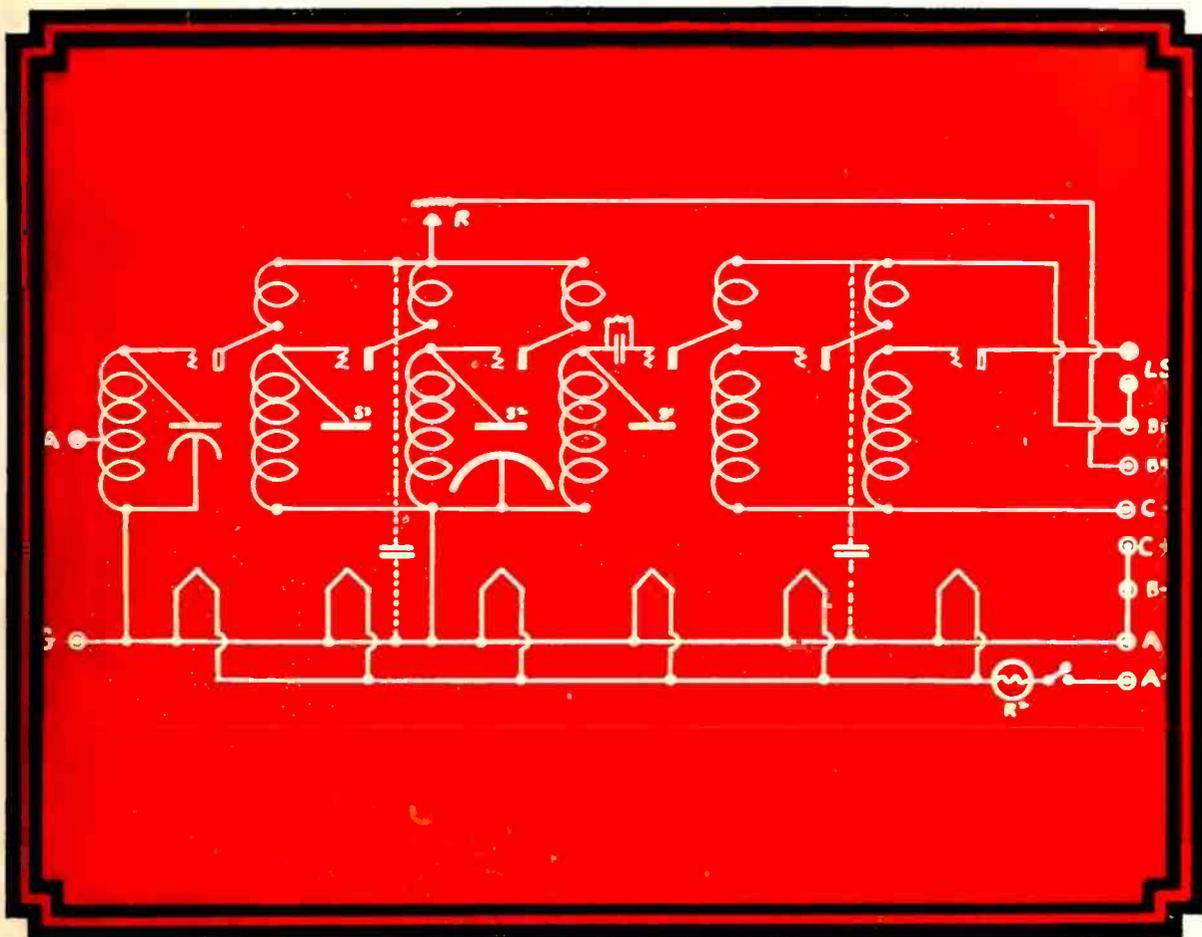


Blueprint Section Every Month

RADIO AGE

The Magazine of the Hour

693/2



**February
1926**

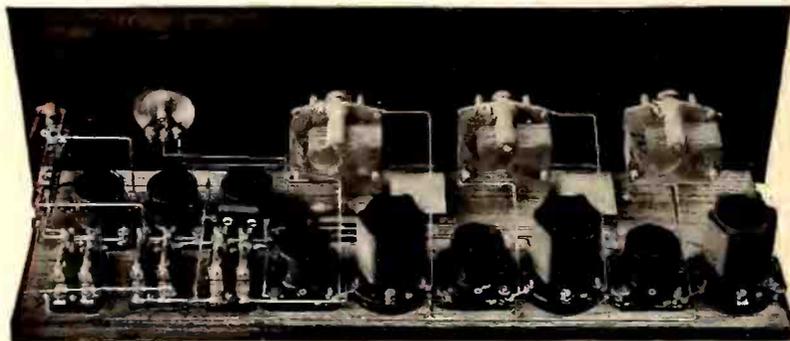
Log-a-wave Chart  Data
on the Corkscrew Wave 
53 Sources of Interference
 Universal Test Board for
1001 Hookups  New Method
of Measuring Frequencies

25¢

Radio Age February Model Receiver
In this Issue

SM

SILVER SIX



DESCRIBED
in This Issue of
RADIO AGE

FACTS THE "WHY OF THE SIX"

SELECTIVITY is such that out of town stations may be brought to Chicago through twelve powerful local stations. Selectivity can be regulated at will, from a degree satisfactory for ordinary reception, up to the surprising limit where side-bands are cut.

SENSITIVITY is so great that nothing will surpass the "Six" except special laboratory-built super-heterodynes. Either coast may be brought in to Chicago during the summer months on a small antenna—in many cases on a loop.

FLEXIBILITY permits the use of antenna or loop with either detector, one or both stages of radio frequency amplification. Interchangeable R. F. Transformers, with adjustable antenna coupler, permit operation on all waves from 50 to 550—or higher if desired.

VOLUME is so great as to paralyze any but the best loud-speakers. Yet it may be adjusted to any degree by a single knob.

QUALITY cannot be excelled due to resistance coupled amplification. It is the only receiver that will bring real appreciation of "cone" speakers.

CIRCUIT consists of two stages of R. F. amplification with special oscillation control uniformly effective at all wavelengths, grid-biased detector and three stage resistance coupled audio amplifier.

EASE OF CONTROL allows use of one, two or three dials at will.

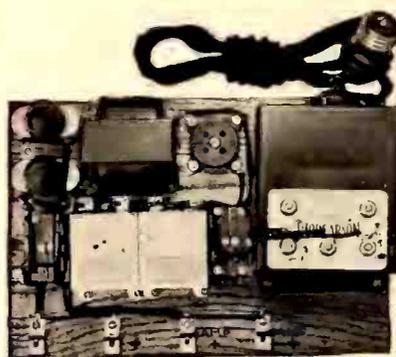
TUBES may be either dry cell or storage battery, with UV201-A's recommended. "B" Battery Consumption at 135 volts is below 10 milliamperes—less than one-third that of other six-tube receivers.

ASSEMBLY requires but a few hours, using only parts supplied in kit.

DESIGNED by McMurdo Silver, Assoc. I. R. E., for easy building. Thousands have built the "SIX" already and thousands are building it right now. Every mail brings new reports that tell how marvelously this amazing new receiver performs. With these kits anyone can build an exact duplicate of Mr. Silver's original "Six."

Type 600 Kit including all parts necessary to build the complete "Six"..... **\$53.00**
Type 610 Kit, essentials only, including 3 condensers, 3 inductances and 3 inductance sockets..... **\$27.75**

See These and Other S-M Products at Your Dealers



THE IMPROVED Raytheon-Thordarson B-ELIMINATOR

This Eliminator will deliver from 20 to 200 volts at three different, adjustable voltages with maximum current of 50 milliamperes—more than enough for the largest receiver.

The SM Type 650 Kit includes Thordarson Transformer, choke, Tobe Condensers, genuine Raytheon Tube, Bradleyohms and all necessary parts
Price.....\$34
Assembly Instructions by McMurdo Silver.....10c

Thordarson Power Transformer

This new, audio power transformer has been endorsed by McMurdo Silver, who says it is the very finest obtainable. Its curve is a straight line—its quality cannot be improved on. Price each..... **\$8.00**

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Mail this Coupon

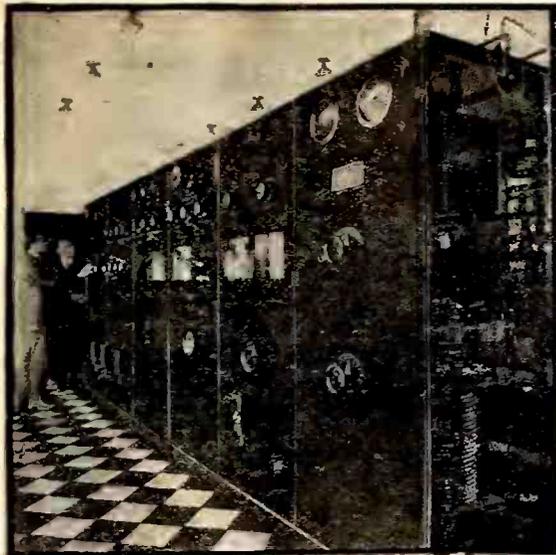
Silver-Marshall, Inc., Chicago, Ill. 114
Gentlemen: Please send me:

A—Complete building data on the Silver "Six,"
for which I am enclosing 50c.

