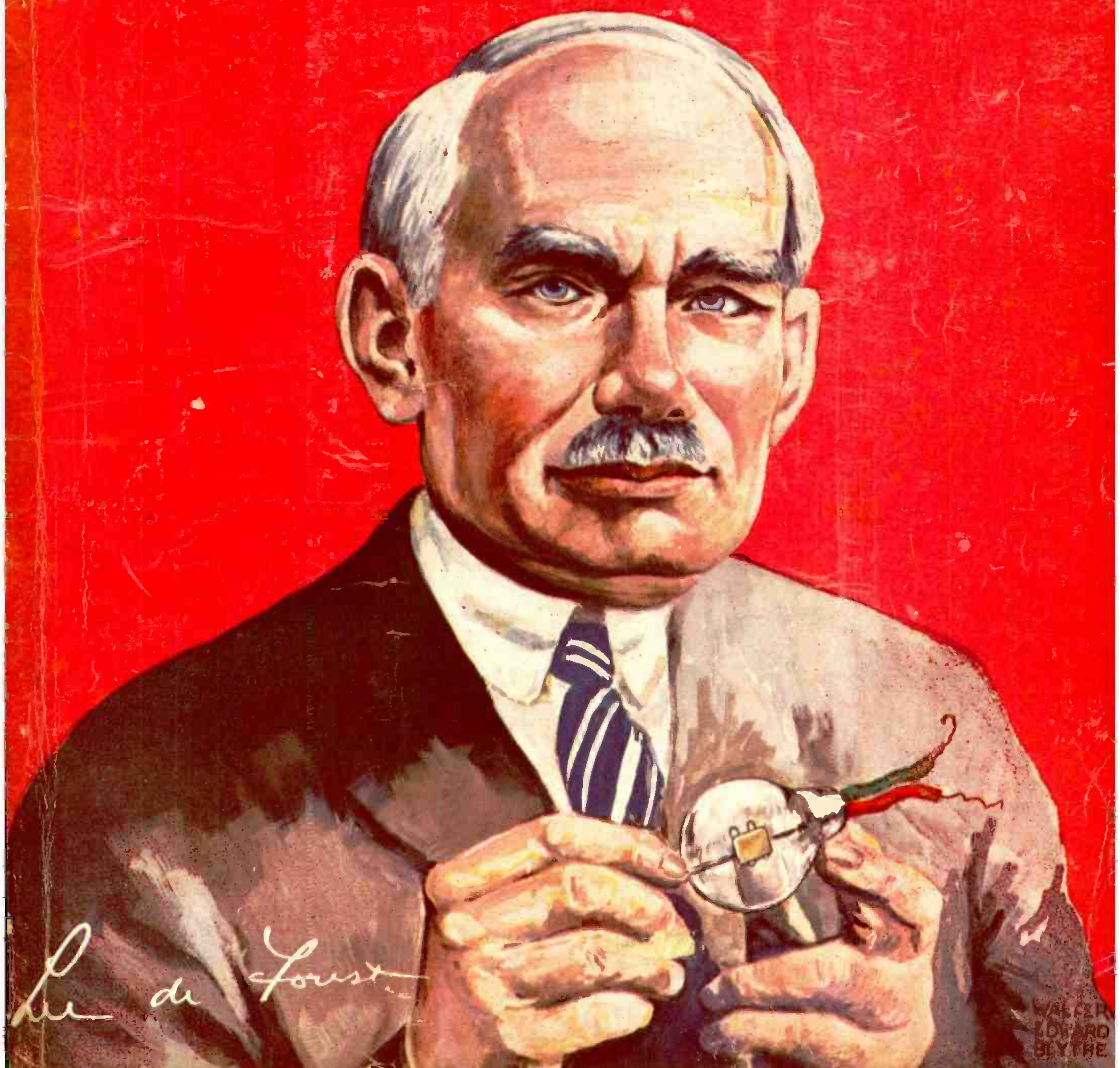
Radio-Craft

for the Professional-Serviceman-Radiotrician

Oct
25 Cents

HUGO GERNSBACK Editor



VOLUME I. **October** NUMBER 4

HUGO GERNSBACK, Editor-in-Chief

R. D. Washburne, Technical Editor. C. P. Mason, Associate Editor

Contents of This Issue:

In The November Issue

More About Resistors .....Charles Golenpaul

Additional information about the application of resistors in radio.

Experiments with 14-Centimeter Waves .....Ernst Gerhard

A series of investigations with ultra-high frequencies which act like light.

Servicing the Freshman "G" and "N" .....Harold Weiler

Where and how to service two well-known radio receivers.

The Development of the Modern Sound Reproducer, Oscar C. Roos

In this article Mr. Roos takes the reader in back of the scenes and shows him new laboratory developments.

RADIO-CRAFT is published on the 5th of the preceding month. 12 numbers per year, subscription price is $2.50 a year in United States and its possessions. In Canada and foreign countries, $3.00 a year. Single copies 25c. Address all contributions to Editor, RADIO-CRAFT, 96-98 Park Place, New York. Publishers are not responsible for lost Mss. Contributions cannot be returned unless authors remit full postage.

RADIO-CRAFT—Monthly—Entered as second class matter in the Post-office at New York, N. Y., June 24, 1929, under the act of March 3, 1879. Title registered U. S. Patent Office. Trademarks and copyrights by permission of Gernsback Publications, Inc., 98 Park Place, New York City, owner of all trademark rights.

RADIO-CRAFT is for sale at all principal newsstands in the United States and Canada. European agents: Brentano's, London and Paris. Printed in U. S. A.

IF YOU WISH TO SUBSCRIBE to RADIO-CRAFT, make out all remittances to the Techni-Craft Publishing Corp., 96-98 Park Place, New York City. Be sure to mention the name of magazine you wish to subscribe for, as we are also agents for the following magazines: SCIENCE WONDER STORIES and AIR WONDER STORIES, subscription price of which is the same as RADIO-CRAFT. Subscriptions can be made in combination with the above publications, at a reduced club rate. Ask for information. Subscriptions start with current issue. WHEN YOUR SUBSCRIPTION EXPIRES, we enclose a renewal blank in the last number. No subscriptions continued unless renewal remittance received.

Change of Address. Always give us old as well as new address and notify us as far in advance as possible.

This magazine is published by

TECHNI-CRAFT PUBLISHING CORPORATION

H. GERNSBACK, President S. GERNSBACK, Treasurer JOSEPH M. HERZBERG, Vice-President IRVING S. MANHEIMER, Secretary

Chicago Advertising Representative: L. F. McCLURE, 737 North Michigan Avenue

Editorial, Advertising and General Offices . . . . 96-98 Park Place, New York City

4 of the 40 Easy Ways to Make $3.00 an Hour In Your Spare Time in RADIO

THE four plans shown are but a sample of the many ways in which our members are making $3.00 an hour upwards, spare time and full time, *from the day they join the Association.* If you want to get into Radio, have a business of your own, make $50 to $75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the $600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.

Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean $50 to $75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. RCA-10 Chicago, Illinois

Below are a few of the reports from those now cashing in on the "40 Easy Ways"

Clears $3,000.00 Frank J. Deutch, Pa. — "Since joining the Association I have cleared nearly $2,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow your easy ways of making money."

$1,100.00 in 6 Weeks J. R. Allen, Calif. — "Have done over $1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

$25.00 a Week Spare Time N. J. Friedrich, N. Y.—"I have averaged $25.00 a week for the last 7 months even though I am not a graduate but just learning."

Training Lands Him Job R. C. Kirk, N. C.—"Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW
If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below *now.* You'll always be glad you did.

Radio Training Association of America
Dept. RCA-10 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

Name ....

Address ....

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

Volume I. OCTOBER, 1929 Number 4

HUGO GERNSBACK, - - - - - Editor

EDITORIAL AND GENERAL OFFICES, 96-98 PARK PLACE, NEW YORK

Wanted, Service Men!

By HUGO GERNSBACK

THERE are still a great many people in this country who do not know what a radio service man is; yet the truth of the matter is that the radio service man is not a new development of the radio industry. On the contrary, the radio service man has been with us, in one guise or another, for many years. There was a time, when radio was young, when he was called a "wireless amateur"; and that was before there were any sets to be repaired. Later on he became a "radio-tinkerer," better known under the name of "radio doctor," who was supposed to know anything and everything about Radio. Still more recently he became a "radio engineer," so-called; as a matter of fact every radio set builder at one time or another has boldly proclaimed himself a "Radio Engineer."

Help Wanted—Male.

RADIO SERVICE MAN

MUST HAVE OWN CAR AND SET ANALYSER; COME PREPARED WITH BEST OF REFERENCES; ONLY THOSE HAVING ELECTRIC SET EXPERIENCE NEED APPLY; APPLY AFTER 5 P. M. S SMITH, VIM RADIO CO., 70 CORTLANDT ST.

RADIO SERVICE WORK—Young man wanted by Atwater Kent distributer; excellent opportunity for mechanical student, reply stating age, references and salary desired. W 708 Times Downtown.

RADIO REPAIR MEN, experts only, with and without cars, excellent opportunity for increased earning. Call Monday morning. Davega, 326 W. 25th, Service Division.

RADIO SERVICE MAN, experienced; salary, commission; must have meters; good references required. Sholrr's Radio, 1446 St. Nicholas av. (182d).

RADIO SERVICE MEN, experienced only; must have own car. Apply 8.30 A. M., Miller & Weston, 208 Lexington av.

RADIOTRICIANS with wide experience and technical knowledge of all modern electric radio sets and panatropes; only experts need apply. W 172 Times.

Nowadays he bears no longer such flowery titles. He has become more human and more matter-of-fact, and he calls a spade, a spade.

The radio service man of today is a specialist; he does only one thing but does that well. He makes a specialty of installing and keeping in good operating condition the factory-built sets and, as a matter of fact, makes a study of this work. In reality, he is a radio doctor and a radio engineer rolled into one and, frequently, he has a good deal more practical knowledge of sets and set construction than many a sheepskinned "radio engineer."

Notwithstanding the millions of factory-built radio sets abounding all over the country now, the really competent radio service man has become comparatively scarce of late. We still have too many poor and untrained service men when we need experts who can diagnose the trouble within a few minutes with any standard set. If it takes a service man more than fifteen minutes to diagnose what is wrong with such a set, his value is low, because it will take him too long to make his daily round of service calls and consequently his value to either his employer or to himself is relatively small.

If you pick up any of our daily newspapers, you can easily find any number of advertisements calling for *experienced* service men, such advertisements, for instance, as reprinted on this page.

This is the day of the specialist and it is the specialist who brings home the bacon.

Moreover, no radio service man has arrived at this position over night. It takes hard work, long experience and a good deal of study to turn out a service man who can stand the gaff of modern requirements. Service men must study, must know the latest radio wrinkles and must use the latest short cuts. They must know which meters to apply and they must know what test sets to use and, if necessary, must know how to build their own testing apparatus.

It is for men of this kind that a great deal of the text pages of RADIO-CRAFT are published.

There are never enough service men (that is, the really good ones) to go around and the demand is always apparently greater than the supply.

For this reason, RADIO-CRAFT is now compiling the most complete list of radio service men in this country.

In the future it will be possible for any radio manufacturer to ask the publishers of RADIO-CRAFT to supply a list of competent service men in practically any part of the country, at short notice.

We urge every service man to carefully read the announcement on page 173.

Radio Leaders on the 1930 Outlook

THE Editor of RADIO-CRAFT recently asked the leaders in the radio industry to give their opinions as to what, in their minds, is the most important thing that Radio will need in 1930. Practically all of them, who could be reached, replied and RADIO-CRAFT is happy to present their views in these pages. If you can read between the lines, you may derive a tremendous amount of information from the terse paragraphs of America's radio leaders.

Better Service Methods

WHERE would the automobile be today if good mechanics were not available? If radio is to take its place as a medium of home entertainment, experienced service men and not the so-called "radio doctors" must be available. This is in response to your request as to the need of the industry for 1930.

H. B. Richmond

H. B. RICHMOND,
(*General Radio Co., Cambridge, Mass.*)
President, Radio Manufacturers' Association.

Stable, Standardized Production

ONE of the most important needs of radio industry for 1930 is control of production consistent with consumer demand. Overproduction is resulting in destructive merchandising practices. Standardization of parts would clear up a great many problems and result in better values. The radio industry needs considerably more stabilization, in order to build up confidence in the public mind on new purchases.

E. S. Riedel

E. S. RIEDEL,
General Sales Manager,
Utah Radio Products Co.,
Chicago.

New Circuits, Special Tubes, Television

FOR the radio frequency end of radio receivers, tube development is ahead of circuit development; so more efficient perfection of screen-grid circuits is needed.

For rectification, power detection, and single-stage audio amplification, circuits are ahead of tube developments. There is a decided need for design of special tubes to meet requirements more efficiently — a departure from handicapping "conventional" construction and intensive laboratory research is essential.

D. E. Replogle

The public has heard much but seen little of radio's latest child, Television. 1930 should see satisfactory working receivers that can receive from a chain of stations, all sending standardized signals for universal reception.

D. E. REPLOGLE,
Sales Engineer, Product Development Div.,
National Carbon Company, New York City.

Men—With Thorough Training

TOO many smooth-tongued salesmen, ignorant of radio's technical make-up, are selling sets; too many piano movers are installing them; too many "fixers" are trying to keep them serviced and repaired. Result, the owner gets mediocre reception. The radio public is demanding more and will get it—as soon as those in the radio business wake up to the fact that they are engaged in a highly-specialized technical business.

J. E. Smith

The radio industry, then, needs men, and more men, with a high standard of technical knowledge.

J. E. SMITH,
President, National Radio Institute,
Washington, D. C.

Campaign For Better Reception

NOT "better sets," certainly; they now are all one could ask for—but better programs and better reception in order to hear them. After all, what use is a radio receiver when you can't get anything worth while on it?

Tobe Deutschmann

First, then, the elimination of excessive advertising "plugs," and then the opportunity to listen free from extraneous noise. The ether roads must be cleared for traffic. Sets, like automobiles, are approaching perfection and demand roads commensurate with their excellence. What radio needs next winter is a nation-wide war on interference and it is going to get it, unless present indications lie.

TOBE C. DEUTSCHMANN,
President, The Tobe Deutschmann Co.,
Canton, Mass.

Screen-Grid and Reproducer Design

IN THE radio industry for 1930, the most important thing will be time to assimilate the new and wonderful screen-grid tube and take full advantage of its enormous capabilities. Tremendous strides have already been made in utilizing this tube, and present screen-grid sets are a revelation. In 1930 we will see further refinements in mechanical construction and electrical design, giving still more amazing results.

Powel Crosley, Jr.

With this there goes the necessity for further improvements in loud speakers to take full advantage of the marvelous quality which can now be built into these sets. The industry needs, and will need in 1930, a much greater knowledge, of what a radio set should be, on the part of the distributors, the dealers and the public; and an increased ability to discriminate between overdrawn advertising claims and real merit in the product.

POWEL CROSLEY, JR.,
President, Crosley Manufacturing Co.,
Cincinnati, Ohio.

The First Television Year

OF COURSE I am expected to say something about television. Therefore, I most emphatically believe that the radio industry, during 1930, must take television seriously. With the inauguration of television transmitting stations, operating on a regular schedule, there is certain to be widespread interest in television reception. Vast experimental possibilities are at hand. And so the industry must provide the necessary components at first; followed by kits and then practical televisors, finally leading to the refined televisor which will be incorporated in the same cabinet as the sound broadcast receiver. Next year will be the first television year.

C. Francis Jenkins

C. FRANCIS JENKINS,
Vice-President in charge of Research,
Jenkins Television Corporation,
Jersey City, N. J.

Technical Problems to Solve

IN MY opinion, some of the more important needs of the radio industry for 1930 are dependable tubes, broadcasts of more interesting and instructive material, really perfected television, and a cheap substitute for wood to be used in cabinets.


Alfred Marchev

Another crucial need, and one which might well be considered the most important, is the development of a silicon steel for transformer laminations that will have a low loss and high permeability without increasing the content of silicon; so that it will still machine, or punch without hardship on the dies, and still give a better reproduction on the low and high audio-frequency tones. In order to get a very effective audio transformer, the silicon content is increased, which very naturally causes the iron to be too hard for punching. Consequently, in the grade that is used now, a large amount of iron must be handled to obtain the required results.

The radio industry needs also some kind of substitute for wood that is considerably cheaper, and yet can be shaped into artistic designs. This would bring a reduction in the price of radio receivers.

ALFRED MARCHEV,
President, Temple Corporation, Chicago.

Avoiding Material Shortages

THE most important need of the radio industry for 1930 is organization of the various accessory branches, to the end that material shortages at the peak of the season may be overcome as much as possible. We have been through various phases of wire and tube shortages in the past, but we are still allowing ourselves to be caught unprepared. The R. M. A. show might be changed to an earlier date, to allow everyone more time.


Colin Kyle

COLIN KYLE,
United Reproducers Corporation, St. Charles, Illinois.

Better Quality of Reproduction

FOR the coming season, radio sets are better and more efficient than any ever before produced. An adequate supply of A. C. tubes and screen-grid tubes for initial use and replacement purposes in many thousands of sets that will be sold is the first need of the industry.


Louis Gerard Pacent

The second need is better audio-frequency amplification in the lower-priced sets. Many receivers offer ample opportunity for improvement in reproduction, and, if the next five years are to be big years for radio, engineers and manufacturers should stress quality reproduction, especially in the low-priced receiver field.

LOUIS GERARD PACENT,
President, Pacent Electric Company, New York City.

Fair Trade Policies

THE most important need of the radio industry for 1930 is for each manufacturer to avoid overproduction, to be a fair competitor, to help dealers earn a profit, and to give the customer what his advertising promises.


W. Roy McCanne

W. R. MCCANNE,
President, Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.

The Radio Professional Replies

NOW that the leaders of the radio *industry* have had their say, and have told us in no unmistakable terms what the main needs in the radio industry for 1930 will be, RADIO-CRAFT calls upon the professionals in the *trade* (that is, radio engineers, radio service men, radio consultants, radio dealers, and radio jobbers) to state what to *their* minds is the crying need of radio for 1930. The best letters will be published in the December issue of RADIO-CRAFT. Address all letters to *Editor*, "Radio in 1930."

—Editor.

Demand For Improved Tubes

THE greatest need of the radio industry in 1930 will be vacuum tubes—good tubes and plenty of them. With the extremely delicate and intricate circuits being incorporated by leading set manufacturers, vacuum tubes must run positively uniform, tolerances must be more rigid, and production must be steadily increased. While we do not believe that a general tube shortage, such as existed last year, will take place, we do think that tube manufacturers must increase their production schedule on the '24 and '45 type tubes, if a shortage is to be avoided. Technically, the outstanding advance will be in quick-heating time.


F. A. LaBaw

F. A. LABAW,
General Sales Manager, Marvin Radio Tube Corporation, New York City.

Salesmanship Along With Service

AS WE see it, the most important need of the radio industry for 1930, in regard to professional service men, is that these men should not only be fully competent to build sets and do efficient service work for customers and dealers, but also be essentially sales-minded. The professional service men occupy such a strategic position in their contact with the public that all radio manufacturers are more than eager that they be conscientious salesmen and builders of good will.


Harold C. Bodman

HAROLD C. BODMAN,
Sales Manager, Silver-Marshall, Inc., Chicago.

Better Business in Broadcasting

WITH the evolution of radio from an electrical novelty to a genuine necessity, every effort should be made to place broadcasting on a sound economic basis. The first step toward that end is a thorough understanding of the costs that enter into the production and broadcasting of programs.


William S. Hedges

The National Association of Broadcasters is now launching an effort for the establishment of a standard method of accounting for broadcast stations. It is equally important that broadcasting should be freed from the onus of advertising of an unethical nature. A code for the guidance of broadcasters in handling advertising has been adopted by the N. A. B.

WILLIAM S. HEDGES,
President, National Association of Broadcasters, Chicago, Ill.

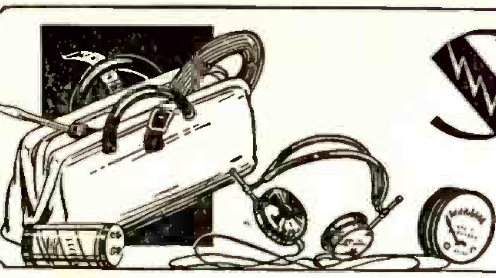
Cut Down Tube Failures

AT THIS time, the most important need of the radio industry is an effort on the part of tube manufacturers to bring the quality of their tubes to the highest standards, to eliminate the enormous amount of service necessary to keep a receiver sold.


George Coby

Quality radio tubes alone will solve the profit-eating service calls which confront the dealer; and those manufacturers who recognize this fact will be predominating factors in the industry this year.

GEORGE COBY,
President, Triad Manufacturing Co., Pawtucket, R. I.



SERVICE MAN'S DATA

A Service Man's A. F. Modulated R. F. Oscillator or "Driver"

Many Service Men own an Audio Oscillator. A still greater number would like to, but have felt that it was too difficult to build. This complete article shows how to take all the hurdles during the building of an Audio Oscillator.

By PAUL R. BAKER

THE service man often has need of a modulated radio-frequency oscillator or "driver," as these instruments are indispensable in the adjustment of certain types of radio-frequency amplifiers. Their principal uses are in compensating multi-stage ganged control receivers, in neutralizing, and for a great many other measurements that are made from time to time. If such an instrument is calibrated, its worth is further increased.

The instrument for the service man's use should be small in size, and completely contained, to obtain portability. It may be built to fit into any kind of a cabinet or case, which should be of ample size to accommodate also the battery supply. The '99-type tube, which requires 3.3 volts at 60 milliamperes for filament supply, is capable of sufficient power output for most purposes, and permits the use of the ordinary 4½-volt "C" battery for the filament; while two 22½-volt light "B" batteries serve for the plate supply.

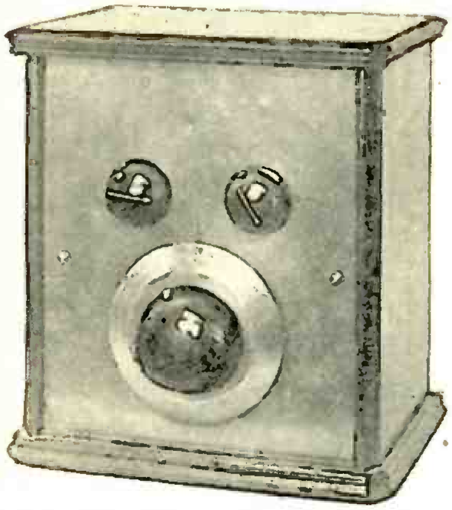


Fig. A. Completed appearance of the Audio Oscillator. The panel is metal (cut from a larger, discarded one); and the dial is also.

Circuit Used

The circuit used is the modified Hartley type. The inductance L1 is tuned by the variable condenser C1, connected in series with a .00025-mf. fixed condenser (C2); the latter is shunted by a shorting switch SW1. When this is open the effective maximum capacity across the tuned half of the inductance L1 is approximately .00016-mf., if C1 is .0005-mf. When C2 is shorted by the switch, the maximum capacity will be that of C1 alone. This arrangement extends the minimum capacity range downward (which is especially useful on the shorter wavelengths) and also lengthens the calibration scale, making for greater accuracy in calibration.

How Modulated

There are a number of different types of modulated R.F. oscillators. Among the most common is that modulated by a separate audio oscillator, which has the disadvantage of requiring additional costly apparatus; while if the tone modulation is made variable, additional controls are required.

Another is arranged to operate directly from the 110-volt A.C. or D.C. light circuit. The modulating source is the same circuit; using the alternating frequency of the A.C. circuit or the commutator-frequency of the D.C. source. One fault with this method is that the modulated frequency cannot be varied, while another is the inherent broad tuning (apparently), caused by the radiation of power from the light circuit. Also, a tone frequency of 60 cycles is inconvenient for use in adjustment or measurement work of any precision.

The driver presented here tunes just as sharply as the more elaborate drivers used with greater power supply, without the additional apparatus necessary in such installations, and also possesses the portability of the line-circuit supply and modulated type. Its fault, of course, is in its battery operation, requiring replacement of these from time to time; but its superior qualities easily overcome this. Another great advantage is that the modulating tone may be varied over a very large scale by varying the grid-leak resistance R2.

It is well known that any regenerative receiver could be made to howl by increasing the feed-back, and that the tone of the howl could be varied or changed by changing the value of the grid leak. In such sets the range of the tone is limited by the small capacity of the grid condenser, which is never given a value of more than .00025-mf.; so small a capacity does not allow sufficient charge to accumulate on the grid of the tube, when it is desired to lower the pitch of the tone. By increasing the value of the condenser to .01-mf., in combination with the proper shunt-resistance value, the tone range may be extended downward; the tone frequency depends upon the value of resistance. The charge accumulating on the grid of the tube is prevented from quickly leaking off to the ground circuit by the grid resistance or "leak." The greater the resistance of the grid leak the longer the time required for the charge to leak off; the smaller the resistance, the shorter the time, and the higher the frequency.

Parts Required

The parts for the construction of this oscillator can be found in most any junk box. They need not be identical with those specified here, but should be of the same values. To prevent later difficulty or trouble in producing oscil-

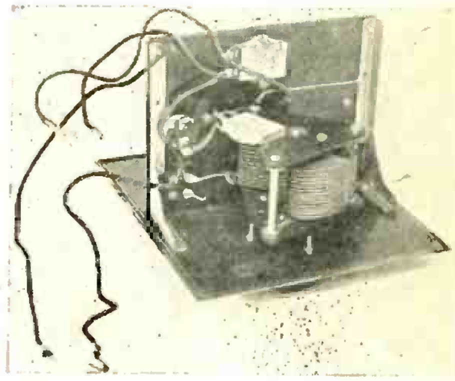
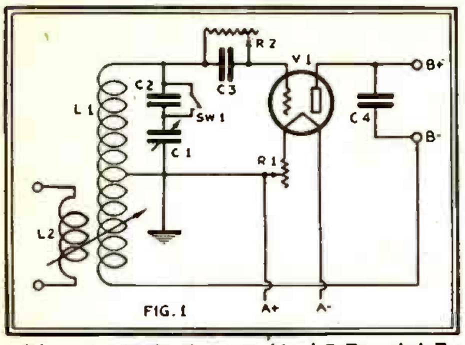


Fig. B. Parts placements under the subpanel.

lations, the parts from the junk box should be given a thorough inspection and cleaning. They are as follows:

1 General Radio .0005-mf. (23-plate) variable condenser (C1).
1 set Aero short wave coils of plug-in type, with plug-in base to which is permanently attached a variable primary (L1 and L2).
2 lengths 2-inch Insuline tubing, 2½ inches long, for broadcast-band coils.
6 General Radio coil plugs to fit jacks of plug-in base.
1 metal panel (size dependent on size of cabinet or case used).
1 cabinet or case not smaller than 8 inches high, 7 inches wide by 5½ inches deep.
1 Carter filament switch used for short switch (SW1). (The filament is turned off by the filament rheostat.)
1 Carter Midget 30-ohm rheostat (R1).
1 Clarostat panel-type variable grid leak—¼ to 10 megohms (R2).
1 Pilot sub-panel type four-prong socket.
1 Flechtheim midget .01-mf. fixed condenser (C3).
1 Flechtheim midget .00025-mf. fixed condenser (C2).
1 Flechtheim midget .001-mf. fixed condenser (C4).

2 brackets (or brass strip for their construction).



Schematic circuit of the combined R.F. and A.F. oscillator described in this article.

1 sub-panel (size dependent upon length and depth of cabinet).
1 National vernier dial.
1 Cunningham CX399 tube (V1).
1 Bright Star or Burgess 4½ volt "C" battery.
2 Bright Star or Burgess portable type 22½ volt "B" batteries.

Construction

The panel and sub-panel are first prepared to size; metal is used for the former to prevent body capacity and, also, serve as the common "A+" return. Bakelite or hard rubber must be used for the sub-panel; the placement of the parts will depend on the size of the panel. In mounting the variable condenser, clearance must be allowed for the batteries in the back or beneath. The panel is drilled and all parts mounted, taking care that the variable grid leak R2 is insulated; as *otherwise a short will result* and no oscillations will occur. The sub-panel is then laid out and the parts mounted (see Figs. B and C). At this time the brackets should be fastened to the sub-panel; if the brackets are made from strip brass they should be bent to shape and fitted. After the complete assembly of the sub-panel, it is fastened to the metal front panel by brass machine screws. Binding posts for the pick-up coil may be placed on the panel or at any convenient point on the sides of the cabinet. If desired, the leads need not be extended for the terminals on the short-wave coil mounting as already provided, may be used as illustrated (Fig. C). With the exception of the leads for the connection to the batteries, the wiring should be of bus-bar; for after calibrating any change in position of the wiring would destroy the accuracy.

Coil Construction

As the short-wave coils and mounting are already on hand, no data will be given for their construction. It will be necessary for the constructor to make two coils to cover the range from 100 to 600 meters; the smaller is wound with 46 turns of No. 2? D.C.C. wire on a 2-inch tube, with a tap at the 23rd turn for the filament return. The large coil is wound with 100 turns of No. 28 D.C.C. with a tap at the 60th turn; this section of the coil should be shunted by the variable condenser and is in the grid circuit. The coils are now provided with the same mounting arrangement to fit the plug-in base, as found on the short-wave coils.

Calibration

If the constructor does not possess a wavemeter, the calibration will be a little more difficult. However, broadcast stations are narrowly separated over the entire band, and their frequencies are maintained at greater accuracy than will be possible to insure with this device (because of the changes in filament and plate supply). Before proceeding with the calibration, a milliammeter should be inserted in the filament circuit and the filament current adjusted by means of the rheostat for 60 milliamperes; at the same time the voltage should be measured. These values should be noted and the position of the rheostat marked; the mark, however, will serve as the check point only as long as the filament current is maintained within 10% of the original value.

Beginning at either end of the broadcast band, stations are tuned in on any broadcast receiver. The grid leak is adjusted to the desired tone, and the rheostat set on the mark as already described. The dial of the driver is now rotated until it peaks and a clear loud note is heard in the speaker or phones attached to the set. If it is difficult to obtain a sharp peak on the adjustment of the driver dial, the driver should be moved farther away. For each successive station checked, a notation should be made. After all calibration points have been marked, the frequencies of the broadcast stations should be entered opposite them in a log for future reference. The short-wave coils are calibrated in the same manner; although it will be difficult to secure complete band calibration unless one is able to receive the Bureau of Standards' *standard-frequency transmissions*, which are exact.

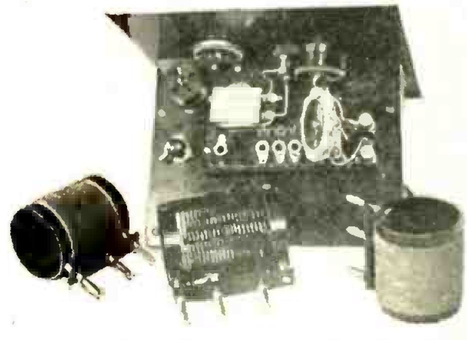


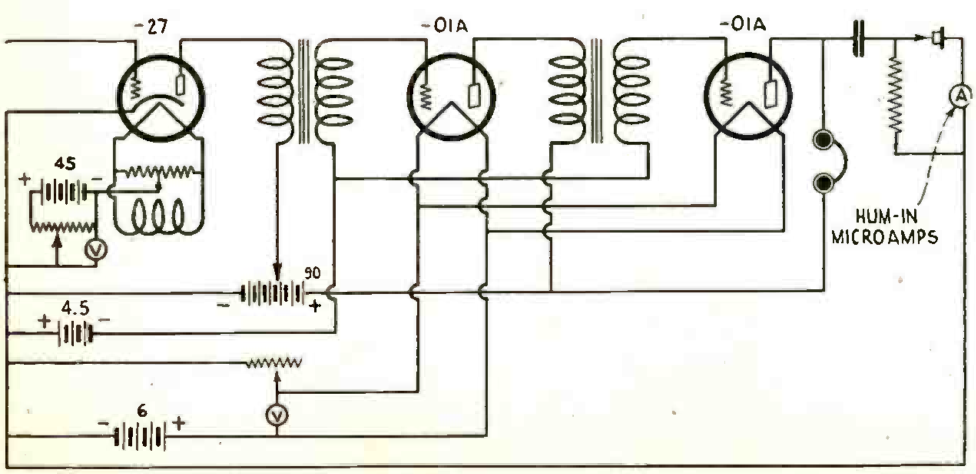
Fig. C. Parts placement above the subpanel.

