief Engineer, Acratest Products Co.

DYNATRON OPERATION

(*Continued from page* 535)

V. tap to the grid connection of the tube, as shown in Fig. 2.

This procedure results in applying a greater voltage to the grid of the tube than is impressed upon the plate. Thus, as the electrons fly through space, after they have left the filament, they strike the surface of the metal elements with which they come into contact, with such force that *other electrons are actually separated from the surface to which they previously belonged.* The electrons that are jarred loose are commonly referred to as "secondary-emission electrons."

Now, suppose we bridge the 90 V. "B" battery with a potentiometer of, say, 10,000 ohms resistance, connecting the plate of the tube to the potentiometer arm; and a 5-0-5 scale milliammeter in the plate circuit between the plate and the potentiometer arm, as shown in Fig. 3.

There is now a means of varying the voltage impressed upon the plate from zero to 90 V., which is the maximum available in our hookup and which is the voltage applied to the grid of the tube in this test. As the potentiometer arm is moved forward from the zero position, in the direction of the 90 V. position it will be noted that the plate current increases at first, with an increase in plate voltage, then suddenly the milliammeter needle begins to drop back toward zero. Then it begins to pick up and continues to indicate an increase in plate current until the maximum voltage of 90 is impressed upon the plate. If the result of what we have done is illustrated, graphically, on cross-section paper it will be found that our curve (assuming that we use plate current values for [vertical] ordinates and plate voltage values for [horizontal] abscissas) indicates an increase in plate current with an *increase* in plate voltage, but only at first; next a *decrease* in plate current accompanies the continued increase of plate voltage; and, finally, the plate current indicates an *increase* in plate current with the continued increase in plate voltage; this continues until the maximum available plate voltage is attained. The graph of this experiment is shown in Fig. 4.

That portion of the graph which indicates a drop in plate current with an increase in plate voltage is known as the "dynatron," or "negative resistance" portion of the characteristic curve just determined; when a tube is being operated under conditions which prevail in order to give rise to this dynatron characteristic it is actually functioning under conditions very different from those which commonly prevail in the more orthodox tube circuits.

Reference to the graph indicates that the dynatron feature obtains, when *the plate voltage is less than the grid voltage;* as a matter of fact it has been found that this action prevails when the plate voltage is approximately 40% of the grid voltage.

A study of the facts reflected by the graph discloses the fact that in the beginning, the plate current increased with an increase in the voltage impressed upon the plate, but only up to a certain point at which it was found that the secondary emission electrons were increasing *in proportion* to the number of electrons moving in the opposite direction. This was due to the fact that the impact against the plate, to begin with, was not strong enough to liberate an appreciable number of secondary-emission electrons. The increase in secondary-emission electrons continues until the curve crosses the base line. At this point in our experiment the needle of the milliammeter crossed the zero line and began moving in the opposite direction; this indicated that the current was now flowing in the opposite direction from that in which it had been flowing but a moment before the zero mark was passed. Now, for a brief period of time, our secondary-emission electrons exceed in number the "filament" electrons, even though we have not stopped increasing the voltage being impressed upon the plate of the tube. This increase in the "negative plate current" (shown dotted) continues for a time, then the negative value begins to decrease, at the lowest point indicated on the graph. This decrease continues to the point where the curve again crosses the base line (in its upward movement) at which point the milliammeter again reads zero current and reverses in indication of circuit polarity. From this point to the end of the characteristic curve, an increase of plate current accompanies an increase in plate voltage; until the maximum value of plate voltage is attained.

The statements made thus far have been said largely with reference to 3 element tubes: there are other tubes that function in dynatron circuits and among them are the 4 element screen-grid tubes, such as the types 22, 24 and 32. As a matter of fact these screen-grid tubes, in general, are better for dynatron circuit adaptations than the 3 element tubes. Therefore, in the next issue we will consider circuits using screen-grid tubes; and we will employ a type 24 tube in our experiments.

COMBINATION TUNER AND P.A. AMPLIFIER

(*Continued from page* 537)

sists essentially of a tuner, a 2 stage phono-microphone pre-amplifier, a parallel push-pull class A prime power output stage, and a power supply proper.

The Superheterodyne Tuner

This superheterodyne tuner shown schematically in Fig. 1, has an overall sensitivity of less than 0.5-microvolt per meter, and has a delayed A.V.C. with resultant interstage noise suppression. This high sensitivity has been obtained through the use of the latest tubes in conjunction with R.F. and I.F. components that represent the last word in radio. The general layout is such that the R.F. and I.F. plate leads and many grid leads are only about 1 in. in length, while the antenna and remaining grid wires are totally shielded to insure absolutely stable performance.

The antenna coil, L1, is protected against burnout by two blocking condensers C13 and C14, one on the aerial and one on the ground side. This coil is litz-wire-wound (see Fig. 3A), and designed for 10 kc. station tuning. The input signals, which may be obtained from an aerial but a few feet in length, or from a piece of screening, are fed through L1 into the first type 78 R.F. amplifier tube V1. Maximum gain is obtained from this tube with an impedance coupling choke and mica coupling condenser, which are all self-contained in the detector coil shield, L2, placed in the grid circuit of

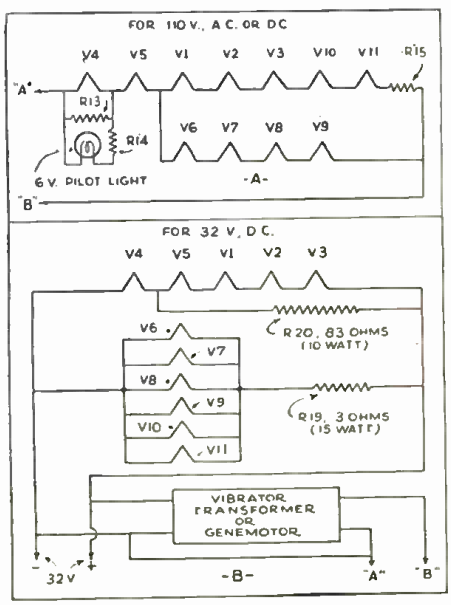

Fig. 2
The connections of the tube filaments.

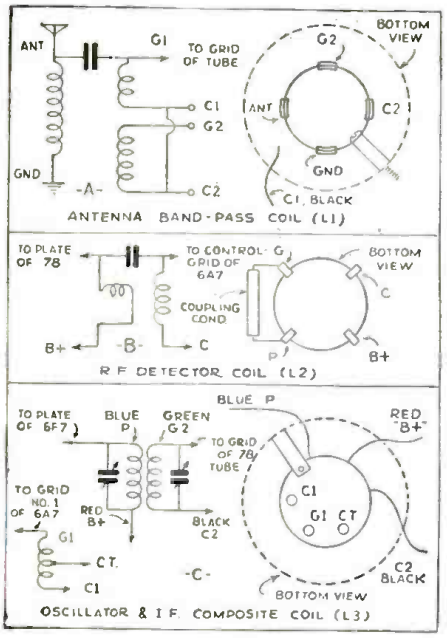

Fig. 3

Coil connections followed in the tuner.

the type 6A7 tube, V2. This tube acts as first-detector and electron-coupled oscillator, and simultaneously as an amplifier. The circuits evolved for use with these tubes and employed in this receiver include an oscillator arrangement which assures a constant output over the entire broadcast band, a condition that is not usually obtained by the use of individual detector and oscillator tubes. The construction and use of the corresponding R.F. components are thereby simplified, permitting the oscillator and I.F. inductances to be housed in a common shielded unit, indicated in Fig. 1 as I.F.T.1. It should be noted that the use of this electron-coupled oscillator tube entirely eliminates the formerly critical superheterodyne "coupling sphynx." As the gang condenser has an automatic oscillator tracking section (C4) the question of assembly, wiring and alignment of the superheterodyne circuit becomes as simple as that of an R.F. tuner.

The 6A7 pentagrid-converter tube is coupled through a 175 kc. pre-aligned I.F. transformer, I.F.T. 1, housed with the oscillator coil, into another, type 78, high-gain I.F. tube, V3. This tube in turn is transformer-coupled through another 175 kc. I.F. transformer I.F.T. 2, into an 85 duo-diode second-detector and triode amplifier tube.

The automatic volume control is obtained by connecting the filtered grid returns of V1 and V3 to the grid leak and condenser combination, R12, C20. The values are so chosen that it takes about ¾-second after a station is tuned in for the signals to be detected and further amplified. This is made possible because the I.F. currents produce a D.C. voltage drop across grid leak R12, which is impressed upon the grid returns connected to it, as well as upon the control-grid of the second-detector V4. However, the grid return filter condensers will take a certain amount of time to charge up, and only then may the type 85 tube, V4, amplify again. This "time constant" depends upon the product of the total resistance in ohms by the total capacity in farads. (Thus, a 1 meg. resistor and a .000001 farad [1 mf.] condenser has a time constant, RC, of 1.000.000 × .000001 = 1 second.) This is, at the same time, a very effective way of creating an interstage noise suppression, as no interfering signals or disturbing noises of any kind are heard, while tuning normally from one station to another. If any one of these bypass condensers is increased in capacity, this time delay may be increased from ¾ of a second up to several seconds, if desired.

The 4 gang superheterodyne condenser used with the inductance referred to above, is obtainable with a dial calibrated directly in kc.

A description of the P.A. section will follow in a subsequent issue of RADIO-CRAFT.

INFORMATION BUREAU

(*Continued from page* 548)

Coil B—50 to 90 Meters

R.F. and Detector coils—24 turns No. 24 enamel wire, single-space wound, tapped at 12 turns for band spread—1 3/16 in. form. Oscillator coil—35 turns No. 24 enamel wire, single-space wound, tapped at 8 turns for cathode and 42 turns for band spread 1 3/16 in. form.

Coil C—26 to 50 Meters

R.F. and Detector coils—19 turns No. 18 enamel wire, double-space wound, tapped at 8 turns for band spread—1 in. form. Oscillator coil—21 turns No. 24 enamel wire, double-space wound, tapped at 6 turns for cathode and 8 turns for band spread —1 in. form.

Coil D—14 to 26 Meters

R.F. and Detector coils—8 turns No. 18 enamel wire, double-space wound, tapped at 2 turns for band spread—1 in. form. Oscillator coil—11½ turns No. 18 enamel wire, double-space wound, tapped at 2 turns for cathode and 2½ turns for band spread —1 in. form.

Coil E—200 to 540 Meters

R.F. and detector coils—110 turns No. 27 enamel wire, close wound—1 3/16 in. form. Oscillator coil—110 turns No. 28 enamel wire, close wound, tapped at 30 turns for cathode—1 3/16 in. form.

A.F. AMPLIFIER FEED-BACK

(246) Mr. C. W. Iverson, Jr., Ogden, Utah.

(Q.) While operating an amplifier that I recently built, I had trouble with feed-back noise due to the microphone being in the range of the loudspeaker. I would like very much to eliminate this trouble and still be able to have a microphone close to the reproducer.

I have seen, in several advertisements, a device which claims to prevent this trouble. Would you please send me a circuit diagram so that I may construct a filter to eliminate this feed-back or advise any other method to eliminate the trouble and still use the mike within close range of the speaker?