B—Descriptive circulars on S-M Products.

Name.....

Silver-Marshall, inc.
114 South Wabash Avenue
CHICAGO



\$50. to \$250 a week IN WORK THAT IS ALMOST ROMANCE

Be a Radio Expert



Get into the great new Big-Pay Industry—Radio. If you're earning a penny less than \$50 a week, **clip coupon now.** Send for **AMAZING FREE BOOK.** Be a Radio Expert, and draw down big money for the easiest and most fascinating work in the world. Positions everywhere. Thoroughly-trained men are in big demand. Need for Radio Experts in every community. Short hours. **BIG PAY.** **Free book gives all the facts.**

Astonishing opportunities—thousands of them! Every day N. R. I. trained men are taking good places in the Radio field. Free book tells all about their success. Send for it now!

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Master Radio Engineers will show you how to qualify quickly and easily at home, for Radio's fine jobs. We **Guarantee** to train you successfully. Lack of experience no drawback—common schooling all you need. Our tested, clear methods make it easy for you. Send coupon now for free proof.

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Spare time earnings are easy in Radio. Increase your income almost from the start through practical knowledge we give you. This is the famous *practical* training that *pays its own way.*



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"Accepted a position with Chicago Daily News—Station WMAQ. My income practically doubled, thanks to your fine course."

KEITH KIMBALL Chicago.



Gets Big Job

"Just been made Sales Manager of this Radio concern—a big raise in pay. Regret, I did not take course sooner."

R. E. JONES, Bay City.

Get
this
Amazing
Book

Most amazing book on Radio ever written—full of interesting facts about this great field and how we

prepare you and help you start. You can do what others have done. **GET THIS BOOK.**

Send Coupon

Send coupon today for special limited offer, including all instruments—you'll get full particulars by return mail.

National Radio Institute
DEPT. BU-3 WASHINGTON, D. C.

You get
all of
these



MAIL THIS NOW

NATIONAL RADIO INSTITUTE,
Dept. BU-3
Washington, D. C.

Without obligating me in any way, send me your free book, "Rich Rewards in Radio," and all information about your practical, home-study Radio course.

Name.....

Address.....

Town..... State.....

Radio Needs Trained Men

LARGEST RADIO SCHOOL IN THE WORLD

ORIGINATORS OF RADIO HOME-STUDY TRAINING

Tell them you read it in Radio Age

RADIO AGE

The Magazine of the Hour

Established March, 1922

Volume 5

February, 1926

Number 2

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A Chat With the Editor

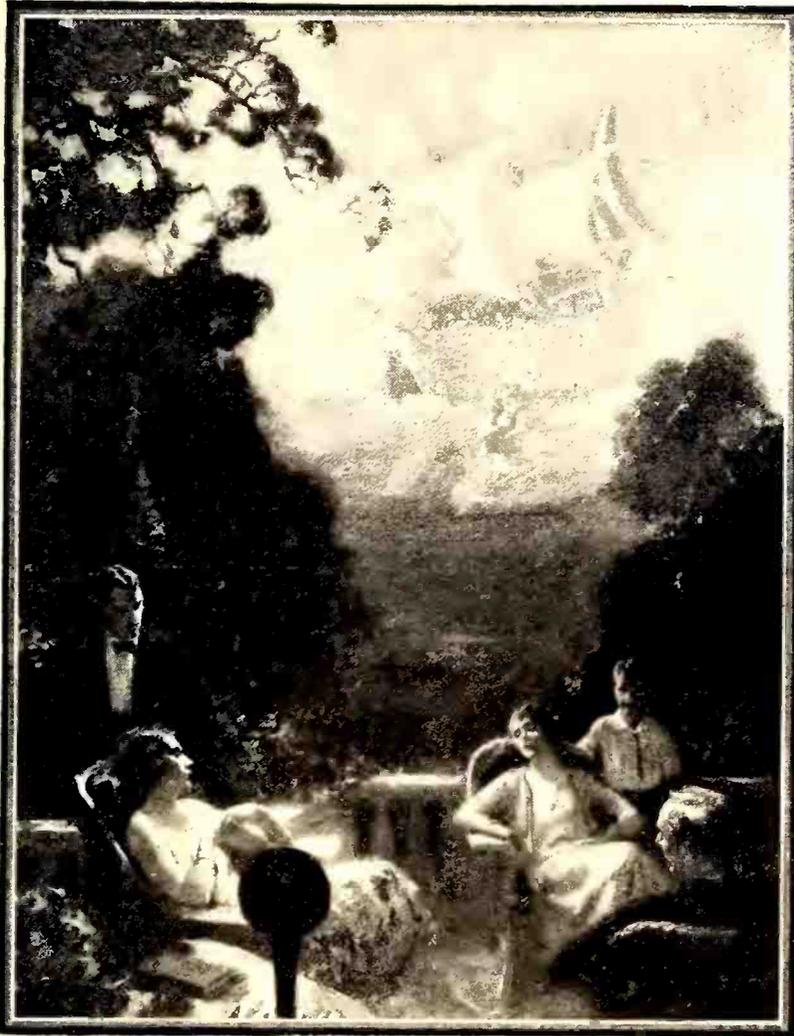
SOME buy radio sets ready-made and others build their own receivers. Many thousands of the members of each of these two classes read this magazine. Explanation of this success in having attracted a following of technical as well as of non-technical fans lies in the fact that RADIO AGE always has aimed to be of service to those who operated radio sets, whether the owners constructed the receivers or bought them.

For example the list of broadcast stations which is published in each issue of this magazine. Refer to the list in the back part of this issue and see whether it is not as complete and accurate as any you are able to obtain elsewhere. It is there each month, in convenient form, corrected according to changes authorized or ordered by the Department of Commerce during the thirty days preceding the date of going to press. At times these changes have been so numerous it was impossible to keep up with them in a monthly periodical. That situation is relieved. It is possible, therefore, to keep each month's list complete and accurate.

Having established a department which thus answers the purpose of a radio call book we have now instituted another, beginning in this issue. In convenient form we have added to the magazine a log chart which broadcast listeners will find of use in connection with the broadcast list. So now we have a magazine which is not only a manual for the constructor of sets, a medium for all radio news that is worth while printing but we have a superior guide to the broadcast list, and a log chart supplementing it. When RADIO AGE finds that changing conditions make other changes desirable those changes will be made promptly. This magazine continues to make substantial *net paid circulation gains*. In the foregoing you have a few of the reasons.

Frederick Smith

Editor of RADIO AGE



The Eveready Hour

LIKE the fabled ship in which Jason brought home the enchanted fleece of gold, the Eveready Hour brings a rich treasure of entertainment to charm the harbor-homes of its hearers.

Inaugurated two years ago, the Eveready Hour was an adventure in broadcasting—an hour of connected entertainment, uninterrupted by the frequent injection of the name of the broadcaster.

Many of these programs have become famous. Thousands of letters voice the appreciation of our audience and ask for repetition of favorites. We make no requests for these letters, but they mean much to our artists and to us, and are of great value in helping us in

our efforts to arrange programs of a distinctive nature and pleasing to the vast audience.

Radio has already become a highly specialized art worthy of the most scrupulous code of ethics, and the Eveready Hour represents a sincere effort to pioneer in providing the most acceptable form of radio entertainment.

Eveready programs cover a wide range of entertainment and human interest, transporting us to periods of wholesome simplicity; to barren islands where marooned sailors meet adventure, starvation and death; to battle-scarred France with singing doughboys; to emotional heights by telling with music the stories of the seasons; and to memories of yesteryear aroused by old ballad and musical comedy favorites.

Eveready Hour begins at 9 p. m. each Tuesday night, Eastern Standard Time.