Hum Elimination in A-C Tube Circuits

By ALLEN B. DU MONT*

THE greatest problem in any radio circuit using A.C. tubes is that of hum and other extraneous noises. While in theory the heated cathode or '27 type tube is said to isolate the A.C. hum and line noises from the delicate radio circuits, this unfortunately does not hold strictly true in actual practice. In fact, more and more background noises have been experienced recently, due to the simple reason that present-day sets are capable of reproducing a far greater range of frequencies than the former sets, and therefore reach down the frequency response scale to the vicinity of the 60-cycle hum. The earlier A.C. sets, on the other hand, with a very poor low frequency response, were quite unaffected by A.C. hum, and the heater tube therefore was considered just about perfect. In addition to A.C. hum, there is being experienced a certain crackling noise, in many instances attributed to static but in reality due to causes within the heater tubes themselves. These causes would not be recognized as such, under any but exceptional testing conditions.

Chief Engineer, DeForest Radio Company.



Circuit of tube hum and noise tester. Grid leak and condenser connect '27 grid and cathode.

Sources of Interference

Of course there are many potential sources of noise in any A.C. set. First of all, it is well to remember that there are outside sources of noise which do influence the A.C. set more readily than the battery-operated set, due to the unavoidable coupling between receiver and power line. Thus leaky transformers, sparking motors, oil burner ignition systems, washers and other devices set up radio-frequency interference along the power line, which is apt to be picked up by any receiver, particularly when operated by socket power. Again, certain conditions within the receiver itself yet outside the tubes, such as faulty resistors, a poor volume control, loose connections, dirty contacts and other causes may lead to noises. Serious hum may be introduced by an unbalanced filament circuit, in the absence of an

(*Continued on Page* 180)

Service from the Office

In this interestingly written story the author illustrates a practical "system" of efficient service which the progressive service man will put into practice. Where "speed" is a standard, this plan will receive the greatest consideration.

By R. EMMET

IT has been no secret, ever since the inception of the radio business, that service has been its "Old Man of the Sea." The dealer really *wants* to give free service to his customers; I do not believe there is a solitary merchant so ridiculously short-sighted as not to realize that a happy and contented customer means more business from recommended relatives and friends. There are good intentions in every retailer's heart; though many disappointed purchasers may smile forlornly at this statement and declare that the dealer who sold them had no heart at all.

The trouble can be traced to the fact that many dealers do not know how to solve the problem of giving service, satisfying the customer and showing a profit at the end of the year. It is therefore natural for them to reduce the necessary expenditures on service, no doubt much against their desires and consciences, in order to show that very important profit.

The large radio retailing organizations in New York City, selling tens of thousands of radio receivers yearly, have tackled this problem in an intelligent and scientific manner that has downed the bugaboo for good. They have found that most of the service on radio can be effectively given from an easy chair in an office without the expenditure of large sums of money. Two principles have been evolved. In the first place, it has been discovered that most service complaints are not based on defective sets and are not really necessary. In the second place it has been found advantageous to *educate* the customer.

Too Much Optimism

Every purchaser of a receiver is very much like an infant. Radio is something he knows nothing or very little about and, like a child first gazing with rapt eyes upon an unknown world, our grown-up infants must be taught. They must be educated what to expect and what not to expect from their radio. They must also learn to co-operate with their dealer and help him keep their sets in good working order.

> ## $25.00 A MONTH
>
> THE Editor wants to hear from every service man who has a real story to tell. Beginning with the November issue, RADIO-CRAFT will pay $25.00 for the best story, giving a real experience that must be of value to other service men.
>
> This story may contain human interest material, or it may be technical, or it may be both.
>
> Stories will be selected mainly for their value for REAL information which other service men can derive from these stories.
>
> You do not have to be a polished writer to win this prize; as the Editors are interested only in the "Meat" and will, if necessary, rewrite parts of the story.
>
> *—Editor*

Thus, a few days after Mr. Smith has bought his radio, he has a complaint to make. He comes in with a woeful look on his usually intelligent face, and says the radio he bought and expected so much of is no good at all.

He is very sorely disappointed. "Help! Help!" we can almost hear from him drowning in his sorrow. It is up to us to render assistance and make him happy again. Do we immediately send out an emergency crew? No! Long experience has taught us there may be an easier way.

"What seems to be the trouble?" our office man asks.

"There is an awful noise in the speaker. I cannot understand a word," Mr. Smith replies.

"I suppose some stations come in good though," says our office man. "How is WEAF?"

"That station is all right," says Mr. Smith.

"How are WJZ and WOR?"

"They're O.K."

"How are WABC and WMCA?"

"They're also pretty good," admits Mr. Smith.

"Tell me," says our man, "what station is it on which you have the noise?"

"Well," says Mr. Smith, "I tuned in Chicago last night and I couldn't understand a word. There was such a crackling in the speaker that I think there must be something wrong with it."

"Mr. Smith," says our man, "you have a wonderful machine." After a five minute discourse on "static" Mr. Smith leaves our office, chest thrown out and head high. He is proud of his set. It is the best at any price. He has just received his first lesson in

(*Continued on Page* 181)

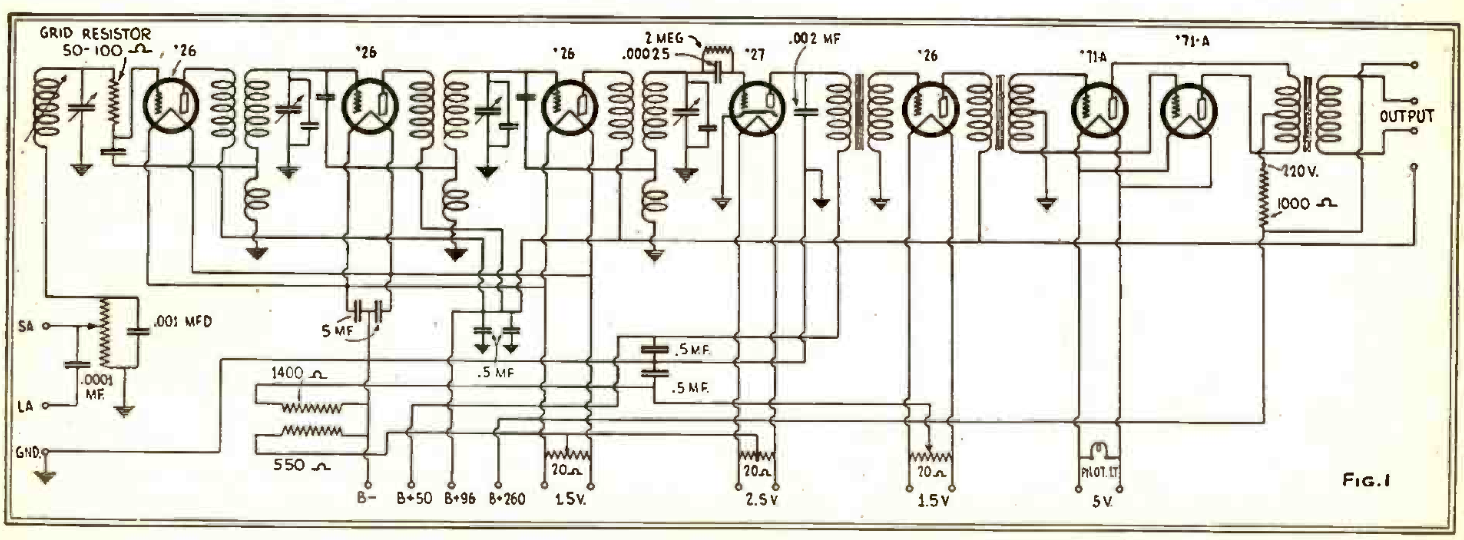


FIG. 1

Schematic circuit of the Majestic 70-B chassis used in the model 72 receiver. In contrast with most neutrodyne arrangements it is noticed that the neutralizing potential is obtained from the grid circuit; the coil being part of the tuned secondary circuit. The service man must remember this important point should occasion arise for servicing one of these modern radio sets. *Two* adjustable 20-ohm "hum balancers" are used in this set.

How a Service Man Does It

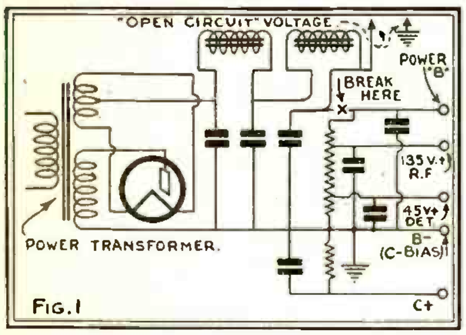
Repair of Transformers, Chokes and Condensers.

By BERTRAM M. FREED

THOSE who test and repair radio apparatus professionally have been confronted many times by defective audio and power transformers, open filter and audio chokes, open dynamic speaker fields, and ruptured or shorted condensers. *For several years the writer has been repairing this type of apparatus without disturbing its place in the radio set or power pack; or tampering with the coil winding.*

As a few laboratories know, an open transformer primary or secondary, ar open choke or field coil is most often caused by the expansion of the coil winding resulting in an open circuit.

What is necessary to repair A.F. transformers, filter chokes and field coils is voltage several times greater than that under which

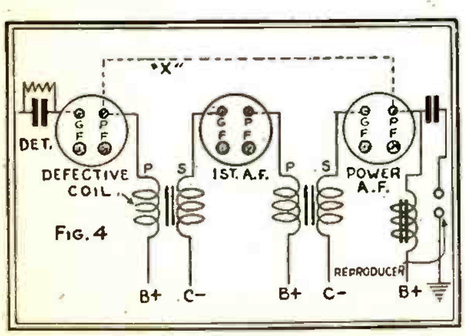


This figure indicates the point at which to break the high voltage to supply an "open circuit" potential.

the apparatus is operating. An A.F. transformer primary usually operates at 45 to 180 volts; in most cases 300 volts is sufficient to close any open A.F. transformer primary. A filter choke usually passes the entire output of a power pack; therefore a higher voltage is necessary to "heal" the open.

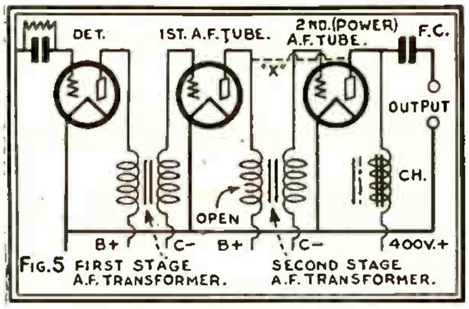
Quick Field Repairs

With the many A.C. sets now manufactured it is an easy task to repair audio transformers and even filter chokes, in the home of the customer without the aid of external means. Most A.C. sets use power tubes requiring at least 180 volts on the plate. The power pack of such a set usually delivers 300 volts *without a load*. A power pack employed in delivering plate voltage for a 210 type tube



Circuit for repairing first stage A.F.T. primary.

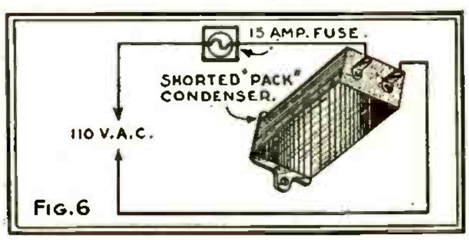
will deliver over 500 volts *without a load*. It is with this "open circuit" voltage that we repair transformers and chokes.



Circuit for repairing second stage A.F.T. primary.

Bring out leads from the negative and high-voltage leads of the pack (Fig. 1) and apply them directly to the terminals of the open transformer primary (Fig. 2). (Bear in mind that the pack must be operating *without a load* to secure the higher voltage.) After five seconds, remove voltage and test. If winding is not closed, repeat procedure applying voltage for a longer period until winding is closed. The same method is used with the secondaries of A.F. transformers (only apply voltage for a second or two as this winding can be burned out very easily).

When a transformer is found with primary shorted to secondary apply voltage to one side of secondary and one side of primary,



Circuit for breaking down condenser shorts.

Fig. 3. Very often, the short is cleared by the breakdown of the turn or turns of wire that are shorting.

A filter choke or field coil of a dynamic speaker, though usually requiring a greater voltage to "heal" it than that under which it operates, has been repaired with only the voltage of the power pack in which it was working.

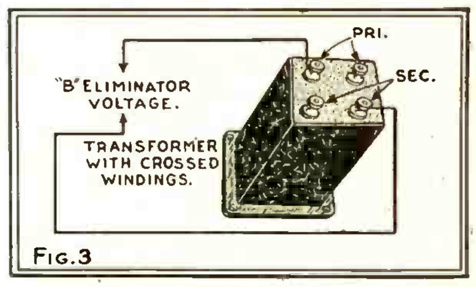
More "Homework"

In A.C. sets where the first audio transformer primary is open, the healing process is much simpler.

Leaving the power pack connected to the set, and, *removing all tubes except the rectifier*, place a wire (X) from the plate of the detector tube to the plate of the power tube (Fig. 4). This will impress upon the primary winding of the first A.F. transformer the whole output of the pack (less the detector voltage). Where the output is 400 volts or more, open second-stage transformer windings can be "healed" in like manner by connecting the plate of the first audio tube to the plate of the power tube (Fig. 5.)

Power transformers can be repaired by applying high voltage to any winding that is open. This applies to A.C. filament windings as well as primary windings. Shorted primary windings of power transformers can be cleared by high voltage impressed upon input terminals. A.F. transformer shorts can be cleared in a similar manner.

N.B. We must bear in mind that the heavier the winding, the greater the voltage impressed must be, and for a longer period. Sometimes voltage must be applied for an hour before any result is attained.

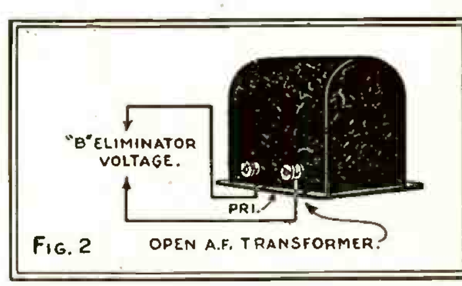


Repairing audio transformers with "crossed" windings.

Perhaps an explanation of this "healing" process will be of moment. When voltage is applied to an open winding, an arc occurs at the open, burning the insulation from adjoining turns, recreating a continuous winding.

A common complaint in audio amplifiers is noisy transformers. A heavy shock of high voltage, for an instant, invariably clears up this trouble. (The poor connection has been fused to better contact.) Fig. 2.

Condensers break down after being in service for some time, or upon the voltage rating being exceeded, due to the insulation at some particular point in the condenser breaking down, causing a short between layers of foil (usually condensers such as these show only a partial short upon testing for continuity. These can most often be easily repaired).



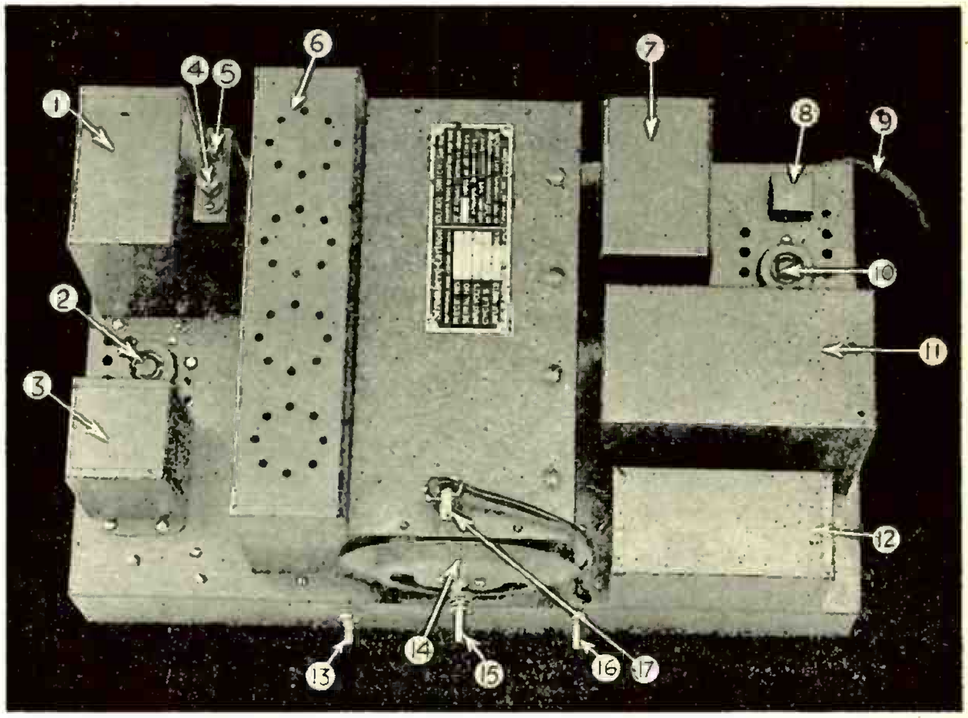
Fixing A.F. transformers on the repair bench.

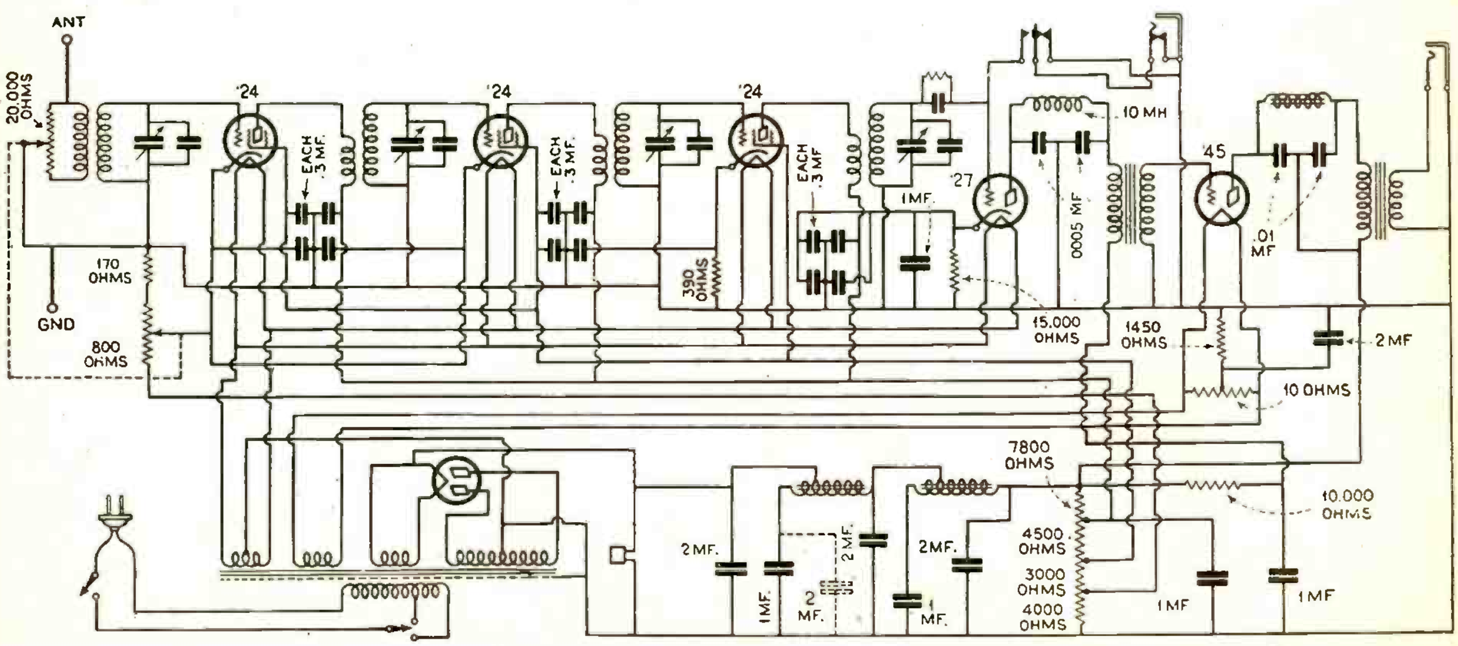
Condensers which are "partially" shorted can be repaired by applying 110 volts A.C. to

(*Continued on Page* 182)

STROMBERG-CARLSON Nos. 641 & 642

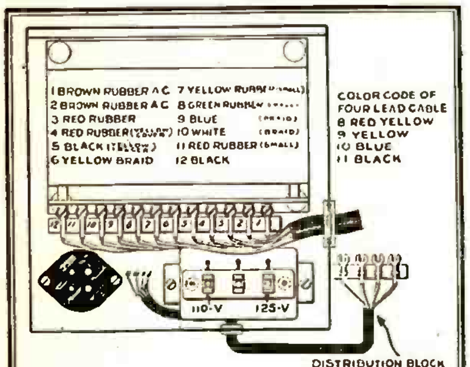
As will be seen in the photograph of the assembled units, all operating parts are enclosed. All transformers, inductances and capacities are mounted in metal boxes; and filled with moisture proof compound. The power transformer leads are laced to the main cable. To insure good connection for the grounding leads, the chassis of steel has been copper plated. The 641 is a small model in a cabinet known as the "Treasure Chest." The 642 is the same chassis, nearly, in an art console. A removable panel is provided on the cabinet bottom to allow ready access to the apparatus and wiring on the under side of chassis base without dismantling the cabinet. (In the case of the 641.) The receiver chassis and reproducer are bolted to a removable structure; as is also the front panel. This renders servicing easy. The items shown in the photograph are numbered as follows: 1, Output transformer assembly; 2, audio amplifier socket ('45); 3, A.F.T.; 4, "gnd." post; 5, "ant." post; 6, cover over tubes (one nearest dial, '27; next three, '24's); 7, filter condenser bank; 8, cover over high-low switch; 9, power supply cord; 10, rectifier tube ('80) socket; 11, power transformer; 12, choke coil assembly; 13, volume control and switch; 14, dial; 15, selector control; 16, on-off switch; 17, pilot lamp socket and bracket. Pin jacks for loud speaker cord are at rear, left, (and consequently not visible); while the pickup jack, power outlet, and power supply cord are grouped at rear right. The volume control is double and operates by varying the biasing potentials on the control grids of the first and second radio amplifier tubes as well as the voltage supplied to radio amplifier from the antenna. The two controls are simultaneously operated from one knob. The grid bias control does not begin to operate until the volume is partially reduced by the antenna control; this prevents distortion due to overloading the radio amplifier when the volume is turned down on very strong local signals. This type of volume control does not cause detuning when it is varied. A '27 is used as a "linear" power detector with automatic bias. This detector operates at high radio frequency voltages provided by the R.F. amplifier and is not subject to the ordinary distortion to which the "square law" detector is heir. The grid bias is automatically adjusted to the proper value for the strength of signal received to obtain this linear characteristic. The value of the R.F. input to the detector is so high that the output may be fed directly into the single stage of amplification shown in the diagram. The output transformer secondary connects to pin jacks, in the model 42 receiver; in the 41, a fixed condenser connects one pin jack capacitatively to the primary of the output transformer, while the other pin jack is then connected to the center tap on the 10 ohm resistor which shunts the power tube filament. A jack has been placed in the rear of the chassis for plugging in a pickup. By turning the volume control completely "Off" (counter-clockwise) the pickup is connected in the grid circuit of the detector tube. This tube then acts as an amplifier, making a two stage amplifier for the pickup energy. To energize an A.C. type dynamic reproducer an outlet has been supplied in the model 41; it is automatically cut off when the set is disconnected at the panel. In the 42 this outlet is used to supply the A.C. needed for the built-in dynamic reproducer. Hum due to this circuit arrangement of the reproducer is nullified by careful design; including the use of a "shading ring." Rust flakes and filings in the air gap will result in distorted reception. To reduce as much as possible this cause of poor operation, the pole pieces have been heavily zinc plated. Very complete shielding is necessitated by the high amplification obtained through use of type '24 tubes. (These receivers give an amplification from antenna to the grid of detector tube of approximately 255,000 and an overall amplification from antenna to output of approximately 2,350,000. Comparing this with a good receiver using the same number of tuning stages with '27 tubes and employing the customary detector and two A.F. stages which gives an amplification from the antenna to the detector grid of approximately 12,500, and from the antenna to the output of approximately 575,000, it will be observed that the Nos. 641 and 642 receivers have approximately 20 times more amplification between the antenna and the detector. This allows the use of a linear power detector, the omitting of the first audio stage and still gives an overall amplification of approximately four times that of the other receiver. Instead of the dynamic reproducer field, a floor lamp may be connected to the A.C. output jack mentioned above.





TEMPLE—Models 8-60—8-80—8-90

In this receiver A.F. transformer TR1 has a ratio of 4-to-1; TR2, 3-to-1. Cases are occasionally reported where, when a loud signal is tuned into the set, the receiver will suddenly go dead but immediately start again if it has been returned. This condition is due to fine metallic dust which collects between the condenser plates and causes an electrostatic short at irregular intervals. Every precaution to overcome this difficulty has been taken and it is not found in receivers bearing serial numbers over 8000. (Pipe cleaners make excellent condenser plate cleaners.) The small carbon resistors on the bottom of the chassis have been color coded (to prevent substitution of wrong values), as follows: 750,000-ohm resisror, either all red or natural color with a blue dot. The 2 meg. leak is natural with a yellow dot and the 43,000-ohm resistor (detector plate lead and also in phonograph pickup lead), all black or black with dark green dot or all black with red end. In case a carbon resistor is substituted in place of the wirewound grid suppressor these will be light in the filament-to-ground circuit of the '45's or a shorted by-pass condenser across the 900 ohm portion of the large resistor. The UX280 or the CX380 is recommended by the manufacturers for the reason that some makes of tubes pass 200 milliamperes instead of the required 125 milliamps, at 350 volts. This would cause (a) the A.C. input fuse to blow; (b) rectifier tube burnout; or, (c) power transformer to heat to a dangerous point. In instances of excessive hum (a rare condition, as unusual precautions have been taken to prevent this, as a study of the schematic will, in part, show), check the characteristics of the detector and first audio tube. All receivers bearing serial numbers under 7,500 have the pilot light in parallel with the '27 filaments. Beginning with serial numbers approximately 7,600 the pilot light lighr is parallel with the filaments of the '45 tubes. This change was made due to the fact that many of the 2½-volt pilot lights supplied by the lamp maker would show a decided flicker when their source of power was from the moist, will be satisfactory. In some instances high resistance in the water meter where sets are grounded to the water pipe will cause oscillation or impaired reception due, often, to excessive regeneration. Cases of this kind are easily remedied. Simply fasten a ground clamp on each side of the water meter and connect a No. 14 wire "jumper" across the meter, attaching to the two ground clamps. The 14 inch dynamic reproducer is designed particularly for this receiver. Tuning is of the single-control type. With every stage balanced at the factory extreme sensitivity and selectivity result. This excellent operation is obtained through proper use of 1000 ohm grid suppressors; and volume is adequately governed by the 6000 ohm unit. Under exceptional conditions it may be desirable to shunt the low resistance R.F. transformer in the plate circuit primary of the second stage (second tube), with a 10 ohm resistance. This unit has been provided; and is controlled by the switch indicated in the schematic circuit. As the field coil of the



DISTRIBUTION BLOCK FOR DYNAMIC REPRODUCER

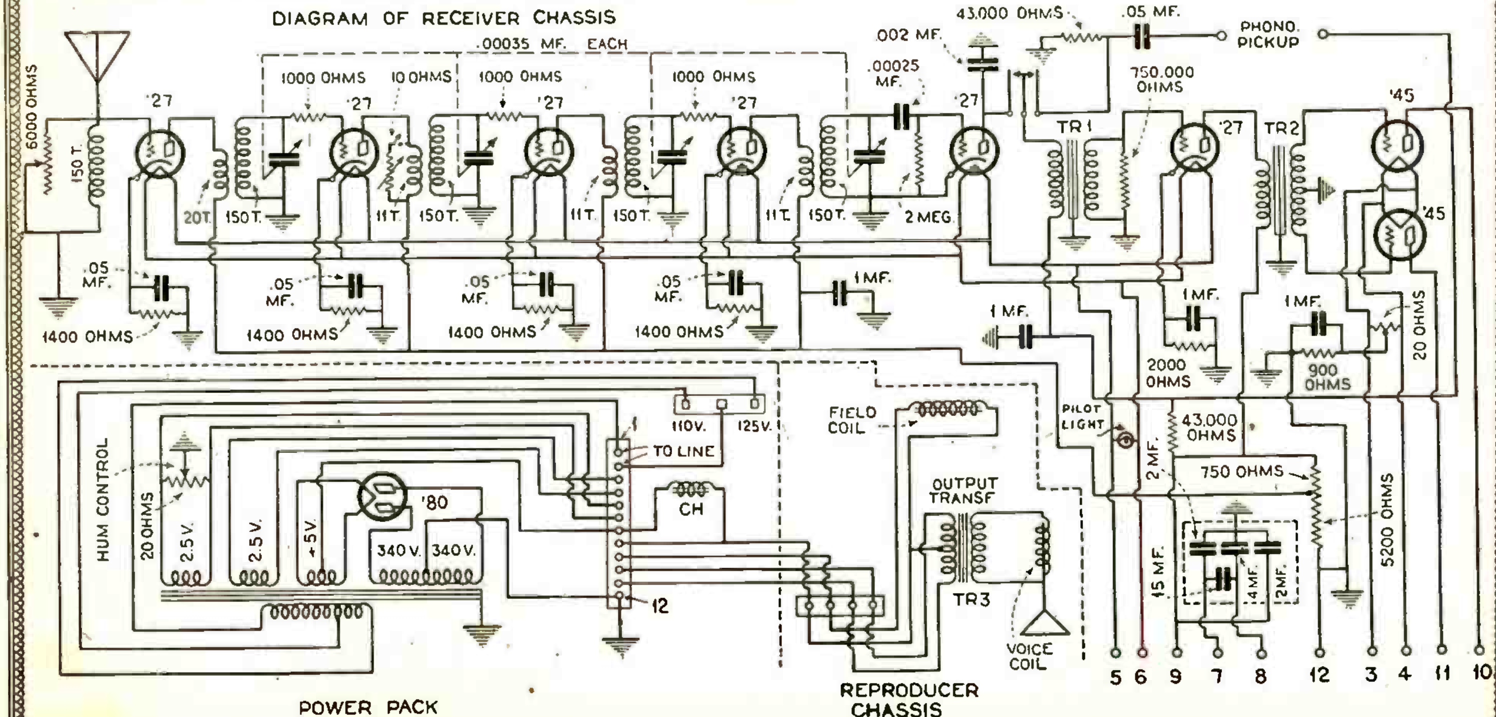
TYPICAL SET ANALYSIS

Tubes		Tubes Out		Tubes In					
		Voltage		Voltage			Normal Plate M. A.	Plate M. A. Grid Test	Plate M. A. Change
Type	Use	"A"	"B"	"A"	"B"	"C"			
'27	R.F.1	2.10	136	2.05	124	7	4.8	6.9	2.1
'27	R.F.2	2.10	136	2.00	122	6	4.6	6.8	2.2
'27	R.F.3	2.15	136	2.00	122	7	4.7	6.8	2.1
'27	R.F.4	2.15	136	2.05	121	7	5.0	7.2	2.2
'27	Det.	2.15	140	2.10	48	0	2.5	3.0	0.5
'27	1st A.F.1	2.15	164	2.10	140	8	4.2	5.8	1.6
'45	Out.	2.45	260	2.25	240	43	26.0	32.0	6.0
'45	Out.	2.45	260	2.25	240	44	22.0	28.0	6.0
'80	Rect.	5.40	AC	4.80	AC	0	*50.0	0.0	0.0

Line Voltage 112. Volume Control Position Full On. *Reading on meter, one anode only; actual current twice this value. Note: Cathode voltages show a reversed reading.

green in color. The voltages indicated in the table, "Set Analysis," for 112 volts; any other than this requiring due allowance for the different values which will be indicated. Wide plate voltage variance denotes poor rectifier tube or defective power pack; great milliammeter variation, unsatisfactory tubes. No reading on the filaments shows that either there is no A.C. input, that a fuse has blown, or there is an open primary in the power transformer. Before making further test be sure that the A.C. line to which the set has been connected is alive. (To test your A.C. line the easiest way is to simply insert any 110 volt lamp in the socket to be used for the radio line connection.) No "C" voltage on the '27's denotes either defective resistors in the cathode return or shorted resistor by-pass condensers. No "C" voltage on the '45 indicates a defective resistor '27 filament line. Changing pilot lights usually remedied this trouble but it was found far more satisfactory to make the change of filament wiring and thereby entirely do away with the flicker. It is suggested that service men working on sets having serial numbers below 7,500 make this filament wiring change while the chassis is out of the cabinet, as a matter of standard practice toward increased customer satisfaction. In spite of the fact that most A.C. sets apparently work almost as well without a ground as they do with, the installer should in no case make an installation where the set is not connected to a good ground. This can be either a cold water pipe or if necessary a steam radiator. In installations where neither are available a six-foot iron pipe driven in the ground outside of the house, preferably in a position where the soil is dynamic reproducer constitutes part of the main filter, any defect in this winding will become manifest in the receiver performance, and plate potentials will not be obtainable; with the exception of the supply to the '45 tubes, which does not go through the reproducer field coil. The first choke coil is contained in the power pack carrying on top of it fuse connections for the 110 volt primary. This winding is tapped for 110 and 125 volt supplies and change is made by reversing the position of the 2 ampere protective fuse. Both the first audio transformer and the input transformer of the '45 push pull stage are mounted in the metal can located nearest to the condenser drive. In case of open A.F.T. windings, replace both transformers (the entire can) thus insuring a perfectly matched audio amplifier at all times.