(A.) In answer to this inquiry we refer Mr. Iverson to an article which appeared in a past issue. (RADIO-CRAFT, December, 1932.) This article, entitled "The Causes and Cures of Audio Oscillation," by L. Van Der Mel, covers the subject in much more detail than is possible in a short answer on this page.

CRYSTAL RECEIVER QUESTIONS

(247) Mr. Joseph Lee, Manila, P. I.

(Q.1) With reference to the crystal set on the Kinks page of the December, 1932 issue, and contributed by Mr. J. M. Nighswander, I have several questions to ask. What size and how many plates does the 500 mmf. tuning condenser contain?

(A.1) The actual number of plates or the size or shape of the plates is not very important, as long as the correct capacity of condenser is obtained. Every manufacturer seems to use a little different shape for his condenser plates. All we can say is to procure a well-made condenser having the specified capacity of 500 mmf. which as you probably know is equivalent to .0005-mf.

(Q.2) What form does the .001-mf. bypass condenser take. In other words what does it look like? Is it an ordinary fixed condenser of .001-mf. capacity?

(A.2) The .001-mf. condenser specified as a bypass condenser is an ordinary fixed unit, obtainable in any radio store. The fact that this condenser is specified as a bypass condenser only indicates its use in the circuit and does not indicate that a special type of unit is needed.

TUBE DESIGNATIONS

(248) Mr. Joseph Dixon, Denver, Colo.

(Q.) Why are some of the new tubes given designations which include letters instead of the older method which uses only two simple figures? It seems to me that the older method was easier and less difficult to remember.

(A.) Many new tubes now bear type numbers assigned under the R.M.A. system, which is characterized by the fact that a letter appears between two digits. The first digit is determined by the filament voltage and in the case of higher voltage tubes, two figures are required (as stated in previous issues of RADIO-CRAFT). Tubes having a filament voltage of 2.0, or less, bear the designation "1"; tubes in the 2.5 V. group bear the designation "2"; 3.0 to 3.9 V. bear the designation "3"; 4.0 to 4.9 V. bear the designation "4," and so on. The special arrangement made with reference to the 2.5 V. group was adopted only for convenience in retaining the figure 2 for this group. A 6.3 V. tube bears the designation 6, while a 12.6 V. tube is given the designation 12.

The final digit refers to the number of useful elements in the tubes which are brought out to external connections. A brief outline of the method of counting the elements is as follows: filament or heater is counted as one. Cathode, control-grid and plate count as one each and the suppressor-grid counts *only* when it is brought out to an external connection. In most cases, therefore, the digit assigned to a tube will be determined by subtracting one from the number of external connections, including the cap if one is used.

The letter used between the numbers is chosen arbitrarily in the order in which the tube is developed; thus, the first pentode of a group would be given the designation "A," while a second pentode, differing slightly in characteristics but having the same number of elements and filament rating, would be assigned the letter "B." An exception to this rule is made in the case of rectifiers, to distinguish them from the balance of the tubes, by starting the letter from the other end of the alphabet.

An attempt is being made to keep tubes having similar characteristics and falling in the 2.5 or 6.3 group identical except for the first digit. A good example of this action is seen in the assignment of 2A7, 6A7; 2B7 and 6B7. The 2A7 differs only from the 6A7 in heater ratings, as is also the case with the 2B7 and 6B7.

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THE PHONOSONE FOR THE NEAR-DEAF

(*Continued from page* 529)

placed right over the mastoid, the path of the bone sound conduction is a few inches less—about six inches shorter, or thereabouts—still, I have not found a great deal of difference in reception between the forehead and the mastoid bone. Another thing, to wear the instrument over the mastoid bone is uncomfortable because this particular unit is too big and proves annoying after a short time. Since bone is a fairly good sound conductor, it has been found in actual practice that, by stepping up the power of the radio set somewhat, that the difference between wearing the unit on the forehead or on the mastoid bone is easily compensated by a little more power.

Naturally, the more nearly deaf the individual is, the more power must be used. In some cases, it may be necessary to use a good audio amplifier connected to the radio set, if extreme power is required, but in most cases, a six- to ten-tube set will prove adequate if the individual has part of his auditory nerve left. If the nerve is dead, the instrument, of course, becomes useless.

A few words as to connecting the unit to your radio set (sketches have been included to show how this can be done, Figs. 1 and 2). If the user wishes to have the continuous use of the unit, it can be installed permanently, as shown. A switch is used, which disconnects the dynamic speaker and switches on the unit. Remember that, when the unit is used in this case, the radio set is silent as far as others are concerned, because all of the energy goes to the unit, the dynamic speaker now being disconnected. If the unit is not desired, all you have to do is throw the switch, when the radio set again plays normally. These instructions are, of course, meant if you have a dynamic speaker. The other illustration shows the old-type magnetic speaker, and here the conditions are similar. The same switch is used, and the magnetic speaker becomes silent when the unit is used for the near-deaf.

I shall be glad to hear from those who have built the instrument, and would like to be informed of actual results obtained with it.

"REPLACEMENT" TRANSFORMERS

(*Continued from page* 539)

well-known set types using types 10 or 50 power tubes and 81 rectifier and then see how the transformer meets the requirements of these sets.

This listing follows:

(1) 26, 27, 50, 81;
(2) 27, 50, 81;
(3) 27, 27, 50, 81.

Then there are set series using 3 V. tubes:

(4) C-484, C-10 or C-586, C-81;
(5) C-26, C-484, C-586, C-81.

In the amplifier and P.A. field there are such combinations as the following:

(6) 27, 50, 81;
(7) 10, 81;
(8) 01A, 50, 81;
(9) 26, 81;
(10) 26, 50, 81;
(11) 24, 50, 81;
(12) 27, 27, 81;

These combinations are called "set types." It is understood, of course, that only the type of tube is considered since the total number of tubes may vary from, say, 6 to 10 or 11. Let us now consider No. 1—the 26, 27, 50 and 81 combination. The type 26 tubes are supplied by the 1.5 V. portion of winding I. The 27's by II, the 10 (or 50) by III and the 81 by the 7.5 V. portion of winding IV. For No. 2—using 27's, 50's, 81's—the 2.5 V. for the 27's is supplied by the 2.5 V. section of winding I. The 50's and 81's are connected to windings III and IV in the same manner as before.

Sets using 3 V. heater tubes offer no special problem. The C-484, C-10 or C-586, C-81 combination is connected similarly to the 27, 50, 81 combination as explained above; the one difference is that the C-484 tubes utilize the whole of winding I which delivers 3 V. The C-10 and C-81 are supplied by windings III and IV, respectively. If the C-484's are used in combination with C-26's these latter tubes may receive their filament supply from either half of winding II or, better, from the 1.5 V. portion of I. Since the C-484's are indirect heaters no complications arise. The greater portion of set types call for straight simple hook-ups. No. 8 is slightly different, however, since the 01A tubes require 5 V. and no 5 V. winding is supplied. Series connection of the 2.5 V. portions of windings I to II, results in 5 V. and everybody's happy.

Some sets and amplifiers split the 27's, placing some on one filament winding and some on an additional winding. Two such windings are supplied so that the solution is simple. A study of the diagram will bring to light many combinations not discussed, such as the use of 6.3 V. tubes (still using types 2A3 or 2A5 as power tubes).

Some of the old-style sets used 99 type tubes in combination with the 10 and 81's. If there are any of these sets still requiring service the 99's will "fit" nicely on the 3 V. section of winding I. Single or push-pull power tubes were not taken into consideration since this merely effects the total drain.

It is, however, assumed the type 81 tubes to be full-wave with filaments in parallel, since this is the usual set-up. This is not a criterion for, by using only one-half of the high voltage winding, a half-wave rectifier is satisfactorily supplied with power. Winding IV has 15 V. total which takes care of those sets with type 81 filaments in series; and sets requiring Kellogg, Cardon and others of the old 15 V. filament tubes.

(Since the Cardon types 484 and 583 types are not mentioned in most tube tables, the following data is given. The type 484 tube is an indirectly-heated general-purpose triode; the 583 is a directly-heated power output triode. Both types are used in Sparton sets; for example, the models 564, 570, 740 and 750 chasses, the schematic circuit of which appears on page 395 of the Official Radio Service Manual, Vol. II.—*Technical Editor*)

It has been predicted that the 4 transformers first mentioned will service 90% of all radio sets now on the market. With the addition of the "new cousin" it is very conservatively estimated that the 5 units can be used to properly service 95% of all receiving sets—past and present.

OPERATING NOTES

(*Continued from page 546*)

RCA-VICTOR R-50, 55

AS MENTIONED in a previous article, this model has necessitated more service calls for fading than for any other condition, a cure for which was described by this writer in the May, 1933 issue of RADIO-CRAFT. One receiver was encountered, however, where the fading persisted, although the A.V.C. heater voltage had been cut to approximately 1.6 V., despite the most sincere efforts on the part of several Service Men; for the fading would disappear at the snap of the line switch. The receiver had been taken to the repair shop and placed on "life test" but the trouble could not be located, as it did not appear. (How often this does happen!) When it was returned to the customer's home, it was decided to make one supreme effort to clear up the condition.

After an hour had elapsed, luckily, the volume gradually faded. The analyzer disclosed a decreasing plate current drawn by the first I.F. tube, due to an increasing control-grid bias with the plate voltage comparatively the same. Here, at last was an indication that pointed almost conclusively to a failure in the A.V.C. circuit. The .1-mf. bypass condenser connected from the A.V.C. control-grid return to cathode was disconnected with no results. The .5-mf. condenser bypassing the A.V.C. cathode to chassis was also disconnected—with no success. But when the 1. mf. condenser bypassing the 1. meg. resistor in the A.V.C. control-grid return circuit to chassis, (both these components being located in the power pack) was disconnected, the volume level jumped to normal. This condenser is one of five in a block mounted on the power pack. Connection is made to the 1. meg. carbon resistor by the blue lead emerging from the block, the other side of the condenser being grounded to the chassis by means of the black lead.

The condenser became leaky and the negative bias impressed on the control-grid of the A.V.C. tube decreased. This caused a proportional increase of the voltage in the plate circuit, which in turn increased the control-grid bias on the R.F. and first I.F. tubes. A new condenser was installed and the job was complete.

On this same model, the condition may be encountered where the receiver is inoperative until the A.V.C. tube is withdrawn from its socket. Of course, this symptom, in addition to the high negative control-grid bias (about 50 V.) impressed on the R.F. and first I.F. tubes, will lead one to suspect the cause to lie with the A.V.C. circuit. This is true, but checking is quite another story and much time may be lost in tracing out the difficulty. It will be found to lie in an open 1. meg. carbon resistor in the control-grid return circuit of the A.V.C. This resistor is situated on the resistor strip under the power pack, fourth in line. The lack of A.V.C. control-grid bias places so great a control-grid bias on the R.F. and first I.F. tubes that the receiver becomes inoperative. Figure 3 clearly illustrates the A.V.C. circuit of this model.

RCA-VICTOR R-73, R-75, R-74, R-76, R-77

FADING or the abrupt lowering of volume on these models was discussed by this writer in the July and August, 1933 issues of RADIO-CRAFT, and is due to an open-circuited secondary-return bypass condenser; since, this condition has many times been traced to an intermittently open-circuiting audio coupling condenser of the same type. To obviate further difficulty, when these models are serviced for fading and the aforementioned grid return bypass units are replaced, the audio coupling condenser should also be changed.