Tuesday night means Eveready Hour
— 9 p. m., Eastern Standard Time,
through the following stations—

WEAF—New York	WSAL—Cincinnati
WJAR—Providence	WWJ—Detroit
WEEL—Boston	WOC—Davenport
WTAG—Worcester	WEAR—Cleveland
WFL—Philadelphia	WCCO—Minneapolis
WGR—Buffalo	WCCO—St. Paul
WCAE—Pittsburgh	WGN—Chicago
	KSD—St. Louis

EVEREADY
Radio Batteries
—they last longer

NATIONAL CARBON CO., Inc.
New York ❀ San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

RADIO EDITORIALS

SEVERAL months ago the opinion was expressed on this page that advertising by radio was the greatest single threat against the continued popularity of broadcasting. At the time that editorial was written several broadcasters were telling their listeners that special sales were to open in department stores, that certain millinery was the very best at the price, that lots in the vicinity of Calumet Harbor were sure profit-makers, etc., etc. When we wrote the criticism of this sort of "entertainment" our statements were true and under the same circumstances the objections would be sound today.

But a change has come about in the methods of radio advertising. Merchandisers discovered, as we did, that the radio public would not lend a receptive ear to promotion of sales under the guise of performing a service to the millions who have invested in radio sets in the hope that they were buying musical instruments rather than musically accompanied billboards. It did not take long for the public to decide that the voice was the voice of Esau, although the hand was the hairy paw of Jacob.

Shrewd advertisers have overcome these objections by eliminating direct appeal advertising from their hired broadcasts. They have engaged the services of nationally and internationally famous vocalists and musicians and have offered programs of delightful excellence which are eagerly accepted by the radio audience.

The average radio listener is distinctly pleased nowadays when he hears or reads the announcement of the Victor Hour of Music. A. Atwater Kent has earned a similar place in the hearts of music lovers. Publicity for the financiers of these programs is limited to the simple statement that the entertainment is given by them. No attempt is made to sell Victor records over the air. Yet McCormack and Bori songs by radio have increased Victor record sales surprisingly. The Atwater Kent products probably have not suffered in popularity as a result of the good music supplied by the manufacturer.

In a strict sense all radio broadcasting is advertising. Your newspaper, your manufacturer, your real estate dealer and your church all are in broadcasting studios because they wish the promotion advantages offered by the microphone. And it is right that they should so do.

The thing to keep in mind is that good broadcasting is the only means of maintaining the popularity of the great indoor pastime of twisting the dials. If any individual or company of individuals desires to spend a small fortune for an hour of music, free to the listeners, nobody will object to listening to the music merely because the name of their benefactor is mentioned. Now that we have started this reformation let us not backslide.

ANOTHER pleasant change in radio is the constant improvement in the methods of sound reproduction. It is now universally recognized that the tone quality of radio music and radio voice have been brought to a much higher degree of fidelity than they possessed a year ago.

For years we listened to phonograph records and we must have approved of their musical product, because we bought many millions of dollars worth of phonographs and records. We were intrigued by the mechanical devices that enabled us to take a piece of music out of a cabinet and play it just as we would reach into the cupboard and take down a jar of jam.

But when radio broadcasting came along we began to take a more critical interest in sound reproduction. We began to suspect that tinny sounds in the throat of our favorite prima donna were not due to transformers, static, poor wire connections, inferior aerial arrangement, or other delinquencies in our receiving apparatus. We came to the conclusion after a deal of listening, that the loud speaker was the culprit. We learned upon inquiry that a great number of loud speakers were built on the principle of a telephone receiver, with so little effort to improve that instrument that a radio loud speaker was merely, in most cases, the same old telephone receiver wearing a new hat.

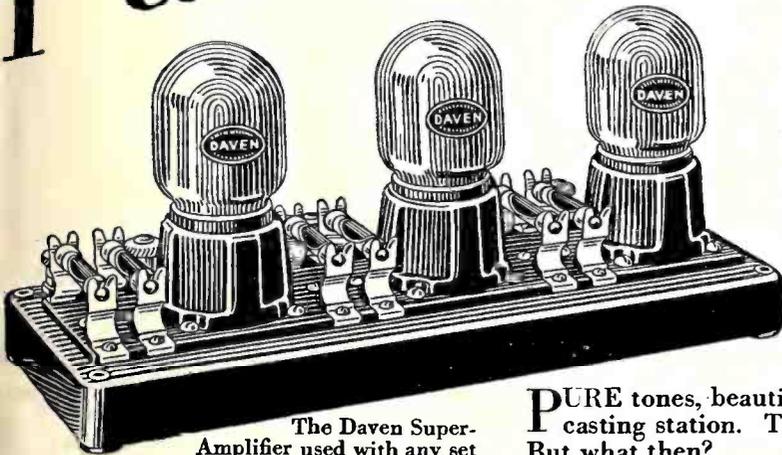
Recently we have noted a great difference. The phonograph people have profited by the experience of radio manufacturers and they have so improved their sound reproduction equipment that the old horn and sound chamber that we bought for three decades seem archaic in comparison.

Manufacturers of loud speakers have discovered that they must have something besides sound reproduction if they are to continue to satisfy the radio listeners. There must be a reproduction of the low notes and high notes with equal fidelity. There are still many sopranos on the air and first violins are busily scraping in the vicinity of all microphones. Something had to be done to take care of these. We mention the two particularly for the reason that violins and soprano voices have not won a full measure of public applause on the air.

But we know of several loud speakers that reproduce high notes sweetly. We know of loud speakers that give you the low throbbing note of the drum and the bass viol as distinctly as they reproduce the higher notes.

If broadcasting is the heart and soul of radio it is equally true that the loud speaker can make or break your radio hour. We suggest, in the interest of the radio art and of the radio industry that all buyers of loud speakers make as careful a selection of their loud speaker as they do of the receiver.

Let the Pure Tones Through



Make Your Old Set A 1926 Model!

The Daven Super-Amplifier used with any set or circuit carries through the full, clear tones of the broadcasting station programs. If you prefer to assemble the Amplifier, obtain the Daven 3-stage Kit, which includes all parts except sockets.

PURE tones, beautifully clear and full, go out from the broadcasting station. They reach your detector still pure and clear. But what then?

From the detector your amplifying apparatus operates. Distortion arises unless you take advantage of a method of amplifying that far-sighted manufacturers and thousands of set builders are now adopting—Resistance Coupled Amplification. Resistance Coupling is not new, *but Resistance Coupling with real volume amplification is new.* It is the most approved method of letting pure tones through.

The Daven Super-Amplifier costs little. It is easily and conveniently installed in any set made. Buy it complete to save hook-up labor. For those preferring to assemble, the Daven 3-stage Kit gives all the necessary parts except sockets. You will join hundreds of others who have written to thank us for the improvement Daven has given.

Write us today for The Resistor Manual, an authoritative book on Resistance Coupled Amplification, 25c at good dealers, 30c by mail.

DAVEN PRODUCTS ARE SOLD ONLY BY GOOD DEALERS

"The Sine of Merit"

DAVEN RADIO CORPORATION

Resistor Specialists

Newark

Reg. U. S. Pat. Off.

New Jersey



THE RESISTOR MANUAL is the handbook of Resistance Coupled Amplification. At your dealer's 25c. By mail postpaid 30c.

CLIP THIS COUPON

DAVEN RADIO CORPORATION
157 Summit Street, Newark, New Jersey

Please send me the following on Resistance Coupled Amplification:
Check One

- Resistor Manual. 30c is enclosed.
- Complete Catalog (free).

Name.....

Address.....

For Dealers: Send your letterhead and we will have our nearest distributor communicate with you.



The new Daven Special Coupling Condenser Type "A", for Resistance Coupled Amplification, sold separately and also included in all Daven Amplifiers, Kits and Resisto-Couplers. For greater volume and better quality.



The new Daven High MU Tube Type MU-20, used with the Daven Super-Amplifier, gives 50% more volume—6 volt, 1/4 ampere. A Daven Power Tube Type MU-6 in the last or output stage helps any set regardless of the method of amplification—6 volt, 1/2 ampere.

THE BIG LITTLE THINGS OF RADIO

Tell them you read it in Radio Age

KARAS Parts Are Intended Only for the Few Who Demand Finest Quality and Workmanship

It takes many manufacturers to supply the tremendous demand for condensers and transformers in this vast radio market of ours. If all home set builders were ready to pay the price which *real* quality commands, a big proportion of them would necessarily be disappointed—the Karas factory could not begin to take care of all. Karas parts are designed and built for the select few—you builders who want the utmost in quality, in quiet operation, in appearance. You who take pride in your workmanship—whose sets have that "professional" appearance which is the envy of all your radio friends.

Just as water quickly finds its level, so did Karas Harmonik Transformers and Orthometric Condensers quickly find the exclusive market for which they were intended.

The most skillful radio set builders the country over, discovered Karas Harmonik Transformers soon after they were placed on the market in 1924. When Karas Orthometric Condensers appeared a year later they were snapped up far too quickly for our own comfort. Perhaps it was because they were the first to meet the demand for a Straight Frequency Line tuning instrument. More likely it was because of the

Buy" is far greater than we first imagined. Our production has been greatly increased to provide for the growing numbers who demand Karas parts and will accept nothing else.