DIAGRAM OF RECEIVER CHASSIS



ATWATER KENT MODEL 55

The Model 55 receiver is a 6-tube (and rectifier) A.C. outfit representing a distinct departure in design from previous models.

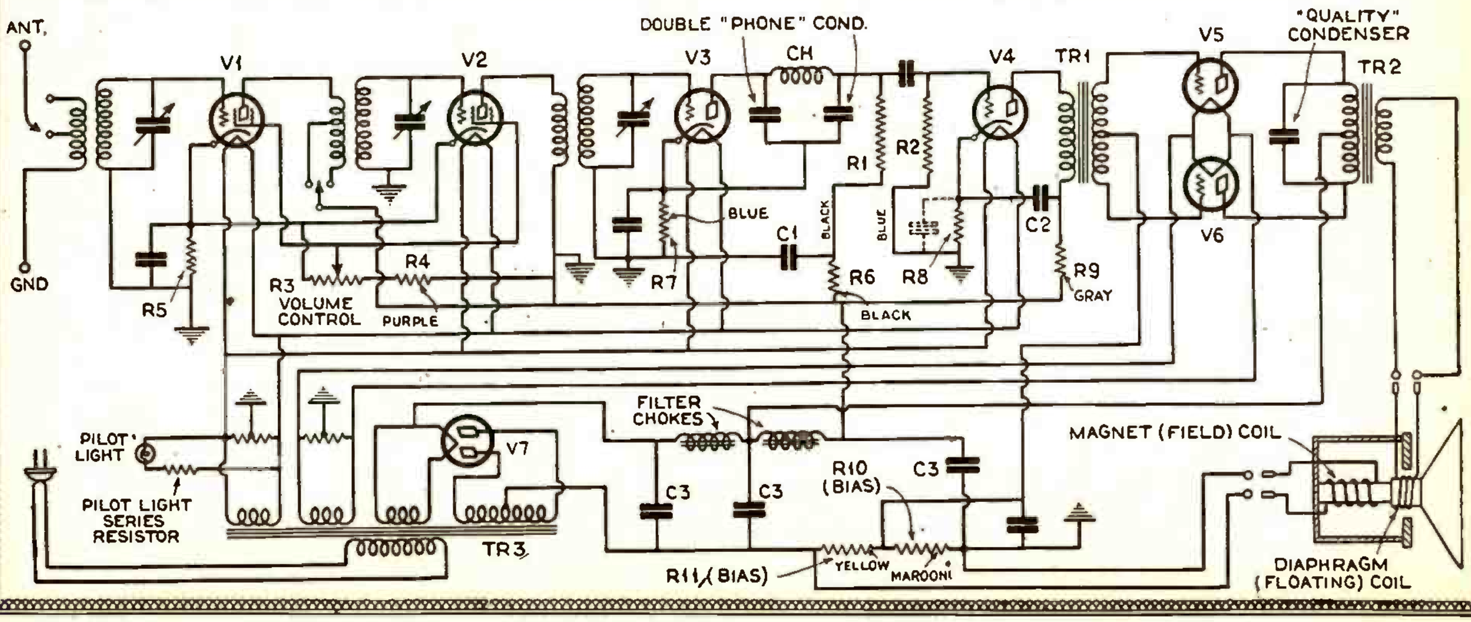
The screen-grid R.F. tubes furnish a high degree of amplification, and as the various units, including the tubes of the R.F. circuits are shielded, the selectivity and sensitivity are excellent. The resistance coupled audio stage assures that signals are passed into the push-pull audio output stage with minimum distortion where they are further greatly amplified with maximum fidelity. Among the other distinct advantages of this type receiver may be mentioned the following: (1) The various units of the power pack are mounted in separate metal containers, simplifying replacement. (2) An illuminated dial graduated in kilocycles makes for easier operation for the customer. (3) The volume control operates by regulating the voltage on the "screen grid" in the R.F. tubes, this voltage being continuously variable from zero to the maximum of about 75 volts. This gives quieter and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model F-4 electro-dynamic speaker which can be used with Model 55 receiver uses for its field supply the entire "B" current supply, same as furnished to plates of all tubes. (5) Tube socket contacts, resistors, and other parts are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages, detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum. As in the other Atwater Kent single dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stage, and transformers. Care must be taken to avoid scratching or otherwise injuring the coils when replacing the shields. Also note that a lead from the secondary of each R.F. transformer to the bottom stator-terminal on each variable condenser should pass under a slot at the base of the shield and must not be caught between the shield and the metal baseplate. To aid the installer it is pointed out that the Model 55 is very sensitive and does not require a large antenna. Two antenna posts are provided on the set, marked "Long Antenna" and "Short Antenna." The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The Short-Antenna post should be used if a very short (inside) antenna is employed. If extreme selectivity is desired use a short antenna connected to the Long-Antenna post. Indoor aerials for Model 55 should be erected as far as possible away from grounded metal, such as pipes, electric wiring, etc. Ground connection *must* be used with Model 55. This set will also not operate (as some A.C. sets do) with either antenna post connected to the ground. The two A.F. output tubes used in the audio stage should be matched on a tube tester, otherwise the set may hum. Do not use any other model of Atwater Kent speaker with Model 55, than the type F-4 or F-4C. Do not remove speaker plug from socket when set is in operation. The set should be operated with the "Local-Distance" switch in the local position when receiving nearby stations. Failure to do this may result in overloading of the detector tube, which will be evidenced by a decrease of output volume at the resonant point on the tuning dial, as well as a slight ragged type of distortion on strong stations. The "Local-Distance" switch controls the number of turns in the plate circuit of V1. In later Model 55 receivers, the tubular resistors are made with cast metal caps or contacts, which have a comparatively low melting temperature. Accordingly it is necessary in replacing these units to exercise considerable care when soldering in order not to melt the entire cap. The soldering iron should be held in place only long enough to insure a good electrical connection between the cap and the lug to which it is to be fastened. A few experiences in soldering these new tubular resistors will quickly show the correct method required for good results every time. Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lugs. For continuity testing, all of the socket contacts may be exposed by inverting the set and removing the plate. Separate parts may be tested for continuity with a voltmeter and battery in the usual way. If there is any doubt as to whether a part is shorted, grounded, or open, it is advisable to remove all connecting leads to that part and test it separately. When synchronizing the condensers, connect the oscillator pick-up lead to the Short-Antenna binding post, and place the local-distance switch in the "distance" position. Adjust the volume control to give about half scale reading on the output meter, and then leave the control in this average position. Owing to the design of the R.F. amplifying circuit in Model 55, it is necessary to use a top shielding plate when synchronizing the variable condensers, and in order to make the rotor of No. 1 condenser accessible for adjustment it is necessary to cut or file a hole in the top-shield over the rotor of No. 1 condenser. This hole should be about 1½ inches in diameter, with its center 2¼ inches from the left edge of the shield and about 1⅜ inches from the front edge. The rotor of No. 1 condenser may then be adjusted with one finger through this hole. No. 2 condenser rotor may be adjusted by turning the control knob, and No. 3 rotor may be reached from the right-hand side of the chassis, as will be seen. Connections to the various units may be found by use of the color code: First R.F.T., black to chassis (held under one of coil mounting bolts), blue to stator of variable condenser, green to short-antenna post, red to long-antenna post; second R.F.T., black to chassis (held under one of coil-mounting bolts), blue (with lug) to stator of variable condenser, green to plate of V1, red-white tracer to distance switch, blue (without lug) to distance switch; third R.F.T., black to chassis (held under one of coil mounting bolts), blue (with lug) to stator of variable condenser, green to plate of V2, blue lead (without lug) to grid of V3. Power transformer assembly—rectifier fil. winding, thin leads with black sleeving; primary winding, thick brown leads; V5 and V6 fil. winding—thin leads with black sleeving; fil. winding leads to V1, V2, V3 and V4 are thick leads with black sleeving. Push-pull input and output A.F.T. assembly, input pri.-black with red tracer and other lead is green, secondary center tap is black while cone grid lead is blue and other is red, the output primary center tap is black with white tracer and the two plate fields are both brown, the secondary leads which connect to the voice coil are both yellow with black tracer. Looking down into the receiver, the parts layout is as follows: Rear left corner, "long antenna" post; to the right, "short antenna"; next, "ground." The four prong receptacle in front of the antenna posts is for the dynamic reproducer; in front of that is the rectifier receptacle. The fully shielded unit in front left corner is the first R.F.T. The socket for V1 is next to the right, followed by the second R.F.T.; V2; third R.F.T.; V3; V4 (front right corner); V5 (next to tube in rear right corner); V6 (rear right corner). Going left along rear we find: the A.F.T. assembly; filter condenser assembly; filter choke assembly; and, next to antenna and ground posts, power transformer assembly.

VOLTAGE REQUIREMENTS

Filament	Approx. Voltage
−F to +F contacts on V1, V2, V3 and V4	2.4 (a)
−F to +F contacts on V5 and V6	2.4 (a)
Filament contacts on V7	4.9 (a)
Plate	
Cathode to plate, V1 (m)	175 (b)
Ditto. V2 (m)	175 (c)
Ditto, V3	105 (d)
Ditto, V4	70 (e)
Filament to plate, V5 and V6	235 (f)
Control Grid	
Cathode to control grid, V1 (m)	3 (g)
Ditto, V2 (m)	3 (h)
Ditto, V3	12 (i)
Ditto, V4	22.5 (j)
Filament to grid, V5 and V6,	42 (k)
Screen Grid	
Cathode to screen grid, V1 and V2 (m)	85 (l)

Additional Test Information

Use high resistance D.C. voltmeter (about 0-50-250) to measure plate and grid voltages; and an A.C. voltmeter to measure filament potentials. Tests made with set in operation, all tubes and speaker plugged in sockets. Tests made in order listed. Low plate or grid voltages may indicate a partially shorted bypass or filter condenser; V3 plate voltage will be low, and V3 grid voltage high, if either of the double "phone" condensers are shorted. (m) denotes volume control set at maximum. NO READING indicates: (a) open filament winding or connection; (b) open high voltage winding, open speaker magnet coil, open filter choke, open primary of 2nd R.F.T., or R5 open; (c) open primary of 3rd R.F.T.; (d) open V3 filter resistor (black) R6, coupling resistor (black) R1, R.F. choke CH, or V3 bias resistor (blue) R7; (e) open V4 filter resistor (gray) R9, primary of TR1, or V4 bias resistor R8 (mounted under maroon and yellow, bias resistors R10 and R11; (f) open TR2 primary; (g) open secondary of 1st R.F.T.; (h) open secondary of 2nd R.F.T.; (i) open secondary of 3rd R.F.T.; (j) open V4 resistor (blue) R2; (k) open V5-V6 bias resistor (yellow) R11, or open secondary of TR1 (if bias resistor R10 is open V3 grid potential will be approximately 85 volts); (l) open connection to slider of volume control R3, open R3, or open bleeder resistor (purple) R4. Make all voltage tests first to get a general idea of the trouble, then disconnect the set and test the suspected parts for opens, shorts and grounds. A condenser, not shown in schematic, by-passes the screen-grids.



EDISON R-4, R-5 AND C-4

In the Edison Receiver, Models R-4, R-5 and C-4, the R.F. amplifying circuit employed is a form of "constant gain" circuit, wherein two primaries are used in each radio frequency transformer, one resonated below and one above the broadcast frequency spectrum. The four R.F. transformers employed are identical with each other and their secondaries are tuned by identical tuning condenser sections. Referring to the Schematic wiring diagram L1, L2, L3 and L4 are low frequency primaries, resonated to approximately 450 kilocycles by means of the condensers C5, C6, C7 and C8; L5, L6, L7 and L8 are high frequency primaries, not shunted by any condenser; L9, L10, L11 and L12 are secondaries tuned by the variable condenser sections C1, C2, C3 and C4, which are shunted by the trimming capacities C1A, C2A, C3A and C4A. Stabilization of the R.F. amplifier is accomplished by the use of grid circuit neutralization: *i.e.*, the employment of neutralizing condensers, C10, C11 and C12, connected from the plate of each R.F. amplifying tube to a coil tightly coupled to the secondary of the input transformer of that tube. These coils in the diagram are L5, L6 and L7, which are at the same time the high frequency primaries of the first, second and third R.F. transformers. Substantial resonance of the first R.F. input circuit to the resonant frequency of the second and third R.F. and detector input circuits is maintained by holding the effective antenna-ground capacity to a value less than 100 micromicrofarads. Antennas of less than this capacity are to be connected to the binding post marked "Antenna," while antennas of greater than this capacity are to be connected to the "Long Antenna" binding post. This latter connection places the condenser C9 in series with the antenna-ground capacity, reducing the effective value of the latter to less than 100 micromicrofarads for antennas of capacities up to 500 micromicrofarads. Self-bias of the first R.F. amplifying tube is secured by the use of resistor R1, by-passed by the capacity C20. Isolation of the R.F. component of the plate current of this tube is accomplished by the use of resistor R2 and capacity C19. Self-bias of the second and third R.F. amplifying tubes in common is effected by the resistor R3 and the section A of the volume control by-passed by the capacity C23. Isolation of the R.F. components of the plate currents of those two tubes in common results from the use of the resistor R5 and the capacity C22. The volume control operates to reduce volume in the following manner: As the contact shown in the diagram is moved leftward from the extreme right-hand end position, the resistance B, lying across the primary system of the first R.F. transformer, is reduced in value following a special resistance taper. After approximately mid-position has been reached, this resistance B has become and is maintained at substantially zero value. A remains at zero value until approximately mid-position of the control has been reached and thereafter increases in value uniformly with angular rotation of the control knob. Resistance A forming part of the bias resistance for the second and third R.F. amplifying tubes, a leftward motion of the contact of the volume control after approximately mid-position has been passed increases the bias on these tubes. The resistor R4 limits the necessary amount of resistance in the section A of the volume control by increasing the current at minimum volume setting of the control from a fraction of a milliampere to between 3 and 4 milliamperes. When minimum volume setting of the control has been reached, a further slight turn of the control throws the radio-phonograph switch, S1, from its lower to its upper diagram position: *i.e.*, from radio to phonograph position, this being the sole means provided for the throw of this switch. The detector "B" is obtained from the plate supply for the R.F. and first A.F. amplifying tubes through a two-stage resistance-and-condenser filter, consisting of R9, C25, R8 and C24. This filter serves a triple purpose: it effects the necessary reduction of plate voltage, the isolation of the A.F. current in the detector plate circuit and a reduction of ripple in the detector plate supply. A positive bias is placed on the heater of the detector tube with respect to its cathode by the connection of the variable contact of the hum adjuster R6 to the cathode of the first R.F. amplifying tube. A high frequency cut-off is provided by the capacity C15 shunting the secondary, L15, of the A.F. amplifying transformer, the primary of which is shown as L14. Hum due to residual 120-cycle ripple in the plate supply for the first A.F. amplifying tube is eliminated by the use of the series circuit C21, R10, connected between the positive of the plate supply and the cathode of this tube. The impedance of this circuit is arranged to be 9 (the mu of the tube) times the impedance of the parallel circuit C26, R11, and the phase angles of the two circuits to be the same. This results in the impression on the grid of this tube of a voltage proper in both phase and amplitude to counteract the effect of the residual ripple of the plate supply. The second A.F. transformer has a primary L16, and two separate half-secondaries, L17 and L18. These half-secondaries are separate in order to permit the insertion between their low potential ends of the resistor R13. Between the center-tap of the filament winding for the second stage amplifying tubes and the fixed center tap of R13 is connected the self-bias resistor for these tubes. A variable contact operating on R13 is connected to the negative of the plate supply. The function of R13 is to permit the increase of the bias on either of the two second A.F. tubes at will by the amount necessary with any two given tubes to balance out residual hum. L32, part of the power transformer primary, is designed for use from 100 to 110 volts; L32 and L33 together from 110 to 120 volts; and L32 and L34 together from 130 to 140 volts. R15 is a bleeder or "loss-current" resistor, the function of which is to build up to the required value the excitation current flowing through L22 and to stabilize the plate voltage on the R.F. and first A.F. tubes for varying values of plate current in the second and third R.F. amplifying tubes.

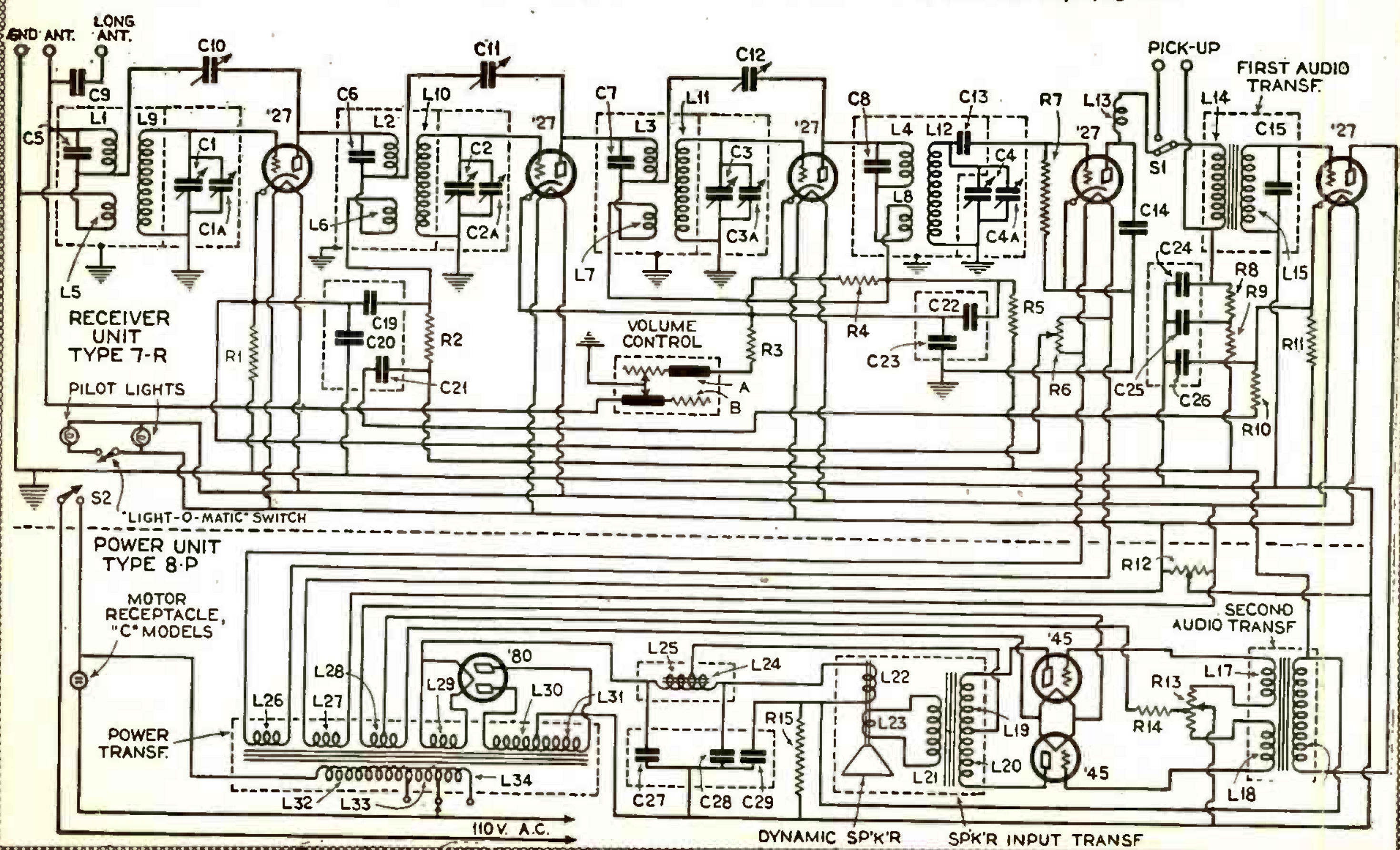
IDENTIFICATION OF PARTS

C1, C2, 2-gang, .000355 mf. each; C3, C4, ditto; C5, C6, C7, C8, .00025 mf. each; C9, .000125 mf.; C10, C11, C12, 40 to 80mmf., variable; C13, .0001 mf.; C14, .001 mf.; C15, .00045 mf.; C19, 0.1 mf., 300 V.; C20, ditto; C21, 0.16 mf., 300 V., (C19, C20 and C21 in same can); C22, 0.1 mf., 300 v.; C23, 1.0 mf., 150 v., (C22 and C23 in same can); C24, 1.0 mf., 300 v.; C25, 0.5 mf., 300 v.; C26, 1.0 mf., 150 v., (C24, C25 and C26 in same can); C27, 2 mf., 600 v.; C28, ditto; C29, 1.0 mf., 300 v.; C1A, C2A, C3A and C4A trimmers on side of variable condenser section which each shunts.

R1, 1000 ohms, 1 watt; R2, ditto; R3, 400 ohms, 1 w.; R4, 40,000 ohms, 1 w.; R5, 400 ohms, 1 w.; R6, 20 ohms; R7, 1.5 meg., 1 w.; R8, 25,000 ohms, 1 w.; R9, 25,000 ohms, 1 w.; R10, 6000 ohms, 1 w.; R11, 2,000 ohms, 1 w.; R12, 20 ohms; R13, 200 ohms; R14, 780 ohms, 5 w.; R15, 10,000 ohms, 5 w.

L1, L2, L3 and L4, 500 mhys., each; L5, L6, L7 and L8, 7½ turns, each; L9, L10, L11 and L12, 245 mhys., each (measured in shield); L13, 50 to 65 millihys.; L14 and L15, 4-to-1 A.F.T.; L16, L17 and L18, 5-to-1 ratio A.F.T. with separate secondaries connected in series by variable resistance R13; L19, L20, speaker input transformer (mounted in speaker frame) having center-tapped primary; L21, secondary, speaker input transformer; L22, dynamic reproducer field coil, 4,500 ohms; L23, voice coil for above; L24, inside third of filter choke, 20 hys., 375 ohms; L25, outside two-thirds of choke.

S1, radio-phonograph switch, S.P.D.T. toggle, opened by volume control shaft; S2, Line switch, S.P.S.T. toggle; Light-O-Matic switch, located in dial mechanism, operating Light-O-Matic pilot light.



SHORT WAVE CRAFT

"The Short Wave Screen-Grid Craft-Box"

Constructed of parts taken from the junk box.

By BERYL BAKER BRYANT

THE unusual development of radio over a brief span of time has left the "junk-box," or drawer, of many radio experimenters well filled with obsolete parts which can no longer be used with any degree of satisfaction in a modern broadcast receiver. These parts have become obsolete, not because of their lack of efficiency, but because of the alteration of broadcast conditions.

The vogue of short-wave code and broadcast transmission offers a purpose wherefore the experimenter or short-wave enthusiast may resurrect many of the parts he had relegated to his own private junk heap. With care of design and construction, a short-wave receiver may be fashioned that will equal the performance and appearance of apparatus constructed of specially-designed and costly parts.

Junk-Box Craft

With this purpose in mind the author set about to design and construct a real short-wave receiver. The old junk box was fished out of the closet and its contents dumped on the floor. (A word of advice, place papers on the floor first; as this will preserve peace of mind later.) After a few minutes spent in selection of parts that might be used, the following were chosen:

2 seven-plate midget variable condensers, 32-mmf. capacity with knobs, *C1*, *C2* (formerly used as compensating condensers in a broadcast receiver.)
4 UX-type sockets. (Not necessary that they match.)
1 unmounted A.F. transformer, vintage of 1922. (Although any of recent manufacture might work better) (*TR*).
1 85-millihenry R.F. choke. (There was some doubt as to the probable efficiency but, in any event, it proved without "dead spots"; as regeneration was obtained over all the short-wave bands. The inductance need not be as great as that used, but may be as low as five or ten millihenrys.)

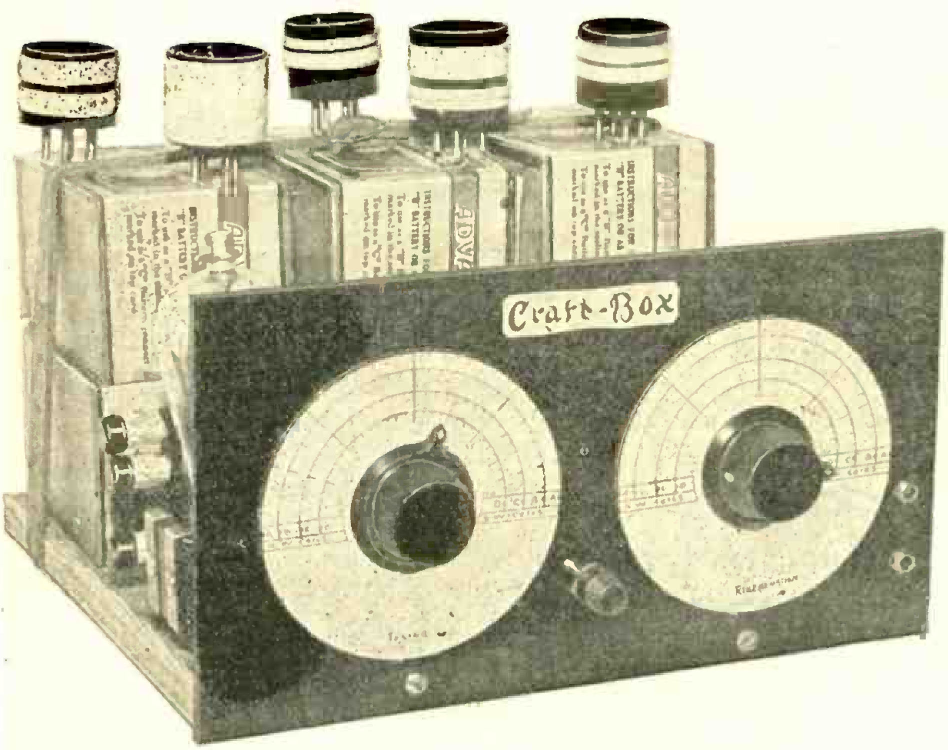


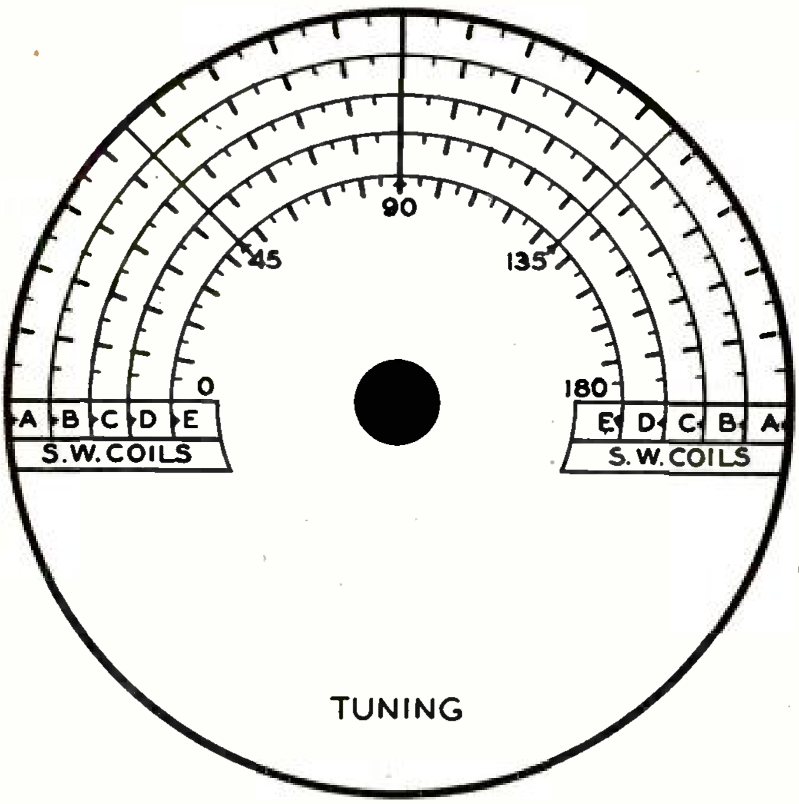
Fig. A. Front view of "The Short Wave Screen-Grid Craft Box." The dials were made for four coils, but five coils eventually were used; dial cut-outs for a five-coil job appear in these columns.

1 battery or filament switch (*S.W.*).
2 mica fixed condensers, .006-mf. (*C4*, *C5*).
1 mica fixed condenser, .0001-mf., (*C6*).
2 grid-leak mountings.
1 grid leak, 2-megohm (*R1*).
1 grid leak, 5- or 6-megohm (*R4*).
3 binding posts.
2 cord-tip jacks (*J*).
1 filament resistor, 15-ohm wire, tapped at 5 ohms to provide grid bias for the '22 R.F. tube (*R2*, *R3*).
1 resistor, 10-ohm wire, for the '99 filaments (*R5*).
5 old tube bases, to be used for coils.
No. 28 D.C.C. magnet wire, 1/4 pound, to be used for coils.
1 wooden baseboard, 10 inches long, 9 inches wide, and 1/2 inch thick.
1 hard-rubber (or bakelite) panel, 10 inches long, 7 inches wide by 3/16-inch thick.
1 '22 screen-grid tube (*V1*).
2 '99 tubes (*V2*, *V3*).
5 small "B" batteries, 22 1/2-volt portable.
2 "C" batteries, 4 1/2-volt for filament supply.
Hook-up wire, wood screws and other necessary hardware.

After the parts have been selected the constructor should carefully clean, inspect and tighten all parts as well as test the various parts for shorts or open circuits. Denatured alcohol and ether mixed in equal parts will remove dirt, oil or grease, when applied judiciously with a small, stiff bristle brush. If the parts are not thus inspected and cleaned before assembling into the complete receiver trouble is apt to appear.

The Short-Wave Circuit

Inspection of the circuit diagram will show the circuit used for this short-wave receiver to be the same old standby—a single circuit regenerative detector preceded by a screen-grid R.F. stage, and followed by a conventional transformer-coupled A.F. stage. In regard to the latter, it was not deemed necessary to use two stages of A.F., as phones would be employed and for this purpose sufficient volume would be obtained with one. The grid circuit of the R.F. stage is untuned, having a 2-megohm grid leak (*R1*) connected from the control grid cap to the bias tap on the series filament resistor (*R2-R3*); the grid leak serves only as a means of blocking the R.F. from the ground circuit, forcing the signal to be impressed on the control grid, while providing a means of applying the 1 1/2-volt "C" bias to the control grid. (Otherwise, a negative charge would accumulate on the control grid



Dial for the "Craft Box." Cut out and paste on the panel. "Regeneration" dial appears elsewhere. A red ink dot on the right line and stations are quickly re-tuned in.

causing the tube to block). The antenna may be coupled direct, or through a small semi-variable homemade condenser ($C3$), to the control grid of the R.F. tube; the choice will depend upon the antenna used.

Construction of Coils

The short-wave coils are of the plug-in type; five are used to cover the band from 25 to 100 meters. They are constructed from old tube bases; five of the UX type as listed above. There are two types of tube bases, the short and the long; if possible, the long should be obtained (especially for the "E" coil) as otherwise it will be difficult to accommodate the required turns on the base. If it should prove impossible to obtain the long type, thin cardboard may be wrapped and cemented around the short base to give the required winding space. Follow the winding specifications:

Coil A: Grid winding 7 turns, tickler winding 7 turns; shortest band, approximately 18 to 25 meters.

Coil B: Grid winding 10 turns, tickler winding 10 turns; tuning range approximately 25 to 35 meters.

Coil C: Grid winding 15 turns, tickler winding 14 turns; tuning range approximately 35 to 45 meters.

Coil D: Grid winding 20 turns, tickler winding 18 turns; tuning range, approximately 45 to 65 meters.

Coil E: Grid winding 50 turns, tickler winding 50 turns on a cardboard tube fitted inside the secondary winding, tuning range, approximately 63 to 100 meters.

The cement and glass are removed from the tube bases. (This may be done very easily with a sharp penknife.) Starting about 1/16-inch from the top edge of the form the grid winding ($L1$) is started and wound for the required number of turns; ⅛-inch space separates it from the tickler winding ($L2$). It is a good plan to prepare the bases before winding by drilling the holes to anchor the winding ends, which are also to be soldered to the prongs. The solder and wires should previously be removed from the prongs by the application of a soldering iron and a sharp knock. The distance at which the holes should be drilled is readily determined approximately as 48½ turns of No. 28 D.C.C. wire may be wound in one inch of space.