RCA 80, 82, 86

AN UNUSUAL complaint was received some time ago on an RCA 80 model receiver. The customer maintained that the station "changed all by itself." The usual preliminary queries soon brought to light the actual cause for complaint. After the receiver had been tuned in, reception would cease at the

slightest vibration or movement of the cabinet, but by retuning the station selector about 40 kc. lower on the dial, the station could again be received. When this occurred, other stations also shifted about 40 kc. on the dial, WMCA at 570 kc. disappearing out of the picture entirely.

The very nature of the complaint, at first thought, would lead one to suspect the oscillator circuit, but it was only after a good deal of checking that the cause was traced. The oscillator series condenser was at fault. If this unit is closely observed, three copper tabs or plates can be seen to emerge from each end of the condenser. These plates are soldered together. Vibration, or perhaps weak construction of the unit itself, causes one or more of the tabs to snap directly at the point where it emerges. As the tabs are soldered together at the end, the break of even one of these tabs or plates will alter the capacity of the series condenser materially, considering its position in the circuit, and the oscillator tuning condenser would track with just that much difference.

When the break does not occur directly at the point where the tabs emerge, with a reasonable degree of care it is possible to solder the "break" together. Otherwise, replacement with a 745 mmf. mica condenser is necessary. This same condition has been remedied, in like manner, on RCA models 60, 62, 64, and 67.

PHILCO 19, 89

THE PHILCO model 19, 89 is a small 6 tube receiver employing a type 75 hi-mu tube as second-detector and A.V.C. When the complaint and symptom of low response is observed, although the action of the shadowgraph (tuning system) is normal and all voltages check correctly, the chances are the trouble is caused by a defective 75 tube. Look for a faint purplish glow within the elements. The remedy, of course, is replacement of the tube.

PHILCO 70

IN THIS model, with serial number above B-22,000, a 27 tube is used as a diode detector with the cathode and plate tied to the chassis. Where an inoperative receiver is encountered and the diode 27 is all "lit up," the probability is that the second I.F. transformer will be found with a primary-secondary short, thus impressing a high positive voltage upon the "grid" (anode) of the diode tube. This may easily be repaired if the leads to the I.F. transformer are un-soldered, the bypass block directly under it removed and the transformer lifted out of its shield. It will be noted that one or both leads of one winding are shorting to the other under the wax. These leads should be moved out of the wax compound and a piece of insulating material wrapped around the second bobbin with the aid of a rubber band.

PHILCO 14X, 91X

ONE OF these models recently furnished grief to a number of Service Men. The symptom and complaint in this instance was a motor-boating hum, a peculiar condition. All tubes, voltages and components checked correctly, but the condition still existed and not a single clue could be found to determine the cause. After "much hair had been torn." it was decided to find a cure instead of the cause. Resistors and condensers were shunted across one circuit and then another, until finally a 100,000 ohm carbon resistor, connected from the control-grid of the first A.F. 37 to chassis, cleared up the motor-boating hum, resulting only in a slight volume decrease and lowering of bass response. It was soldered into position and a repair was effected.

PHILCO 71X, 91X, 19X, 14X, 89

ONE OF the most common and frequent complaints on these receivers is an inoperative condition at either the low- or high-frequency end of the dial. In some cases, reception is obtained when the dial is rotated one way and none when the dial is turned back. In other instances, we may find dead spots in the middle of the band, where the receiver will be inoperative from 860 kc. to 1,300 kc. or 650 kc. to 900 kc. This trouble is caused by the 36 type tube, employed as combination first-detector and oscillator, going "flat" (not oscillating) at certain frequencies or over the entire band and, ordinarily, the only solution is replacement.

Where this does not help, it may be necessary to change the value of the oscillator cathode bias resistor from 15,000 ohms to 10,000 ohms. The model 91X and 14X already have the latter value, so the change in this case should be 7,500 ohms.

On all these models, with the exception of the 89, a shadowgraph is utilized for the visual indication of signal resonance. This component is in the "B plus" circuit of the R.F. and I.F. tubes. A common trouble is the failure or open-circuiting of the shadowgraph, which will result in an inoperative receiver.

STROMBERG-CARLSON 38, 39, 40, 48, 49, 50, 51

ONE OF the most frequent causes for an inoperative receiver in these models is an open-circuited or burned-out visual tuning meter. The meter will burn out or open-circuit if the .3-mf. condenser bypassing the meter should short-circuit or become leaky for, in this way, the full voltage output of the set will be shunted to ground through the meter. Where the meter is found defective, this condenser may be found to check O.K. In any event, the bypass condenser should be clipped out of the circuit and a new unit with a high working voltage installed.

Another cause for an inoperative condition is in a short-circuited I.F. "B plus" bypass condenser. If the schematic is closely scrutinized, it will be seen that this condenser is in shunt with the 6 mf. filter condenser in the power supply. The short-circuited unit may be removed from the circuit without substitution, with no ill effects.

STROMBERG-CARLSON 38 (2nd TYPE)

IN THIS Stromberg-Carlson model, instead of a 58 tube used as a demodulator (second-detector) and A.V.C., and a type 56 tube in the first A.F., two type 55 tubes are employed. A complaint of low response is often received on this model. Usually the cause for this trouble will be found to lie with the 1. mf. bypass condenser in the demodulator plate circuit; this unit often becomes leaky and lowers the plate voltage on the demodulator tube. The correct potential is approximately 100 V., measured between the plate terminal and chassis. If the plate voltage on this tube should be found to be 15 V. or more below that given, this condenser should be checked and if necessary replaced.

MAJESTIC 307

RECENTLY one of these models was serviced because of the complaint of low and distorted reproduction, with the volume control only effective at the extreme beginning of its range. Every component that could possibly cause this trouble was checked until finally, the coupling condenser (a 1 mf. unit coupling the diode output to the G 57 first A.F. tube) was found leaky, breaking down under load. It was checked by substituting another unit. This condenser is connected from the diode input-transformer secondary (center tap) return to one end of the volume control.

A cause for poor tone and low response has often been found to be caused by the G 58 tube which is employed as a phase reverser for the push-pull resistance-coupled stage.

KOLSTER 70, 75, 80, 90

FADING on these models is well-known and frequent. Whenever the volume control is set for the desired volume level, reception will fade right out. This can be repeated several times with the same symptoms until the volume control has reached the limit of its range. In every case, the condition has been overcome by changing the A.V.C. 24A tube with a "new type" tube. Interchanging the A.V.C. tube with one of the other 24A tubes will sometimes clear up the condition, but it is advisable to replace with a dome-top 24A.

SPARTON 18

A FREQUENT cause for complaint on the Sparton model 18 is intermittent reception, where volume will decrease abruptly to a lower level and in some cases, almost entirely fade out. In practically every instance, this trouble has been traced to the components mounted upon the terminal strip located beneath the first A.F. and A.V.C. sockets. The space between these parts and the side of the chassis is very small, and upon vibration, the condensers and resistors mounted upon the strip short to one another. The surest and quickest method of locating or determining the offending members is to press the insulated terminal strip in several places in an effort to duplicate the effect of intermittent reception or decrease in volume. Sometimes, pulling upon the wires and connections will disclose the source. The remedy obviously is simple, once the two shorting parts or loose connections are found.

However, more often than not, the trouble will be found to lie with the supposedly soldered connections to the wire-wound resistors upon the strip. These resistors have metal ends, with holes through which the wires pass. An insulated pick or fiber screwdriver is ideal for work of this nature.

SPARTON 30

THE Sparton model 30 receiver is an automatic phono-radio combination. One of the most common troubles with these automatic phono. mechanisms is their failure to adjust themselves for 10 or 12 in. record operation.

This is most often caused by the indicator switch located under the nickel-plated compartment on the kick-off arm. Should this indicator switch fail to make contact, thus actuating the solenoid which operates the mechanism for the changeover, the pickup will lower into the position for playing 10 in. records only. The kick-off arm and compartment may be lifted by removing the nut holding it in place so that free access may be had to the switch. The contacts may be worn or dirty. In other cases, the failure may be caused by the shifting of the solenoid through which the plunger operating the changeover mechanism, passes. All that is necessary is to adjust the position of the solenoid (located under the phono. panel near the volume control) so that the plunger arm works in and out freely. At this point check the tension of the plunger arm-spring which returns the plunger to the 12 in. record operation position.

Another source of annoyance with this phono. mechanism is the "blowing" of the receiver fuse every time the kick-off arm starts its cycle of operation. This condition is caused by the indicator switch under the kick-off compartment shorting to the shaft as the roller mechanism begins to lower, or the terminals of the switch shorting to the side of the compartment covering the switch. The remedy for this difficulty is to line the inside of the cover with some insulating material such as empire cloth or to wrap a layer of tape around the shaft in such a way that it will not interfere with the operation of the roller mechanism.

ZENITH 230, 240, 245

A FREQUENT cause for complaint on the Zenith models 230, 240, and 245 is oscillation, motor-boating and a slight amount of hum (which sometimes is more than slight). This condition may be traced to a defective dry-electrolytic filter condenser. These condensers lose their effective capacity and the only remedy is replacement.

ZENITH 410, 411, 420, 430, 440

HUM on these models is also caused by bad electrolytic filter condensers. One of the causes for an inoperative receiver is an open shadowgraph. When the condition is met where the receiver is inoperative until the type 57 A.V.C. tube is withdrawn from its socket, the cause is often a bad 57.

ZENITH 750

THE ZENITH model 750 is a small 6 tube superheterodyne. Where an inoperative receiver is encountered, with an additional

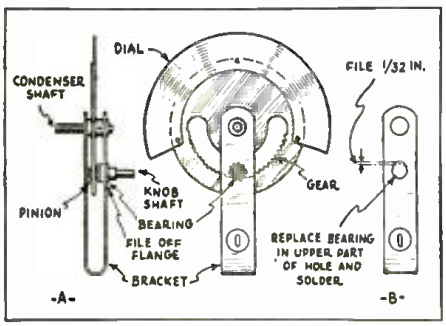


Fig. 4
Rejuvenating a Jackson-Bell Dial.

symptom of an I.F. 58 tube whose grids glow red hot, the trouble can be traced to a shorted I.F. transformer. As in the case mentioned for the Philco 70, the "short" is due to the leads of one winding shorting to the outer side of the other winding. These leads should be carefully insulated to effect a repair.

ZENITH 91, 92

THIS MODEL has been the cause of two unique complaints. In one instance, the receiver will be found inoperative, until the A.V.C. 24 type tube is withdrawn from its socket. Another complaint consists of the condition of distortion upon resonance which will clear up only when the station selector is slightly detuned. Both complaints are due to the A.V.C. cathode voltage divider, which will be found open-circuited in one case and changed value in the other. The section connected from screen-grid to cathode is usually at fault, and should be 15,000 ohms.

JACKSON-BELL

I WAS called to service a Jackson-Bell midget radio. Inspection of the set showed that the teeth of the gears in the dial assembly were not meshing well. The teeth were not badly worn or stripped; but there was no way to adjust the centers closer together. The bearing of the knob-shaft was pressed into the metal bracket through which the condenser shaft passed (thus giving a fixed distance between the shafts, as shown in Fig. 4A). Since it would have been difficult to replace the dial assembly without considerable delay I decided to repair the dial myself.