In many places, good dealers who wanted a stock of Karas products could not be supplied. If you are still unable to find them in your local stores, tell your dealer that we are now able to take care of his requirements. Or, if you wish to get Karas parts in the quickest possible time, we will be glad to send them to you direct.

However you buy Karas Harmonik Transformers or Orthometric Condensers, you do not run the least risk of their not performing up to your highest expectations. If there is the slightest cause for disappointment during a thirty days' test, you are invited to return the parts to the dealer from whom you bought them, or to us if you buy direct. Your money will be promptly refunded without question or quibble.

Karas Harmonik Transformers are specified for the 6 tube radio frequency hook-up described in this issue by Radio Age staff designers, and both Condensers and Transformers are highly recommended for all types of circuits after exhaustive laboratory tests by Radio Age and other prominent radio publications.

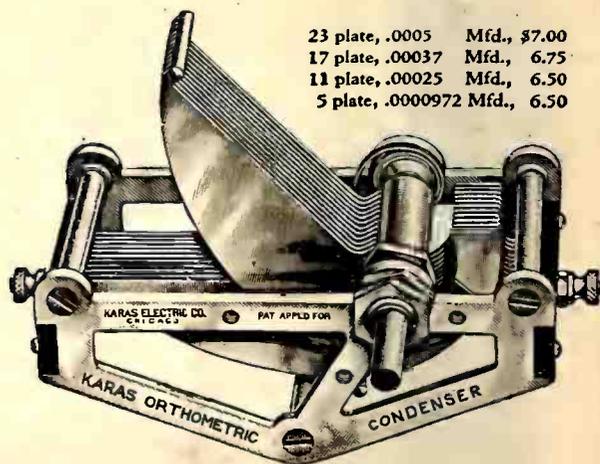


THE KARAS HARMONIK "ALL-STAGE" RATIO AUDIO FREQUENCY TRANSFORMER

Price \$7 each. Shipped direct where dealers cannot supply, cost plus a few cents postage paid to postman on receipt. Parcel post is prepaid where payment accompanies order. Our 30-day Money Back Guarantee applies, wherever and however purchased.

enviable reputation created the year before by Karas Harmonik Transformers. At any rate, it was months before we could fully supply the insistent, clamorous demand that came to us from all sides.

We begin to think now that the number of set builders who want the very "Best that Money Can



23 plate, .0005 Mfd., \$7.00
17 plate, .00037 Mfd., 6.75
11 plate, .00025 Mfd., 6.50
5 plate, .0000972 Mfd., 6.50

THE KARAS ORTHOMETRIC (STRAIGHT FREQUENCY LINE) CONDENSER

Prices and sizes above. Shipped direct where dealers cannot supply. No money in advance. Pay the postman price plus a few cents postage. Or send cash with order and we prepay parcel post. 30-day Money Back Guarantee.

Karas radio parts are the pride of an organization that has been making precision electrical apparatus for more than thirty years. We believe we are making the finest transformers and condensers possible to produce and we are glad to back them up with this, the strongest guarantee we know how to write.

KARAS ELECTRIC COMPANY
4060 NORTH ROCKWELL ST. CHICAGO

RADIO AGE

The Magazine of the Hour

M. B. Smith
Business Manager

A Monthly Publication
Devoted to Practical
Radio

Frederick A. Smith
Editor

TWO CONTROLS for Four Stages TUNED RADIO

By Radio Age Technical Staff

FURTHER simplification of the Model Set whereby a single variable tunes the antenna coupler, and a triple compensated variable tunes three stages of radio frequency amplification is made the subject of study for this month's model receiver.

Although certain types of coils and capacities are shown in the model, the scheme is yet flexible enough to be used by any radio fan with any type of inductances or capacities. Thus instead of the triple condenser three single ones may be used if there is no objection to the multiplicity of controls. For simple control, however, the three-in-one condenser shown with its compensating method is a great space and time saver.

The inductances shown are of the toroid style and were mounted fairly close together without too great difficulty in interaction. The use of the semi-restricted field inductances also permits shielding of the receiver in cases where the owner is located under the shadow of a broadcasting station. For those who live at a distance from a large transmitter the matter of shielding does not become of great importance.

If the builder has any type of induct-

ances they may be used in this particular model, although if the inductances are of the solenoid type a little more spacing should be allowed between units. No neutralization is used in this model, the control for undesired oscillation being the variable resistor in series with the plate circuit of the three r. f. primaries. Neutralizing condensers may be utilized if desired by the builder, and the resistor either eliminated or retained as a means of flexibility. However if the tubes are neutralized such neutralization will be a fixed one and will not allow an even amplification over the entire wave band, but rather good amplification at one point and less at other points on the scale. For this reason the resistor has been used to simplify matters and to give a control that can be shifted at will.

Wire By Schematic

FOR THOSE about to build this type of receiver, it is suggested Fig. 1, which is the schematic circuit, be carefully studied so as to become familiar with the actual wiring of the set. The circuit is the conventional tuned r. f. type, consisting of three stages of radio, detector, and two stages of audio amplification, transformer

coupled. Since the secondary of the detector coupler is also radio frequency, the set has been considered a four stage r. f. receiver. On account of the variation in aerials it was not considered feasible to link the antenna coupler into one of the multiple condensers, but to give it a control by itself. However for a given antenna, if it is not to be changed, arrangements can be made to include the antenna tuning on a multi-section variable condenser and add a vernier, consisting of a small capacity in parallel with the antenna coupler tuning section so as to compensate it for the antenna. However in this particular case this procedure would involve the use of a four section variable, and so far we do not believe any have been marketed, although there are many gang condensers used in some of the factory sets using as high as four and six sections.

Consultation of Fig. 2, which shows a view taken from above the receiver, will show the manner in which the various units are laid out on the panel and the wiring going to its respective locations. Spaghetti was only used where it appeared a possibility of shorting might occur, although all of the wiring was done with



In Fig. 4 is shown the completed set in its cabinet ready for operation.

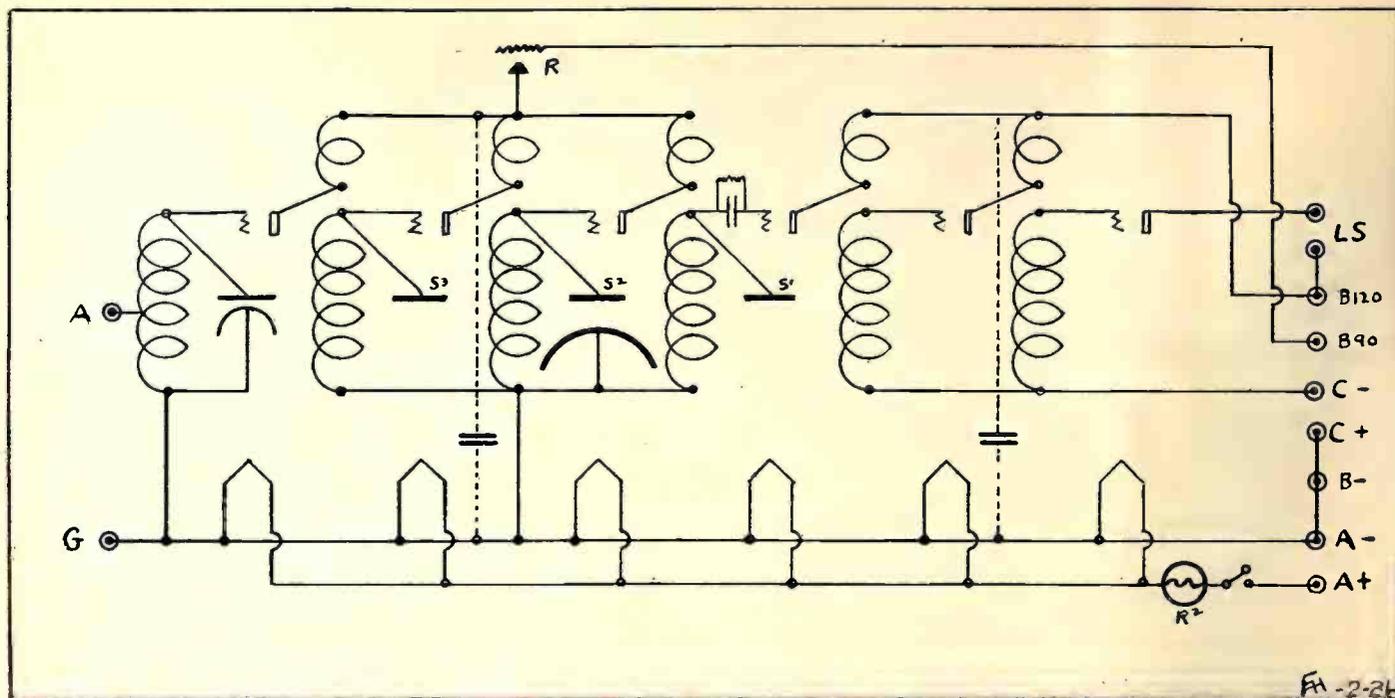


Fig. 1 is the schematic circuit by means of which the receiver should be wired for electrical accuracy.

busbar in order to get a stiff assembly and one that would be rugged.