To start the grid winding, the end of the wire is passed through the hole drilled at the top of the base, then passed down through the *grid* prong and soldered. The proper number of turns is wound, breaking the wire but leaving about six inches free. The insulation is removed to within ½-inch of the point where the wire enters the hole; the wire is passed through the hole and down through the filament prong on the same side as the grid prong. Start the tickler winding ⅛-inch from the end of the secondary; the wire is again passed through the hole and soldered to the remaining filament prong and the proper turns are wound. Remove the insulation as before and pass the wire through the lower hole, through the plate prong, and solder.

The tickler of the "D" coil is wound double-layer. The tickler for the "E" coil is wound on a small length of cardboard tubing which is placed inside the secondary form. Care should be taken that the beginning of the tickler winding is connected to the filament prong on the side of the plate prong.

Parts Assembly

The hard-rubber or bakelite panel is first drilled for the mounting of the two midget variable condensers, the filament switch and the two cord-tip jacks. Two holes are also drilled near the lower edge, for fastening the panel to the baseboard, which may be done at this time. The midget condensers are now mounted to the panel, followed by the switch and the jacks. The sockets are next fastened to the base board; that for $V2$ in the center of the base board and one inch from the panel. The R.F. socket and A.F. sockets are placed, each ⅜-inch from the edge of the baseboard and ¾-inch from the panel, and that for the tube-base coils equidistant between them and 2¾-inches from the panel. The R.F. choke is placed between the detector and A.F. sockets in the same way.

The A.F. transformer is placed immediately in back of the A.F. socket, with sufficient clearance, to enable short connecting leads. The detector grid leak is mounted directly to the "G" post of the socket by a small stiff bracket made of brass. The holder for the antenna resistor is also mounted vertically

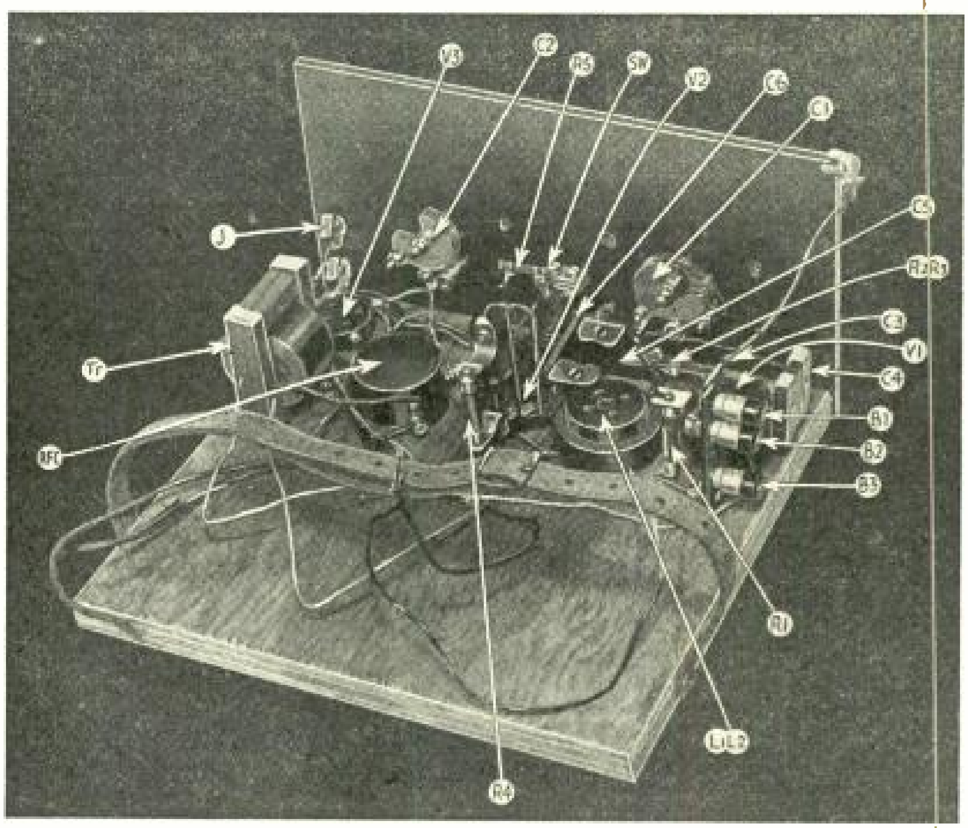


Fig. B. Rear view of the "Craft Box." All the parts, few in number, are easily seen. What parts would YOU use?

and fastened to the baseboard immediately behind the R.F. socket; to its top is soldered a small plate of brass or copper for *C*3. The dimensions for the condenser surface are ½ x

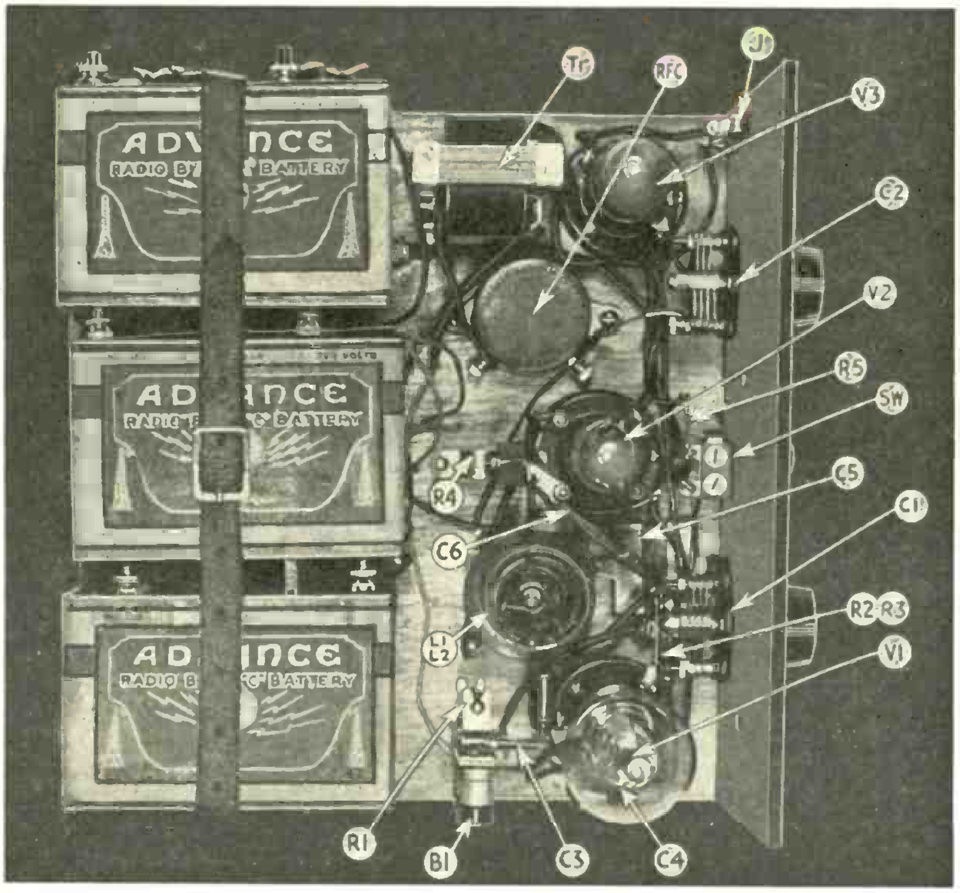


Fig. C. Batteries in place; all leads connected; tubes in their places; with the aerial and ground attached we are "rarin' to go," whither our old "Craft Box" will take us.

¾-inch; the piece is cut with a tab ½-inch long and ⅜-inch wide near one end and on the side. This tab is soldered directly to the clip of the grid leak as shown in Fig. C. A similar piece is made and drilled with a hole in the tab to pass a 6-32 brass machine screw. A hole is drilled ¾-inch from the screw fastening the clip to the bakelite mounting strip of the grid-leak mounting. The second strip is now arranged in such manner as to be variable in the surface exposed to the fixed strip, being pivoted by the same screw used for the mounting of the binding post as shown (Fig. 2). The binding post (*B*1), used to connect the antenna directly to the grid of the R.F. tube, is fastened to a screw soldered to the one which fastens the clip to the bakelite strip. The ground binding post (*B*3) is mounted on the bakelite strip in the same manner as the series-condenser binding post (*B*2) and its screw is soldered to the lower clip of the mounting. On the rear of the baseboard should be left a space 1¼-inches wide by 9 inches long for the "A" and "B" batteries, which are held in position by a strap of fibre or "fish" paper. This strap should be an inch wide and strong enough to prevent tearing.

Wiring

The wiring is extremely simple and direct. As a matter of fact, the efficiency of the receiver is directly due to the placement of the parts and the shortness of the interconnecting leads. It is best to wire the filament circuits first as these are nearest the panel. Beginning with the "F+" of *V*1, the lead is continued to "F+" of *V*2, and then to *V*3; the hookup wire is left long enough to extend to the back of the baseboard for connection to the battery. A battery lead of similar length is now soldered to the filament switch, the other side of which is connected to the filament resistor of V1, and the latter soldered directly to the "F—" post of the socket. The filament resistor for the 199 tubes (*R*5) is soldered directly to the filament switch. From the other side of this switch a lead connects to the negative post of *V*2 and then *V*3. The ground end of the antenna resistor (*R*1) is soldered to the tap between *R*2 and *R*3; there should be ten ohms resistance between the tap and the socket terminal. The plate terminal of *V*1 is connected to the grid terminal of the coil socket; then to the fixed plates of the tuning condenser (*C*1). This lead also is soldered to the terminal of the grid blocking condenser (*C*6), the other terminal of which is soldered directly to the "G" post of the detector socket. A lead connects the rotor plates of the condenser to the "F—" of *V*2 as well as to one side of the by-pass condenser *C*5. The other side of the latter connects to the filament terminal of the coil socket on the same side of the grid. To this same terminal is soldered a long lead which extends to the batteries and connects to "B+ 135."

A similar lead is soldered to the "G" terminal of the R.F. socket *V*1, to which is soldered the by-pass condenser *C*4 for the screen-grid. The other side of *C*4 is connected to the negative filament. The detector grid leak *R*4 has been connected directly to the "G" terminal of the coil socket; its other side should now be connected to the "F+" terminal of the detector socket.

The plate terminal of the detector socket is now connected to the plate terminal of the coil socket; the filament terminal on the same side is connected to one side of the R.F. choke, and then to the stationary plates of the regenerative condenser *C*2, the variable plates of which are connected to the "F+" of the A.F. socket. The other side of the R.F. choke is connected to the "P" post of the A.F. transformer, and the "B+" post of the latter is provided with a long lead to extend to "B+ Det." The "G" post of the transformer connects to the grid terminal of the A.F. socket, and the "F—" return of the transformer to the negative filament between the filament switch and the 10-ohm resistance. The "P"

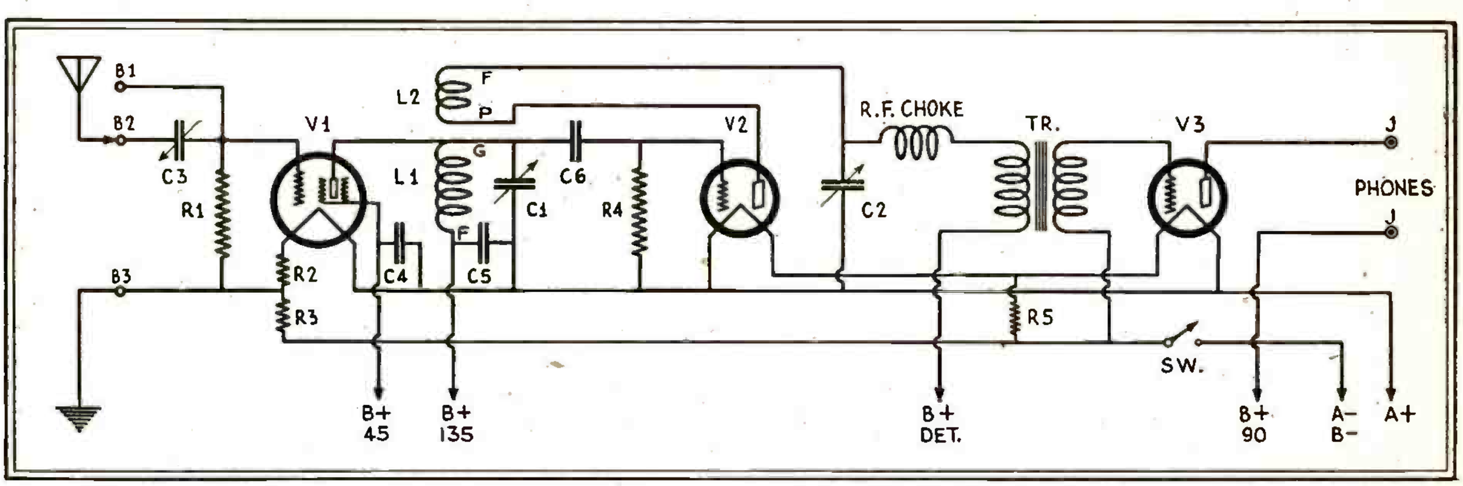


Fig. 1. Schematic circuit to be followed by those who want to dig into their junk box and ride the short waves via the "Craft Box." As 90% of construction is getting started, it's up to you"; we have eliminated all the mechanical difficulties.

(*Continued on Page* 183)

The Radio Craftsman's Own Page

In these columns will be found letters of RADIO-CRAFT readers from every quarter of the globe. Here old friends will renew acquaintances of long standing.

TRANSMITTING DOPE WANTED

Editor, RADIO-CRAFT:

After discussing thoroughly at two of the club's sessions RADIO-CRAFT, its merits and demerits, we have come to the conclusion that it is one of the finest magazines that a "Radio Ham" can read.

It is a very comprehensive and diversified edition; does not dwell on only one type of radio apparatus, but rather discusses the many types on the market.

Despite all of the merits found we sincerely believe that the magazine should contain much more short-wave articles concerning both transmitting and receiving apparatus. "Hams" would appreciate it.

AMATEURS' RADIO CLUB,
Passaic, New Jersey.

(We are very appreciative of the interest bestowed upon us by the Passaic AMATEURS' RADIO CLUB. It is our desire to interest the majority of our readers and toward that end we cannot devote too great a portion of RADIO-CRAFT *to any particular subject. However, we would like to present a larger section dealing with the frequencies above 1500 kc. The limiting factor is the readers themselves; unless they advise us of the new developments, ideas and kinks of the short-wave craftsman we have no way of learning of them.*

But what this country needs, aside from good five-cent cigars, is a really authentic list of short wave schedules. And now, that International agreement has nearly settled the frequency allocation nightmare, we may look forward to being able to publish information of this nature which will still be truthful when the magazine is received. Until now, published short wave schedules have been the little private joke of the short wave clan. One of the first published schedules to last over night is the England and Holland "sked" which appeared on page 117 of the September issue of RADIO-CRAFT *—it is O.K. at this writing. What authentic "skeds" do you have?—Ed.)*

IT'S UP TO OUR READERS

RADIO-CRAFT:

Gentlemen:

Just a word to let you know how I appreciate reading a good magazine. I received my copy recently, and must say it will furnish me plenty of desirable information until the next one arrives. Then I will also have plenty of reference data to lay away. It is the kind of magazine I have always desired.

Now, I think the task is left for us fans (that is, if we expect to have a good magazine better) to contribute more ideas, kinks, etc., and ask more interesting questions concerning radio and its parts. I am enclosing diagram and description of a neutralizing condenser of my own make; I find this to be very essential, especially with ganged condensers which have no "trimmers." I expect to contribute more to you this coming season.

L. B. FERGUSON,
Bluefield, W. Va.

(Mr. Ferguson hits the nail right on the head, and we heartily second his motion. The interchange of experience which he suggests will do a great deal to benefit us all; and YOUR letter is solicited, right now. What has been your experience with others' ideas, and what have you thought up, AND TRIED OUT SUCCESSFULLY, yourself?—Ed.)

A SET BUILDER'S OPINIONS

Mr. Hugo Gernsback, *Editor*,
RADIO-CRAFT:

I enclose a money order covering a subscription to your new magazine. It would appear to me that a magazine gotten out to suit the set owner would have more circulation than any other. The average set owner is not interested in a lot of technical language, charts, graphs, etc. Personally I would like to see every set, kit or circuit analyzed, so that I might know what it will do. Right now, I know of at least half a dozen friends who want to get a new up-to-date set with money (in reason) no object. It is not necessary to state that one set is better than another; but enough information can be given to allow the builder or owner to decide for himself which is best suited for his requirements.

The majority of radio owners are not interested in freakish doings or stunts beyond their ability to perform. If Tom Jones comes over to my house, and I furnish him with entertainment from KFI, KSL, KOA and several others, and kid him because his set will not bring in any of them at the same time, Jones is going home and commence to read up and see if he cannot get hold of something that will beat my set; and so it goes.

THE letters of encouragement and praise which our readers have been showering on us have been very welcome to the Editors of RADIO-CRAFT, and they take this opportunity of acknowledging the great number to which it has been impossible to reply personally, much as they would have liked to do so. Bouquets, however, are not all they are looking for. This is YOUR magazine, and it will welcome every letter which expresses a definite wish for a certain line of editorial information. It is only in this manner that we can know just what You want and what will be of most use to You. Our readers realize, and so do we, that there is still much room for improvement in RADIO-CRAFT; and, with Your cooperation, it will be forthcoming.

We especially invite letters telling of your experiences with sets, circuits, and practical radio problems, as they come up in your work. We know that our readers like to know what others are doing, as much as to read the more formal articles available from those who are active in industrial development of radio; and we trust to make this Experimenter's page the stamping ground of those who like to follow out their own ideas and do something a little different. What have you found out for yourself that will help along other experimenters? Write to the Editor of RADIO-CRAFT and tell your story in your own words.

Another thing the set owner is interested in and has no way of ascertaining, is what's on the air to-night, where and what time? For instance, I like band programs and the only way I get hold of one is by chance. I cannot subscribe to all the papers in the U. S. telling what their local stations are doing.

Of course, this is the personal opinion of one man; but at the same time it would seem that the radio publication that caters to the majority will be the most successful. I wish you every success in your new undertaking and hope that I can look forward to each new issue with pleasure.

FRED T. FIELD,
Fort Lauderdale, Fla.

(The policy of RADIO-CRAFT *is to avoid the presentation of technical facts in a difficult way, so far as possible. There are magazines for the reader who has a "bug" for mathematics, and who is capable of tackling the Einstein theory, single-handed; but this will not be one of them. Our readers, we know, prefer practical details of construction. However, it is obviously impossible to say what set is the best for all requirements; if it were so, only one type of receiver would be in use. That upon which manufacturing methods have concentrated is the simplest to operate, but not the most efficient from a radio standpoint.*

As to the lack of a means of checking up on nation-wide programs, that cannot be helped, under the conditions of broadcasting which have grown up in the United States. At one time the editor of this magazine undertook the publication of such a radio program publication; but it was impossible to cover even a comparatively small area efficiently, since the information was not forthcoming from the stations themselves. In Great Britain and Germany, where broadcasting is a semi-governmental monopoly without commercial programs, and where the whole country is no larger than one state of the Union, radio program publications of a very satisfactory kind are issued. Even there, however, there is not available complete and definite information as to what to expect from other European stations within range of a powerful receiver. It will be our endeavor to give the reading matter most acceptable to the largest number of radio readers, and RADIO-CRAFT *again heartily invites all to co-operate by letting us know your personal opinions as to what this should be.—Ed.)*

LUCKY FOR US BOTH

Editor, RADIO-CRAFT:

I received your magazine by a mistake; I had sent for SCIENCE WONDER STORIES. But I think RADIO-CRAFT really something good. So I send my subscription for *both* magazines, and *all* numbers of each from the first.

With regard to fastening metal to glass, I do it often with common sealing wax; for vessels containing spirits or alcohol I use gypsum (plaster of Paris). Can you tell me the method used in America to designate radio tubes?

E. S. LEVISON,
Lijsterstr. 31, Leeuwarden, Holland.

(Unfortunately, there is no regular system used to designate tubes in this country, as there is in England, where the type number conveys some information about the characteristics. The article by Mr. Palmer in this issue commences a study of the types of tubes on the American market, which will be of special interest to foreign readers.—Editor.)

A SCREEN-GRID HINT

Editor, RADIO-CRAFT:

I have logged 141 stations since July 4 with the "Portable Screen-Grid Four" described in your July issue. I find an '01A tube won't handle the volume without a 500,000-ohm resistor in the 45-volt screen-grid lead. I use this as a potentiometer between the "B+45" and the "A—," with the arm to choke 12, leading to the grid prong of the socket.

E. L. GODFREY,
Binghampton, N. Y.

(Little suggestions of this kind will be appreciated by many readers, as well as longer articles. Do not think that you have to write a long letter for this page.—Editor.)

ATTENTION, CORRESPONDENTS! WRITE

Editor, RADIO-CRAFT:

I feel it my duty to you to give my opinion of RADIO-CRAFT. I have before me the first two issues, and I must say that great improvement is shown. The first was well worth the money; but the second is by far better. The cover design is marvelous; Paul is an artist *par excellence*. Your editorials are most interesting and instructive; I look eagerly for them when the time arrives.

All I can say is that I find no fault with your publication, but I do think a "Correspondence" page should be inserted. Wishing you further success,

CHRISTIAN KELLER,
Ozone Park, Long Island, N. Y.

(One thing which we cannot write in the editorial offices is our Correspondence page; we are anxiously waiting for our readers to do that. And, while we enjoy reading little bouquets, we know well that what our readers prefer is an interchange of practical experiences, kinks, and the like. What have you to tell, supposing that all the readers of RADIO-CRAFT *were standing round the workbenches in the Cooperative Laboratory or somewhere? Let us have your suggestions, as informally as you wish.—Editor.)*

A "50" Public-Address Power Amplifier

The requirements for proper coverage of a 4,000-person capacity theatre, auditorium, or equivalent outdoor assemblage are not fully understood by the average constructor. This article by Mr. Baraf covers these conditions.

By S. L. BARAF

THE amplifier described in this article is capable of magnifying its program input (from a radio set's detector, a microphone, or a phonograph pick-up) to a volume level more than amply sufficient to cover a theatre with a seating capacity of 4,000, or an outdoor meeting of similar dimensions.

Primarily designed for public-address purposes, this amplifier can be used in motion-picture houses (for synchronized or unsynchronized discs or films), amusement parks, clubs, hotels, auditoriums and private homes. With it one is assured of the finest radio and record entertainment. When used in spacious homes to feed a number of dynamic speakers placed in various rooms, besides affording life-like reproduction of records, the amplifier is admirably adapted for use also in conjunction with any conceivable type of radio tuner; even though the tuner be a superheterodyne with the most critical plate and "C" bias voltages.

Design and Layout

In designing the amplifier, the primary consideration was the prevention of audio-frequency oscillations and "hum." These are factors which, unless eliminated, will inevitably ruin the finest characteristics of any sound unit. The segregation of the power transformer, chokes and filter condensers in a heavy copper shield-can, and the correct placement of the audio transformers to prevent magnetic coupling, insure a quiet-working, hum-free amplifier. The modulated 60-cycle hum cannot be heard with the volume throttled down to a whisper.

The use of *three audio stages* with an undistorted output of a little over fifteen watts necessitated the employment of two type '74 "regulator tubes" in the resistance network. By keeping the input and first-stage plate voltages at constant potentials, the regulator tubes lessen (and in practise counterbalance) whatever reaction might occur through the resistance network from an overload in the power output stage. The stabilizing action of the regulator tube extends also to the "C" bias voltages; so that the amplification factor of the unit and the proportion existing between plate and grid voltages is not disturbed. Thus the useful undistorted output of the unit is measurably increased.

An outstanding improvement in this amplifier is the employment of "parallel plate feed" to prevent the plate D.C. from circulating through the primary winding of the push-pull input transformer. By this method a clearer definition of bass-note fundamentals is obtained, and the lowest frequencies emanating from the broadcasting or recording medium, heretofore not even heard, are reproduced with uncanny fidelity.

Parallel plate feed to the input push-pull stage would be quite impossible without the use of an A.F. impedance such as the choke (*L2*), the inductance of which is greater than that of the transformer primary winding to which it is coupled. Such a parallel-feed choke requires an inductance of about 400 henrys or more, with a relatively low D.C. resistance. Fortunately, it has been made available for the purpose.

The filter condensers are at a distance from the heat generated by the rectifier and power tubes; and all tubes are fully ventilated. It was not found necessary to shield the power output stage; but it is strongly advisable to place the filtering section in a separate copper can (Fig. 3), as shown in the pictured amplifier which was wired as per Fig. 1.

Fundamentally the power supply unit is a transformer (*PT1*) rated to carry a continuous load of 200 milliamperes with a filtered output of 550 volts. It has a tapped 100-120-volt A.C. primary; a high-voltage secondary winding for two '81 tubes in full-wave rectification; a 7½-volt winding for the filaments of these tubes and, finally, another 7½-volt winding for the filaments of the type '50 tubes arranged in push-pull.

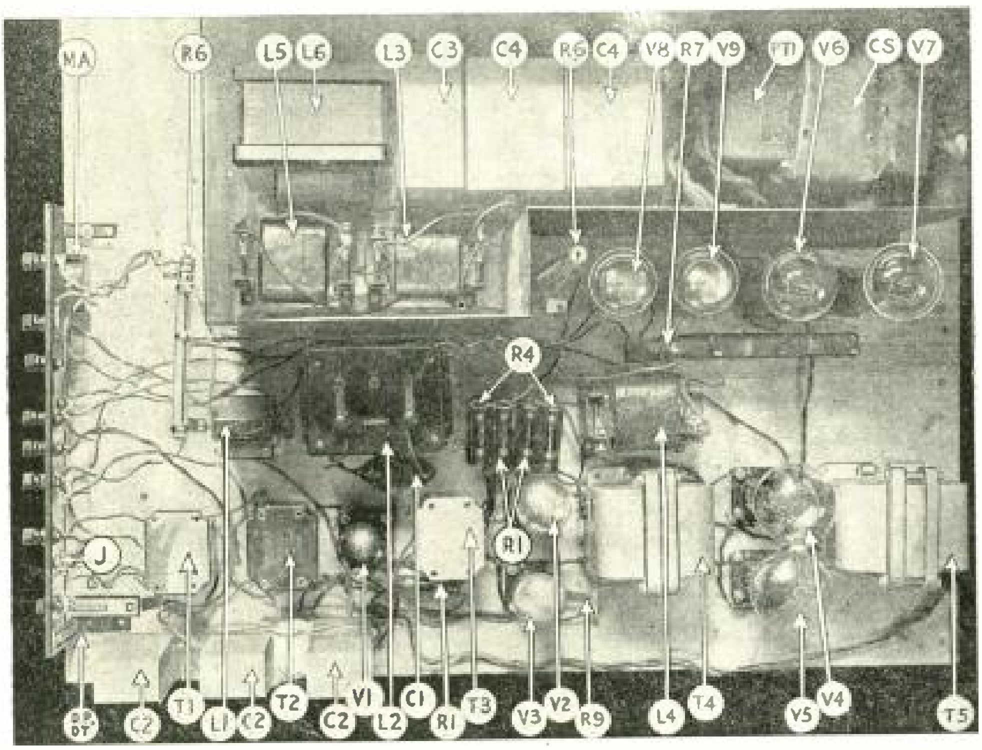


Fig. A.

In this photograph is illustrated the parts layout for the "'50" theatre or "public address" amplifier. Although the wiring seems to have been run with no regard for convention, every lead has received full attention in respect to the possible troubles which could develop if undue resistance or coupling existed.

Filtering the Power Supply

A triple filter choke is placed in series with the positive high-voltage line. The center choke, however, also acts as an audio choke for the "B+" power; thus the type '50 amplifier is kept from oscillating in this part of the circuit. In choosing the '50 tubes, care should be taken that they are perfectly matched since otherwise circuit oscillation may occur. With matched tubes and the choke placed in the circuit as suggested one is assured of a unit that is perfectly stable in its operation. Tubes that turn blue should not be used. Their tendency to draw reversed grid current and the resultant loss in brilliancy and depth of tone, together with the increased hum drone, are a few indications of bad tubes in the power-output stage.

As this amplifier is required to deliver 140 to 160 milliamperes, choke *L6*, conservatively rated at 250 milliamperes, is placed in series with *L4* and *L5*, all properly by-passed by conservatively rated filter condensers (*C3*, 2-microfarad, at the input and *C4*, both 4-microfarad, at the midpoint of the triple choke filter, and at the output). In series with the high-voltage line, a 5,000-ohm resistance *R7* (rated at 100 watts) is used to secure the correct drop for the first and intermediate stages. This resistor is connected to the second (*V9*) of the series-wired regulator tubes.

In this amplifier, the input is held at a constant plate voltage of 90 by the first regulator tube *V8*; and the intermediate push-pull stage (*V2-V3*) is held at a constant plate voltage of 180 by *V9* which is in series with *V8*. Those desiring voltages other than these may employ 25,000-ohm variable wire-wound resistors, each with one arm in series with a regulator tube, as shown in the schematics. It is to be noted that the high-voltage tap for the plates of the '50 tubes is wired to the choke, *L5*, the other end of which is then connected to the center point between chokes *L4* and *L6*.

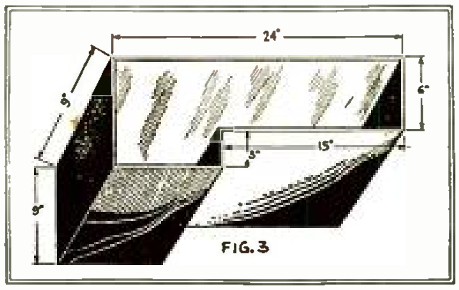
Optional Construction

The choice of D.C. or A.C. tubes in the first and intermediate stages ahead of the type '50 tubes is optional and equally good results may be obtained with either. However, the use of A.C. tubes will require a filament transformer *PT2*, to light the filament of the '27 tube in the first stage and the filaments of the '26 tubes in the intermediate push-pull stage. This transformer should be placed next to *PT1*, if it is incorporated in the amplifier.

The reader will note that grid biases for the first and intermediate stages are obtained by means of the drop across the variable resistor at the negative end of the resistor network, *R6-1*. This method applies only when D.C. tubes are used in these stages; the use of A.C. tubes will require separate resistors for each stage. For an A.C. tube in the first stage, a 2,000-ohm variable wire-wound resistor *R2* should be used. it is connected to the cathode of the '27 tube. In the intermediate push-pull stage, a 1,000-ohm variable resistor *R5* will be found adequate to supply bias for the '26 tubes. The proper method of obtaining grid bias for A.C. tubes is clearly shown in the separate schematic diagram (Fig. 2). It should not be confused nor interchanged with Fig. 1, the schematic for D.C. tubes; for otherwise the builder will come to grief, wondering how an excessive amount of hum and other forms and causes of distortion have crept into his amplifier.

The negative grid bias for the power tubes in push-pull, which require a plate current of 110 milliamperes, is obtained by inserting another 1,000-ohm variable resistor *R6* between the center tap of the 7½-volt winding for the type '50 tubes, and the negative side of the filter-choke network.

The experienced fan and set builder will welcome the inclusion of jacks to measure the plate current of the power tubes, the R.F. or input and the intermediate A.F.; as well as the total loss and the plate current consumed



The copper shield required for the high voltage units is shown above.

up to the power output stage. It will be seen that jacks are placed in the plate lead of *each* '50 tube; thus facilitating the matching of these tubes and allowing an immediate check on the performance of the tubes over any lengthy period. In this unit the plate current of *V1* must never exceed more than five milliamperes (it should be a little less than three); the intermediate stage should draw at most between twelve and fifteen milliamperes; and the entire total, minus the 110 milliamperes drawn by the output stage, should never exceed fifty milliamperes (normally it should be about thirty-five milliamperes).

Back coupling, or interstage feed-back, is effectively blocked in this amplifier through the isolation of each circuit. It will be seen that an audio choke of relatively high inductance (*L2*) is placed in the "B+" lead of the first stage, and shunted by a 2-microfarad condenser. In the intermediate stage, parallel feed is used to prevent magnetic saturation of the core and distortion of the wave-form incident to the amplification of alternating current. As will be seen in the diagrams, the direct current flowing in the circuit is blocked by the condenser *C1*, in series with the primary winding of the input push-pull transformer *T3*. It does, however, go through the choke *L2*, which is in parallel; the high impedance of the choke, however, prevents the A.C. signal voltage from going through. Only the alternating-current signal thus passes through the condenser *C1* and the primary of *T3* where it is desired. The center tap lead of the primary intermediate push-pull transformer *T4* has in series with it a husky audio choke, *L3* (the other end of which goes directly to the 180-volt tap). The by-passing of the 90- and 180-volt taps with 2-microfarad condensers (*C2*, as shown in schematic—not pictured) is advisable.