The pressed flange holding the bearing to the bracket was filed off and the bearing hammered out (taking care not to damage it). A round file was next used to elongate the bearing hole in the bracket, as shown in Fig. 4B. When the hole was cut out about 1/32-in., the bearing was replaced, aligned, and soldered into its new position, closer to the condenser shaft. When the dial was assembled again the teeth of the gears were in perfect mesh.

This same method can be used to repair some types of friction-drive dials, when they become worn.

ALBERT W. FRIEND,
316 Forest Ave.,
Morgantown, W. Va.

NEW LITERATURE

AN interesting booklet has just been released by Wholesale Radio Service Co., Inc., of New York City, entitled "How to Make Money on Public Address." Those contemplating entering this field will find invaluable data in this book dealing with sales and installation short cuts.

The WIRELESS WORLD—an English periodical and published by Iliffe and Sons Limited, Dorset House, Stamford Street, London, England—is printing a diary for 1934 which contains considerable reference data on radio theory and circuits. It is in convenient pocket form; and information concerning how to obtain this diary may be obtained by writing direct to the publishers.

SERVICING THE "TALKIES"

(*Continued from page* 539)

3. Although every projection room carries a limited stock of tubes and other spares, special condensers, resistors and so on are not commonly included in such reserves, and the projectionist necessarily has less experience than the radio man in wiring resistors or condensers in series-parallel to secure a desired value or using a transformer winding as a temporary choke. The radio man can often help a highly competent projectionist to make a haywire temporary repair to restore the show until such times as it is possible to do a proper and permanent job, because the radio Service Man does things of that sort every day, but the most competent projectionist, seldom.

4. The radio man's own stock of spare parts will almost always serve to effect an emergency repair when the projectionist might not have equipment on hand to make one, and very frequently will serve satisfactorily for permanent replacement.

To the occasional projectionist—there are still some—who is in fact incapable of repairing serious trouble in an amplifier in any length of the time, the radio man will of course be of even greater value.

However, if the radio man can be of help to the projectionist, the latter will also be of help to the radio man. He will know the layout and wiring of his own projection room, and he will commonly know sound equipment, and his own especially, more intimately than the radio man can hope to. He will know its past troubles and what was done to heal them, and which parts are likeliest to be at fault when anything goes wrong again. The projectionist and the radio technician, each strongest where the other happens to be weakest, make a powerful team when they cooperate harmoniously.

The one thing that is certain to prevent any possibility of such cooperation is any assumption on the part of the radio man that he is an essential instead of an aid. *He can be a powerful aid.* Unless the projectionist is entirely incompetent he cannot be essential; the majority of the country's theatres get along today without outside help of any kind.

The Projectionist as Purchasing Agent

The radio man has one important advantage the average projectionist misses, in familiarity with obscurer forms of electrical equipment. The typical projectionist will logically know less than his radio neighbor about voltage control devices, electrolytic condensers, battery-replacing rectifiers, or the cheapness and availability of A.F. amplifiers for emergency purposes. The radio dealer can help the projectionist with good advice on these and similar matters, and in return for his trouble quite possibly supply the theatre with such equipment.

The radio man should know more about tubes than the average projectionist. The latter is accustomed to reading plate current, and his amplifiers are commonly equipped with dynamic tube tests, and often comparatively small information about market prices of tubes of various types or makes.

What is true of tubes is even more true of other parts used in a sound system, with which the projectionist has even less frequent contact—resistors, condensers, transformers, inductances, potentiometers and so on. Testing such parts is something the average projectionist does only once in a while (if then) and he is not likely to know much about current market prices for them, or where to get them in a hurry. Moreover, he has other matters to occupy his attention, including are carbons, lenses, screens, and putting on a good show.

Electrical Companies' Repair and Sales

A minority of the country's theatres operate under service contracts with the electrical company that manufactured their sound equipment. What this means to the radio man is, that in the case of these theatres, he must expect to be compensated for any services he may render only in the form of

orders for materials, since the theatre is already paying a direct service charge. He can, nevertheless, render services of great value.

The chief service he can offer to such theatres in the matter of repairs lies in the advantage of his availability. He is in town, or close to it. He is not a long distance away, looking for a train or road to get him to that town in a hurry. His stock of emergency parts is within his reach, he does not have to wire to some distant point to get a little gadget needed to keep the show going. Not but that those companies render remarkably good service—they do—but the local Service Man still retains distinct and highly valuable advantages.

In respect to supplies, he has the great advantage of being able to recommend any supplies, including those the electrical company in question does not sell; or supplies similar to the ones they do sell, but at lower cost. In this connection it is important to note that radio is a mass production industry while sound is not and never can be. Therefore, whenever a radio part can be used for sound purposes, it is necessarily less expensive—often amazingly less expensive—than the similar product of a sound manufacturer.

However, the majority of theatres in this country do not operate under any specific arrangement for service, although very often the sound manufacturer will supply a service engineer at a charge in the vicinity of $35 per day or fraction of a day. The advantage of a competent local radio man, in the case of such theatres—which constitute the majority—needs no further comment.

Thus it would seem that nothing but an ill-advised attempt to "high-pressure" the theatre people before he has won their confidence can prevent the radio man making a highly profitable connection with the greater number of theatres operating under either dispensation.

The Projectionist as a Union Member

Projectionist unions are numerous and well organized, and in most cases affiliated with the American Federation of Labor. Unions have rules, and their members must abide by them. In some jurisdictions, the projectionist is subject to a heavy fine by his union if he permits a non-union person to perform any labor in his projection room. Wherever this rule is strictly enforced, the radio man has no choice but to cooperate with the projection staff in an advisory capacity, even down to the extreme and slightly ridiculous point where he must ask the projectionist to manipulate a rheostat but not touch it himself!

In general, the radio man entering a projection room will find it both advisable and courteous to ask permission before he so much as touches a button to take a meter reading. Personal acquaintance and confidence, and tactful bearing on the part of the visitor, will soon end small annoyances, whether the projection room is under union operation or not. On the other hand, any impatient attempt to make free with union requirements may result in an order from local headquarters barring the intruder from every projection room in its jurisdiction. Union conditions will not be a handicap to any radio man who takes the trouble to adapt himself to them, *but he must take that trouble.*

The radio man will do well to confine his attention to sound and not try to learn too much about projection as distinct from sound. This attitude on his part will protect him against suspicion that he might be willing to serve in place of the projectionist in event of a strike. For labor unions do not grow of themselves, they are created out of effort and sometimes through suffering, and those who have created this form of protection for themselves, and benefit by it, will not expose it to risk for any consideration of minor convenience.

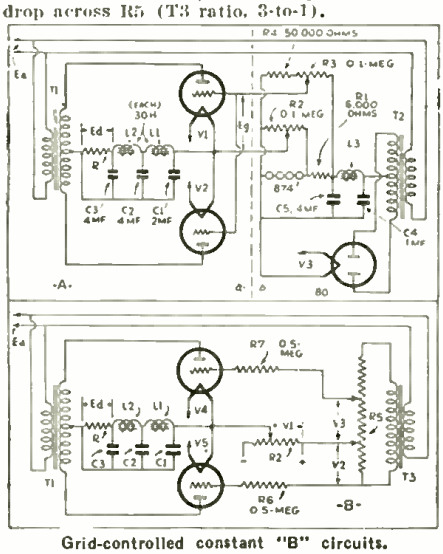
With a scrupulous attitude of strictest neutrality in all union matters, and careful respect for union rules, the presence or absence of union conditions will be a matter of no practical importance to the radio man—he can deal with a union theatre quite as readily as with any other.

GRID-CONTROLLED "B" UNITS

When triode power tubes are used as rectifiers approximately constant D.C. voltage can be obtained by having changes in the A.C. line voltage control their grid bias. Dr. L. A. Richards (Cornell Univ.) states that a 10% A.C. voltage change causes 0.1- to .02% filter D.C. voltage output, according to a recent issue of THE REVIEW OF SCIENTIFIC INSTRUMENTS.

Circuit A shows D.C. grid control. Choke L3, 20 hy.; R, load resistor; R1, variable. Tubes V1, V2 (45, 50, 2A3, 10, etc.), optional; for fixed Ea their mu determines the output D.C. voltage. Ratio of T2 (3.4-to-1), ½ its sec. V. to Ea.

Circuit B, A.C. grid control. Drop across R2 (in shunt to 874's connected as at *b*) furnishes D.C. bias; A.C. component is the drop across R5 (T3 ratio, 3-to-1).



Grid-controlled constant "B" circuits.

LATEST IN RADIO

(Continued from page 549)

A "Build Your Own" Radio Kit (420)

RADIO CONSTRUCTION KIT

For the person who wants to start in radio "on the ground floor," there is now available a kit of parts suitable for numerous fundamental circuits. Included in the kit is a picture diagram of our old, familiar "3 circuit tuner" circuit, that is capable of good DX reception; a plate-circuit variometer affords regeneration.

The kit includes the following items: grid leak, grid condenser, 500 mmf. variable condenser, R.F. coil, small variometer, type 30 "battery" tube, headphone, tube socket, filament resistor off-on switch, headphone bypass condenser, drilled panel, baseboard, and miscellaneous wire, solder, lugs, etc.

RADICALLY NEW, HIGH-POWER TUBE (421)

What is said to be a radically new design in amplifier and transmitting tubes has been announced. It is designated as the type 212-D; and is of superpower, improved, extra-long life type.

The main drawback experienced with the usual 212-D tube is lack of uniformity in characteristics. In fact, this type has been offered in four classifications, due to production differences. A special thoriated tungsten filament is used in place of the usual, oxide coated filament for the purpose of attaining and maintaining high-vacuum stability when high plate voltages are used. (The difficulty of matching such a filament and the established operating conditions were finally mastered.) The special, thoriated-tungsten filament overcomes particularly the vacuum instability which is an inevitable result of the use of an oxide-coated filament in tubes operating at high plate voltages. The addition of a graphite mass anode further insures the maintenance of the vacuum due to the "keeper action" of the graphite mass, even when the tube is subjected to overloading.

●

"'RESONATOR' LOUDSPEAKER"

Under the title, "The New 'Resonator' Loudspeaker" (RADIO-CRAFT, November, 1933), appeared an article describing a novel method of applying the principles of resonance to the operation of reproducers. In effect, resonating cylinders are used to correctly load the diaphragm of a dynamic reproducer. Although this article was written by Pierre Hemardinquer, the actual unit illustrated was invented by a Mr. A. d'Alton (France), according to correspondence we have received from him in this connection. (Mr. d'Alton failed to furnish patent numbers.) We quote as follows:

"I am the inventor of the apparatus which you describe, as you will note by reference to the June, 1933 issue of LA T.S.F. POUR TOUT. . . . I have been working on this device for about 7 years . . . (and) . . . have disposed of licenses for France and her Colonies to "Compagnie Francaise Thomson-Houston." . . . You have per contra in 1930 and in 1933 mentioned the name of Volf as being the originator of a system somewhat similar to my own."