Figure 3 is the equivalent of a photographic isometric view of the set, taken from the rear at an elevation, and shows some of the back-panel detail not made clear in the photograph in Fig. 2. The front panel layout is shown in Fig. 4, and shows a minimum of controls, there being but the two vernier dials for the single and triple condensers, and the knob for the variable plate resistor. The two little knobs, one at each side of the right hand vernier dial, are for compensating the capacity of sections 2 and 3 of the triple condenser. After the correct compensation has been made for the set, no change is necessary.

Drilling the Panel

IN DRILLING the panel the same method was followed as in previous models. A center line is run half way up the panel dividing the panel into two sections. All apparatus is mounted on this center line for the sake of symmetry. The Micarta panel is held to the baseboard by means of five screws spaced equally across the lower side of the panel.

The baseboard which measures 25 by 10 inches is an inch shorter than the panel in order to allow the set to be put into a cabinet without the baseboard interfering. Quite a bit more space is necessary back of the panel to take care of the triple condenser than if singles were used, but the gain is in favor of simplified control and space was no object.

The sockets, made by Silver-Marshall, are for the UX and CX type bases and occupy very little space. They are placed on a line, and held in place by a single mounting screw which goes through the center of the socket base. This simplifies the mounting of the sockets and allows a little more space between tubes than

would be secured with larger sockets.

The single .00035 SLF variable, made by Cardwell, is installed at the left of the panel and fitted with a Phenix vernier dial. The triple compensated condenser, with .00035 mfd. per section, made by the United Scientific Laboratories, is installed to the right of the single variable. Two additional holes have to be made for the compensating section knobs. The detail of the distances will be shown on the template furnished with the condenser, as is also the case with the Cardwell. A second Phenix dial is used on the triple condenser.

Four All-American toroid coils are mounted, with the antenna coupler at the left, between respective sockets so as to have short grid and plate leads.

Between the first and second condenser there is mounted a Centralab 0-200,000 ohm variable resistor, which is used as an oscillation control for the primaries of three of the toroids. In the event the All-American coils are used in the builder's set the use of a variable resistor is not absolutely essential, although if other inductances are substituted, it will be necessary to have some oscillation control.

As is customary in manufacturing almost all types of toroids the primaries are generally made short of inductance on purpose to prevent difficulty with undesired oscillation on the short wave bands. To gain greater amplification per stage on the higher waves the manufacturers figure on allowing greater mutual inductance between windings. Such coils are generally designed for use either with a neutralizing condenser or without and for that reason the primary inductance is generally short. However, in using a plate resistor to control undesired oscillation more primary turns can be allowed and give better energy transference over a wider band. However we

do not believe radio fans will ever see the complete agreement between the laboratory and the production departments. Anyone familiar with the history of radio since the late nineties will find ample verification of this fact on many occasions. But the public is not in position to pay for laboratory standards and to duplicate laboratory standards on a quantity production basis would mean an inordinate increase in cost of the delivered product. So the fan must rest content with the material, of uniformly good quality, which the manufacturers are turning out, and not expect to get Bureau of Standards products at a cost within their reach.

Laboratory versus Factory

THESE remarks are occasioned by the constant reminders we receive in the mail, of the disparity between the laboratory product and the factory product. It applies to condensers, inductances, sockets, tubes, and everything in radio. The day of perfection at low cost is not yet here; until it arrives it is necessary for all of us to be content with the best obtainable at a moderate price, and find solace in the thought that there are years and years of research yet to be expended on the young science of radio. This, however, is not to be construed as an invitation to wait for perfection, for if one were to do that he would still be waiting years hence.

Getting back to our story, the grid condenser and leak, or rather the condenser and clip, is made by the Sangamo Electric, who are advertising a product whose capacity will be found within ten percent of its rated value under all temperature and humidity conditions.

The grid leak is an Allen-Bradley 2 megohm leak and slips into the clips furnished on the Sangamo condenser.

The mounting of the Sangamo is a simple process since there are two screws at each end of the condenser by means of which it may be easily affixed to any apparatus, and the clips also attached.

The two Karas audio transformers are mounted so their grid and plate wires will be the shortest possible. These transformers have a large number of turns of wire and in the case of the primary, it was not found necessary to bypass it with the usual .002 mfd fixed condenser.

The jack and the combination panel light and switch are furnished by Yaxley, the latter unit being a handy device for reminding the set owner his tubes are constantly consuming current. The little pilot light goes out at the moment the contact on the switch opens and serves as a warning when the set is on that it is in operation

In the filament circuit, in keeping with the process of simplification, it was decided to use the Daven ballast resistor No. 5 which will take care of five-quarter ampere tubes. The use of the added tube in this particular receiver, did not affect the resistor which was able to carry the added quarter ampere load without any trouble. The resistor and clip was inserted in the positive lead between the positive A battery and one blade of the combination panel light and switch.

A Belden cable cord was used in order to have the wiring from the A B and C batteries simplified. In previous receivers the C battery has been embodied in back of the panel but in the February model it was decided to make use of one of the leads in the Belden cable cord and let it be attached to the negative of the C battery, whose positive terminal was made common with the negative A and negative B batteries. Thus in the Belden cord there is one color for the negative A, negative B and positive C; one color for the positive A; one color for the positive 90 volts; one color for the positive 120 volts, and one color for the negative C battery, making a total of five wires in the cable cord.

Bypass Capacities

TWO one mfd bypass condensers, made by Kellogg, were used. The first one was placed from the junction of the resistor arm and the r.f. primaries of three coils, to the negative of the A battery, which is the left hand filament connection on all of the sockets. Thus this bypass is for any stray r.f. energy which is immediately shunted into the negative filament and does not get a chance to return through the common B battery. The second one mfd bypass condenser was placed from the junction of the 120 volt B battery terminal and the B terminal of the audio transformer to the negative A filament connection. Thus the 90 volts used on the r.f. primaries of the three toroids is bypassed to negative, and also the 120 volt B battery used for the audio frequency stages is likewise bypassed to filament. This

permits of stable operation of the set without interaction due to common plate potential batteries.

The ground connection for this receiver may be made to the negative filament line, if desired, by means of a clip. The antenna connection may also be clipped onto one or the other of the two antenna taps provided on the antenna coupler. One tap will give loud signals and a little broad tuning, while the other will sharpen up the tuning although at a slight sacrifice in the volume.

After the receiver has been assembled and wired, and all joints soldered with rosin core solder, check over the connections against the schematic in Fig. 1 to make sure you have not made any errors in connections. Then place tubes in the sockets one by one and see that all light properly when the switch is turned on.

Try It On Weak Signal

IN TUNING up the receiver it is best to take a comparatively weak signal for test, instead of depending upon a strong one. It is generally easier to note the difference between no sound and a little sound, than between a loud sound and a louder or softer one where the difference is only very slight. Thus if you are testing it out in the larger cities, take one of the signals from a local transmitter which is not so powerful and make all your capacity compensations before looking for distance.

No compensation will be required on the first condenser on the left, since this is a single capacity spanning the secondary of the antenna coupler. There will be a very small change in dial setting as between the two antenna taps, but this difference is not enough to cause one to either get or lose a signal, especially locally.