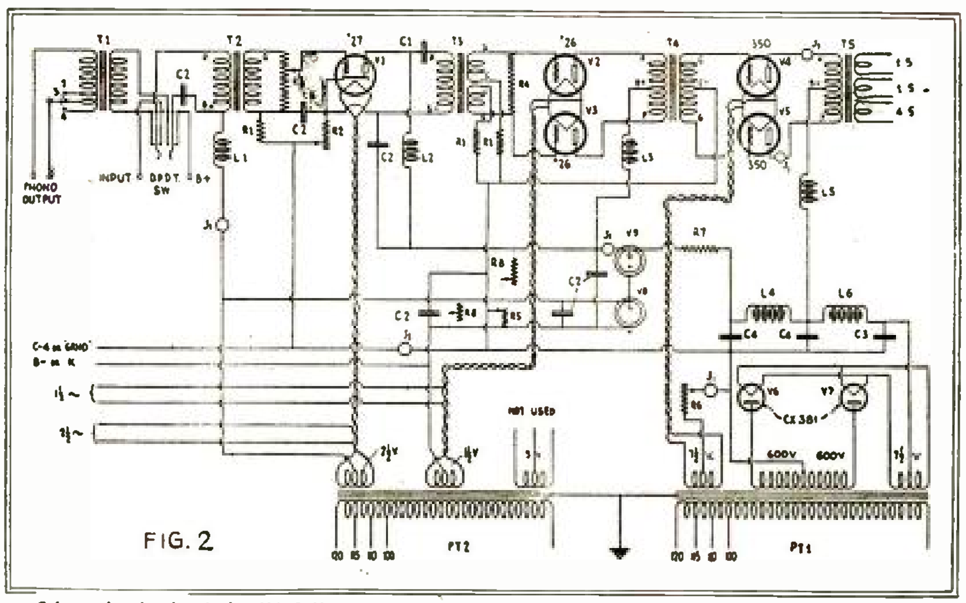
Operating Conditions

The tremendous amplification delivered by this unit necessitates the employment of effective volume controls. A noiseless 500,000-ohm variable resistor *R3*, which may be wired to any convenient point, shunts the secondary of the first stage transformer *T2*; and a fixed 250,000-ohm resistor *R4* is placed across the secondary of the push-pull input transformer *T3*. (The author did not have available the correct value and that is why the photograph shows two resistors as *R4*; these were 500,000-ohm units, wired in parallel.)

When working the amplifier in connection with ***phonograph pick-ups***, it is desirable to use an impedance-balancing transformer, which has an adjustable primary to match the various magnetic pick-ups. The transformer *T1*, specified for this purpose, assists to provide the finest phonograph reproduction and will match the best pick-ups obtained today. A double-pole, double-throw switch is incorporated to provide for instantaneous change from radio to record music.

For ***microphone*** coupling purposes, special transformers are to be used, the type required depending on that of the microphone employed. When the amplifier is used with either pick-up or microphones, the operator will find it best not to cut down his input and intermediate voltages but rather, if necessary, to reduce the volume through the 500,000-ohm control *R3*.

The amplifier cannot be used with ordinary speakers of the balanced-armature type because of the latters' unsatisfactory frequency response at high power levels and incapacity to stand up under the load delivered by the output. Dynamic speakers of the exponential-horn type are to be preferred. Excellent results may be obtained with dynamic speakers of the new type (which use type '80 tubes



Schematic circuit of the "A.C." design. There is provision for both microphone and phonograph pick-up, and circuit testing jacks have been included in six places. Voltage regulation has been held to very narrow tolerances. There is no need to stress the point that only the best of parts should be used, where the experienced constructor is concerned. It is to the new-comer we would venture this caution.

to energize their field coils). To secure an evenness of range, at least three differently-pitched speakers should be employed. The new output push-pull transformer *T5* used in this amplifier is capable of feeding at top efficiency *nine speakers of the new twelve-inch auditorium type.* The prospective builder is cautioned not to use one dynamic speaker —unless he is desirous of finding out how quickly he may wrench the voice coil out of position when passing a strong signal through the amplifier.

Order of Wiring

In wiring up the amplifier, it is well to complete first the filter-choke section; the output stage should next be wired, then the filaments of the remaining tubes should be wired and brought to their respective filament-transformer windings (or binding posts, if a storage battery is used for the input and intermediate stages). The wiring of the resistor network should be the final task; and all "B+" leads should be bunched and strung together. The layout of the amplifier makes possible very short A.C. filament leads, and these should be segregated from all other wiring. Grid and plate leads are very short and well spaced from one another.

All transformers, chokes and filter condensers must be grounded. Stray inductive hum, intermittently recurring, is a sign that one or several of the transformers are not effectively grounded. The tubes used for this amplifier should be the finest obtainable.

The high-quality alloy-core transformers used in this power unit make possible the construction of an amplifier which is remarkably free of distortion peaks. It has an over-all-gain frequency-range that is practically flat from 40 to 8,000 cycles. The average human ear cannot recognize a more perfect amplifier. The most critical of listeners will be captivated by the impression of realism which the unit conveys, whether the amplifier be turned down to a soft whisper or stepped up to an intensity greater than that of the actual original reproduced. Instrumental tones, the singing voice, and speech are conveyed with all the delicate shadings of pitch and timbre so characteristic of the original.

When this amplifier is used in movie installations for musical synchronization with films, a table holding three pick-ups and three turntable motors will more than meet the requirements for this purpose. When they are so used, a song may be played, and some other effect superimposed on the song; or two different effects may be played, while the third is set for fade-over to another theme.

To affect the change-over smoothly, a variable resistor with a value between taps which does not change the gain more than two DB is necessary. Continuously variable resistors having linear, logarithmic, and "constant impedance" variation design are now obtainable.

> **NOTICE**
>
> WHETHER your interest in audio reproduction is academic, technical, or practical, we want to have your respective opinions and ideas on this subject; with particular consideration of the design, construction, installation and maintenance of acoustic equipment for use in theatres, auditoriums, hotels, dancing-pavilions or -halls, amusement parks, and large outdoor gatherings. What odd or unusual experiences have you had in your contact with the field of "public address"? What information of particular interest to you would you like to see in RADIO-CRAFT MAGAZINE? As this magazine intends to give the professional man more and more technical data which will enable him to increase his earning capacity proportionately, it is necessary that we learn from the men in the field just what is of greatest interest. Then we can offer you that "Knowledge (which) is Power."

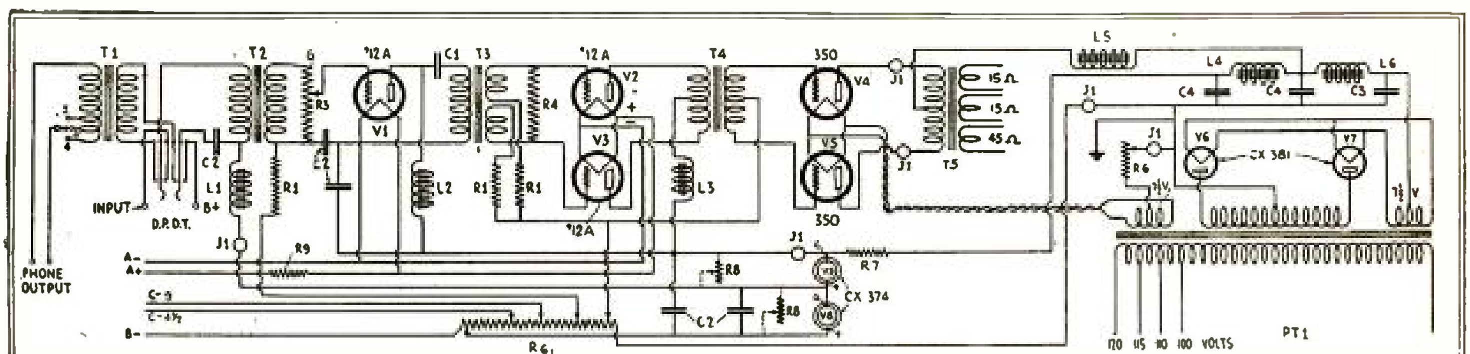


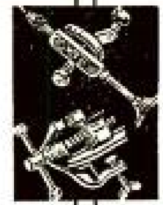
FIG. 1

Schematic circuit of the "D.C." arrangement. In this form, as well, every precaution has been exercised to obtain maximum performance. The output is "like a rock" in its steadiness; perfect operation of a critical "series filament" superheterodyne having been obtained in one test.

Lists of Components Used

1 Amertran No. 389 phonograph equalizer, *T1;*
1 Amertran "DeLuxe" audio transformer, first stage, *T2;*
1 Amertran No. 710 intermediate push-pull transformer, *T4;*
1 Amertran No. 151 input push-pull transformer, *T3;*
1 Amertran No. 678 output push-pull transformer, *T5;*
1 Amertran No. 256 choke, *L1;*
1 Amertran No. 641 parallel-feed choke, *L2;*
4 "Amerchokes": two No. 854, *L3-L4;* one No. 709, *L5;* one No. 557, *L6;*
1 Amertran No. PF 250 power transformer, *PT1;*
1 Amertran No. H 67 filament transformer (for A.C. operation only), *PT2;*
9 Aerovox fixed condensers; one 0.25 mf., No. 402, *C1;* 5 No. 402, 2-mf., *C2;* one No. 1102, 2-mf., *C3;* two No. 802, 4-mf., *C4;* (add one No. 402 for A.C.)
4 Aerovox "Lavite" resistors, with one double and two single mountings; three 50,000-ohm, *R1;* one 250,000-ohm, *R4;*
1 Electrad "Truvolt" 2,000-ohm resistor, Type-T20 (or one Carter Type-P20-2M) with one slider (for A.C. only), *R2;*
1 Electrad Type-L 500,000-ohm resistor (or one Carter No. 5 "Hi-Ohm" volume control), *R3;*
1 Electrad Type-B10 (or one Carter Type P15-IM) resistor with one contact (for A.C. only), *R5;*
1 Electrad Type-D10 (or one Carter Type-F-1M) resistor with one contact, *R6*. (For D.C., a second, with *four contacts, R6*1);
1 Aerovox Type-996 5,000-ohm resistor, 100-watt, *R7;*
2 Electrad "Truvolt" Type-T250 resistors (or one Carter Type-PW-25M potentiometer), use of these is optional), *R8;*
1 Amperite, ¾-amp. (for D.C. operation); or Yaxley Type L-3 resistor, *R9;*
1 Yaxley D.P. D.T. switch;
4 Yaxley phone-tip jacks; *PTJ;*
1 baseboard, 21x30x1-inch, and one special copper can with cover (see detail drawing, Fig. 3);
2 rolls "Corwico" *extra heavy* hook-up wire;
6 Carter No. 2A closed-circuit short jacks, *J1;*
8 Eby binding posts (for D.C. operation) "Input," "B+," "A—," "A+," "B—," "C—4½," "C—9," "B+R.F.," or ;
8 Eby binding posts (for A.C. operation) "Input," "B+," "1½" (2 required), "2½" (2 required), "B—," "C—";
3 Audak "Electro Chromatic" pick-ups (see text); and
3 Bodine motors.
9 Tubes. The tubes required (those listed were used, although other makes may be tried) are three Ray X-112A (for D.C. operation) or one Ray X-227 and two Ray X-226 (for A.C. operation), *V1, V2, V3;* two Ray X-250, *V4, V5;* two Ray X-281, *V6, V7;* two Cunningham CX-374 voltage regulator tubes, *V8-V9;*
9 Benjamin sockets for tubes *V1-V9;*
1 Weston 0-100 milliammeter, Model 506, *MA.*

RADIO CRAFT KINKS



RADIOCRAFTSMEN:

HOW good are you at remembering the thousand and one little things that occur during a day, a week, or a month of experimenting, designing, constructing, wiring and testing of radio sets and parts for yourself or your friends?

Everyone has an equal chance to be awarded one of the two copies of "The Radio Amateur's Handbook" (A Manual of Amateur Short-Wave Radiotelegraphic Communication; contains 200 pages chock-full of the things you want most to know; right up-to-date and absolutely the best book of its kind obtainable), which are to go to the two readers of Radio-Craft who send in the greatest number of contributions to this department in one month.

All accepted material, will, in addition, be paid for at space rates.

The correct address is:
Radio-Craft Kinks Department,
c/o Radio-Craft Magazine,
98 Park Place,
New York City.

HOW TO MAKE FORMS FOR WINDING YOUR OWN COILS

By Charles P. Hansen

THE tyro, the fellow just breaking into the game, can seldom find the information as to just what to do to obtain a certain result, in the best way. It is obtainable only in the "School of Hard Knocks." Occasionally, a bit of data will be found which lightens the work of becoming an experienced technician.

For example, below is described the manner in which the writer fabricates his own coils (generally referred to as being of the "solenoid, low-loss" type). Ten "forms," of various standard sizes, comprise the kit of the author.

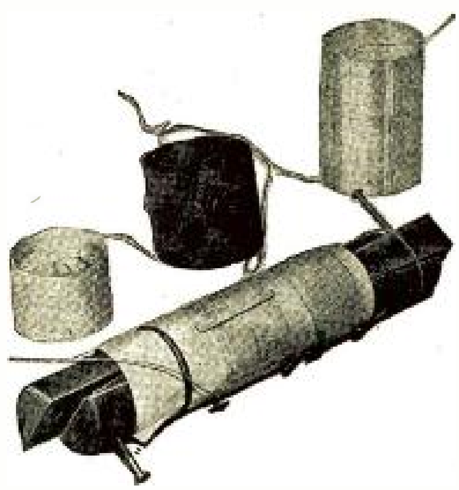
Shaping the Wood

When making coil forms the first requirement is a rectangular piece of wood (Fig. 1). On each end of this block a circle is scribed. Just how much oversize this should be, depends upon the wood-working ability of the constructor; because these two circles determine the resultant size of the form, since the wood is to be worked down to the diameter these circles indicate. Sandpaper the form to the final size.

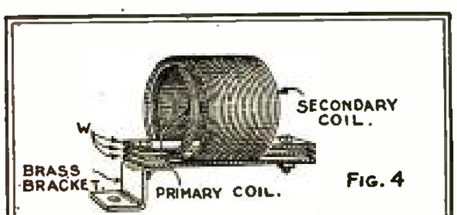
All sharp corners are rounded off with knife and sandpaper.

Dimension *a* is two inches longer than the desired length of the winding space of the form; and dimension *b* is, approximately, the desired diameter of the form. Lines *c* are drawn across one end of the block, to show the smallest thickness of the wedge which will result (as described below); dimension *d* is the largest thickness of this wedge. Lines *e* are then drawn; these being the lines to follow with a saw, to produce the wedge. Holes *f*, for machine screws, are drilled now. At this point, saw, knife and sandpaper are called into use to obtain the shape shown in Fig. 2.

Fig. 3 illustrates the end and side appearance of the finished form. Flat-head machine screws drop flush with the surface, and thread into nuts sunk in the form.



Coils completed and in the course of construction are illustrated above.



A convenient way of mounting "low loss" coils constructed with the aid of the forms.

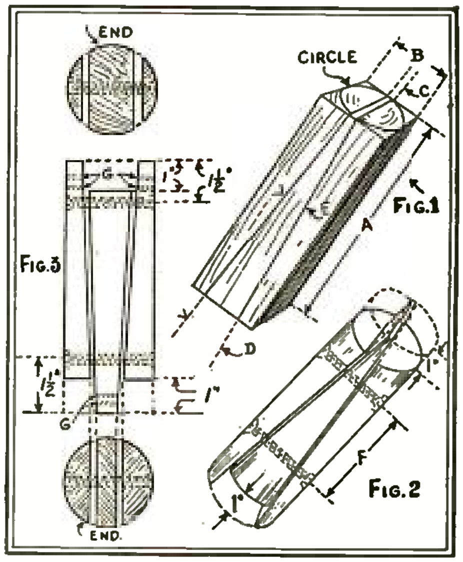
Making the Coil

To start the coil, wind a piece of writing paper twice around the form. Hold with rubber bands. Press thumb tacks at desired start and finish points of coil. Fasten wire by threading through holes *g*, and wind.

When wound, coat with collodion, (being careful not to slop it on the wood form). When dry, remove the two screws, tap wedge with hammer, and disassemble; and finish by gently pulling the writing paper from the inside of the coil.

Coils may be mounted on paraffin-dipped wood strips (*w*) as illustrated in Fig. 4.

The photograph shows an almost-completed space-wound short-wave coil, with holding strips cemented across the outside. *One at a time,* duplicate strips are cemented to the inside when the coil is removed. Use of too much cement at this time will cause the coil to come apart. The "5-and-10" stores stock tubes of this (transparent) cement.



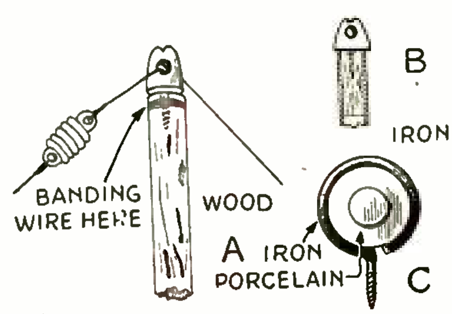
The various steps for form making are evident in this drawing.

IMPROVED ANTENNA RIGGING

By A. B. Clark

HOW many times have you had trouble with pulleys and wires, or possibly ropes on aerial supporting poles? Here is the way to get away from all this difficulty on the ones you erect.

Instead of using a pulley, use a porcelain house bracket insulator. This has a screw moulded into it and a perfectly smooth hole through it. Screw this into the top of the wooden pole (*A*); or, if an iron pipe is used put in a plug, bore a hole in the plug and screw in the insulator (*B*). At (*C*) is shown another form of screw insulator which may be used. You can now run a small wire (which usually lasts a lot longer in the weather than one of the stranded ones) through this for the pull-up wire. It cannot get out; runs through the insulator freely; and will never rust.



This stunt is a good one to apply in many different ways besides the one shown above.

Vacuum Tubes for Radio Reception

By C. W. PALMER

A GREAT deal of interesting information (and some misinformation) on the vacuum tube has been printed in books and periodicals. But, of all the data, very little is useful to the professional man and the more advanced fan. Practically all the information is limited to the listener who is interested merely in replacing the tubes in his receiver.

It is the purpose of this article to bring out some of the points which have been neglected, or purposely left out of the previous articles; as well as to supply a definite source of information for the characteristics of the standard tubes. It might be well to begin by explaining that, although there are more than 150 manufacturers of receiving tubes, the actual number of types of tubes is comparatively small. By this we do not mean to imply that the tubes of all manufacturers have the same characteristics; but the purposes for which the similar tubes were made are sufficiently distinct to allow a classification in this way. We will give the characteristics of the most standard and best-known of these tubes.

Looking back on the beginning of broadcasting, we find the difference in the tube situation is very striking. At that time, the fan who had been using a crystal for reception would at some time get a great desire to own one of the remarkable vacuum tubes that he had been hearing about. After deliberating for some time, and probably saving his spending money for a number of weeks, the fan would shyly enter the best-known and perhaps the only radio store in his locality and timidly ask the clerk for a "tube". This he would receive with no further question, either in a rough box or with no protection at all. Now, when a prospective buyer goes into the nearest store for a tube, he must give a very close description of its purpose and use and he has the choice of a number of different makes at different prices.

Factors Which Control Tube Life

To answer the question, "What is a 'good' tube?" we must consider the situation from several standpoints. First, there is the mechanical construction, which is entirely a matter of the design and manufacture. Next there is the choice of materials; and the quality of materials, which are also matters concerning the manufacturer.

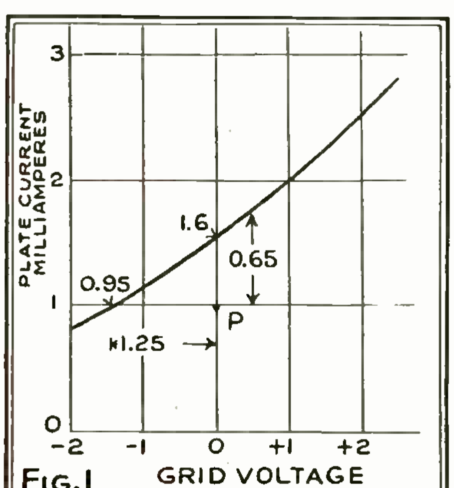


FIG. 1

A single graph indicating a variation in plate current with grid voltage change.

SAVE THIS SERIES

this article on vacuum tubes Mr. C. W. Palmer describes the general "characteristics" which average vacuum tubes have. The theoretical discussion of these characteristics is followed by practical examples of the application of the information which "characteristic data" convey. After reading this article, the reader will have an extensive knowledge of the things which occur in, and around, the vacuum tube. The experimenter, set builder, service man, "broadcast listener" and dealer will be able to learn how to effect actual cash savings; by application of the simple "rules of tube health" which Mr. Palmer lays down for those who have occasion to use radio vacuum tubes.

The idea of the "Standard Equipment Package" used by one of the well-known tube makers is also mentioned. This greatly facilitates tube purchase and handling.

In succeeding articles Mr. Palmer will show how tubes are automatically tested, accurately, at the rate of 8,000 an hour; how tubes are made; what the "power tube" is for and when to use it; and, of course, the next portion of the "Characteristic Data of Radio Receiving Tubes" chart will appear.

However, these are not the only points to be considered. It has been estimated that about 30% of the A.C. tubes which break down prematurely, do so because the tubes are placed in the wrong sockets of the set; as in the case of the '26 tube being placed in a power-tube socket. Another point concerning the *user*, is the continued use of excessive filament and plate voltages, which results in the shortening of the life of the tube.

There was a time in the history of tube fabrication when manufacturers deplored the long life of their products. Now, however, in these days of high competition, each tube maker must use the very best material and employ every precaution to make his tubes last as long as those of his competitors; for otherwise his products would get a bad name with resulting loss in sales.

The Tube Laboratory

Practically every tube manufacturer maintains a laboratory in which materials are tested, and samples of the manufactured tubes are subjected to various tests. This laboratory must be equipped with both electrical and chemical research and testing units; since it is necessary to test the composition of the materials; such as the nickel and molybdenum, employed in the construction of the grid and plate elements, and also the insulating materials such as the glass and the ceramic tubes which separate the filament from the *cathode* in the heater types of tubes.

It may be safely said that *standard tubes are made with every known precaution for long life and efficient service;* and although there is still room for improvement in the design, the tubes are remarkably consistent. A glance at the records of tube failure, maintained by a number of the larger manufacturers, shows a remarkably low percentage of tube returns. For example, the returns of the De Forest Radio Company, for a period of six months, were less than 1%; and many of the replaced tubes were proven to be injured through misuse and not through manufacturing failure.

From the above, it will be noted that the point of *correct use* has been emphasized; therefore, below are additional data on the correct use and care of tubes. This information will be of service to the dealer and professional man as much as the consumer.

The Filament

Vacuum tubes, properly used, are far from extravagant. Any reliable make of vacuum tube with a genuine *thoriated tungsten or oxide-coated* filament, OPERATED AT THE PROPER FILAMENT VOLTAGE, has a life far in excess of a thousand hours; and it is not uncommon to see tubes going strong after several thousand hours of daily service. Furthermore, *reactivation* of thoriated filaments is entirely unnecessary in obtaining this long life. Reactivation of a filament is a confession of abuse, either through sheer carelessness or pure ignorance of the meaning of correct use.

The filament of a vacuum tube is, of course, the very heart of reception. It gives rise to the circulation of *electrons*, on which is dependent the entire operation of the apparatus. The robust filament gives off a healthy flow of electrons even at moderate temperatures; while a sickly filament requires an excessive operating temperature to raise the "emission" to the same degree, and this soon brings the useful life of the tube to an end.

Not so long ago, vacuum tubes made use of *solid tungsten* filaments, similar to those used as electric lights. These had to be heated to a bright *incandescence* in order to provide sufficient electronic emission; making multi-tube sets very expensive to operate. (The filament consumed four times the current of our present '01A type tubes.) Today, however, special filaments are employed, capable of copious electronic emission at relatively low temperatures (and therefore with a minimum current drain). The A.C. tube, which must have a higher amperage flow for correct operation, consumes little *wattage*, because of the very low voltages used.

The study of the action in a thoriated-tungsten filament is remarkably interesting.

Inside the Filament

When the tungsten mass is heated to the required temperature, the embedded thorium particles are diffused to the surface which cover with a layer of thinness measured in atoms. The clusters of electrons (given off by the thorium) are then virtually plucked off by the attraction of the (positive) plate; but other electrons immediately take their place on the surface. There is a critical temperature (an "optimum" value) at which the filament operates with the greatest efficiency; and at this the thorium particles are diffused to the surface just fast enough to keep the latter properly covered.

If the temperature is too low, there is not a sufficient flow of electrons; and if the temperature is too high, the thorium is thrown off—"evaporates"—from the filament faster than it can diffuse to the surface. The first condition results in low efficiency, while the second causes a "de-activation" of the filament, ending in a marked decrease in current flow from filament to plate. There is still another effect from the second condition; the filament's crystalline structure, which has received very careful attention (in the process of drawing the wire into the hair-like filament) is altered, greatly reducing the life of the tube.

In the case of the heater type of tube, the excessive heat soon burns the active coat from the cathode, and also shortens the life of the tube; while the filament which heats the cathode cylinder is subject to the same changes as the other types of filaments.

Thus it is seen that filament temperature is one of the most important factors in tube life. There are several other considerations which are also very important, although they are not as obvious as those associated directly with the filament. One of these is the grid voltage.

"C" Bias and Tube Life

In a power tube, such as the '71A or the new '45, if the grid-bias resistor is short-circuited or the "C" battery removed from the circuit, the *plate current* increases enormously; and in some cases the extra heat produced by this increase is sufficient to permanently injure the tube in a comparatively short time. (The normal plate current for the '45 tube with 250 volts on the plate and 50 volts on the grid is 32 milliamperes. If the grid bias is removed, the plate current jumps immediately to about 60 milliamperes!)

There is another effect of incorrect "C" bias. The modern set usually draws all of its plate current from a single rectifier tube (usually one of the '80 type) and, as these tubes are often operated at very nearly their maximum current, the increase of the current flow in the power-tube circuit often causes failure of the *rectifier.*

In order to facilitate the explanation, we will give a list of the most important points in getting the most from your tubes. (These points were listed in a book published by the Sonatron Tube Co., "HOW TO TAKE CARE OF YOUR RADIO TUBES.")

(1). Keep the prongs of the tubes clean in order to assure good contact. The prongs of the sockets should also be cleaned.

(2). Use the correct filament voltage at all times; it is a good plan to run the tubes at about three-quarters of their rated voltage, if the quality is not greatly affected in this way.

(3). The correct "C" bias (for the "B" potential applied) must *always* be supplied to *every* tube; incorrect "C" voltages will cause distortion. (And other forms of mal-performance. See above.—*Author*).

(4). The correct "B" voltages must be applied; if lower voltages are used, you will not get the correct volume or quality. If a "B" power unit is used, be sure that it is capable of delivering sufficient voltage to the plates of the tubes. If variable voltage controls are provided, it is a good plan to check the output of the unit with a *high-resistance* voltmeter.

(5). Always use the tubes for the purpose specified by the manufacturer. The use of tubes for purposes other than those for which they are designed will often result in short life and poor results. Also be sure that you place the tube in the correct socket in the set; a great number of "blow-outs" are caused by failure to do so.

(6). Never attempt to use a "hi-mu" tube in a transformer-coupled *amplifier;* by doing so, you will get distortion. These tubes, however, are often good *detectors* when properly used with audio transformers.

(7). When using dry-cell tubes such as the '99, be sure that you do not use more than 3.3 volts on the filament. *It is advisable to connect a voltmeter across the filament to* show the voltage. These tubes soon become paralyzed if excessive filament voltage is applied.

(8). In using A.C. tubes *make sure* that the transformer supplies the correct voltages. Due to changes in the line-voltage, a transformer will often supply much higher voltages than those required. An accurate *A.C. voltmeter* should be used to check these values.

(9). Follow the manufacturer's instructions for using a tube. The manufacturer has spent considerable time and expense in the design of the tube, but it cannot operate correctly unless the instructions which accompany each tube are followed exactly.

(It would be a good idea for dealers to have made a large copy of these hints for getting the best from vacuum tubes and place it where everyone can read it. It would help to promote sales).

The Characteristics of Tubes

The folders wrapped with each tube advise the purchaser of certain "characteristics" which differentiate the tube from other types. These characteristics are not always understood properly except by engineers; as the terms are not familiar to the fan and, in many cases, they are not entirely understood by the dealer and service man.

The *filament voltage, grid voltage,* and *plate voltage* can be easily understood by everyone who might use a tube. The *amplification factor,* the *plate resistance,* the *mutual conductance,* and *undistorted output* are the more technical characteristics which cause confusion. For the professional man, who is required to test the operation of various tubes, we will show methods of finding these values.

The two main factors that enter into the design of vacuum tubes are the *amplification factor* and the *plate resistance.* The amplification factor (*"mu"*) increases with the distance between the plate and the grid, and depends also on the spacing and size of the grid wires. Although theoretically, *"mu"* is constant, in practice it decreases slightly at low voltages. The amplification factor is defined as "*the ratio of the change* in the plate voltage (necessary to give a change in plate current of a certain value) to the change of grid voltage (which will produce the same change in the plate current)". In other words,

$$"mu" = \frac{dEp}{dEg}$$

The amplification factor is useful in determining the qualities of a tube as an amplifier and, in common practice, it is the value which is used most frequently for determining the purpose for which a tube can be used. It can be determined from a graph showing the *variation of plate current with grid voltage,* by taking a reading at some value of plate voltage slightly different from the one used in making the curve. (This type of graph is very common and can be obtained from any manufacturer of tubes). The point should be plotted on the graph with reference to the grid voltage-plate current readings used for the original curve. For example, Fig. 1 shows a graph made for a common tube with a plate potential of 45 volts. The point P is the new value when using a plate voltage of 35; hence, the change is 10 volts, the grid remaining at zero voltage in respect to the negative end of the filament. It is seen that the plate current drops from 1.60 to 0.95-milliampere; which is a difference of 0.65-milliampere.

From the above definition, the amplification factor is equal to the change in plate voltage divided by the change in grid voltage. The grid voltage which would produce this same change in the plate current is the horizontal value from the point P to the curve. (In this case 1.25 volts.) Thus, 10 divided by

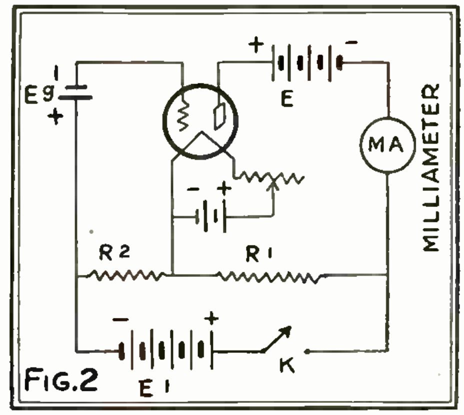


FIG. 2

Schematic circuit of the units used to obtain the most important "tube characteristic" readings. From these figures the "amplification factor" may be determined

1.25, or 8.0, would be the "amplification factor" of the tube.

Another way of measuring the amplification factor is shown in Fig. 2. The equipment consists of a 10-ohm resistor r2, a resistor r1, calibrated up to 500 ohms, and a key K. When K is open, the tube is in normal operating condition, r1 being too small to affect the plate current; when the key is closed, the battery E1 (about 10 volts) discharges through r2 and r1. The voltage divides through the two resistors according to their values. The voltage across r2 is applied to the grid in the reverse direction to that impressed on the plate due to the drop across r1 in the plate circuit. The voltage on the grid is amplified by the tube and produces a voltage *"mu"* times as great in the plate circuit. If these opposing voltages do not balance, a small difference in the plate current, shown in the milliammeter, results. By closing K and increasing or decreasing r1 until no change is noted, then r1 is *"mu"* times r2 and the amplification factor is *"mu"*=r1/r2. If r2 is 10 ohms, it is necessary only to divide r1 by 10 to obtain the amplification factor.

Plate Resistance

The term "plate resistance" does not refer to the resistance offered to the flow of *direct current* in the plate circuit, but is the resistance offered to the flow of *alternating* current in such a circuit. The plate resistance may be calculated from the values found for the amplification factor. Plate resistance

$$Rp = \frac{dEp}{dIP}$$

In the example above, the change in the plate voltage was 10 volts, and the change in plate current 0.65 milliamperes or .00065 ampere. The ratio of 10 to .00065 is 15,400, which is the A.C. plate resistance in ohms.

Mutual Conductance

Both the *plate resistance* and the *amplification factor* affect the performance of the tube as an amplifier. In order to have a simple value for comparing the merits of tubes, a term called *mutual conductance* was devised. This expression takes into consideration both the above values. "Mutual conductance" is the *ratio* of the amplification factor to the plate resistance. The usual unit for the mutual conductance is the *micromho.*

We know that

$$\text{"mu"} = \frac{dEp}{dEg} \text{ and that } Rp = \frac{dEp}{dIp}.$$

Hence the ratio of these two units is equal to

$$Gm = \frac{dEp}{dEg} \div \frac{dEp}{dIp} = \frac{dIp}{dEg}$$

In other words, the mutual conductance may be defined as the ratio of a small change in the plate current to the change in the grid voltage required to produce the same change in the plate current.