RADIO SHORT-CUTS

(*Continued from page* 530)

other parts are easily found in the average repair shop. (Fig. 4.)

Our own repair shop is located on the top floor of a three-story warehouse and since the street door is kept locked, we were continually running up and down stairs to let people in and out. The use of this call system eliminates practically all of this. To simplify calling, the amplifier is switched to the remote position and left running. The speaker on the street level is mounted directly over the door outside, facing down. Since there is a small recessed entrance-way it is well protected from the weather and no trouble is experienced here. Trouble may possibly be found in the amplifier where, due to the input and output leads approaching one another so closely, oscillation may be encountered. When first built, oscillation in the amplifier was quite bad. However, by changing the throw-over switch to a large porcelain knife switch of the battery charging type, the oscillation was reduced to a point where connecting the .02-mf. condenser across the speaker side of the output transformer entirely eliminated it. The volume is ample, and one need stand no closer than six or seven feet to obtain excellent results. In fact, standing any closer or raising the voice above an ordinary conversational tone will cause the speaker at the other end to overload, so great is the volume.

This outfit has been in use for nearly a month and has given excellent results. The only drawback we can find is having to throw the switch to change from one end to the other. However, the cost was practically nothing since nearly all the parts are junk which was kicking around the shop, a very important feature.

I believe the diagram is self-explanatory and that no Service Man, worthy of the name, should encounter any difficulty in getting the rig going. Uses for it should crop out all over the shop. (I know at least three places around our own warehouses and store where one would be very handy.)

List of Parts

Two .25-mf. condensers, C1, C2;
Two .02-mf. condensers, C3, C4;
One 1 mf. condenser, C5;
One 500 ohm resistor, R1;
One .25-meg. resistor, R2;
One .5-meg. resistor, R3;
One 1,500 ohm resistor, R4;
One 6-1 ratio A.F. transformer, T1;
One secondary of push-pull input transformer, T2;
One output transformer to match magnetic speakers, T3;
Two filament windings to suit tubes, T4, T5;
One 24A tube, V1;
One 71A or 45 tube (pentodes not recommended), V2;
One large porcelain-base knife switch, Sw.1;
Two good-quality magnetic speakers, SPKR1, SPKR2.

"How long did it take you to do the trip, old man?"

"Er—about, er—two Bach cantatas and a couple of fox-trots!"

(Courtesy—English Periodical, Unknown)

MAKING A TALKIES SOUND HEAD

(*Continued from page* 538)

Then make a small slit in the can ¼-in. in length directly under the "sound track" of the film. Figure 2 shows the complete film drum. The next step is to mount the drum in the projector, which is easily done by mounting it on the brackets. The film drum is then fastened directly under the takeup idler and beneath this drum is mounted the takeup sprocket. On the end of the shaft which is pulling the takeup sprocket is placed the 2 in. pulley; this pulley is then connected to the belt which drives the takeup reel. This pulls the film at a constant speed over the film drum on which is mounted a thin strip of black felt, thus protecting the film. The 4 prong socket in which the photoelectric cell is placed is then mounted in the opening of the film drum, and the cell centered with the slit in the drum. Next make a holder for the exciter lamp, as shown in Fig. 3 (with the lens or optical system mounted). A hole is cut in the front of the projector, directly in line with the slit. The distance from the exciter lamp to the photoelectric cell is 5 ins. This completes the assembly. The adjustments are simple.

Figure 4 shows the hookup of the photo-cell to the amplifier which is a high-gain unit using a type 24 input, a 27 intermediate and two 47's with an 80 rectifier.

The projector is threaded in the regular way. Figure 3 shows the procedure of threading. The exciter lamp is focused by moving the tube in and out, until a sharp light is obtained on the sound track. With the amplifier turned on, the exciter lamp lit, with 90 V. of "B" battery on the photoelectric cell and the projector in motion, you have adequate motion picture sound-on-film reproduction.

The sound head described has been in use for over a year running satisfactorily with many sound films. Any further questions or problems concerning the construction, or further details of the sound head, will gladly be answered by the writer. (Be sure to enclose postage.—*Technical Editor*)

●

BOOK REVIEW

ELEKTRISCHE MUSIK, by von P. Lertes. Published by Theodor Steinkopff, Germany. Size 6 x 9 ins., 207 pages, 169 illustrations, paper covers. Price, $4.00 (approximately).

We do not know of any other book dealing with the subject of electronic music, of which several practical instrument designs have appeared in past issues of RADIO-CRAFT.

The author describes not only most of the commercial electronic musical instruments, but presents a broad review of fundamentals that will enable the student and experimenter to go far in their work.

We recommend ELEKTRISCHE MUSIK (ELECTRONIC MUSIC) very highly.

ELECTRONS AT WORK, by C. R. Underwood. Published by McGraw-Hill Book Co., Inc., New York, N. Y. First Edition. Size 6 x 9 ins., 354 pages, 220 illustrations, cloth covers. Price, $3.00.

ELECTRONS AT WORK, by Charles R. Underwood, and published by the McGraw-Hill Book Company, is essentially (as the name implies) a book dealing with the subject of electronic tubes and their various applications.

Primary theory such as, potential energy, potential, capacity, electrons and ions, space, time, and oscillations, etc. etc., are found in the first few chapters. From then on some highly interesting but very technical subjects are covered, i. e., electronic tubes, circuit phenomena, gaseous-discharge tubes, photoelectric cells, cathode-ray tubes, X-rays, cosmic rays, invisible light—with application data.

While evidently not intended for the average layman, it is an invaluable text for the student or engineer.

SYNCHRONIZED, "SAME-WAVE" BROADCASTING

THE first move, by any station in the United States since the North American Radio Conference in Mexico, has been made by WBBM, Chicago, key station of the Columbia Broadcasting System, and KFAB, Lincoln, Nebraska, which, at the time of writing this, are synchronizing the latter part of January. The move is regarded as significant inasmuch as it may signalize the widespread introduction of synchronization in the commercial broadcasting industry of the country.

The perfection of synchronizing equipment now makes such a development a practical possibility. The equipment to be used by WBBM and KFAB provides a precision of carrier frequency never before approached in broadcasting transmitters. It has been developed by Bell Telephone Laboratories as a result of years of experimentation which as early as 1927 produced successful tests with synchronous operation. The equipment was built by the Western Electric Company.

The system operates as follows. In the first place the equipment includes an extremely accurate source of carrier frequency which entirely replaces the master oscillator of the station. A reference frequency is furnished by wire from the Bell Laboratories to the stations involved which serves to control the carrier frequency of each station.

Whenever the local carrier frequency—the crystal oscillator—deviates from the control frequency by even a small fraction of a cycle, an automatic mechanism in the synchronizing equipment is set in operation and immediately corrects the minute difference. Consequently the carrier frequencies of the stations included in the system are at all times kept in synchronism.

As far as the synchronizing itself is concerned, no special link between the individual stations is required other than the circuit supplying the reference frequency. Although designed primarily for common frequency broadcasting, the equipment can be used also as the master oscillator of a radio transmitter to provide extreme carrier frequency stability to stations not operating on a common frequency basis.

The plan for WBBM and KFAB calls for the two stations to be synchronized on 770 kc., their present assignment. Both stations now operate full time during the day but alternate during certain hours at night.

Synchronization will enable these two part-time stations to utilize the air full time. The service they render to radio listeners in their area will be proportionately lengthened.

Plans to synchronize have been under consideration by WBBM and KFAB for some time and the Federal Radio Commission gave its sanction several months ago. Considerable importance is attached to this decision of the Commission as evidencing its desire to encourage wider use of synchronization in view of the possibilities it offers for relieving the congested commercial broadcasting band and broadening good service.

The common frequency broadcasting equipment consists of two racks designated as the No. 1231A and the No. 1232A panels. These racks are covered with protective, locker-type doors. The block diagram shows the relation of all the essential components.

The left-hand rack assembly (No. 1231A panel) contains duplicate crystal oscillators with their associated control units and a 2 stage R.F. amplifier. The right-hand rack (No. 1232A panel) contains the wire-terminating equipment, the reference frequency amplifier, and the multipliers for bringing the reference frequency up to a value comparable to that of the assigned carrier frequency.

Each panel contains separate, stabilized power apparatus. The power supply is drawn entirely from the A.C. power mains.

Although designed primarily for common frequency broadcasting, the equipment can be used also as the master oscillator of a radio transmitter to provide extreme carrier frequency stability to stations which are not operating on a common frequency basis.

Theory of Operation

The block illustration when studied with the following description will provide a clear

(*Continued on page* 572)

AN ANALYZER FOR RESISTANCE-VOLTAGE

(*Continued from page* 533)

meter circuit to allow zero adjustment.

With the ohmmeter connected to the Selector Unit, suppose it is desired to check the resistance of a circuit from some tube element socket contact to ground. Refer to the diagram, Fig. 1. The clip marked "ground clip" on the test cable is connected to the chassis of the receiver, and the tube associated with the circuit to be tested is removed from its socket.

Suppose, for example, that the tube is a 2A7 and it is desired to check the resistance of the circuit about the second grid (the plate-grid of the oscillator section—that is, the second-grid, counting from the cathode). The test plug is inserted in the 2A7 socket of the receiver, with the A.C. line disconnected from the set, and the 7 prong group of tubes consulted in the test data chart on the panel. Under 2A7 it is seen that G2 (the second grid) appears under column 7. This means that when the selector switch is turned to point 7, the resistance of the second grid circuit is read on the ohmmeter. If the test is made to chassis, the "ground clip" is secured to some part of the chassis. If the test is made to cathode or other part of the circuit, this same clip is fastened to the contact in question, to complete the circuit.

Each circuit about the remaining tube elements may be tested separately, by turning the selector switch. The test chart shows proper settings of this switch in the adjoining columns for each tube prong circuit.

Some circuits may require resistance readings that cannot be reached through any of the tube sockets. It is not necessary to disconnect the ohmmeter from the Selector Unit to make these tests. Simply turn the selector switch to the position marked Test (No. 11), which connects the ohmmeter to the ground clip and the test prod which extends from the selector unit case. The test prod may then be applied to the proper point on the wiring of the receiver to check between the desired points.

In addition to resistance analysis of receiver faults, it is sometimes useful to determine if voltage is actually getting up to some particular tube element. The selector unit serves this function. The voltmeter is connected to the instrument in place of the ohmmeter, and the same procedure in the use of the chart and switch is observed, as outlined above.

In cases where it is desired to ascertain that the tube is getting filament voltage, a filament voltmeter can be plugged into the tip jacks on the panel adjacent to points 3 and 4 of the selector switch. These points are the filament or heater terminals for practically all tubes, as shown on the test chart.

When making voltage tests, the power must be turned on, of course.

Constructing the Selector

After obtaining the parts as outlined at the end of this description, proceed to mount the selector switch and two pin jacks on the top of the box, as shown in Figs. A and B. Next, mount the other two tip jacks on the side of the box, opposite the selector switch. Proceed to wire the 9 wire cable to the various points of the selector switch, according to the wiring diagram, Fig. 1, starting with taps 1 and 2 on the top as shown and proceeding to No. 12 in a clock-wise direction. It will be noticed that this places the filament voltmeter pin jacks opposite to taps 3 and 4; and the ohmmeter tip jacks on the side of the box adjacent to taps 10 and 11. Connect the test prod to terminal 10 as shown and bring this wire out of the box with the cable.