The second condenser, which is a triple one, should be compensated, one section at a time, until the maximum signal has been received for a given setting of the vernier dial. The un-compensated section in the Model was placed in the secondary

LIST OF PARTS

- 4 All American toroid inductances
- 6 Silver-Marshall sockets
- 1 USL triple compensated variable, .00035 mfd per section.
- 1 Cardwell, .00035 mfd variable condenser.
- 1 Centralab 0-200,000 ohm variable resistor.
- 2 Kellogg 1 mfd bypass condensers.
- 2 Karas audio transformers.
- 1 Yaxley panel switch and light.
- 1 Yaxley phone jack
- 1 Weston phone plug
- 1 Belden cable cord
- 1 Daven ballast resistor No. 5 and mounting for same
- 1 Sangamo .00025 mfd grid condenser and clips
- 1 Allen-Bradley 2 megohm leak
- 2 Phenix clockwise vernier dials
- 1 Micarta panel 7 by 26 by 3-16
- 1 Baseboard 10 by 25 by 3-4
- 10 Lengths Belden round busbar wire
- 50 Kellogg soldering lugs
- 3 Lengths spaghetti
- 1 Blandon cabinet for 7 by 26 panel

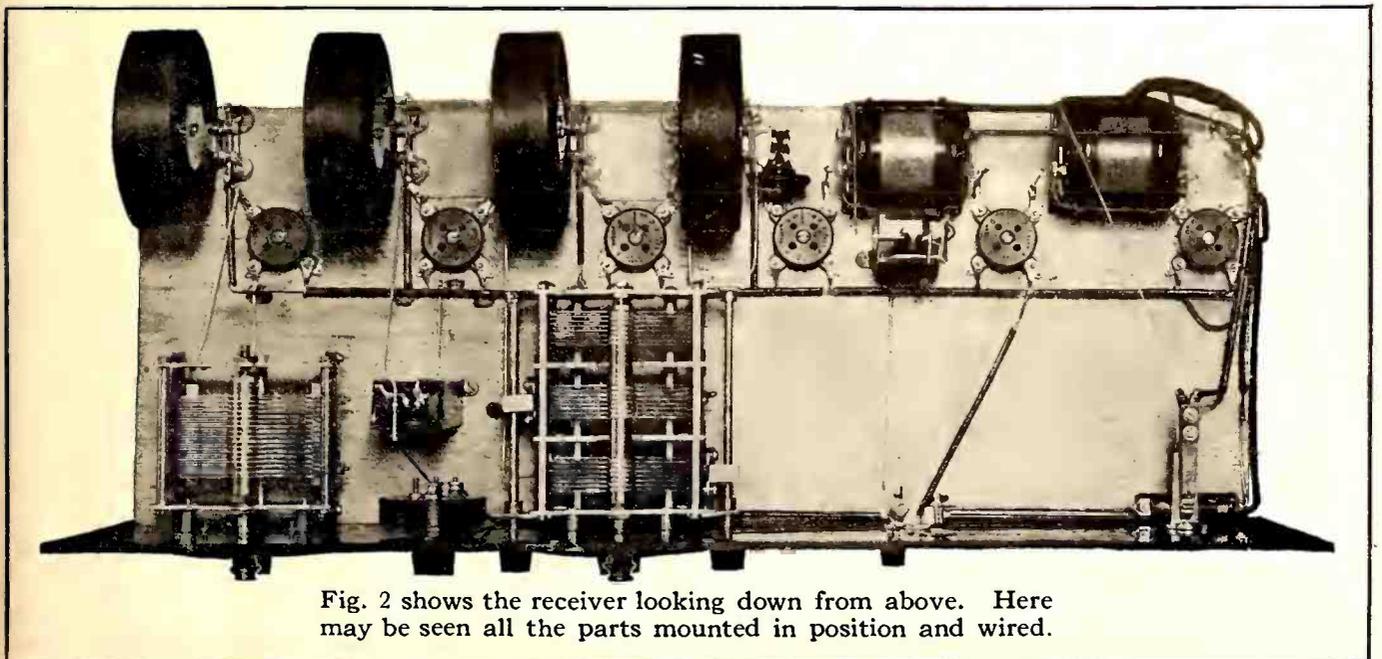


Fig. 2 shows the receiver looking down from above. Here may be seen all the parts mounted in position and wired.

circuit of the detector's inductance, and all capacity differences balanced against this. It was found the capacity variation for the sections 2 and 3 of the triple were practically the same, which indicates the three inductances are almost the same exact natural period as far as inductance is concerned.

Where honeycomb or home made coils are used in this type of a receiver it will be found the capacity variation will not be the same for all sections unless the builder has measured his inductances with a slide wire bridge and has made a very close calculation on the windings. In cases like these one finds the advantage of compensating capacities, although the U. S. L. condenser does not really have an additional capacity; it makes the variations by means of an eccentric which alters the relationship of stators No. 2 and 3 as against rotors two and three.

Resistor for Control

We would again like to call attention to the fact that with the inductances shown in the model practically no resistance is needed in the plate circuits of the r.f. stages. However with honeycomb,

solenoids or other forms of inductances, and particularly the home built variety, there will be need for the 0-200,000 ohm variable resistor so as to prevent the tendency of the tubes to oscillate on low wavelengths.

The dials on the model are of the clockwise type, that is, as the pointer moves in clockwise fashion the capacity increases and hence the inductance value. The lower waves are from zero to 35; the medium waves between 35 and 60, and the higher ones between 65 and 100 on the scales. The first vernier which is on the single condenser across the antenna coupler does not track with the triple condenser, nor could we expect it to. The condensers and inductances used permit the securing of signals from the lower band beginning at 210 meters on up to the highest broadcaster on 545 meters.

Making use of the log which appears in the January number, page 12, one may mark changes of dial leading so as to make use of the same log. Or else the reader may make use of the new radio log which we are printing on page 68 of this issue. In that log the lowest wave

(highest kilocycle) is shown at the top and the highest wave (lowest kilocycle) is shown as the bottom. The log takes in all of the assigned broadcast frequencies in the United States, together with a few of the channels which are used by Canadian stations and on which channels the United States has not placed transmitters out of courtesy to the Canadian government; for after all, we do not own all of the air on the North American continent.

In concluding the description of the February model, we believe simplification has been carried about as far as it can be with the types of apparatus generally available. The use of more than four stages of tuned r.f. is possible if one is willing to go to the expense of additional multi-capacities and to shield between stages thoroughly so as to get the greatest possible gain per stage. However it is felt such work is at present a little too expensive for the average set builder, although there are many to whom money is no object and who would build a fifteen tube set were it not for the fact they would have to build a new bungalow in which it could be properly housed.

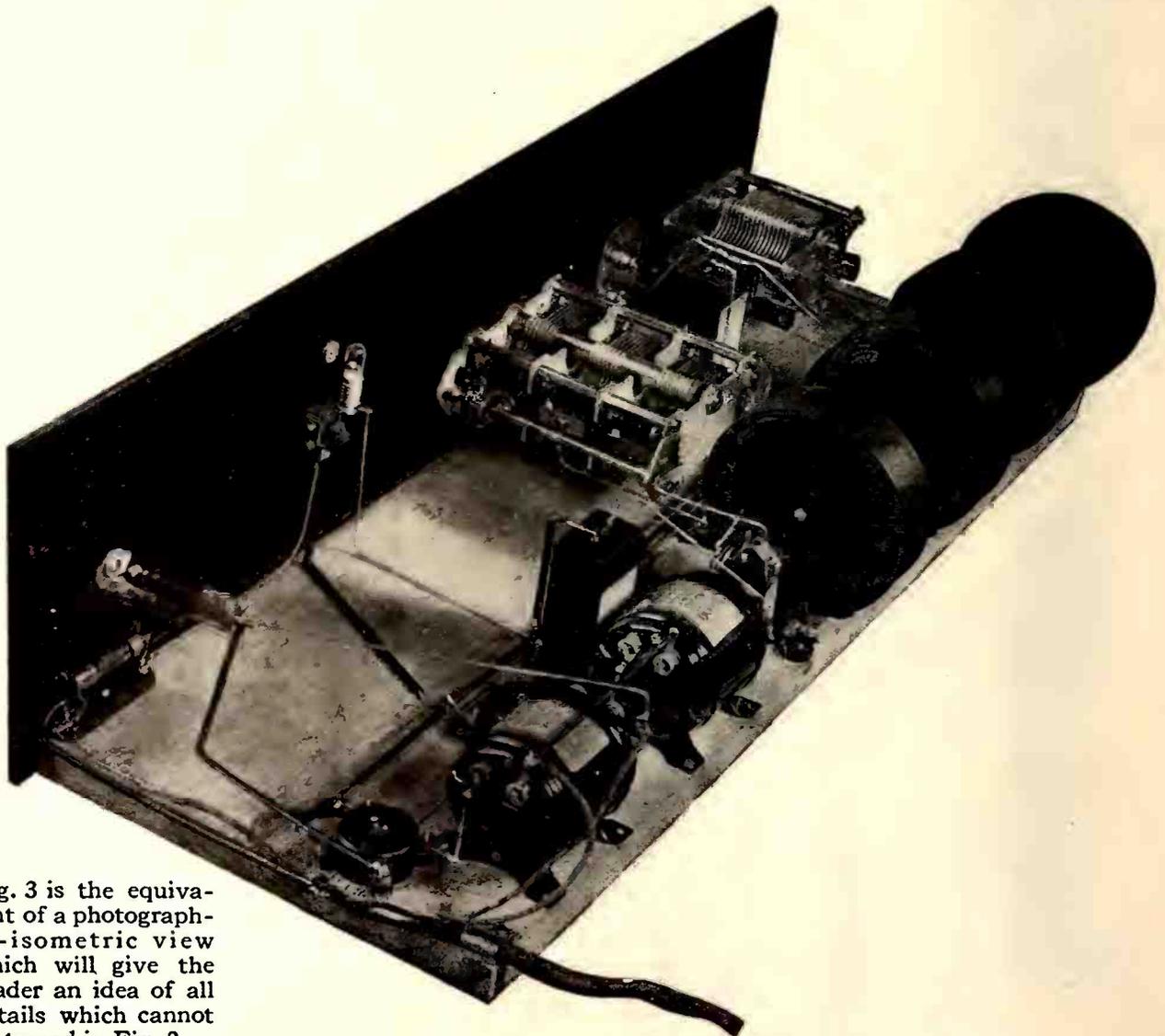


Fig. 3 is the equivalent of a photographic-isometric view which will give the reader an idea of all details which cannot be traced in Fig. 2.