Tubes having high values of mutual conductance are more efficient amplifiers than those having lower values; but the comparison must be made for tubes designed for the same purpose and having similar characteristics. Thus, a tube such as the '12A has a mutual conductance of 1600 micromhos and the '71A has an average value of 1360 micromhos for the same plate voltage. However the '71A can supply about 160% greater "undistorted output" than the '12A when a louder signal is being received. The tubes are designed for different purposes.

Undistorted Output

This valuation, which is heard frequently in the design of modern sets, is the factor which is used to compare the amount of current which two tubes of different types will carry without introducing noticeable distortion into the signal. In other words, if one tube—such as the '12A—distorts considerably with a certain volume, the use of a larger tube such as the '71A, '45, or '10 will prevent this distortion.

The unit on which the undistorted output is based is the *watt.* Since most tubes will not carry a full watt of power, the unit is reduced and the *milliwatt* or one-thousandth of a watt is employed for rating. In order to obtain the greatest amount of power from a power tube, it is generally accepted that the plate resistance should be equal to the resistance of the reproducer *or* the coupling unit.

The conditions for maximum output are limited by the extent to which the output is considered undistorted. A distortion of 5% is quite imperceptible to the listener and, hence, may be allowed; especially since only a relatively small power increase is obtained with a greater distortion level. By this we mean that the output volume would not be increased, even though the tube were forced further, and the signal would be distorted to a much greater extent.

Under certain conditions, the greatest undistorted output may be obtained with different ratios of the plate resistance to the load resistance; and investigations indicate that a maximum undistorted power output is obtained when the LOAD resistance is equal to twice the PLATE resistance. (This conclusion is based on statements made in the "Proceedings of the Institute of Radio Engineers," vol. 36). This condition is realized when the plate and grid resistances are adjusted to their best values and, of course, the statement does not hold true for other voltages. The apparent conflict of the statements made above is due to the difference in the conditions considered as undistorted; in the first case, the tube distortion in the power tube is neglected, and in the latter, the over-all conditions are taken into consideration.

"Static" and "Dynamic" Tests

The method of determining the mutual conductance, the plate resistance and the amplification factor, which were described above, give the "static" values.

TABLE A

Name of Set	*Model*	*Equipment Package*
Atwater Kent	40; 52; 56; 58	EQ1
" "	45	EQ2
" "	46; 53	EQ3
Brandes	B-10	EQ4
Bosch	28	EQ3
"	29B	Special
Bush and Lane	4A	EQ3
" " "	De Lux	EQ6
Crosley	704; 706; 708	EQ3
"	804; SB	EQ5
Eveready	1; 2; 3	EQ3
Fada	All 1929 models	EQ5
Grebe Synchrophase	AC-6	EQ1
" "	AC-7	EQ2
Kolster	K-20; K-22	EQ1
"	K-21	EQ2
Kennedy	....	EQ6
Lyric	....	Special
La Salle	6-T	EQ1
" "	7-T	EQ3
Lafayette	....	EQ3
Majestic	71-72	EQ3
Philco	511	EQ1
President	T-C	EQ3
Radiola	17-18-33	EQ1
Stewart Warner	801	EQ1
" "	900	EQ6
Steinite	261	EQ1
"	40	EQ5
Stromberg-Carlson	635-636	EQ4
Standardyne	7	EQ2
Victor	7-11—7-26	EQ1
Admiral	....	EQ3
Apex	36	EQ1
Balkite	....	Special
Case	73-B	EQ2
Freshman	M-11	EQ1
Arborphone	45-55	EQ3
Temple	....	EQ6
Zenith	33-X	EQ4

TABLE B

EQ1......	4, '26; 1, '27; 1, '71A; 1, '80
EQ2......	5, '26; 1, '27; 1, '71A; 1, '80
EQ3......	4, '26; 1, '27; 2, '71A; 1, '80
EQ4......	5, '27; 1, '71A; 1, '80
EQ5......	5, '27; 2, '71A; 1, '80
EQ6......	5, '27; 2, '45; 1, '80

The above tables indicate a novel idea for increasing tube sales by reducing sales resistance.

There are two methods of obtaining the characteristics of tubes. One is the "static" method mentioned above, and the other the "dynamic" method. Both have their uses; but the professional man will be able to find data on the second method very easily by referring to technical books on the subject. One very good book on the operation of vacuum tubes valuable to the engineer is "The Thermionic Vacuum Tube" by H. J. VanDerBijl.

General-Purpose Tubes

Under this head may be included the tubes of earlier design which operate with either dry batteries or storage batteries for the filament supply. The first type of these tubes is not used very extensively at this time, although it is still being made for replacement purposes; this is the WD-11 and WX-12.

Filament voltage, 1.1; current 0.25-ampere.

Plate voltage, 22½ to 45 as detector; 90 to 135 as amplifier; current 1.5 ma. at 45 volts; 2.5 ma. at 90 volts; 3.5 ma. at 135 volts.

Grid bias, 4½ volts with 90 on the plate; 10½ with 135 on the plate.

Plate resistance, 15,500 ohms at 90 volts; 15,000 at 135.

Amplification factor, 6.6.

As these tubes are used only for replacement purposes, we will not discuss them further.

Next in line we have the '99 type; these tubes have won favor especially in portable sets because they save much weight in construction. Because of the extremely small filament current, ordinary dry cells are suitable for the filament supply and, if only a few tubes are used in the set, the batteries last for some time. Three dry cells, connected in series, are the usual source of filament supply; a two-cell storage battery is occasionally used.

Filament voltage, 3.3; current, .063-ampere.

Plate voltage, 45 as detector, 90 as amplifier. Plate current 1.0 ma. at 45 volts, 2.5 at 90.

Grid bias, 4½ volts with 90 volts on the plate.

Plate resistance, 15,500 ohms.

Amplification factor, 6.6.

The next tube we will consider won favor everywhere as a general-purpose tube and has only been supplanted lately because of the great demand for A.C.-operated tubes. This is the '01A type, the standard, all-around duty, storage-battery tube, which functions well in all circuits whether as oscillator, radio-frequency amplifier, detector or audio-frequency amplifier. More of these tubes have been made than of all others combined.

While the '01A can be used in the last audio-frequency stage, it is not a power tube, for its maximum undistorted output is only 55 milliwatts. Various manufacturers have different type numbers for this tube: as the Cunningham, CX-301A; CeCo, AX; R. C. A., UX201A; de Forest, 401A; Triad, T-01A; Diatron, 201A; Ray-O-Vac, RX201A; Cable Supply Co., Speed 201A; Raytheon, RayX-201A, etc. Each manufacturer has an individual and distinctive name and model number for the tube, and different methods of mechanical construction are used; but the electrical values are designed to conform to standard circuit requirements.

Filament voltage, 5 volts; current, 0.25-ampere.

Plate voltage, 45 as detector; 90 to 135 as amplifier.

Plate current, 1.5 ma. at 45 volts, 2.5 ma. at 90 and 3.0 ma. at 135.

Grid bias, 4½ volts at 90 plate volts; 9 with 135 on the plate.

Plate resistance 11,000 ohms at 90 volts, 10,000 at 135.

Amplification factor, 8.

Undistorted output, 15 milliwatts at 90 volts, 55 at 135.

There is one other general-purpose tube which has been made by a number of tube manufacturers, including the CeCo Mfg. Co., the French Battery Co. (Ray-O-Vac) and several others. This tube is known as the 201B,

(*Continued on Page 185*)

Characteristic Data of Radio Vacuum Tubes

MANUFACTURER	Trade Name	Type Number	Designation Radio-Craft	Base	Filament Volts	Supply Amps.	Plate Volts	Supply Milliamps.	Plate Resistance Ohms	Amplification Factor Mu.	Mutual Conductance Micromhos	Neg. "C" Bias Volts	Undistorted Max. Output Milliwatts
Radio Corporation of America	R.C.A.	WD11	'D11	Special; plug in	1.1	.25	45 67½ 90 135	1.5 2.0 2.5 3.5	18000 17000 15500 15000	6.6	340 360 425 440	 3 4.5 10.5	.... 7 35
E. T. Cunningham, Inc.	Cunningham	C11	"	"	1.1	.25	45 67½ 90	1.5 2.0 2.5	18000 17000 15500	6.6	340 360 425	 3 4.5	 7
Sonatron Tube Company	Sonatron	11	"	"	1.1	.25	22½-45 90 135	1.5 2.5 3.5	16000 15500 15000	6.6	405 425 440	 4.5 10.5	.... 7 35
Cable Radio Tube Corporation	Speed	WD11	"	"	1.1	.25	45 90 135	1.5 2.5 3.5	16000 15500 15000	6.6	405 425 440	 4.5 10.5	.... 7 35
Radio Corporation of America	R.C.A.	WX12	'D12	std. bayonet	1.1	.25	Same electrical constants as WD11				only base is different		
E. T. Cunningham, Inc.	Cunningham	CX12	"	"	1.1	.25	"	"	"	" C11			
Sonatron Tube Company	Sonatron	X12	"	"	1.1	.25	"	"	"	" 11			
Cable Radio Tube Corporation	Speed	WD12	"	"	1.1	.25	"	"	"	" WD11			
Radio Corporation of America	R.C.A.	UV199	'V99	Special; bayonet	3.3	.063	45 67½ 90	1.0 1.7 2.5	19500 16500 15500	6.6	320 380 425	 3 4.5	 7
E. T. Cunningham, Inc.	Cunningham	C299	"	"	3.3	.063	45 67½ 90	1.0 1.7 2.5	19500 16500 15500	6.6	320 380 425	 3 4.5	 7
Sonatron Tube Company	Sonatron	V199	"	"	3.3	.063	45 90	1.0 2.5	19500 15500	6.6	320 425	 4.5	....
Cable Radio Tube Corporation	Speed	V199	"	"	3.3	.06	20-90	2.5	15500	6.6	425	4.5	....
Champion Radio Tube Works	Champion	UV199	"	"	3.3	.06	45-90						
Duovac Radio Tube Corporation	Duovac	DV199	"	"	3.3	.063	45 67½ 90	1.0 1.7 2.5	10500 16500 15500	6.6	320 380 425	 3 4.5	 7
Sylvania Products Company	Sylvania	SV199	"	"	3.3	.06	45 135	1.0 3.2	 15500	 6.6	 425	1.0 10.0	 7
Gold Seal Electric Company, Inc.	Gold Seal	GSV199	"	"	3.3	.063	45 67½ 90	1.0 1.7 2.5	10500 16500 15500	6.6	320 380 425	 3 4.5	 7
Perryman Electric Company, Inc.	Perryman	RHV199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Ken-Rad Corporation		V199	"	"	3.3	.063	90	2.5	14500	6.7	460	4.5	7
Ce Co Manufacturing Company	Ce Co	B	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Radio Corporation of America	R.C.A.	UX199	'X99	std. X small	3.3 3.0	.063 .06	45 90	1.0 2.1	 15500	 6.6	 425	 4.5	 7
E. T. Cunningham, Inc.	Cunningham	CX299	"	"	3.3	.063	45 67½ 90	1.0 1.7 2.5	19500 16500 15500	... 6.6 ...	320 380 425	0.5 to 1.5 1.5 to 3 4.5	 7
Sonatron Tube Company	Sonatron	X199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Cable Tube Company	Speed	X199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Champion Radio Tube Works	Champion	UX199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Duovac Radio Tube Corporation	Duovac	DX199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Perryman Electric Company, Inc	Perryman	RHX199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Gold Seal Electric Company, Inc	Gold Seal	GSX199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Ce Co Manufacturing Company	Ce Co	BX	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Marvin Tube Company	Marvin	UX199	"	"	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Ken-Rad Corporation	Ken-Rad	X199	"	"	3.3	.063	90	2.5	14500	6.7	460	4.5	7
Sylvania Products Company	Sylvania	SX199	"	"	3.3	.06	45 135	1.0 3.2	 15500	 6.6	 425	 4.5	 7
Sonatron Tube Company	Sonatron	A199	"	large std. X	3.3	.063	45 90	1.0 2.5	 15500	 6.6	 440	 4.5	 ....
Sonatron Tube Company	"	X29	"	small std. X	3.3	.063	90 135	0.75 1.0	45000 40000	21	468 525	1.5 3	....
Sonatron Tube Company	"	X19	"	small std. X	3.3	.063	90 135	1.0 1.5	35000 30000	18	515 600	1.5 3	....
Ce Co Manufacturing Company	Ce Co	C	"	large std. X	3.3	.063	90	2.5	15500	6.6	425	4.5	7
Sonatron Tube Company	Sonatron	X200	'00	"	5.0	1.0	16½ to 22½	1.0	.....	...	...	...	detector
Sylvania Products Company	Sylvania	SX200B		large std. X	5.0	.125	20	1.0					Caesium vapor soft detector
Ce Co Manufacturing Company	Ce Co	H		"	5.0	.25	45 80	1.5 3	30000 14000	20 14.4	680 1030	... ...	Hard detector
Radio Corporation of America	R.C.A.	UX-200A	'00A	"	5.0	.25	45	1.5	30000	20	666	+ Bias	Caesium vapor soft detector
E. T. Cunningham, Inc.	Cunningham	CX-300A	"	"	5.0	.25	45	1.5	30000	20	670	+ Bias	Alkali vapor soft detector
Sonatron Tube Company	Sonatron	X200A	"	"	5.0	.25	45 67	1.5 0.5	30000	20	666	+ Bias	"
Cable Radio Tube Co.	Cable	200AA	"	"	5.0	.25	135	1.5	.....	20	800	...	"
Champion Radio Tube Works	Champion	UX200A	"	"	5.0	.25	45	1.5	30000	20	670	+ Bias	"
Sylvania Products Company	Sylvania	SX200A	"	"	5.0	.25	20 45	1.0 1.5	 30000	 20	 680	 ...	Caesium vapor soft detector
Marvin Tube Company	Marvin	UX200A	"	"	5.0	.25	45	1.5	30000	20	670	+ Bias	detector
Gold Seal Electric Company	Gold Seal	GSX200A	"	"	5.0	.25	45	1.5	30000	20	670	+ Bias	Hard detector
Perryman Electric Company, Inc.	Perryman	PA200A	"	"	5.0	.25	45	1.5	.....	...	...	...	Soft detector
Ken-Rad Corporation	Ken-Rad	200A	"	"	5.0	.25	45	...	.....	25	...	...	detector
Eveready Carbon Company	Eveready-Raytheon	Ray X200A	"	"	5.0	.25	45	...	.....	...	...	...	detector
Sonatron Tube Company	Sonatron	X201B	'01B	"	5.0	.125	45 90 135	2.0 2.5 3.0	 10000 9000	8	 825 900	 4.5 9.0	 ....
Sylvania Products Company	Sylvania	SX201B	"	"	5.0	.125	45 90 135	1.0 2.0 3.0	..... 11000	... 8.5 ...	... 725 ...	... 4.5 9.0	detector ....
Radio Corporation of America	R.C.A.	UX201A	'01A	"	5.0	.25	45 90 135	1.5 2.5 3.0	..... 11000 10000	... 8	... 725 800	+ Bias 4.5 9.0	detector 15 55
E. T. Cunningham, Inc.	Cunningham	CX301A	"	"	5.0	.25	45 67.5 90 135	0.9 1.7 2.5 3.0	18500 14000 11000 10000	8	430 570 725 800	1.0 3.0 4.5 9.0	detector 15 55
Sonatron Tube Company	Sonatron	X201A	"	"	5.0	.25	45 90 135	2.0 2.5 3.0	 11000 10000	8	 725 800	 4.5 9.0	
Cable Radio Tube Company	Speed	201A	"	"	5.0	.25	45 90 135	... 2.5 3.0	....	8.2	800	4.5 9.0	....
Champion Tube Company	Champion	UX201A	"	"	5.0	.25	45 90 135	... ...	....	... ...	... ...	 4.5 9.0	detector ....
Duovac Radio Tube Corporation	Duovac	DX202A	"	"	5.0	.25	45 90 135	1.5 2.5 3.0	..... 11000 10000	... 8	... 725 800	+ Bias 4.5 9.0	detector 15
Sylvania Products Company	Sylvania	SX201A	"	"	5.0	.25	45 90 135	1.0 2.0 3.0	..... 11000	... 8.5 ...	... 725 ...	... 4.5 9.0	detector ....
Perryman Electric Company, Inc.	Perryman	RH201A	"	"	5.0	.25	45 90	1.5 2.5	 11000	 8	 725	 4.5	 detector
Gold Seal Electric Company, Inc.	Gold Seal	GSX201A	"	"	5.0	.25	45	1.5	.....				
Ken-Rad Corporation	Ken-Rad	201A	"	"	5.0	.25	90	2.5	11000	8	725	4.5	15
Arcturus Tube Company	Arcturus	101A	"	"	5.0	.25	135 45	2.3 1.5	11700	8.3 ...	710 ...	9.0 ...	 detector
Eveready Carbon Company	Eveready-Raytheon	Ray X201A	"	"	5.0	.25	90 90	2.5 2.5	11000 11000	8	725 725	4.5 4.5	15 amplifier
Marvin Tube Company	Marvin	UX201A	"	"	5.0	.25	45	1.5	.....	...	...	+ bias	detector
Ce Co Manufacturing Company	Ce Co	AX	"	"	5.0	.25	90 45 90	2.5 1.5 2.5	11000 11000	8 8 ...	725 430 725	4.5 + bias 4.5	15 detector ....
Triad Manufacturing Company	Triad	T.01A	"	"	5.0	.25	135 45	3.0 ...	10000	... ...	800 ...	9.0 ...	....
De Forest Tube Company	De Forest	401A	"	"	5.0	.25	90 45 90	... ... 2.5	11000 11000	8 ... 8	725 ... 725	... ... 4.5	detector detector amplifier

LATEST THINGS IN RADIO

Manufacturers are invited to send to this department photos and descriptions of new apparatus

THE "SILVER GHOST"

IN these columns appears a photograph of the new custom-built A.C. radio receiver designed by C. R. Leutz, Inc. It has been named the "Silver Ghost."

The particular receiver illustrated, six feet long, cost over $1800, but the average cost of the more standard chassis, with ordinary equipment, is about $900. This set included a short wave receiver, phonograph pickup and an unusually complete control system.

The standard design includes four stages of screen grid amplification (five tuned circuits), detector, first stage of audio frequency amplification, second of A.F. amplification in push-pull connection, and a third stage also push-pull.

The tubes required are: 4, '24 (R.F.); 1, '27 or '24—see description below—(detector); 3, '27 (first and second A.F.); 2, '50 (power output); 2, '81 tubes (rectifiers). That completes the broadcast receiver requirements; while the short wave unit operates with: 1, '24 (radio frequency); 1, '27 (detector); the audio amplifier system of the broadcast receiver being used in conjunction with the short wave unit, when desired. The dynamic reproducer requirements are optional with the set owner; in the receiver illustrated a 12" cone dynamic reproducer was used.

There are seven control panels. Although they present a formidable appearance, the operation of one is practically a duplicate of the operation of any of the others. And, this operation is merely the tuning of the stages, and control of the voltages on each tube.

For that matter, the tuning controls may be neglected, if desired, if we except a single tuning control. To obtain this "single dial tuning" the owner may lock up each condenser by means of a screwdriver. Accurate resonance of each is obtainable, for extreme distance reception, by use of available "trimmers."

An excellent example of the custom set builder's art. This is truly an engineering job.

Straight line wave length, General Radio, variable condenser units are used; each one being

Appearance of the latest Radiola-Victor receiver.

balanced for the particular stage in which it is used.

Switches permit selection of any number of stages from one to four. Variable resistors effect voltage variation in plate, control grid, and screen grid circuits. The plate voltage range on the screen grid tubes is 60 to 200; on the control grid, 1 to 12 (the resistor being a 5 watt unit in the cathode, grid return circuit); on the screen grid, 0 to 90. The detector plate potential may be varied from 0 to 140 volts, the usual operating voltage being about 80.

A feature of this receiver is the optional use of either a type '27 A.C. tube as detector, or the type '24. Also, one has the choice of grid leak and condenser rectification, with its attendant sensitivity, for extreme distance reception; or, plate rectification (power detection) where reception is being had from local stations. When the screen grid tube is being used as the detector, the "screen grid" circuit is used and not the "space charge" circuit.

The detector is resistance-capacity coupled to the single '27 first audio stage. This is followed by a push-pull connection of two '27s, using Sangamo transformers; this being followed by two '50 tubes in push-pull. The output connection depends upon the selection of reproducers. Each receiver is given an A.F. characteristic test and the average range, with negligible frequency discrimination or variation is 50 to 5000 cycles; most of the receivers exceed this standard and extend the range to 32 cycles and 7000 cycles. The total current consumption of the receiver is about 250 watts.

The short wave components are in the rear of the extreme right control panel. Five coils are used to cover a wave band of 18 to 100 meters. This results in very easy tuning appreciated by those who have tried to tune in short wave stations on this wavelength range and using only three or four coils. The tuning condenser has a capacity of 80 mmf. (It is a General Radio, transmitter type, double-spaced-plates instrument); the regeneration control condenser capacity being 250 mmf.

The power supply includes two, type '81 tubes and the output is practically pure D.C. One of the major difficulties encountered in sets having high amplification, is that of obtaining a humless current supply; without such a supply, it would not have been possible to achieve humless reproduction using four stages of screen grid amplification.

That transcontinental and transoceanic reception are possible with this receiver under permissible atmospheric conditions is a foregone conclusion.

THE RADIOLA 66

A NEW receiver, employing an improved A.C. superheterodyne circuit, and enclosed in a console cabinet with an electro-dynamic loud speaker, has been announced by the Radio-Victor Corporation of America.

The superheterodyne circuit used in the new receiver, Radiola 66, includes a tuned antenna coupling circuit, one stage of radio frequency amplification, oscillator, first detector, two stages of intermediate frequency amplification, second (power) detector, and one stage of audio frequency amplification. The elimination of one stage of audio frequency amplification materially increases the tone fidelity and reduces the possibility of distortion present when successive stages of amplification are used, we are advised.

Six type '27 and one power amplifier tube type '45 are used in the circuit. The type '80 is employed in the power unit to rectify the A.C. for the plate and grid supply of all the tubes and, also, to provide current for the reproducer field supply.

The single tuning control operates a new type of stencil cut selector dial by means of which illuminated scale markings from 0 to 100, as well as approximate kilocycle markings, are *projected* on a translucent composi-

(*Continued on Page* 187)

Men Who Made Radio—Lee de Forest

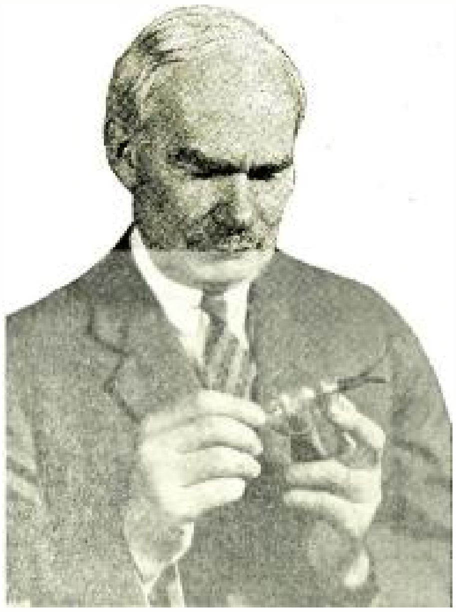
THE FIRST OF A SERIES

THE illustration which adorns the cover of RADIO-CRAFT this month, the first of a series of the "Men Who Made Radio," has undoubtedly been recognized at a glance by thousands, who do not need to consult the signature. No man, among the many who have contributed their inventive genius to the development of radio science, is better known to our readers for his accomplishments.

At the risk, therefore, of boring those already familiar with this subject, we may repeat a few biographical facts concerning the famous personage illustrated here, and his numerous contributions to the science and practice of electricity—one of which stands out so vividly in the public mind, compared with many others into which the inventor has put enormous labor and research.

Lee de Forest was born at Council Bluffs, Iowa, on August 26th, 1873 and has, therefore, just entered his fifty-seventh year. After preparatory work at Mt. Hermon, Mass., in 1896 he entered the Sheffield Scientific School (Yale University); he graduated in 1896, and continued his post-graduate studies until he had earned his doctorate in physics and mathematics. Thus equipped, he entered commercial research work with the Western Electric Co., but later set up in business for himself.

He had been early attracted by the new developments of radio telegraphy, and labored to devise the system which was in operation under his name until 1910. This work, in competition with the numerous others who were striving simultaneously to make "wireless" a commercial success in the United States, won a gold medal for its scientific value at the St. Louis Exposition of 1904. However, Dr.



Dr. de Forest, in the cover picture, is holding an early commercial model of the "Audion."

de Forest's greatest gift to radio was to be conferred in an unexpected manner.

In connection with the problem of finding a satisfactory detector for radio telegraphy, at a period when every sort of chemical and mechanical combination had been tried out, Dr. de Forest had made experiments on the heated flame of a gas lamp, which was found to be affected by the presence of electric waves.

Turning in 1906 to telephone work, with which he had commenced his investigations years before, he was confronted by the problem of obtaining a "relay," or what we would now term an "amplifier." A long series of experiments resulted in the revolutionary discovery of the principle of the "third element" —the grid—of a vacuum tube, and the production of an electrical "valve," the "Audion" —now known to all Americans simply as a "tube"—which soon made possible first long-distance telephony over wires, and then the even more astonishing feats of radio telephony. This was displayed, long before the days of broadcasting, on the linking up of Arlington, Va., by telephone with Honolulu and Paris by radiophone in 1915—the same year that saw the opening of commercial trans-continental telephony in America.

Dr. de Forest's other contributions to the electrical art have been manifold, as we have said. For the past two years and more his principal efforts have been devoted to the development of Phonofilm, a "talking-movie" system in which the de Forest "Audion" finds another unique opening for its services. And there is no reason to despair of seeing equally novel and striking future developments of the functions of the "Audion," from the ingenious brain of its creator.

Attention: Radio Service Men

RADIO-CRAFT, as explained on the editorial page of this issue, is now engaged in compiling an international list of names of qualified service men throughout the United States and Canada, as well as in foreign countries.

This list, which RADIO-CRAFT is trying to make the most complete one in the world, will be a connecting link between the radio manufacturer and the radio service man.

RADIO-CRAFT is continuously being solicited by radio manufacturers for the names of competent service men; and it is for this purpose only that this list is being compiled.

There is no charge for this service to either radio service men or radio manufacturers. It is simply an extra service that RADIO-CRAFT will perform for the industry.

The greatest need of the industry at this time (as the president of the Radio Manufacturers Association and many other authorities in the trade emphasize elsewhere in this issue) is *trained and experienced service men.* We are asking every reader of RADIO-CRAFT who is a professional service man to fill out the blank printed on this page or (if he prefers not to cut the page of this magazine) to put the same information on his letterhead or that of his firm, and send it in to RADIO-CRAFT. The data thus obtained will be arranged in systematic form and will constitute an official list of radio service men, throughout the United States and foreign countries, available to radio manufacturers. This list makes possible increased cooperation for the benefit of the industry and all concerned in the betterment of the radio trade.

Address *National List of Service Men,* care of RADIO-CRAFT, 98 Park Place, New York, N. Y.

National List of Service Men,
c/o RADIO-CRAFT, 98 Park Place, New York, N. Y.

Please enter the undersigned in the files of your National List of Radio Service Men. My qualifications are as set forth below:

Name (please print) ....
Address .... (City) .... (State) ....
Firm Name and Address ....
(If in business for self, please so state)
Age ...... Years' Experience in Radio Construction........ In Professional Servicing ....
Have Agency for Commercial Sets...... (Makes) ....
....
Custom Builder .... (Specialties) ....
Study Courses Taken in Radio Work ....
From What Institutions ....
Specialized in Servicing Following Makes ....
....
Specialized in Following Testing Apparatus ....
Testing Equipment Personally Owned ....
Other Trades or Professions ....
Educational and Other Qualifications ....
Comments ....
(Signed) ....

The Cooperative Radio Laboratory

Where all experimenters may meet on a common ground to discuss and develop radio technicalities.

DAVID GRIMES, Director

THE analytical development of the "Hybrid-Crystal" circuit (described in the August and September issues of RADIO-CRAFT) has now reached a point where serious thought may be given to various radio-frequency arrangements to give R.F. amplification in conjunction with the crystal. You will recall, from the previous articles, that the hybrid-crystal connections were recommended as affording the most sensitive detector action possible outside of the regenerative tube—and the regenerative circuit, from the audio standpoint, is no longer seriously considered for broadcast reception because of its deleterious effect on tone quality. But one of the most important things to bear in mind about the hybrid-crystal circuit is its apparent ability to deliver good quality on signal strengths which would completely choke the average grid-leak system. So the crystal-tube combination is being advocated not only for sensitivity, but also for quality on loud stations. Can you imagine a better-behaving detector?

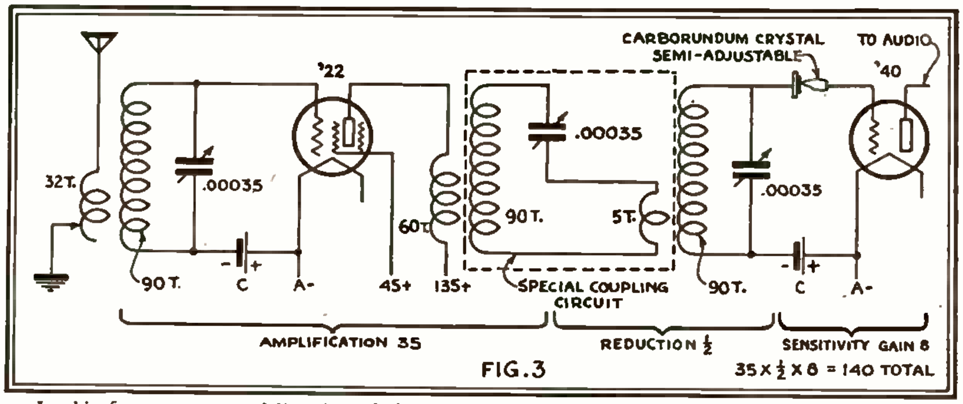
All of which means just this: while the previous articles dealt with tuned filters and crystal rectification, with no reference to radio-frequency amplification, this was deliberately done to emphasize the extreme sensitivity of the device. There is absolutely nothing to prevent us from adding about as much radio frequency as we desire without sacrificing our tone quality on nearby stations. In this respect, the crystal circuit is most unique—being practically a power detector.

Screen-Grid Developments

Nevertheless, in order to make haste slowly, we will confine our radio activities to one stage only for the present. Then, when we have mastered some of the peculiarities of screen-grid amplifiers, we will be ready for perhaps a second stage. Yes, we said *screen-grid* radio amplifiers. No, we have not fallen for the latest fad. We fully realize that our present attitude toward this matter is an "about face" from some of our writings of a year ago. The screen-grid tube is really coming into its own.

The first reaction against the battery-model '22 tube was adverse. It had been a little "oversold" and everyone was expecting too much. Then, again, instead of being designed to operate on a standard-battery filament voltage, it appeared with the same filament operating specifications* as the '20 dry-cell tube. It was really a dry-cell job. Imagine the grief experienced in combining this with other tubes at full five volts filament.

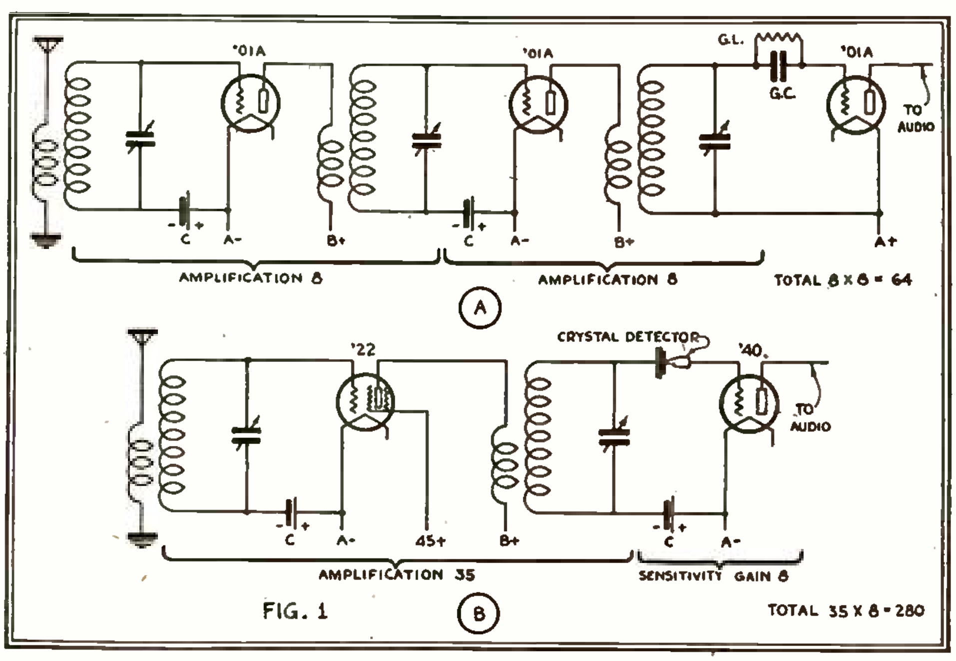
Well, now you have our story, anyway. One stage of screen-grid R.F. ahead of the hybrid-crystal. And you fellows who have been accustomed to "steen" stages of R.F. have a surprise in store for you. Already, several experimenters have anticipated this ideal stunt and have written in reception reports that read like a transcontinental itinerary. You see, the screen-grid tube is capable of delivering considerable amplification—much greater than the '01A tube. This fact, coupled with *the extreme sensitivity of the hybrid tube,* makes really distant stations subject to call, almost at will. Fig. 1 gives a fair comparison between a good two-stage R.F. amplifier with grid-leak detector and the hybrid-crystal with *one* stage of R.F. screen-grid amplification.