Then connect the cable wires to the 7 prong analyzer plug, being careful to follow the color coding of the cable. The colors indicated on the schematic diagram do not necessarily have to be followed, if the particular cable colors differ. Simply be careful to connect the same colored wires to the correct terminals on the switch and on the analyzer plug.

It will be noticed that the black wire in the cable terminates in the ground clip. It is necessary to splice a length of wire to the

Fig. B
Interior of the "Selector."

cable conductor, so that the clip can be free to grip the chassis during tests. Also, the brown wire terminates in a grid cap such as found for the control-grids on a number of screen-grid and similar tubes. This is also equipped with an extra length of wire and is for the purpose of making tests through the circuits normally connected to the top caps on these tubes.

The test chart printed here should be cut out and pasted directly on the front of the selector box, for handy reference, as shown in the photographs.

It will be noticed that no connections are made to taps 8 and 9 on the selector switch. These are reserved for use with tubes having 8 and 9 prongs, if and when these tubes are introduced.

The author will be glad to supply any further information required, or answer any questions that may arise in the construction of the unit.

List of Parts

One Weston 12 point selector switch, Sw.1;
One Alden 7 prong analyzer plug;
One Alden 7 prong adapter (for large 7 prong tubes);
One Alden 6 prong adapter;
One Alden 5 prong adapter;
One Alden 4 prong adapter;
One 9 wire analyzer cable, 2 ft. long;
One Blan test prod;
One small battery clip (Ground Clip);
One tube cap;
Four phone tip jacks;
Two rubber grommets to fit analyzer cable;
One metal or wooden box with removable bottom, 7 x 4 x 2¾ ins. high;
As needed, flexible wire, screws, nuts, etc.

●

SHORT CUTS MARKING PANELS

(*Continued from page* 531)

However, most of us can letter, more or less passably, with a pen and ink, and therein lies the solution (no pun intended). Get yourself two bottles of ink; one regular black drawing ink and one Chinese white; and any kind of a pen that suits your fancy; better try lettering on a piece of paper first to get the "thang" of it. Then proceed as follows:

Using a rag wet with alcohol, thoroughly clean the surface to be "engraved," being particularly sure to remove every trace of grease. Then, if you are not an experienced letterer lay out what you want with *light* pencil marks; you can see them even on a black bakelite panel. Using the white ink for bakelite and other dark surfaces and the black for aluminum and surfaces of similar nature proceed to "engrave" the lettering or scales you have laid out. If the ink does not flow evenly and freely it is a sure sign that you have not thoroughly removed all traces of grease from the surface. (See Fig. 8.)

When you are through you will have a panel which, if you are skilful at lettering, can not be told a short distance away from a real engraved job. But it still has one fault, the ink does not stick very well to this type of surface and would soon rub off; so, to complete the job we cover each group of letters with a coating of thin white shellac or if you want the finest possible appearance cover the entire panel with a thin coat of high-grade varnish.

"SAME WAVE" PROGRAMS

(*Continued from page* 569)

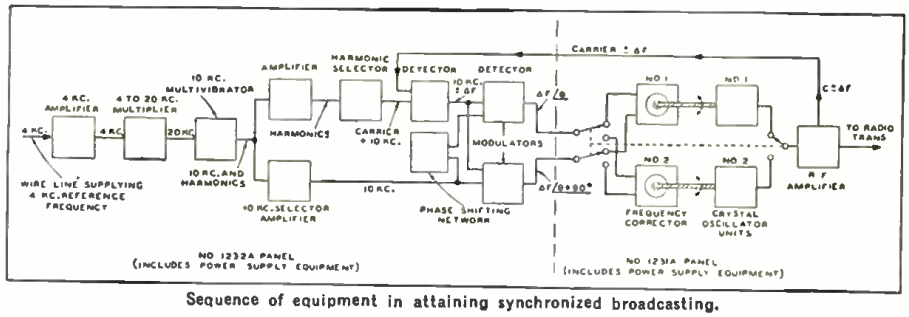
understanding of the theory of operation of the equipment.

Upon being brought into the station by wire line the 4 kc. reference frequency passes first through an amplifier. The output of the amplifier is fed into a frequency multiplier which generates the fifth harmonic (20 kc.) of the fundamental frequency. This 20 kc. frequency is used to control a 10 kc. "multivibrator." The output of the multivibrator contains the 10 kc. fundamental frequency and all its harmonics up through the broadcast range. The 10 kc. fundamental frequency is passed through one amplifier and the harmonics are passed through another.

The amplified harmonics then are fed into a selector which selects and further amplifies that harmonic which is 10 kc. *above* the assigned carrier frequency of the station. The carrier frequency, generated by the crystal oscillator, which may be assumed to differ from the assigned value by some difference D is combined with the selected harmonic in a detector.

The amplified harmonic beats with the carrier frequency in this detector producing a difference-frequency of 10 kc. + D. This 10 kc. + D, together with the amplified 10 kc. reference frequency from the multivibrator constitutes the input to a pair of balanced modulators.

The 10 kc. reference frequency before being applied to one of these modulators is passed through a phase-shifting network which retards its phase by 90°. The output of each modulator becomes one phase of a two phase alternating current of the frequency D. The output of both modulators is then fed into a "corrector unit" consisting of a small, synchronous two phase motor mechanically connected to a small variable condenser associated with the crystal oscillator circuit. The



Sequence of equipment in attaining synchronized broadcasting.

two phase current from the modulator stage has a direction of phase rotation which depends directly upon whether the carrier frequency is above or below the assigned value. If the carrier departs from the assigned frequency, the synchronous motor will revolve in the proper direction so that the resultant change in the variable condenser will alter the frequency of the crystal oscillator and so bring it back to the assigned value.

Any deviation of the carrier frequency from the assigned value operates the frequency corrector, *thus providing a precision of carrier frequency never before approached in broadcasting transmitters.*

Quartz Crystal Oscillator

The crystal oscillator unit was especially designed for use in this equipment. The equipment contains the crystal oscillator unit and the associated corrector device in duplicate. Should one of the units fail the other may be placed immediately in service by a simple switching operation. The spare unit is kept at operating temperature continuously so that no warming up period is required before placing it in service.

The oscillator circuit, together with its associated quartz crystal control, is housed in a single unit. The quartz crystal control is enclosed in a separate chamber, within this unit. The temperature of this chamber is closely regulated by a mercury thermostat. The circuit, the crystal and the thermostat are adjusted and calibrated as a unit. This insures high precision of calibration as well as permanency of adjustment.

The oscillator tubes used are uniform in construction and, therefore, need not be calibrated individually with the oscillator unit. It is possible even to replace the oscillator tube without appreciable frequency change in the oscillator. The absence of mechanical relays in the crystal heater circuit is an important factor in maintaining satisfactory service.

Advantages of the Equipment

Equipment such as that described has been found the most practical means of holding the carriers of radio transmitters in synchronism. Using the reference frequency to control the output of a local crystal oscillator, rather than as the basis for generating the carrier frequency, makes the station carrier independent of any interference which might be received with the reference frequency.

This arrangement also insures against the necessity of the station ceasing operation if there is a failure of the synchronizing appa-

• Index to Advertisers •

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

ratus or an interruption of the reference frequency supply. Under such conditions the crystal oscillator will continue to supply a carrier which will not drift from the assigned value by more than a few cycles per minute over a period of several hours—a variation which would not be sufficient to cause serious interference at listeners' receivers. As soon as normal conditions are re-established, precise synchronization is restored promptly and automatically.

This "common frequency broadcasting equipment" makes it possible to operate a chain of widely distributed stations on a common frequency system without any special synchronizing link between the individual stations other than the circuit providing the reference frequency.

When stations in a chain are using the same program these must necessarily be the usual program line connection. Otherwise, all that is necessary to operate the station in synchronization with another station or with a chain of stations is a wire line connection to the 4,000 cycle reference frequency source.

●

ELECTRIC CLOCKS ON D.C.

SERVICE MEN have had electric clocks thrust upon them, in many late radio set models but, until now, it has only been A.C. receivers that were so equipped. Now, according to the December 30, 1933 issue of NATURE (London), a novel discovery makes it possible to operate synchronous electric clocks in certain D.C. districts.

In England the D.C. power supply is obtained, in some instances, by means of mercury arc rectifiers from a 3 phase, time-controlled, 50 cycle system, in which there is a pronounced third-harmonic ripple in the D.C. supply.

Although the clock in question was designed for 230 V. and 50 cycles, the same principle of operation would hold for any A.C. clock provided it "matched" the ripple.

After putting into the clock a 3-to-1 reduction gear the seconds hand rotated 1 r.p.m. Then, as the amplitude of the ripple voltage was only about ¼ that for which the clock was designed, a transformer of 1-to-10 step-up ratio was installed between the supply and the clock coil; a condenser in series with the clock and one side of the D.C. power supply isolated the clock and passed only the A.C. component.

This information is furnished to experimenters in the hope that something may be developed for use in America.

●

FREE SERVICE?

A SUBJECT that has been discussed from every possible angle, and which has not as yet been settled to anyone's satisfaction, is that of "free service." And now it seems that this most vexing problem has finally floored English radio dealers.

One solution to their problem was a recommendation that the dealer demand a certain sum for maintenance instead of supplying the consumer with free service. That idea was tried here, but, somehow, it failed to go over. However, if it "clicks" on the shores of Merrie England—we might try the scheme all over again.. It certainly would mean the end of gyp-service or price cutting in service work.

The illustration below, indicative of the present status of American dealers, is borrowed from "THE BROADCASTER AND WIRELESS RETAILER, an English publication.

The solution to the dealer's problems?

HERE IS A GROUP OF FINE QUALITY RADIO PARTS THAT "*Shouts*".. VALUE!

Mershon Triple 10 Mfd. Electrolytic Condenser

A genuine Mershon Electrolytic condenser at this low price for the first time.

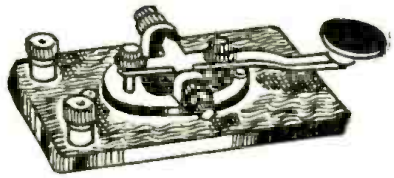
Contains three 10 mfd. condensers in one. Used as a replacement in many different receivers.

Proven design, puncture - proof, constant capacity—are the features which distinguish this condenser from others.

Positive terminal leads are brought out to bolts on top of the condenser. Negative is grounded to the container.

Price **$1.25**

POWERTONE SENDING KEY

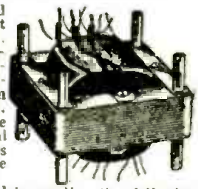


This popular design is widely used as a low power transmitting and code Practice key.

Mounted on a mahogany finished base. The key is well-balanced and fully adjustable for clearance and tension. Contacts are designed for heavy service. A commercial key at the amateur's price. Base dimensions 5¼ inches long and 2⅝ inches wide.

Price **79c**

CROSLEY POWER TRANSFORMERS



Constructed of the finest materials. Large oversized construction insures freedom from heating. Massive core and oversized coil provides long trouble free life.