No Great Discoveries in 1925 But Steady Progress Shown in Radio

Tubes, Circuits, Condensers and Allied Apparatus in Review

By F. A. HILL

WHILE no startling disclosures of a radio nature were made by manufacturers and experimenters during the twelve months ending on December 31, nevertheless there have been a great number of changes in the industry which have all redounded to the benefit of the experimenter and the purchaser of the factory built apparatus.

In the tube industry alone with the expiration of the three element patents covering the use of a grid inside an evacuated vessel, a host of manufacturers of radio tubes sprang up over night, some good and some bad. The prices which had been charged for tubes were cut considerably and a lively struggle started for what is probably one of the greatest items in the game—the replacement of tubes. Those who could not stand the strenuous pace dropped out, leaving a large number of tube makers, including the original ones, in the business and delivering a uniformly good product at a lower cost to the public than had been experienced before. It is difficult to see just what changes are to be expected in 1926 although we do not have any doubts as to constant improvements in the structure and cost of tubes being made.

Resistance coupled amplification, used by the Navy during the war, and dabbled in by the older experimenters at the close of hostilities, has taken a stronger grip on the fancy of the fan. A great deal of progress can be observed in the manufacture of resistances whose value of resistance can be relied upon. This fact in itself is a considerable advance over the old graphite rods, pencil marks and other dubious expedients to which the average experimenter resorted earlier in the days of a budding industry. Today there are a number of firms turning out resistance coupled units and resistance coupled amplifiers which can be depended upon for excellent results.

Audio Amplification

TRANSFORMER manufacturers have not allowed the encroachment of resistance coupling to interfere with their business. On the contrary they have made improvements in their own product so overall efficiency has been raised and greater possibilities found for the faithful reproduction of the wide band of frequencies made use of in broadcasting music and speech. Using advanced types

of core material and increasing the number of turns, together with more accurate tube impedance matching has resulted in much better quality ensuing from the transformer coupled audio stages.

In phase with the developments made on the tubes and transformers, sound reproduction methods have been given a careful search and better loud speakers may be obtained than at any other time in the history of the science.

The use of fixed resistances for the filament circuit of the radio and audio frequency stages has increased to a great extent. The use of the tuned radio frequency circuit has made possible the practical elimination of the variable rheostat, thus abolishing one of the controls which with the use of soft tubes had been necessary. The soft tubes themselves are not being used as much as heretofore except in the regenerative sets and their number is fast being reduced.

Further steps in the elimination of the resistances, fixed or otherwise, in the filament circuits is being made with the presentation by one manufacturer of tubes to float on the 6 volt storage battery, the filament being made so its resistance is sufficient to permit the tube to idle on the storage battery without any external resistances. While this practice is not general as yet, nevertheless it is not hard to visualize a time when each tube will be its own rheostat.

SOCKETS have undergone an evolutionary experience too. For years past the bayonet type of tube base with the Navy standard socket has been in use. Coincident with the issue by the biggest tube maker in this country of a tube with long prongs, socket manufacturers began producing the new universal sockets to take the UX and CX prongs. All of the UV type bases still have to use the standard socket because their prongs are not long enough to make good contact in the new universal sockets. In this connection we believe there is room for improvement on universal sockets, so the grip will be much tighter than at present. The universal socket idea has permitted decreasing the overall size of the socket so it now occupies less space than before.

In the condenser line there has been an agreeable advance in the use of the multiple stators which will permit the simultaneous tuning of one, two and three stages of radio frequency amplification by means of a single dial. Some of the manufacturers have used trimmers on their tandem condenser while others have not believed this feature advisable. The radio experimenter can find any number of good condensers on the market now which will give him either double or triple tuning possibilities with but a single dial. In using the home made inductances it has been found almost imperative that trimmers or some means of balancing the capacity of the various stators be utilized, since the home builder is not in position to construct his inductances with great accuracy, certainly not with sufficient exactness to permit all coils to have the identical natural period of inductance. In buying the manufactured inductances of the higher quality type there is little need for compensating capacities unless the builder is so unwise as to run his grid and filament leads at great and varying lengths.

SLC Versus SLF

THE battle between the straight line capacity and the straight line frequency, commonly abbreviated SLC and SLF, goes merrily onward, to the accompaniment of many pages of technical descriptions in which each individual maker views through rosy spectacles his own product and reverses the opera glasses when observing his competitor. Some of the first condensers made by the inventor of the audion had the SLF characteristic at a time when their use was not required because there were not enough broadcasting stations in the country to even fill the lower end of a dial. Today we see eccentric plates, either stator or rotor, devices for turning the condenser slower at the minimum capacity and faster at the maximum capacity, and all kinds of means of making a condenser do more than any human could expect it to perform. The SLF idea is to allow a large movement of the shaft at the lower end of the broadcast spectrum with a small capacity change so the many short wave stations on the lower band will follow in orderly process their ten kilocycle separation maintained by the government.

Vernier dials are coming thick and fast

and with good reason. Tuned r.f. circuits require a great deal more accuracy in tuning than with the older regenerative form of reception. Then too the logging of a set requires that a great many hairs shall be split in tuning and it is necessary to have each of these fine lines shown clearly. With the ordinary hand movement of the dial such a step is very tedious and not at all certain. Experimenters have welcomed the vernier dial, regardless of its ratio, as further simplification of their tuning problems.

Power Tubes

IN KEEPING with the advances made in the improvement of tonal quality in transformers, resistors and other means of transformation, the use of the power tubes for the last stage of receivers has solved a difficulty that for many spelled distortion. In nearly all cases previously the last tube in a set could not possibly handle the volume delivered to it by its neighbor. As a result we had the blasting and overloading of the last tube. The use of a C battery helped some to straighten out this tangle, but it remained for the power tube to accomplish the result to a nicety and still not involve a great deal of apparatus. Before when the last stage could not handle the load one merely push-pulled the last two tubes at a considerable expense and secured good results or else he paralled the last two tubes using two of the quarter ampere type. Now with good power tubes available on the market, which incidentally do not take anywhere near the filament load the older power tubes did, one can safely arrange his last stage so it will reproduce with fidelity the volume and quality which is delivered to it.

In the circuit division of the industry we still have the regenerative, regardless of the method by which the regenerative characteristic is accomplished. Patents on the regenerative feature still have a few years to run and without a doubt this receiver which is an excellent one when built and handled properly, will still be with us for a good many years.

The super-heterodyne still has a number of years to run on its patent and is yet the king of receivers if its owner cares to have a large number of gratuitous harmonics of broadcasting stations on his dials. With the simplification of tuning r.f. stages public attention is turning away from the super and confining itself to the latter type of receiver.

THE tuned r.f. patents were part of a number seized by the government during the war and turned over to the alien property custodian, who in turn handed them to the Navy department for its use. The Navy department now has a cross-licensing arrangement with a number of American firms who may make the tuned r.f. sets if they in turn allow the Navy to use certain of their patents. This has resulted in a large number of manufacturers making the tuned r.f. sets and selling great quantities of these receivers to the public.

Prof. Hazeltine still has control of the fixed neutralization principle which bears his name and which is embodied in all of

the neutrodyne sets which have been sold in the past two and three years. What affect the single and two dial sets are having on the three dial type is more or less to be expected, and the use of a variable means of controlling the tendency of a set to oscillate will probably have further effect on the use of the Hazeltine patent.

In the tuned r.f. group the variable means of controlling undesired oscillations, embodying a capacity in series with a variable resistor covered in patents granted to a prominent Middle West manufacturer, seems to stand out at the end of 1925 as a step in the right direction. The use of a plate resistor for controlling oscillations is an expedient now used with success by a large number of set makers. Another means is the use of a variable high resistance across the grid circuit of the second r.f. tube. A host of other oscillation preventers are also in use, each manufacturer picking the type which seems best adapted to his product.