In this figure we see a delineation of the faults and advantages of a circuit designed particularly for selectivity; and with no inherent amplification characteristics in the special coupling circuit at desirable frequencies.

Many engineers assume an R.F. amplification of 10 per stage; but this, in our experience, is a little high. Most of the R.F. circuits that we have tested measure around the eight-per-stage figure; this means that over the two stages there is a total gain of 64. Now let us look at the screen-grid circuit; the screen-grid radio amplifier (conservatively) produces an R.F. amplification of 35 per stage. Then, the increased sensitivity of the hybrid-crystal has been found to be equal to at least another standard stage of R.F. amplification. This gives a total effective R.F. gain of 35 times 8, or 280; and 280 is "some gain" as compared with 64!

*(Nearly—Editor.)



In Fig. 1 we find a direct comparison between the amplification obtained with an ordinary circuit (A) and the screen-grid hybrid tube development (B). Letters we are receiving indicate this circuit has great possibilities.

The Selectivity Problem

There is only one bad feature in a radio set which has too much radio gain; it has *apparent* broadness of tuning. The shape of the resonance, or tuning, "peak" is largely governed by the number of tuning circuits employed, other things being equal. Two hook-ups, having the same number of tuning circuits, will be sharp or broad according to the relative amount of amplification in each. This means, generally speaking, that an extra-good R.F. amplifier *will be broader than our average R.F. amplifier with the same number of tuning circuits.*

Now, a glance at Fig. 1 will at once indicate that we are running into selectivity difficulties. Our new screen-grid circuit gives much greater R.F. amplification with only two tuning circuits, instead of three shown in the standard radio circuit using the '01A tubes. Obviously, such a set will pick up plenty of distant stations—providing no locals are on the air at the same time. Many of you will recall, in this connection, the old untuned-radio-frequency sets. They certainly had real pick-up; but the selectivity was so poor that a nearby local station would come in all over the dial.

Something must be done to increase our sharpness of tuning; so we will resort to the same system that we have previously advocated for increasing the selectivity of the crystal. An extra stage of *tuning only* will be inserted. This gives what is commonly known as a "band-pass filter"; we prefer to call it a "Tandem-Tuner." Such a device consists merely of two tuned circuits coupled together in a fairly loose manner; under which conditions each acts almost independently of the other. It really increases the selectivity almost as much as the additional stage of tuned radio frequency which is present in the standard R.F. hookup in Fig. 1.

This Tandem-Tuner scheme looks like a wonderful discovery! Why not proceed *ad infinitum*—adding tuner after tuner and thus obtain any desired degree of selectivity? Alas! There seems to always be a compensating factor in Nature that keeps us within reasonable bounds by demanding compromises. True, the selectivity may be geometrically increased by a series of such coupled circuits, but only at sacrifice of signal strength. The volume suffers a noticeable reduction upon passing through each Tandem-Tuner component. In the particular Tandem-Tuner design shown herewith, in Fig. 2, the signal strength is cut in half. But the sacrifice is well worth while, because the sharpness of tuning is increased according to the *square*—not merely doubled!

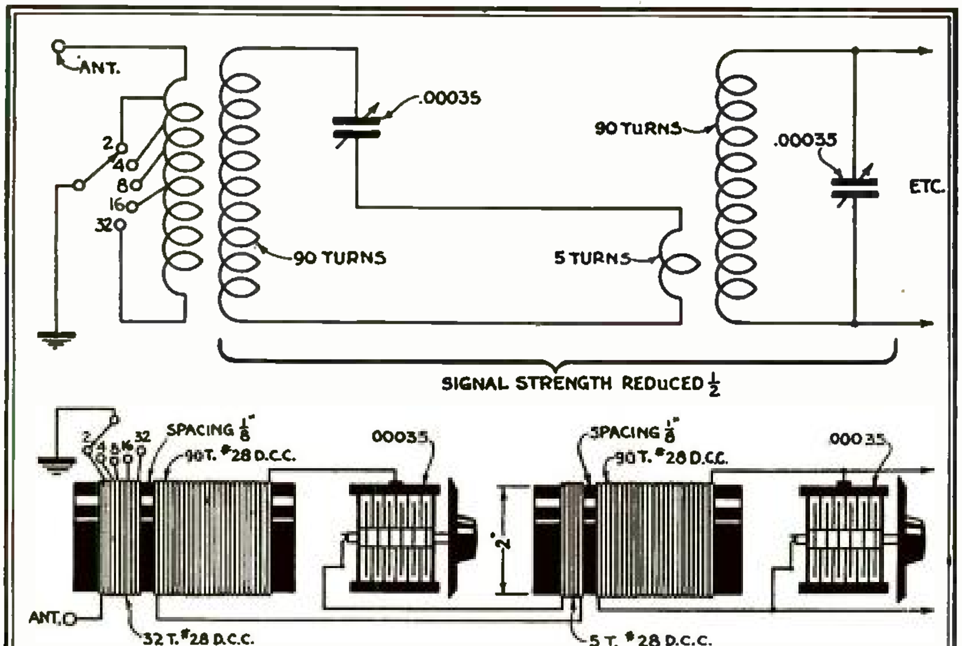


FIG. 2

A "close-up" of a selectivity design the regular set-builder will do well to observe. The two sets of inductances should be arranged to prevent coupling except through the five-turn coupling coil.

Furthermore, we can well afford to give up half of our signal strength, and still be way ahead of the standard two-stage radio-frequency set in sensitivity. Glancing once more at Fig. 1, we see that reducing our amplification factor by half still leaves 140, as against 64 for the standard set-up. As a matter of fact, we could add yet another tuner, giving a strength of 70 to our incoming signal, and still be ahead of the 64 index above. However, this is not necessary now; perhaps, later on, it will be worth trying.

Avoiding "Cross-Modulation"

Our next real problem is to locate the proper place in the circuit for this tandem tuner, band-pass filter, or whatever you desire to call it. In the straight hybrid-crystal-circuit, shown in last month's article, there was only one place for it; and that was between the hybrid-crystal tube and the antenna. But now, we have a choice of two positions; the filter may be located between the screen-grid R.F. amplifier and the crystal-tube combination, as shown in Fig. 3. It is almost generally found here in present popular cii uits. Perhaps it was because of this fact that we first seriously questioned the desirability of locating the filter here. Of course, the only other place for it is between the screen-grid tube and the antenna. Superficially, it looks like a question of "Hobson's choice," or the other platitude of "six of one—half a dozen of the other." Actually, there is a vast difference. No, it isn't a matter of signal strength. It isn't even a matter of selectivity. The Tandem-Tuner should be between the aerial and the first R.F. tube in any circuit for an entirely different reason. That reason is "cross-modulation."

But don't let that term discourage you; for you have undoubtedly experienced the difficulty many times without realizing it. One is particularly apt to encounter it when operating a set near a local broadcaster; especially if the first radio tube has little or no "C" bias on the grid. This is inherently the case with the '22 and A.C. screen-grid tube. You see, the proper negative grid bias for this tube is only 1½ volts; while on the standard '01A, even at only 90 volts plate battery, the bias is at least 4½ volts.

You are now wondering what "cross modulation" is all about! Let us give you some of the symptoms. Of course, we mentioned this problem superficially in the last issue; but it is such an important consideration that further detail is warranted. A nearby station is tuned out, let us say, in ten degrees on the dial; it disappears completely. Then, as we tune along, we come across a weak program; perhaps it is a distant station. This new broadcaster may be twenty or more dial degrees away from the powerful local. Only silence has been encountered on the dial between the two. But, lo and behold! As soon as the weak station is properly tuned in, there is the powerful nearby local right in the background—riding right through *on the carrier wave* of the new station. It often happens that such an annoying condition exists on many stations. This whole problem of *cross-modulation* is particularly provoking when an untuned coupling tube is used between the antenna and the first tuning stage. It is almost as bad, though, on a tuned stage that is efficiently coupled to the antenna.

(*Continued on Page* 190)

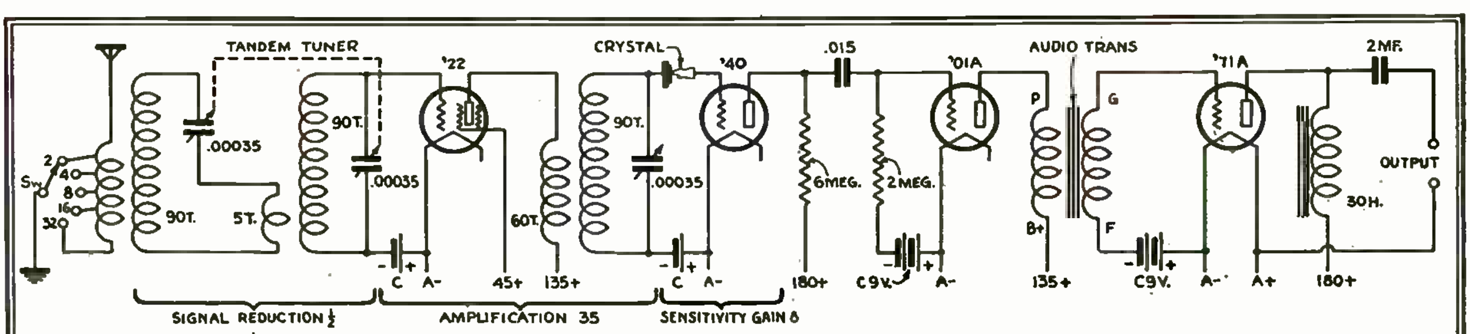


FIG. 4

The final circuit of a battery-operated receiver in which are used the '22, '40, '01A and '71A. The undistorted power output of this combination is sufficient to tax the reproduction ability of 75% of the reproducers in use today.

INFORMATION BUREAU

SPECIAL NOTICE

When writing to the Information Bureau, correspondents are requested to observe the following rules:

(1) Ask as many questions as desired, but furnish sufficient information to permit a proper diagnosis. Carefully drawn schematic diagrams are often desirable.

(2) Inquiries (not too involved) to be answered by mail must be accompanied by 25c in stamps, per single question. Blueprints are not available.

(3) Use only one side of paper and LIST each question.

(4) We cannot furnish comparisons between commercial instruments.

(The reader with the greatest number of interesting questions each month, although they may not all appear in the same issue, will find his name heading this department.)

Highest for the Month: BERT WEHMEYER with 9 Interesting Questions

1-DIAL T.R.F.—AUDIO HOWL—DUAL RANGE

(22) Mr. N. E. Lilley, Montreal, Que., Can.

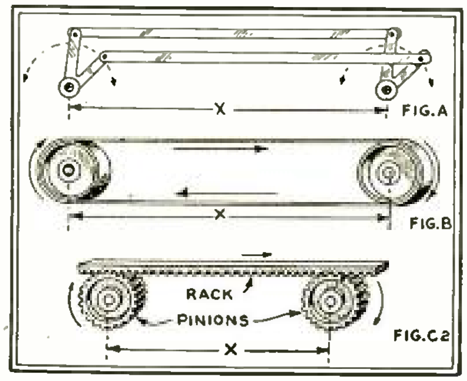
(Q.) How can I make a three-dial T. R. F. set into a one-dial control?

(A.) This may be accomplished in one of several ways.

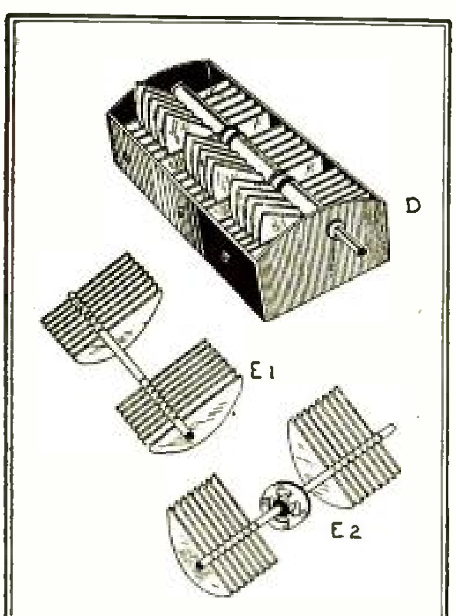
The simplest method is to apply a mechanical gearing which will couple all three tuning controls. This gearing may be applied at the front of the panel, but to hide it will necessitate mounting another panel in front of the first one. If mounted in back of the regular panel, it may be necessary to reset the variable condensers to accommodate the new equipment.

Three types of devices for obtaining indirect "ganging" are illustrated here: the toggle; the belted; and the geared. Of the first type, several manufactured units are available. The distance, *X*, between centers is determined by the design of its constituent parts. (See Fig. *A*.) Two parallel bars are required to overcome a "dead-center" effect; which in earlier models of even the two-bar type resulted in "bumpy" operation. In Fig. *B* is depicted a flexible coupling, the distance, *X*, between centers being only a matter of correct belt length; the belt may be made of strong cord or it may be a metal band. A rack-and-pinion arrangement is shown at *C*. In this system the gear teeth must be very accurately designed and aligned to prevent "back lash." By making a "rack" of any determinate length, spacing *X* is easily obtained.

Another conversion system for two- and three-dial sets uses a single condenser unit having the requisite sections. The principle is made clear by drawing *D*. These are usually constructed as "bath tub" type condensers and are used to replace the old variable condensers. In some receivers it is convenient to do this, but in others it is not. Use of these condensers results in a neat and efficient job; although all the rotors must be wired to have the same potential.



(Q. 22.) In Fig. A, above, is illustrated a toggle coupling; Fig. B, belting (such as Freshman uses); Fig. C2, a form of gears.



(Q. 22.) Ordinary variable condensers of the "run-through shaft" type are pictured as E1. The E2 plan is used where rotors must be insulated from each other; the "insulating coupling" accomplishes this. A "bath-tub" construction is shown at D.

If it is desired to replace the older variable condensers with more modern ones, those having a removable shaft may be used; mounted and coupled (with a single long shaft) as shown in Fig. *E1*. If it is necessary to use condenser units which have non-removable shafts, a special coupling may be used, as in Fig. *E2*. Conductive couplings are used between rotors at the same potential, while the insulating type is required when rotors are at different potentials. Just how and where the condensers can or may be placed, using either plan, is determined by the characteristics of the circuit and the ingenuity of the "rebuilder."

(Q.) What is a "microphone howl?"

(A.) We thought everyone knew the answer to that.

It is a loud noise due to motion of the elements within one or more vacuum tubes in the set. The detector tube is the greatest offender; although any tube in the set may be the source of this trouble.

The generation of this noise is caused by sound waves (usually from the reproducer) setting the tube elements in motion. Placing the reproducer elsewhere may eliminate the trouble. Padding (with paper, cloth or cotton), or loading (with lead, rubber or spring devices), may stop the noise. Both are makeshifts; the correct solution is to replace the tube (or tubes) with a tube in which the elements are supported more rigidly.

(Q.) Is it possible to make a three-dial tuned radio-frequency set adaptable to short-wave reception, in the same receiver?

(A.) It is "possible" but not to be recommended. A good short-wave set is a job all by itself. To incorporate its structural demands with those of a tuned radio-frequency set is to court disaster.

We presume our inquirer is most interested in phone reception on the short waves and we will be interested to hear from any of the readers of "RADIO-CRAFT" who may have been able to develop a successful set. The one described by Mr. Sklar, in the August issue of this magazine, as designed does not meet the conditions stated, although the idea could be adapted.

"BOOSTER" QUERY—JUNCTURES

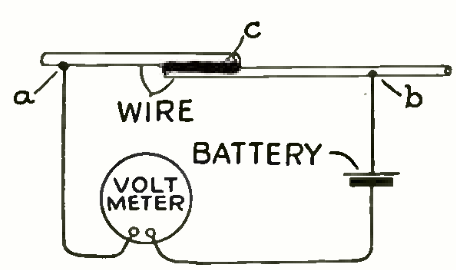
(23) Mr. Merle A. Heath, Waterloo, Iowa.

(Q.) Can you furnish the diagram of the Fitch "Detector Booster"; what is its advantage?

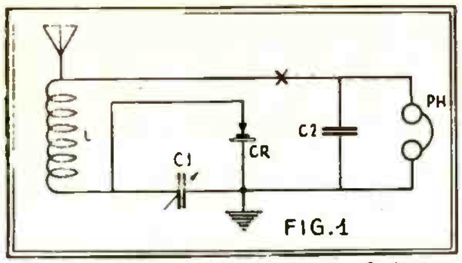
(A.) The manufacturers have not as yet made public this circuit, the advantage of which is, as stated in the July number of RADIO-CRAFT, to increase "——the output of the detector tube, making the set more responsive to distant stations and bringing the volume of weak stations up to normal loud-speaker volume."

(Q.) What is meant by a "high-resistance" joint in the aerial or ground wires?

(A.) An aerial (or ground) wire may often consist of several sections of wire. The junction points of these wires should be soldered, but seldom are. Due to atmospheric action, these junctures become corroded and an imperfect (high-resistance) contact is the result. The degree of "high" depends upon the degree of contact; and this may be determined in the laboratory by the use of a delicate voltmeter and a source of current (as illustrated in these columns; where *c* is the point of contact; *a*, one wire; *b*, the other; and VM, the volt-meter). If, having made contact on each side of the joint, the meter indicates the full battery voltage, there has been no current loss due to resistance in the joint; if the meter voltage reading is even one-tenth less than the known battery voltage, we know that there is a high resistance in the circuit and that this must be at the joint, *c*.



(Q. 23.) Testing the continuity of a joint. A milliammeter instead of a voltmeter, and the *corresponding* voltage supply, is suggested, also.



(Q. 26.) A selective crystal circuit. It is not new, being one of the earliest forms of crystal-detector hookup.

S. G's. IN NEUTRODYNES—BLOCKING TUBE

(24) Mr. Roger Barker, Leamington, Ont.

(Q.) In what manner can screen-grid amplification be added to a neutrodyne to obtain greater selectivity, sensitivity and volume?

(A.) This cannot be done, if the set is of the single-control type.

If of the older, multi-control type, the first stage of radio-frequency amplification may be rewired to include a screen-grid tube but the "improvement" would be questionable.

The reason for this is, that the neutrodyne is a "balanced" circuit and any change in one part of the circuit affects the remainder of the circuit. If the screen-grid tubes are wired in to replace the regular tubes, the neutralizing capacitors are not needed and the set is no longer a neutrodyne; and, in addition the set in tuning would be several times as broad as before.

As inductances and capacities must be exactly matched for single-dial operation, it is impossible to use the same equipment and obtain matched tuning; for the screen-grid tube has different internal capacity values from those of "regular" tubes; and its grid and plate circuit inductance requirements are different.

(Q.) Does a "blocking" tube amplify?

(A.) Yes; but the input and output coupling circuits may be so poorly matched as to amplify and pass only a small portion of the signal current; and the effect of a reduction in volume may in fact be obtained.

(Q.) What is the reason for using a "blocking" tube?

(A.) The inductance and capacity values of the aerial, and the primary of the input transformer form a circuit having frequency-discrimination characteristics, resulting in uneven operation over the tuning band. "Dead spots," these are called. (This effect is particularly pronounced on the waves below 200 meters.) The use of a blocking tube greatly reduces this effect and it does two other things.

It makes "ganging" of the tuned stages a more convenient and satisfactory proposition; and it greatly reduces the radiation of interfering signals when circuit oscillation results due to a "spill-over" of a regenerative circuit.

A.C. ADAPTER

(25) Mr. M. Nieto, Minatitlan, Ver., Mexico.

(Q.) Please show, in RADIO-CRAFT magazine, the schematic circuit for a short-wave adapter to be used with A.C. sets.

(A.) A circuit arrangement of a short-wave adapter, using the type '27 tube, is depicted, in answer to this query.

It must be mentioned this is a throw-back to the old 3-circuit regenerative set of some time ago; and the comparison of results obtained on this arrangement with those of the regular radio set, at the broadcast wavelengths, will not be a good recommendation for the adapter. At the short wavelengths, however, good code reception should be obtained and the few phone stations broadcasting should be heard. Squeals and whistles and distorted reception generally will result when trying to tune in the harmonics of broadcast stations. This is quite natural, as the harmonics cannot be expected to reproduce as clearly as the fundamental frequencies.

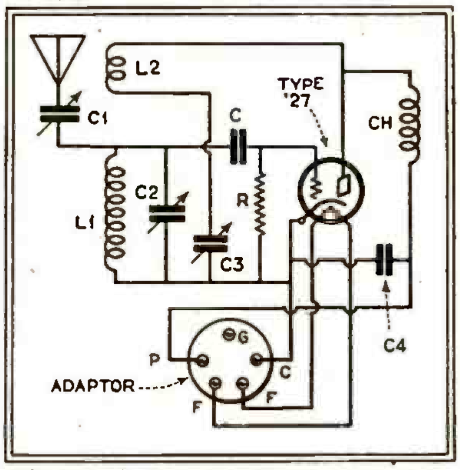
Inductance *L1* and *L2* are the standard windings, which constitute one of the coils of a short-wave kit. The 5-prong plug is a standard tube base. Resistor *R* is a grid leak with a value of about 3 megohms or more. Condenser *C4* is of .00025-mf. capacity. Condensers *C2* and *C3* are the usual tuning and regeneration units, the capacities of which are determined by the particular set of short-wave coils decided upon. The antenna coupling condenser, *C1*, is very necessary and has a value of about .0001-mf. The grid condenser, *C*, is 00015-mf.

SELECTIVE CRYSTAL — OSCILLATION CONTROL — CHOKE COILS

(26) Mr. Bert Wehmeyer, Webster Groves, Mo.

(Q.) Is it possible to make a radio receiver with a crystal detector, to be used in a locality in which there are several fairly powerful broadcast stations? The ordinary crystal receivers are of no use until the locals have signed off, due to the broadness of tuning these sets ordinarily have. What is needed is a circuit having as much sensitivity as a regular crystal set, but with greater selectivity.

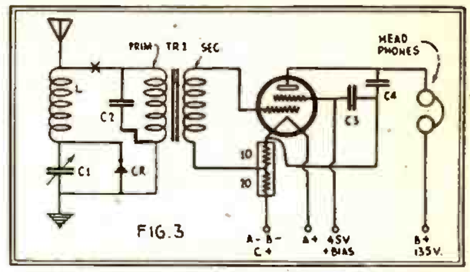
(A.) A circuit such as you require appears in these columns. This is Fig. 1. The tuning inductance L may be the usual coil used with the particular tuning condenser C1 selected; although the coil and condenser constants will be dependent in part upon the particular aerial and ground arrangement used. Condenser C2 is the usual phone by-pass unit, having a capacity of about .001- to .006-mf. Whether it is desirable to place a radio-frequency choke at X must be determined by experiment. Headphones are indicated as PH; and the crystal detector as CR. This detector may be of any convenient type. If it is desired to receive mostly from powerful stations, carborundum will be the most satisfactory; distant stations will be received with greater volume if a good piece of galena is used. However, the latter requires constant attention and the former is practically a "fixed crystal."



(Q. 25.) A short-wave adapter is shown in this schematic circuit. To put it in operation the detector tube is removed from the broadcast set and plugged into the adapter socket. The adapter plug connects into the broadcast set, in place of the detector tube.

Audio amplification may be added, as shown in Fig. 2. A transformer with a very low-resistance primary (such as a cheap audio-frequency transformer usually has) is to be recommended as TR1. A high-grade transformer must be suggested for use as TR2. Any output tube may be used; a '71 being shown. Again, the optional position of an R.F. choke is indicated at X. A "loud speaker" may be connected to the power tube, for room volumes.

Where other considerations may be involved, such as compactness, headphone operation, or lower cost, the circuit shown as Fig. 3 may be followed. In this arrangement, a screen-grid tube has been connected in the regular screen-grid fashion and functions as a single stage of A.F. amplification, in conjunction with the audio transformer TR1. Similar observations regarding the characteristics of this unit are made as were applied to TR1 in Fig. 2. Headphones are shown shunted by a fixed condenser C4 of .001- to .006-mf. capacity. The screen-grid ("G" on the socket) connects to the 45-volt biasing battery and is shunted by a fixed condenser of 0.25-mf. The control grid (the cap on the screen-grid tube) connects to the secondary of the A.F. transformer. The primary of this transformer connects from aerial to ground, and is shunted by a fixed condenser of about .001- to .002-mf. capacity. Index X may be an R.F. choke.



(Q. 26.) In this figure the screen-grid tube has been incorporated with a crystal detector.

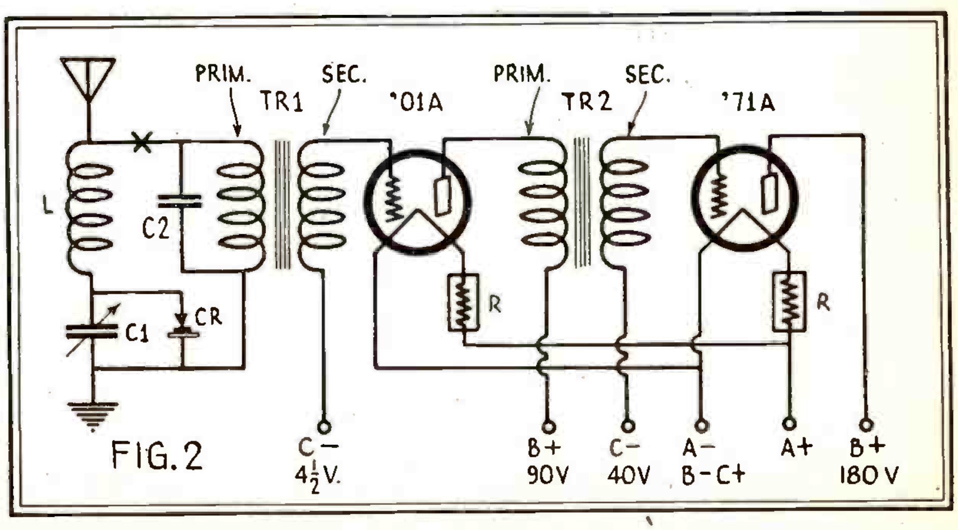
(Q.) While recently repairing a radio set, I found a fixed resistor connected across the secondary of one of the radio-frequency transformers. What was the purpose of this resistor?

(A.) This resistor was used as one of several optional means of controlling circuit oscillation. This is a very effective method and does not possess as many disadvantages as some other systems. It cannot be called purely a "losser" method; for it does not cause a reduction of the signals in the same proportion as the parasitic circuit oscillation is reduced. Many service men apply this oscillation control means to balky receivers, as it is very convenient; not necessitating the breaking of any leads.

(Q.) How is it possible to tell whether a choke coil is needed in a short wave receiver?

(A.) The purpose of a choke coil is to prevent the passage of alternating current. Its location in a receiver depends upon the design of the receiver. Some sets call for the use of choke coils in dozens of places, while other sets entirely dispense with their use. The usual place for at least one choke coil, in a short wave receiver, is in the plate circuit of the detector. In one position, it makes regeneration a possibility; without it, no regeneration or circuit oscillation is possible. This is probably the use you have in mind. Another action of the choke coil, also in the plate circuit of the detector, is to prevent radio frequency currents getting into the audio amplifier. In this position it will be found in a majority of the better commercial broadcast receivers. These same receivers, as well as the short wave receivers, use choke coils in the leads which supply plate potential to radio frequency stages, as well as bias potentials for the screen grid of screen-grid tubes. When used to prevent radio frequency currents passing into the current supply units, these choke coils are almost always by-passed with fixed condensers, as is seen upon inspection of most any schematic circuit; the radio frequency is "led" from the "high potential end" of the radio frequency choke, to a point at low potential. This is ordinarily

(*Continued on Page* 190)



(Q. 26.) In this circuit are shown a crystal detector and two stages of audio amplification, using a power tube in the last stage.

WHOLESALE PRICES

For Dealers, Service Men, General Repairmen and Set Builders!

FREE CATALOG

Our new, HUGE LARGER PAGE SIZE (8" x 10½") WHOLESALE CATALOG No. 19, 2nd Edition, enjoys the enviable distinction of being universally accepted by the RADIO TRADE in the same manner that a school treasures the Dictionary and Encyclopedia Britannica—or the home, the Bible and Almanac!! Those "in the know" regard our catalog AS THE OFFICIAL ORGAN OF THE 1929 RADIO SEASON!!!

This FREE CATALOG is literally a most valuable ENCYCLOPEDIA—YOU cannot well afford to be without one—and, you do not have to. Your request for one is all that is needed! In these many years we have been in the Radio Mail Order Business, we have learned to GAIN AND RETAIN THE GOOD WILL OF OUR CUSTOMERS. In this, our DETERMINED GOAL, RADIO SPECIALTY COMPANY OFFERS TO SHIP PRACTICALLY ALL ORDERS IN FROM 6 to 24 HOURS—OFFERS YOU 100% MERCHANDISE ON A STRICT MONEY-BACK BASIS IF NOT SATISFIED—AND OFFERS YOU ALL MERCHANDISE AT ABSOLUTE ROCK BOTTOM NET PRICES!

Our Catalog Lists More

Completely Assembled All-Electric A. C. Receivers

than any other Radio Catalog!

Available in chassis form, or mounted in table or console cabinets, with and without built-in loud speakers.

OUR ROCK BOTTOM NET PRICES FOR THESE SETS WILL ASTOUND YOU!

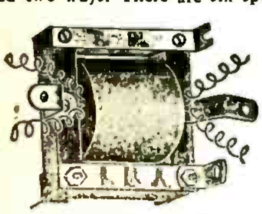
In this new catalog there are also listed large assortments of CAMERAS, HOUSEHOLD ELECTRICAL APPLIANCES AND ELECTRICAL TOOLS OF EVERY DESCRIPTION.

HERE ARE TWO OF OUR BIG BARGAINS

Order From This Page—Send Money Order—Check—or Postage Stamps

RASCO REPLACEMENT AUDIO TRANSFORMERS

Can be mounted in either of three positions, that is, lying down, or standing up with the core parallel with the base on which it is resting, or standing up with core perpendicular to the base. Other replacement transformers can only be mounted two ways. There are six specially designed feet to provide this most convenient choice of mounting, and any of them can be removed at will, should you so desire. Thus, it is logical to conclude that our Replacement transformers can be installed in *ANY* receiver, either custom or factory built, no matter how small a space there may be available, whether such mounting is to be above, or beneath, a subpanel, or baseboard. The coils themselves are of the first quality, and are only found on the most costly Transformers. The core is the highest grade silicon steel, and of ample proportions. A happy combination of electrical values in both the core, and coil, assure maximum amplification possibilities—more than sufficient volume, yet with no trace of distortion! The silicon steel stampings are very rigidly bolted together by a generous size bar which is attractively nickel plated. 2½ in. long by 1½ in. high by 2¼ in. wide.

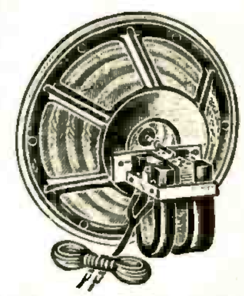


No. 7900. Your net Cost.. $0.80

TERMINAL STRIP MODEL

The primary and secondary leads are spaghetti covered, and unusually well soldered to generous size lugs. Strip is bakelite and properly lettered.
No. 7950. Your Net Cost.. $1.01

DUO-MAGNETIC CONE SPEAKER CHASSIS



No other magnetic speaker chassis is so strongly constructed! Note the heavily ribbed, sturdy "spider leg" white-lead casting! The entire frame work is one piece—a beautifully molded job! A Duo-Magnetic cone speaker unit is bolted to the rear mounting plate of the chassis, and the Burtex "ribbed" cloth cone is fastened between two heavy rings of cardboard—these rings are held in place by either screws and nuts, bolted to the frame of the chassis, or by being pressed up against a baffle mounting board. Although this speaker can be used as illustrated, it is strongly recommended that it be used in conjunction either with a baffle board or mounted within a box, a cabinet, or speaker compartment space in any console. *The tone quality is comparable to any speaker selling for many times its trivial cost. Will stand all the volume any radio set can "give it."* Will work satisfactorily with a D.C. or an A.C. set—with 90 volts applied through it, *or even as high as* 500 *volts! No blasting! No distortion! No rattling!* You will be most impressed with its *splendid performance!* Overall dimensions: Diameter 9 in. width of mounting ring ½ in., depth (rear of unit to mounting baffle board plate) 6¼ in.; diameter of unit mounting plate 4½ in.