B. H. model supplies the following voltages:

1½ volts for 4-226; 2½ volts at 2 amps. for 1-227; 5 volts at 1½ amp. for 1-171A; Winding for Raytheon Type B.H. tube: 250-250 High voltage; Primary 110 volts A.C. 60 cycle. Price **$1.00**

Fast .06-.06 Condenser

A high grade by-pass condenser made by one of the foremost condenser manufacturers in the country. Contains two .06 condensers in one can. Separate terminals are brought out for the common connection and both positive. Can is not grounded.

Price **12c**

60,000 ohm Ward Leonard Vitrohn Resistor

A high grade well known heavy duty resistor. Will dissipate 25 watts continuously. Total resistance is 60,000 ohms tapped at 1500. Comes completely mounted on a bakelite strip to ease installation. Bakelite strip measures 4 inches in length and 1¼ inch wide.

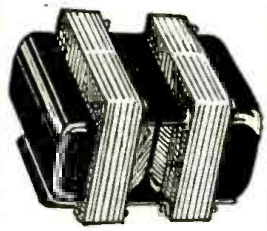
Price **19c**

4 Prong Bakelite Socket

We bought a great quantity of these sockets before the price rise. Here is your chance to stock up. They will go fast at this low price—send in your order now. Phosphor-bronze contacts assure permanent connection

Price **5c**

CROSLEY DOUBLE CHOKE



A unit consisting of two chokes which can easily be separated. Each choke is rated at 30 henries at 60 mills. Sturdily constructed and will handle an overload of 15%. Fully shielded in an attractive black enameled can. Measurements 3⅝ ins. long, 2⅛ ins. high, and 2¾ inches wide. Each choke contains separate terminals.

Price **69c**

R.C.A. VICTOR HAND MIKE

Provides true toned reproduction of music and voice. Ideal for use in home recording systems, and as a home broadcasting mike. Widely used in amateur portable public address systems. Neatly finished in brown gun metal enamel — complete with 5 foot cord.

Our Price **$1.25**

FARRAND INDUCTOR DYNAMIC SPEAKERS--9" MODEL

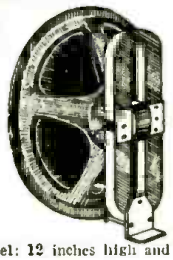
The ideal short wave receiver speaker; eliminates hum and line noise; draws less current; absolutely genuine Farrand; Compact in size; brings in the very weak short wave stations.

Do not confuse this model with the various similar types on the market posing as Farrands. This is the true Farrand Inductor Dynamic. Its adaption to Short Wave Radio Receivers has proven a popular step. The most inaudible stations are brought in with remarkable clearness without the customary noise and hum of regular dynamic speakers. Has two magnets parallel to each other with a bracket placed between them to facilitate mounting. Overall 9" model. Please state power tube when ordering.

Price **$3.95**

12" MODEL

The Genuine Farrand Inductor For The First Time At This Low Price



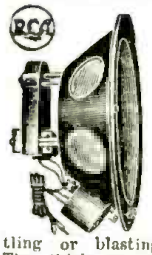
These models are not to be confused with the various types now on the market and labeled Farrand Inductors. These models are all factory built and not just put together haphazardly.

The 12 inch models have two magnets standing upright, with a bracket on the bottom to ease mounting. Dimensions of the 12 inch model: 12 inches high and 6½ inches deep.

(12" Model)

Our Price **$4.95**

GENUINE R. C. A. MAGNETIC CHASSIS

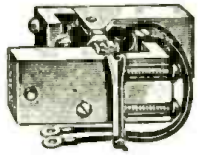


This chassis is the identical one used in the R.C.A. 100A-100B Speakers which list for as high as $35.00. Note built-in output transformer which permits use of 450 volts without distortion, rattling or blasting. Generous oversized magnet. The thick armature is accurately centered, the sturdy metal frame is lined with a special self-baffling fabric, greatly improving acoustic properties of this sensational speaker. Note the corrugated surface of the cone, an exclusive feature—enhances perfectional reproduction qualities considerably; most compactly made; 9" outside diameter, 4½" deep overall.

Price **$2.50**

Replacement Unit

The genuine replacement unit mechanism for the R. C. A. 100A, 100B, and 103 speaker chassis. This unit is complete in every detail except that it is furnished less the magnet. Guaranteed to be in perfect condition. Can also be used for replacement purposes on any other type speaker.



Our Price **95c**

With Magnet **$1.25**

BALDOR Television Motor

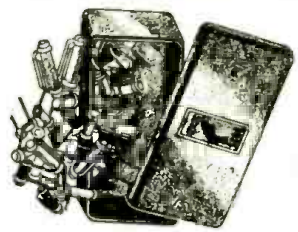
A silent synchronous motor used in the Jenkins Television receivers. All genuine brand new Baldor Motors.

SPECIFICATIONS

Type M 2 C R
H. P.—1/15
R. P. M.—1700
Volts—110 volts A.C., 60 cycle
Amp.—1.0
Ph.—1

Standard shaft 3¼ inches long. Overall height 8 inches. Width 4¾ inches.

Price **$6.95**



Handy Kit of 50 R.M.A. Color Coded Resistors ½-⅓-1-Watt

A complete assortment of resistors which will prove invaluable to the service bench. Their long tinned leads and small size permit easy insertion or replacement. A compact kit and easy to carry. Odd values can be obtained by connecting two or more values in series or parallel. R.M.A. color coded for easy identification.

FREE—With each assortment of 50 resistors a beautiful bakelite case—a souvenir of the Chicago Century of Progress Exposition. Size of box: 6⅛ x 3¼ x 1⅜ inches.

Price **$2.95**

All orders are F. O. B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Deduct 2% if full amount is sent with order.

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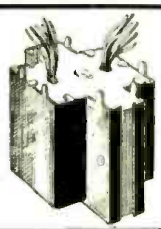
245 Greenwich St. Dept. RC New York, N.Y.

SALE OF ORIGINAL *Majestic* REPLACEMENT PARTS

All Parts Used in MAJESTIC Receivers Have Been Known to Be of the Highest Quality



FILAMENT AND PLATE TRANSFORMER
Model No. 25
Primary 115 volt 25 cycle
Secondary to anode center tapped
Secondary 5 volt 2 amp.
Secondary 2.5 volt 7 amp.
Secondary 2.5 volt 7 amp. center tapped
Weight 13 lbs.
Original Majestic Part No. 5883
$3.45 Each

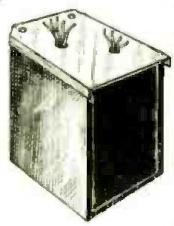
FILAMENT AND PLATE TRANSFORMER
Model No. 23A
Primary 115 Volt 60 Cycle
Secondary to anode center tapped
Secondary 5. Volt 2 Amp.
Secondary 2.5 Volt 7 Amp.
Secondary 2.5 Volt 3 Amp. center tapped
Weight 20 lbs.
Original Majestic Part No. 2156
$3.65 Each

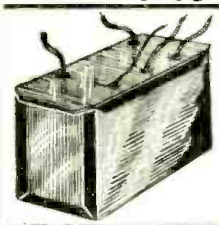
FILAMENT AND PLATE TRANSFORMER
Model No. 10 Converter
Primary 110 Volt 50-60 Cycle
Secondary to anode center tapped
Secondary 5. Volt 2 Amp.
Secondary 2.5 Volt 3½ Amp.
Weight 4 lbs.
Original Majestic Part No. 6414
$2.29 Each

UNIVERSAL POWER TRANSFORMER
Primary 110, 120, 150, 200, 220, 240 Volt
Cycle 25, 100
Secondary to anode center tapped, supplies 385 Volt D.C. at 140 M.A.
Secondary 2.5 Volt 3 Amp. for No. 82 rectifier
Secondary 2.4 Volt 7 Amp., center tapped
Secondary 2.4 Volt 4 Amp., center tapped
Weight 13 lbs.
Original Majestic Part No. 9529
$3.95 Each

UNIVERSAL POWER TRANSFORMER
Primary 110, 120, 150, 200, 220, 240 Volt
Cycle 25, 100
Secondary to anode center tapped, supplies 380 Volt D.C. at 120 M.A.
Secondary 2.5 Volt 3 Amp. for No. 82 rectifier
Secondary 2.4 Volt 13 Amp., center tapped
Weight 13 lbs.
Original Majestic Part No. 9178
$3.95 Each

FILAMENT AND PLATE TRANSFORMER
Model No. 130A—Chassis 131-132-133
Primary 115 Volt 60 Cycle
Secondary to anode center tapped
Secondary 5. Volt 2 Amp.
Secondary 2.5 Volt 7 Amp.
Secondary 2.5 Volt 3 Amp., center tapped
Weight 16½ lb.
Original Majestic Part No. 891
$3.45 Each





PICKUP TRANSFORMER
Model No. 155
Weight 3 lbs.
Original Majestic Part No. 5532
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Model No. 155
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Model No. 100
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PUSH-PULL INPUT TRANSFORMER
Model No. 30
Weight 4½ lbs.
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PUSH-PULL INPUT TRANSFORMER
Model No. 100B—90B
Weight 4½ lbs.
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89c Each

PUSH-PULL OUTPUT TRANSFORMER
Model No. 30
Weight 3 lbs.
Original Majestic Part No. 3053
69c Each

CONDENSER BANK
For No. 100B and 90B
Original Majestic Part No. 1585
$1.79 Each

CONDENSER BANK
Contains 3—2 mfd.
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$1.49 Each

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Model No. 35
Contains 4-1/10 mfd.
Weight 1 lb.
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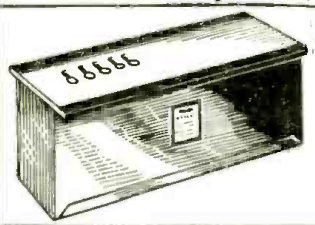
69c Each



CONDENSER BANK No. 7BP3
Weight 6½ lbs.
Original Majstic Part No. 716
$1.49 Each

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Model No. 390
Original Majestic Part No. 9167
69c Each

BY-PASS CONDENSER AND TERMINAL STRIP ASSEMBLY
Model No. 200
Original Majestic Part No. 6298
69c Each

CONDENSER ASSEMBLY
Model No. 340B
Original Majestic Part No. 9043
69c Each

CONDENSER ASSEMBLY
Model No. 25 and 25B
Weight 3¼ lbs.
Original Majestic Part No. 5607
69c Each

CHOKE ASSEMBLY
No. 7P3
Dual choke
Weight 5½ lbs.
Original Majestic Part No. 712
89c Each

FILTER CHOKE UNIT
Model No. 50
Weight 5 lbs.
Original Majestic Part No. 3051
89c Each

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Weight 8 lbs.
Original Majestic Part No. 281
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Complete . . . Nothing Else to Buy

Imagine the convenience of just sitting back in an easy chair or lying in bed and merely by pressing a series of buttons, starting the radio located in a far off room or hidden away in the basement. Not only that, but selecting one of ten stations from a remote point. If this is the machine age, it is also the age of convenience. The remote control is a machine designed to tune your radio automatically. Why not take advantage of it, especially when it is priced more than 30% below its original list value.

This remote control outfit was used on one of the Colonial remote Control receivers which sold for more than $300.00; yet you or anyone at all handy with tools can attach it to your own radio. You can then hide the radio either in the closet, basement, or some other out-of-the-way place and extend wires to any number of speakers, strategically located in various parts of your apartment. Imagine the surprise of your friends or guests at dinner or at special gatherings, when, by merely pressing a button the room is gradually flooded with beautiful music or other entertaining programs, by the hidden speakers. Aside from being a novel idea it is also a very practical one.

RADIO SERVICE MAN and CUSTOM SET BUILDER—Here Is Your Opportunity!

You need but mention the words "remote control" to your customer and immediately you command his entire interest and attention. You are able to do this because the idea to him, is new and because it immediately implies expensive equipment. However, when you inform him that you can construct or **ADAPT HIS RECEIVER FOR REMOTE CONTROL OPERATION** for only a few dollars more, his interest will most certainly materialize into an order. We need not give YOU any more talking points on this subject because you probably can muster up more than we.

EXTREMELY SIMPLE TO OPERATE

The outfit comprises two small motors (one for turning the tuning condenser and the other for turning the volume control), a 10-position commutator switch for selecting 10 different stations, a step-down transformer for energizing the motors and a 13 button control board (10 buttons for the 10 stations, two buttons for increasing or decreasing the volume and one button for silent tuning). A pilot light in this control board indicates when the receiver is operating.

If the shafts of the tuning condenser and volume control of your present receiver can be extended so that the commutator switch section and one of the motor gears can be slipped over the tuning condenser shaft and the other motor gear on the volume control shaft then you can easily adapt this outfit to your receiver DIRECTLY without any further changes. With some sets it may be necessary to remove the volume control entirely from the chassis and mount it directly on the gear of the volume control motor. Custom set builders need have no headaches about this remote control, inasmuch as they can design the physical layouts of their sets to conform with this equipment. The illustration clearly shows all component parts of this complete remote control system. Shipping weight 18 lbs.

No. 1789 Colonial Complete Remote Control Outfit
YOUR PRICE, Only $5.97

Greatest Buy in America! Pilot Six-Tube Two-Volt ★ Battery Receiver

COMPLETE. NOTHING ELSE TO BUY

There are ONLY 20 of these battery receivers available. ACT FAST if you desire to have one at this low price. Every one is familiar with the fine quality and performance of Pilot receivers. Their precise engineering and elaborate design has made them famous throughout the world. A fortunate buy permits us to sell these 6 tube 2-volt receivers at a price which is almost 300% below list.

This receiver may be operated from a storage battery as well, without any additional changes. Uses 2-30's, 2-31's and 2-32's. These tubes are arranged in a highly sensitive tuned radio frequency circuit which assures stability throughout the entire life of the set. Every component part, including the tuning condenser, are thoroughly shielded to prevent stray signals from entering the circuit. A large 8" magnetic speaker, specially designed to work from push pull tubes, reproduces the programs with a clarity which compares favorably with the original renditions. Both chassis and speaker are mounted in a two-toned cabinet of special columnaire design. The four controls on the front panel are respectively volume control, station selector, "on off" switch and tone control. The cabinet measures 18" high by 16" wide by 9" deep. Shipping weight 30 lbs.

No. P-200—Pilot 6 Tube 2-Volt Battery Receiver, Less Tubes. YOUR PRICE $13.50
Complete set of tubes for this receiver $4.80

Don't Junk Your Old Tube Checker! Modernize it With This Multidapter

Contrary to popular belief the advent of the seven prong and other new tubes has not rendered your tube checker obsolete. Why throw away an expensive tube checker when it can be easily, without any internal changes, brought up to date? You merely plug this new Multidapter into the four prong socket of your present tube checker and you are all equipped to test every tube that was ever placed on the market. The legends of more than 60 of the new tubes are lithographed directly on the front panel of the Multidapter.

Furthermore, the unit is so flexibly constructed that the operator has access to every single element of any tube. In other words, aside from being able to make standard tests, every conceivable other test desired by any serviceman or experimenter can be readily made through the manipulation of four plugs and the series of plug jacks, symetrically arranged on the front panel. This feature makes the unit a perpetual instrument. Shipping weight 5 lbs.

No. 205—Multidapter
YOUR PRICE $7.50

★ Servicemen's Wire Wound Fixed Resistor Kit

You have probably never seen or used a resistor of this type. It is new, it is radically different from other resistors, both in construction, accuracy and maintenance of calibration. These resistors are "ARMORED" in the strictest sense of the word. A heavy steel covering around fine wire element protects it indefinitely and prolongs its life. A RESISTOR OF THIS TYPE MAY BE USED OVER AND OVER AGAIN, FROM SET TO SET, WITHOUT LOSING ITS CALIBRATION OR WEARING OUT.

The kit consists of 24 resistors, only 4 of which are duplicated. In other words there are more than 20 different values. If these units were bought individually they would cost more than $6.50. Manufacturers and custom set builders are rapidly becoming aware of the fact that these resistors defy adverse conditions. They **will stand a considerable overload without breaking down.** It is quality merchandise of this kind which builds up the business and reputation of a serviceman or custom set builder because "cheap things are expensive in the long run."

CONTENTS OF KIT

The kit contains one each of the following values: 20 ohms C.T., 40 C.T., 60 C.T., 50 ohms, 100, 150, 250, 300, 400, 600, 1250, 1500, 2000, 2500, and 3000; and two each of the following 200 ohms, 500, 750 and 1000. Shipping weight 3 lbs.

No. 'MU-KIT"—Service Men's Wire Wound Fixed Resistor Kit.
YOUR PRICE ..... only $2.25

★ A REAL MICROPHONE at the Price of a Toy

Here is the largest value ever offered in a commercial type microphone! An unusually large two-button microphone, ruggedly constructed and designed especially for broadcast purposes. Frequency range 30 to over 6,000 cycles—adequate for all speech and music reproduction. **EXCELLENT FOR PUBLIC ADDRESS WORK.** Stretched cushioned diaphragm of duralium with pure gold center contacts on buttons and diaphragm. Standard 200 ohms per button. Finished in beautiful polished chrome. Net weight 1¾ lbs. Shipping weight 2¾ lbs.

No. "F" 2 Button Mike.
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High Emission 201-A Tube

This tube may be called a "cross" between a 71-A and the 201-A. It has the M type filament of the former and the characteristics of the latter. In other words it is a 201-A tube, which, due to its "M" shape filament has a very high electronic emission. This **means high plate current. These characteristics make it exceptionally suitable for use as an oscillator in transmitters or in receivers. May be used to advantage as oscillators in 5 and 10 meter transmitters.** Filament voltage 5 volts, filament current .25 amps, maximum plate voltage 150 volts. Shipping weight ¼ lb.

No. ZRF—High Emission 201-A Tube
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ANNOUNCING

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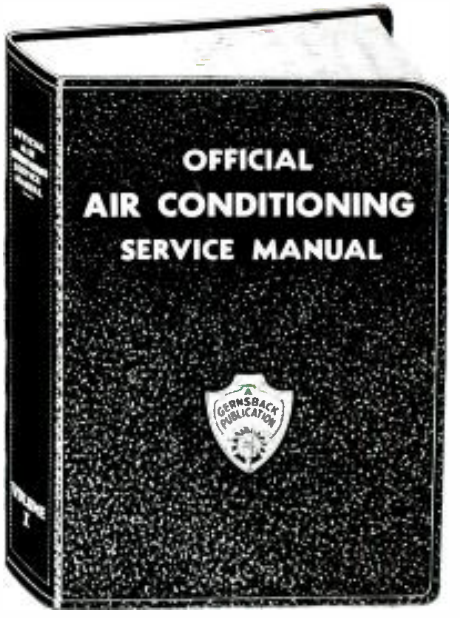
THE idea of electricians, radio service men and other mechanically inclined men, servicing Air Conditioning and Refrigeration Units is self-evident and the thought has occurred to some untold thousands ever since air conditioning equipment has been installed in public auditoriums, theatres, studios, department stores, office buildings and manufacturing plants. The tremendously broad possibilities in this new industry are bound to give employment and success to men far-sighted enough to see its advancement and development. We quote an excerpt from Mr. Hugo Gernsback's editorial which appeared in a recent issue of Everyday Science and Mechanics:

> *"I advise young and progressive men to go into the air-conditioning business during the next few years; because, this, without a doubt, is the coming industry in this country. Thousands of small firms will spring up, undertaking to air-condition private houses, small business offices, factories, etc. We are not going to tear down every building in the United States immediately. It will be a gradual growth; yet small installation firms will air-condition small houses, and even single offices in small buildings."*

This is only partial proof of the certain success of this new field. Further assurance is that engineering schools have already added many important courses on air conditioning to their regular curriculum. Architects and building contractors are giving considerable thought to installation of this equipment in structures which are now being planned and built. The beginning of this business will probably be similar to the auto and radio industry, but in a few short years it will surpass these two great fields.



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In this Air Conditioning Service Manual nearly every page will be illustrated; every modern installation and individual part carefully explained; diagrams furnished of all known equipment; special care given to the servicing and installation end. The tools needed will be illustrated and explained; there will be plenty of charts and page after page of service data.

Remember there is a big opportunity in this new field and plenty of money to be made in the servicing end. There are thousands of firms selling installations and parts every day and this equipment must be cared for frequently. Eventually air conditioning systems will be as common as radios and refrigerators in homes, offices and industrial plants. Why not start now—increase your earnings with a full- or spare-time service business.

You have the opportunity to get your copy of the OFFICIAL AIR CONDITIONING SERVICE MANUAL today—at a saving of ONE DOLLAR. When the book comes off press, which will be March 15th, the price will be $5.00 a copy. YOUR ORDER TODAY BRINGS YOU A COPY FOR $4.00, POSTAGE PREPAID. This is our usual courtesy, pre-publication offer which enables us to determine the approximate print order for the first press run. Send us the coupon today, together with a deposit of $2.00. When the book reaches you, you pay the other $2.00.

Here are some of the chapter heads of the AIR CONDITIONING SERVICE MANUAL:

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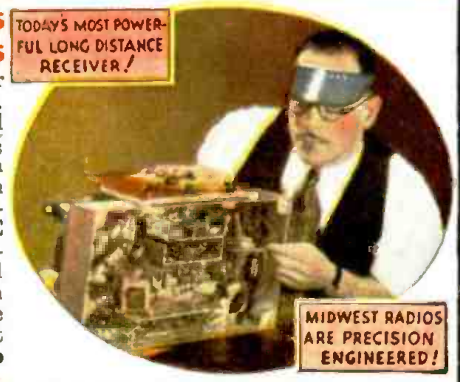

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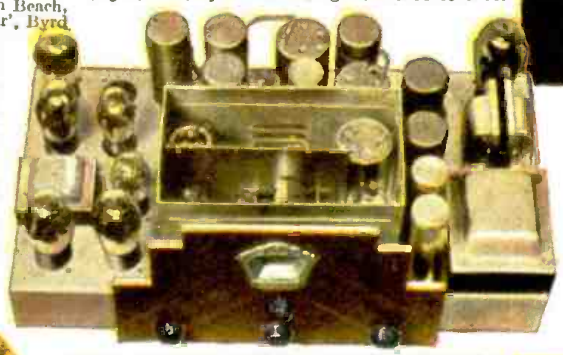

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