No. 6850. COMPLETELY ASSEMBLED. Including DUO-MAGNETIC UNIT and cord. AS ILLUSTRATED. Your Special Price Net Cost.. $6.75

No. 6852. MOUNTED IN A CABINET OF EXTRAVAGANT BEAUTY. Your Net Cost.. $9.44

RADIO SPECIALTY CO.

98C Park Place
New York City

BUY FROM RADIO'S OLDEST MAIL ORDER HOUSE

A. C. Tube Noises

(Continued from Page 153)

adjustable center tap for the grid return. Yet all in all, the greatest source of noises in any A.C. set may generally be traced to the tubes themselves, and particularly to the heater type which has been considered noiseless.

The Interference Checker

With a view to determining the cause of A.C. hum in the heated cathode type of tube, the DeForest Engineering Department recently conducted an investigation. The first step was to produce a well-shielded amplifier, operating on direct current supplied by the usual "A," "B" and "C" batteries. The best grade audio transformers were employed, in order to pass about the same proportion of 60-cycle hum as the average good receiver of today. The general arrangement of the test amplifier is shown in the accompanying diagram. The usual bypass condensers are used, although not shown for the sake of clarity. It will be noted that two stages of audio amplification, with transformer coupling, are employed, together with the A.C. heater tube under test. The potential between cathode sleeve and heater may be adjusted for any voltage. The output circuit includes a coupling condenser, high resistance, rectifier and microammeter (for taking comparative readings); and head-phones (for determining whether the meter reading represents hum or crackle, or both).

Having arranged this test amplifier, the DeForest engineers next made up various types of heater tubes, following the standard designs now in production by tube manufacturers. A '26 or A.C. filament tube was tested in the amplifier, and gave a noise reading of 36, as a basis of comparison. The heater type tubes were then tested and a characteristic curve plotted for the degree of hum and crackle while varying the cathode heater bias.

Causes of A. C. Tube Noises

The noisiest tubes were found to be those with an insulator tubing of greater length than the cathode sleeve. The readings for these tubes were found to be quite erratic, with some samples fairly quiet and others very noisy, even when made precisely alike. A closer examination revealed the fact that the cathode sleeving was higher on some insulator tubings than on others, and those with the highest cathode sleeving were the most quiet. This led to important conclusions. The De Forest engineers deduced from these observations that the heater wire must be shielded by the cathode sleeving for practically its full length, and particularly at the top, for otherwise the inductive field of the heater wire affects the plate and induces a hum in the delicate plate circuit. Also, the crackle is believed to be a charge accumulating on the exposed insulator tubing and subsequently discharging to the cathode sleeve, particularly since the heated ceramic may become somewhat of a conductor at the high working heats.

Following the foregoing observations and deductions, tubes with cathode sleeving the full length of the insulator tubing were made up and tested. These proved remarkably quiet; in fact, they average one-tenth the hum of the usual exposed insulator tubes, and do away with the crackle. Also, due to the more efficient distribution of the heat from the heater, the heating time is reduced to about 10 seconds as against 20 to 30 seconds required by the average insulator type heater tube.

Service from the Office

(Continued from Page 154)

his radio education. He now knows that distance and noise are synonymous and we have saved another unnecessary service call. (Do not think the above an exaggeration. It really is a daily occurrence.)

Local Reception Conditions

Mr. McCarthy, big, husky and Irish, now strides into the office with a look of utter disgust upon his manly features.

"That set I got here isn't any good," he announces with assurance.

"What seems to be the trouble?" our office man gently inquiries.

"I can't get any stations," is the answer.

"Do you get WEAF, WJZ, WOR, and WABC?"

"Yes," admits McCarthy, "they come in pretty good."

"Well then what makes you say you don't get the stations?"

"I tried to get the prize-fights last night and I couldn't tune in WMSG for love nor money. Imagine my feelings, inviting over my brother-in-law to hear the returns. Why I could have thrown the blankety-blank thing right out of the window."

"Mr. McCarthy," says our office man, "your machine is all right. Do you know that you live in a "dead spot" where you can't pick up WMSG with any set?" A thorough explanation, and in a little while our complainant leaves the office satisfied he is getting the best he possibly can out of his radio. He has been educated. He may decide to move his residence up against WMSG's antenna or forget about that station. That depends upon how ardent a prizefight fan he happens to be.

These are representative examples of the daily occurrences wherein we educate the customer and save a tremendous number of needless service calls.

Teaching the A.B.C. of Radio

The second part of our customers' education is of greater importance than the first. We teach them to forget that helpless feeling with which the average radio enthusiast looks upon his favorite receiver that has suddenly balked. The attitude that "I bought the set from the company and it's the company's job to take care of it" does not get the customer very far with us. "It's your set" we feel and tell him, "and its up to you to *help* us keep it in working order." It is surprising how much service is facilitated *with a customer's aid*.

It has been found that the large majority of real troubles are due to defective tubes. We are, of course, referring to all-electric receivers since we have sold only this type lately. When Mr. Customer comes in or telephones that his set is not functioning properly, is noisy or has ceased to operate altogether it is assumed that the trouble is due to bad tubes. Our office man inquires, "What seems to be the trouble, Mr. Customer?"

"I have a Majestic 72," may be the reply; "it plays nicely and suddenly dies down to a whisper. A few minutes later it will just as suddenly come in with a roar."

"Bring in your detector tube, Mr. Customer, your set is perfect."

"I can't bring any tubes in," Customer usually says, quite insulted. "I don't know what a detector tube is and I don't even

(Continued on page 182)

Office Service

(*Continued from page* 181)

know how to take a tube out of the set."

"We can best help you when you help yourself. Any child can take a tube out of a radio set."

Mr. Customer invariably comes in with his tubes a little later. He may grumble somewhat but then we all know that the process of education is painful. It is not very long, however, before Mr. Customer learns to appreciate that, by bringing in his tubes and so co-operating with us, he has saved a few days of waiting for a service man to reach his home. He also realizes that *the testing facilities at the office are much better than our man could transport with him.*

Knowing the Ropes

In the solution of crime the detective's byword is *"Cherchez la femme"*—we have just as infallible a slogan—*"Look for the tube."* We look for the mischief-making tube first, for any or all symptoms that the balky set may display. Tubes must be tested and found perfect before anything else is done. The results of this system are remarkable. We may say, without exaggeration, that the personnel of the service department may be cut in half and more efficient and rapid service still be rendered.

The small number of cases in which there is really something drastically wrong with the receiver are likewise aided by our office man. We have discovered, by the handling of so many thousands of radios, that certain manufacturers have their pet weaknesses.

We all remember the old Radiola 17 models. The grid suppressors had a habit of burning out. When the owner of a Fada 10 or 16 is getting an abnormal amount of noise it is very likely the volume control that is to blame. Crosley makes a fine machine, though we could never understand their on-and-off switches. Thus we could go down the entire line of standard receivers all of which, in general, are well constructed but for their weak links. It is obvious that by knowing these weaknesses much time is saved in their discovery and repair.

SERVICE REPAIRS OF PARTS

(*Continued from page* 155)

the terminals (see Fig. 6). A fuse must be inserted in one side of the A.C. line to blow (instead of the 20- or 30-ampere fuse in the meter box, which is very often located in a most inaccessible part of the basement), when voltage is applied to the shorted condenser (Fig. 6). Very often, several (15 ampere) fuses must be used before the condenser is repaired.

This method of healing transformers and chokes and condensers has been found to be 90% efficient and is sure to save much time, labor, and money. A certain company estimates a saving of $1,000 during the past two years, using these methods of "shooting" apparatus.

"GIANT" SPEAKER SATISFIES

Editor, RADIO CRAFT:

I have built the "Giant" free-edge cone speaker described in the August issue, and have had results which are better than with any dynamic I have heard. I have made some improvements on it with arc-shaped legs which I put on the bottom, and tapestry of which I use just enough to cover the ends of the chamois around the hole.

EMIL SAJATOVIC,
4835 West 22nd Place, Cicero, Illinois.

"The Craft Box"

(*Continued from page* 162)

terminal of $V3$ is now connected to one of the cord-tip jacks on the panel. The other jack is provided with a long lead for connection to "B+90."

To the fixed vane of the antenna series condenser $C3$ is now soldered a 3-inch flexible lead, the end of which should be provided with a clip for fastening to the control grid of the R.F. tube.

Adjustment and Operation

To operate the receiver the batteries are first placed on the rear of the baseboard but not fastened down until connected; all are connected in series, to provide 135 volts. Two 4½-volt "C" batteries connected in parallel

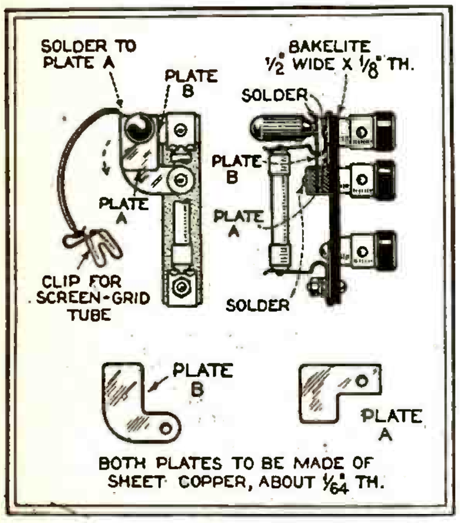


Fig. 2

Detail of the binding post plate in conjunction with which is the antenna variable series capacity.

are used for the "A" battery or, if longer life is desired, three dry cells connected in series may be used. "A—" and "B—" are connected together and to the lead from the filament switch. The "A+" is connected to the "A" battery, "B+ Det." and the R.F. screen-grid lead to 45 volts positive. It was found by experiment that a slight increase (not over 67½ volts) on this grid improved signal strength to a noticeable degree. The "B+ 90" and "B+ 135" are also connected to the proper battery terminals.

Caution: do not connect the batteries, especially the "B" batteries, until the constructor is positive that all connections have been properly made in the receiver.

The tubes are now inserted in their respective sockets and the filament switch turned on. The phone tips are inserted in the jacks, and the antenna and ground are connected to their respective posts.

Beginning with the "A" coil, which is now inserted in the coil socket, the secondary tuning condenser "C1" is rotated over its scale. At each point the regenerative control condenser "C2" is rotated until a loud rushing sound is heard. On increasing this a soft thump should be heard. With the tuning condenser at maximum the regenerative condenser should be meshed three-quarters of the way; this setting of "C2" should be identical with all coils. Should it be less, turns should be removed from the tickler. Should it be more or apparently require more, turns should be added.

(*Continued on page* 184)

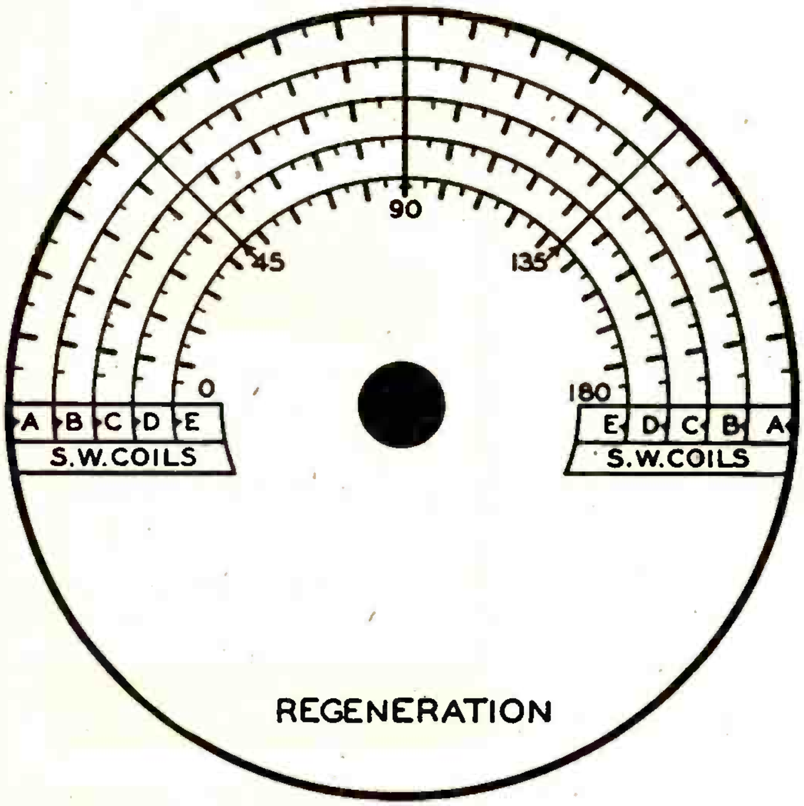
"THE CRAFT BOX"

(*Continued from page* 183)

Some experimenting may be necessary with the detector grid-leak, especially if the '99 tube is used for a detector. In regard to the latter, some tubes are better detectors than others.

To further enhance the appearance of the receiver, the constructor m make two scaled white dials, one of which is reproduced here. If desired a scale may be provided for each of the coils (or, as done by the author, the scales may be provided for only four of the coils, making the lines of the dials more widely spaced). These are held in position against the panel by the bushing nuts provided for the mounting of the condensers.

The size and arrangement of this receiver adapts it admirably for portable use. If a more permanent installation is wanted, "heavy-duty" "B" units may be employed and storage-battery tubes. The only changes necessary for use with the latter are to increase the 5-ohm section of the '22 series filament resistor ($R3$) to 15 ohms, and to change $R5$ to 4 ohms. It may be found that regeneration with the '01A tube is too great, in which case turns are removed from the tickler windings.



This is the cut-out for the second dial of "The Craft Box." Just cut around outside edge and then paste the dial so made on the receiver panel. "Tuning" dial appears on page 161.

Vacuum Tube Types

(*Continued from page* 170)

or similar numerations. The characteristics are very similar to the '01A tube, except that the filament current is 0.125-ampere instead of 0.25-ampere. This reduced filament current allows the tube to be operated in conjunction with the '80 rectifier tube. The tubes are all connected in series, instead of the usual parallel method; so that the current drain will be within the limits of the rectifier. The reduced filament current adapts this tube also for the semi-portable receivers used in automobiles, etc.

One manufacturer, the CeCo Mfg. Co., makes a tube similar to the '01A, but adapted particularly for radio-frequency amplification. The characteristics are the same as those of the '01A, except for the plate resistance; this value is almost double that of the regular tube made by this company. This special tube is known as the "K" type and the regular tube is called the "AX."

Special Battery-Type Tubes

Besides the regular battery tubes listed above, there are several other types which are adapted for specific purposes and are not really suited to other purposes. Among these is the special detector tube known as the 200A or 300A type. Most manufacturers use a symbol similar to the above one for this tube, although there are several deviations from this standard. The CeCo Mfg. Co. call their tube the "H" type; the E. T. Cunningham Co. use the symbol 300A; the Raytheon Mfg. Co. use Ray-X-200A; the French Battery Co. (Ray-O-Vac), use RX200A, etc. The tubes are very similar in their electric characteristics, though.

This tube is designed to be used exclusively as a detector, and is peculiar in the fact that, instead of a high vacuum being used, the tube is filled with a gas. The tube is more sensitive to weak signals than the '01A type, but, in order to obtain the greatest success, several changes must be made in the connections of the detector circuit. The grid return, which is ordinarily made to the positive side of the filament (when a grid leak and condenser are used) is changed to the negative side for this tube.

Due to the gas content of this tube, it must be operated with a low plate voltage; it is advised that one of less than 45 be used. Excessive "B" will cause "ionization" of the gas and the resulting effects are many, varied, and all highly undesirable.

Filament voltage, 5 volts; current 0.25-ampere.
Plate voltage, 45; plate current, 1.5-ma.
Plate resistance, 30,000 ohms.
Amplification factor, 20.

This concludes a list of the general-purpose battery tubes; although we have not considered the power tubes, which are suitable for both D. C. and A. C. use, or the screen-grid tubes. These tubes are used very extensively at present, and deserve more space than we could devote to them at this time. However, we will discuss them at length in the next issue. The screen-grid tube in particular deserves much attention, as it is becoming very popular in the newer sets; and, because it requires different circuits from those adapted to the older tubes, it is often misused and misjudged.

We will give also some advance information in reference to a tube which has been used for some time abroad, but which has not yet made its appearance on the American market. We refer to the "Pentode" or screen-grid

(*Continued on Page* 191)

BOOK REVIEW

Trouble Shooter's Manual. *By John F. Rider, published by Radio Treatise Co., 1440 Broadway, N. Y. C.; 8½" x 11", 118 text pages and 255 illustrations. Black, flexible, pebble-grain leatheroid. Price,* $3.50.

This book, in common with the companion volume we reviewed in the August issue of RADIO-CRAFT, is compact, but very valuable to the man for whom it is intended.

It is quite probable that 99% of the broadcast listeners, given this book for review, would pass it by as of no particular interest. But, by that same token, 100% of the radio service men who see this book will want it.

We noticed, with regret, that there are numerous typographical errors. In no instance, however, did we note that it affected the technical accuracy.

The author states on page 1, "The average radio service man who calls upon a set owner makes a stock query, which actually has little significance. 'What seems to be the trouble?' is the usual introductory comment. On first thought, the question may appear logical but upon second thought, it is just the contrary because the reply is seldom informative." We disagreed with this opinion and, later, noted that the author's exemplary service man gives, as normal procedure: "I usually query the person calling, assuming that the need for service is advised in person or by telephone, and ascertain the type of receiver to be serviced and make an effort to determine the possible fault from the owner's statements.—"

However, a glance at the chapter headings under the "Table of Contents," and another at the names of the companies represented in the section devoted to schematic circuits, will indicate to the practical service man his actual need for a copy of the *Trouble Shooter's Manual*, by John F. Rider; even though this need for it may not be evident at the instant.

Excerpts from table of contents: Service Procedure; Practical Application of Analysis; Vacuum Tubes; Operating Systems; Aerial Systems; "A" Battery Eliminators; Trouble in "A" Eliminators; Trouble Shooting in "A" Eliminators; "B" Battery Eliminators; Troubles in "B" Battery Eliminators; Trouble Shooting in "B" Eliminators; Speakers and Types; Audio Amplifiers; Troubles in Audio Amplifiers; Trouble Shooting in Audio Amplifiers; Troubles in Detector Systems; Radio-Frequency Amplifiers; Trouble Shooting in Radio-Frequency Amplifiers; Series-Filament Receivers; Testing and Testing Devices; Commercial Receivers; Troubles in D.C. Sets; Troubles in A.C. Sets.

Under "Commercial Receivers" are listed circuits of radio receivers made by the following concerns: Radio Corporation of America, Federal, Atwater Kent, Crosley, Zenith, Majestic, Fada, Stromberg-Carlson, Stewart Warner, Grebe, Philco, Freshman, Kolster, Freed-Eisemann, All-American, Dayfan, Colonial, Workrite, Amrad, Sparton, De Forest, Grimes, Thermiodyne, Magnavox, Garod, Ware, Kennedy, Operadio and Sleeper.

This book will unquestionably go into several reprints and we hope it will be revised, eliminating the typographical errors and certain circuit inaccuracies which were observed. It is probable that these slipped through due to the press of getting the book out to meet a demand which had become very insistent, as soon as it became known that the book was being compiled.

(*Continued on page* 191)

LATEST THINGS IN RADIO

(*Continued from page* 172)

tion screen and magnified for easy reading. The volume control regulates the reproducer output from inaudibility to full volume. A "local-distance" switch provides equally fine reception on both strong local and weak distant stations. Facilities are provided for attaching an electric pick-up to reproduce phonograph records.

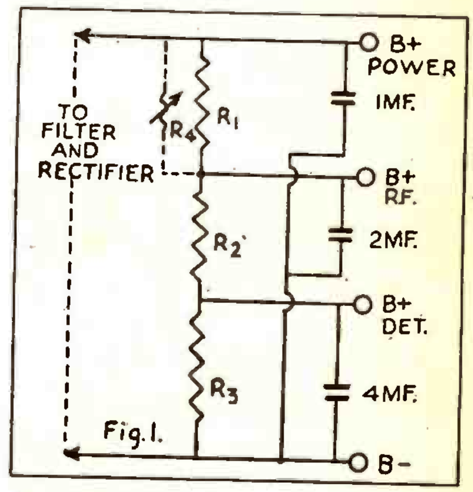
The cabinet is of attractive two-tone walnut veneer, with burled maple overlays. The reproducer opening and control panel are covered with cut velours. The pattern of the material has been skillfully worked out so that the controls appear to form a part of the design.

HOW TO GET MORE DISTANCE

By Charles Golenpaul*

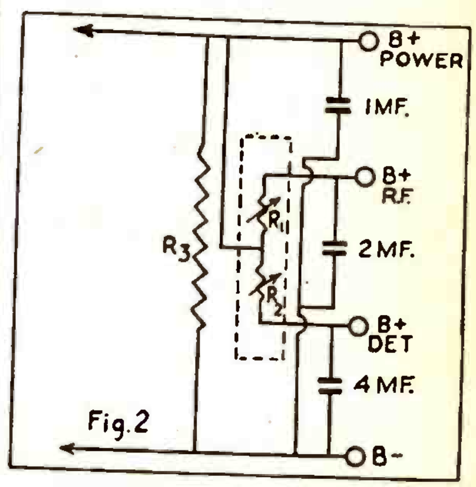
NO one will deny the convenience and simplicity of the fixed resistance network for the electric set. However, there are times when one desires more pep, and it is at such times that the fixed resistance network is a handicap.

A simple stunt which the ingenious service man resorts to occasionally is the signal booster arrangement of lowering the resistance of part of the fixed resistance network by means of



The method of adding an external resistor for "B" control in eliminators is shown above.

additional and adjustable resistance, Fig. 1. Thus an adjustable resistor $R4$ of sufficient current-carrying capacity may be shunted across the *maximum* and the *R.F.* tap of the fixed resistance network, $R1$, $R2$, $R3$, and adjusted until the desired increased signal strength is obtained. It is surprising how volume and sensitivity are increased by this simple expedient. When a standard or power clarostat is



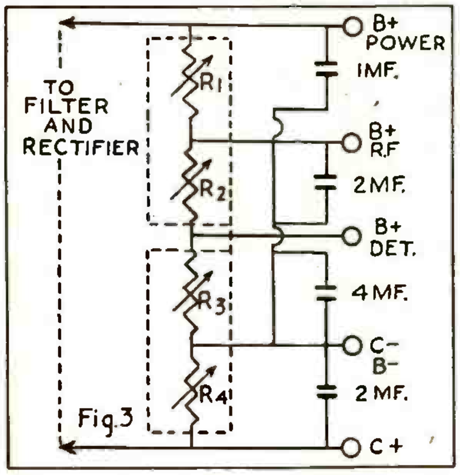
A convenient means for simple network connection is illustrated.

employed, it becomes possible to obtain a precise adjustment of resistance so that the detector will operate at maximum sensitivity at any wave length or frequency, without "spilling over" or breaking into oscillation.

* *Clarostat Mfg. Co.*

In fact, it will usually be found best to adjust the resistance over the entire wave length band. Thus at the higher wave lengths, less resistance will be required, so as to obtain a higher voltage on the R.F. tubes and detector. while more resistance or less voltage will be necessary at the lower wave lengths where the tendency toward oscillation is usually more pronounced.

This is not a full voltage divider but is an



The use of two double- or duplex-resistors is indicated.

accessory to be used with the fixed resistance type of divider.

More Exact Control

The purpose of the voltage divider or resistance network in the B-eliminator is, of course, to apportion the necessary voltage and current flow for each tube or set of tubes in the radio receiver and amplifier. However, since the current drain varies from one circuit to the next, from one type of tube to another, and even from the new tube to that same tube six months later, it must be apparent that some compensating means is required for precise adjustment of voltage and current flow. Consequently, a voltage divider or resistance network should be such that compensating resistance may be increased or decreased to supply the necessary voltage and current flow at all times.

In Fig. 2 appears one of the simplest forms of voltage divider providing the necessary compensating feature together with fixed resistance values when desired. There are no knobs to fuss with and bring the service man out on a wild goose chase. It will be noted that a suitable gang type variable resistance is employed, such as the duplex clarostat, *R*1, *R*2 affording two variable resistance values for supplying two adjustable voltages. (*R*3 is a 50,000-ohm voltage-stabilizing resistor). In this manner we have the maximum voltage tap, the intermediate voltage tap, and the detector tap, in simple form. The resistance values are obtained by means of a screwdriver adjustment of the duplex clarostat, and left permanently fixed until tube or circuit changes necessitate a readjustment. The duplex clarostat is compact and readily installed on the baseboard or on the panel with only the adjustment screws exposed. Two units *R*1, *R*2, *R*3, *R*4 may be employed for four adjustable voltage taps, Fig. 3, furnishing "C" bias for the power tube in addition to the regular plate potentials. It must be remembered that this "C" potential reduces the available plate voltage this amount.

The Cooperative Laboratory

(*Continued from page* 175)

Detection in R.F. Tubes

What causes this? A detailed understanding of it will explain the remedy, and the remedy is the Tandem-Tuner. So far as the grid of the first tube is concerned, the circuit is only as sharp as the tuning devices between it and the antenna. Now, we all know that an antenna tuning condenser is rather broad. Hence, several stations are noticeable at any one time on the grid of the first tube. Then, the second tuning circuit, in the grid of the succeeding tube, still further selects the desired station to the relative exclusion of the others. This is all very well, if the first tube acts *purely as an amplifier;* which is not the case at all if the incoming signals are sufficiently strong to overpower the negative "C" bias on the grid. Then the first tube acts in a different role.

Let us assume a powerful local broadcaster is coming in on the grid of the first tube with sufficient strength to run the grid positive. Let us still further assume that this condition obtains, even with the first dial considerably detuned. Under the above conditions, the tube will act *as a detector* for the strong signal, even when the dial is adjusted for another station. Then the detected currents, which by the way are naturally of audio frequency, flow in the plate circuit of the first tube—causing similar changes in the plate voltage of this tube. These audio changes in plate voltage, in turn, affect the amplification of the other carrier waves—including the one desired and selected in the following tuning circuit. The audio currents, caused by the detection in the first tube of a strong signal, impress themselves upon the other waves therein. The program of the powerful local thus *modulates* the weaker stations coming through the tube.

The only answer to this is greater selectivity before the first tube; so that there is no powerful local present to be detected while the weak distant station is tuned in. Fig. 4 shows this circuit suggestion, together with some of the important constructional details. In the next article we hope to get around to describe the A.C. circuits for the hybrid-crystal receiver.

Letters addressed to "The Cooperative Radio Laboratory" should contain detailed information, (on the particular parts used) if they are reports on results; while inquiries should be specific.

INFORMATION BUREAU

(*Continued from Page* 178)

the ground or the "A" circuit. When it is desired to use the choke as a coupling unit between stages, the fixed condenser connecting to the high potential end of the choke "leads" the R.F. to the stage which follows, instead of to ground.

Erratic regeneration will result if a choke coil is not used in certain circuits. Without choke coils, a tuned radio frequency receiver may operate with only one-half the volume it should. Radio frequency choke coils often prevent radio frequency circuits from going into uncontrollable oscillation. In screen grid circuits they are almost a necessity.

If a choke coil is poorly made, "holes" in tuning result; there will be points at which the short wave receiver goes out of regeneration or oscillation; or, it may go into oscillation with an uncontrollable "thump."

More detailed information appeared in the August issue of RADIO-CRAFT magazine under the title, "Some Notes on Short-Wave Operation," by Robert Hertzberg.

BOOK REVIEW

(*Continued from Page 187*)

Radiomovies-Radiovision-Television. *By C. Francis Jenkins, published by Jenkins Laboratories, Inc., Washington, D. C. 6" x 9", 57 illustrations and 70 pages of text. Green cloth cover, grained. Price,* $2.50.

In what is probably the Author's Preface (of this we cannot be sure, since it is unsigned and undated), mention is made of the many stages through which the Jenkins television experiments have progressed.

The book will excellently serve as a constructor's manual, the first chapter, "How to Make Your Own Televisor," containing complete construction details for an effective, simply-built and inexpensive apparatus for picture reception. (As the Jenkins organization is broadcasting on schedule, such a receiver has immediate application.)

Radiomovies, Radiovision and Television is an interesting book containing 82 pages of cover title material.

Eleven pages are taken to develop his physical law, "The Law of Free Movement." However interesting or valuable it may be, we do not see why it should have been included in this book.

With the same thought in mind, we call attention to chapters entitled, "Weather Maps by Radio"; "Predicting Hurricanes"; "The Jenkins Landing Altimeter"; "A Radio Crash Warning"; "Airplane Radio Channel"; "Ground Speed Meter."

The attention of experimenters is called to the excellent schematic circuit which is, the caption informs us, an "Ideal Radiovision Receiver."

There are no questions remaining in the mind of the reader after perusal of the very clear and concise word-picture the author presents of his work, covering early silhouette transmission and reception with the Nipkow Disc Scanner; and later development of the Lens-disc Scanner (the author rather definitely proves the doom of the Disc Scanner); the Drum Scanner; the Plate Receiver; and, the Sensitive Plate Transmitter.

To begin to realize the trend of "vision" development one must read *Radiomovies, Radiovision and Television.*

VACUUM TUBES

(*Continued from Page 185*)

power tube. Information has been received from a source (which we believe to be reliable) that the Arcturus Radio Tube Co. has a tube of this type on the way; and a rumor has been heard that the R. C. A. is also experimenting with this type. Of course, these tubes will not be ready for some time, as a considerable period must elapse before the technical observations of the laboratory can be transposed into a smooth-working production proposition; but a little advance information will enable the professional man to study the theory and application of the item—with consequent result of faster and more satisfactory acceptance of the product by "the general public."

In these columns we have included a table of the characteristics of the radio receiving tubes which have received special reference in this chapter.

The author observes an interesting sales idea contained in the data sheet of the Champion Tube Works.

The "Standard Equipment Package"

It presents to the set user, a convenient means to obtain exactly the correct number and type of tubes as the first tube purchase, or complete replacements, for any standard radio receiver.

The tables (A and B) indicate the application very clearly. Although not complete, Table A lists some of the best known receivers and the corresponding "EQ" tube assortment (the "Standard Equipment Package") for these receivers. Table B shows just what tubes are included in each "EQ" kit.

SCREEN GRID RADIO

WHOLESALE PRICES

FREE RADIO CATALOG

HERE is a book it will pay you to get—148 pages of desirable radio merchandise—everything new right up-to-the-minute of going to press—at prices that will make you wonder how we can possibly offer such bargains. Wholesale prices prevail throughout. From the first page to the last this book is crowded with values that will please and astound you—every radio need and requirement fulfilled in this greatest of all Radio Books.

Standard Sets as low as

$15.95

Marvelous offerings in new, Humless, Screen Grid A. C. all-electric and battery operated sets; a wide range of beautiful consoles, from the small table model types to the most ornate and artistic of radio furniture; dynamic speakers of tremendous volume and richest tone; accessories, parts and kits in wide variety—in fact, everything that is standard, as well as everything that is new, in Radio. Get this book *today!* Supply your every Radio need at rock-bottom wholesale prices, and pocket the saving. Such startling values have never before been offered at like prices.

Write for This Catalog Now!

The New Screen Grid Receivers

The outstanding Screen Grid Receiver of the year featuring advanced engineering practices and a new perfection in circuit design—that is establishing a new standard in radio performance.

Humless

The use of the new heater type tubes assures freedom from hum and all extraneous noises assuring unusual tone quality.

A. C. Operated

Practical A. C. operation assures consistent performance operates directly on 110-125 volt, 50-60 cycle A. C.

Power Detector

A tuned detector stage in keeping with modern radio engineering imparts unusual power to the receiver.

"245" Push Pull

The use of two "245" super power tubes assures faithfulness in reproduction without danger of overloading.

Screen Grid Tubes

Three screen grid tubes in this famous chassis assure extreme sensitiveness and remarkable distance range.

Super-Sensitive

Power detector coupled with Screen Grid R. F. efficiency imparts unusual sensitivity to the circuit assuring extreme distance range.

Dynamic Tone

Two stages of audio frequency the last employing two "245" power tubes with oversize transformers assures finest tone quality.

Tremendous Volume

Perfection in audio circuit design makes possible tremendous undistorted volume from a whisper to the full blare of an orchestra.

CHICAGO SALVAGE STOCK STORE

World's Largest Radio Store

509 So. State St. Dept. 130 Chicago, Ill.