Reflexing tubes does not grip the public fancy with anywhere near the power it formerly exerted, principally because the need for reflexing on account of the high cost of tubes has passed. Another thing which has contributed to the waning popularity of the reflex is the fact no two radio fans have secured identical results with it, and it has been the bane of existence of countless technical departments in radio magazines and newspapers.

Considerable work has been done on the balanced capacity circuit, sometimes called the capacity bridge, and if properly designed the circuit has been a very stable one. One or two forms of the bridge may be seen in some of the receivers now on the market.

Shielding of Receivers

SHIELDING of receivers, which originated before and during the war, is coming more into favor, especially with the thousands and thousands of residents under the shadow of countless high power transmitters. The use of the restricted field coils, on the toroid principle, has permitted greater effectiveness in shielding without an undue loss due to the proximity of the coils to the shield. In the case of the solenoid type of inductance the spraying effect could easily include the shielding with a resultant increase in the r.f. resistance of the coils. With the restricted field this effect was not so pronounced.

In all the history of the lowly crystal, it seems to remain the same. Apparently no new rectifying material has been unearthed although the synthetic manufacture of crystals has been an accomplished fact for some time. And the crystal is always the starting point of many a radio fan's existence.

Some steps in the development of B battery eliminators, generally called power supply devices, have been taken and we find the filament-less rectifying tube which in a well constructed eliminator will rectify both sides of the cycle and by proper chokes and condensers allow the output to be very smooth d.c. suitable for even the plate of the detector tube if the loud speaker is used. Variable

resistors in the circuit permit variation of the plate potential, although in some power supply devices the voltage steps are permanent and fixed. The principle beauty of the power supply device aside from the fact it delivers its output from the light socket, is the fact that plenty of space current is available and without a depreciation in voltage.

Plenty of Dry Cells

REGARDLESS of the power supply devices the manufacturers of dry cells still have a remarkable field and tremendous sales. They do not feel any apprehension over the B eliminators since there will always be a widespread demand for the dry cell on account of its portability.

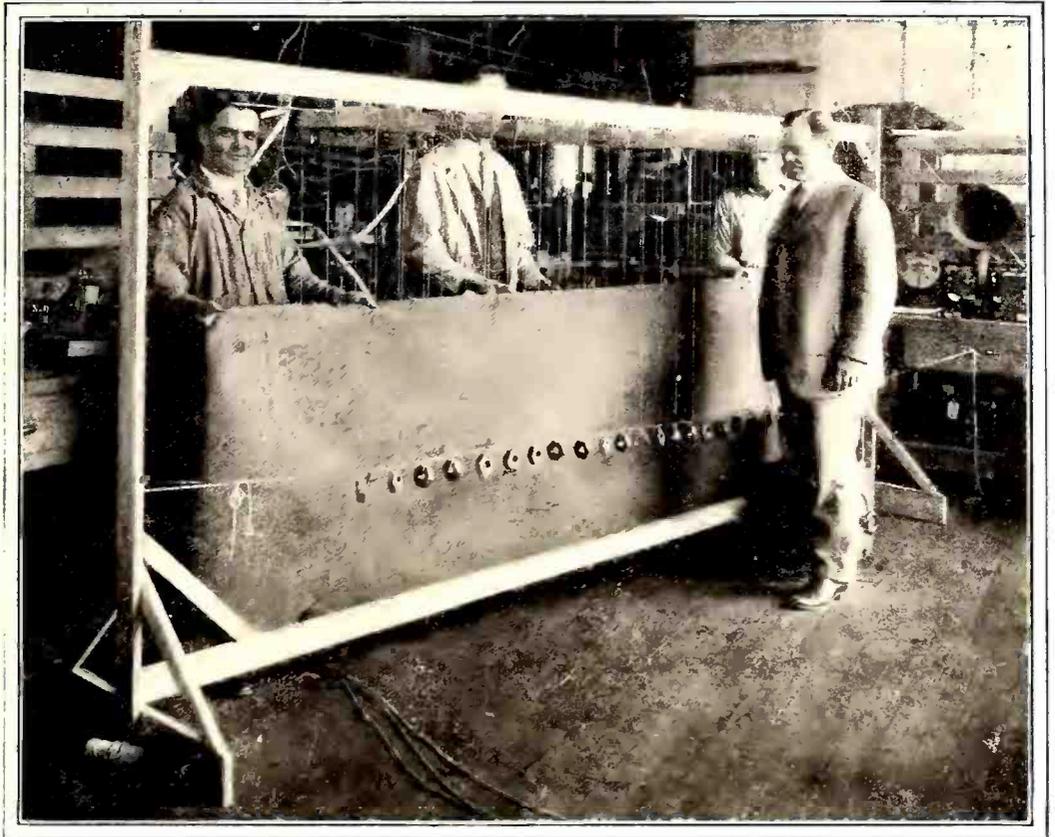
In insulating material for panels there has been little change, practically all of the present makers having made their panels since about 1915 or 1916. The use of metal panels is increasing although not to a great enough extent to make an impression on the insulated panel makers. The metal panel and its metal cabinet involves quite a bit of labor and cost and is only used as a last resort when all other means of preventing outside interference have been exhausted.

Binding posts are not quite so much in evidence as during the past twelve months. The use of a cabled set of wires running to a head on the baseboard, or individually to the units and then cabled, has simplified connections and allows easier connections with less labor on the baseboards. While originally manufacturers only made use of these devices there is now an insistent demand on the part of the individual set builders and each experimenter tries to make, his handiwork look as nearly like the factory model as it is possible to build it.

IN THE transmission field a great deal of work has been done on determining the proper type of radiators to use so as to secure greatest distance of transmission with the minimum of power. In this work the short waves have been pretty well investigated by the General Electric, Westinghouse, Radio Corporation and the Navy department as well as the Army. In this connection Dr. Alexanderson's article on page 13 of this issue is especially interesting since it reviews the research work done by the larger transmission companies, all of which will have its effect upon better transmission which in turn will mean better reception.

What of the Year 1926?

A radio man would be taking entirely too much of the prophetic properties generally attributed to an oracle if he were to make any predictions for the future. The field of radio in the future is somewhat akin to the weather to be expected in 1926. We know we will have a great deal of weather; some good and some bad; but no one can lay his finger down on the calendar and specify what the humidity on a certain day will be, nor whether there will be precipitation. So as to what the future holds we must relinquish our pen to others who do not hesitate to tackle such a formidable task.



MECHANICAL model set up in the General Electric laboratory to study the wave motion in the horizontal and vertical planes shows if a wave is started in a plane 45 degrees between the two it assumes the shape of a corkscrew, which is exactly in accordance with theory, according to Mr. Alexanderson. The twisting is due to the different velocities in the two planes of polarization.

The model consists of twenty-two weights, arranged in a row and connected together by rubber bands. Each weight is suspended from a yoke and an equal weight is hung from the other side as a counter balance but shielded from view to avoid confusion in observing the wave motion.

Science Watches New

Wave Propagation Technique

RADIO development has during the last year entered into a new phase. Until recently most efforts were devoted to apparatus in the sending and the receiving ends. In this respect, the radio technique has already reached a high degree of perfection. The milestones in this development have been the introduction of continuous wave transmission and reception, and of radio telephony for broadcasting.

Thus a large industry has grown up making practical use of wave propagation through space, a phenomenon of nature which was very little understood. About two years ago, the Radio Corporation and associated companies decided to make a determined effort to shed new knowledge on this subject upon which the further growth of radio depends.

One of the first results of this effort to explore the phenomena of wave propagation led to the discovery of horizontally polarized radiation. Since these discoveries were first announced the subject of wave polarization has been brought into the limelight and is receiving much attention from radio investigators, amateurs as well as professionals. A wave of optimism has swept over the radio fraternity and brings forth new reports of success in the struggle against the old enemies of radio—static and fading.

High degree of perfection in apparatus; radiation now subject of research

By E. F. W. ALEXANDERSON*

STUDY of wave propagation over large distances requires a comprehensive organized effort. To this end the General Electric Company undertook to do the technical pioneer work in devising new forms of radiators and receivers, whereas, the Radio Corporation undertook to judge the practical value of this new development by making use of it in its communication system. It has become a tradition among radio communication engineers to accept the judgment of traffic operators as final in valuation of the quality of a radio circuit. The reason for this is facts in regard to radio communication are not simple measurable phenomena such as we are accustomed to in most other engineering arts but are statistical averages. The traffic operator

measures how many words per hour and per day he can transmit over a radio circuit with a required degree of reliability, and the statistical results so obtained are as definite and reliable as the mortality figures of an insurance company, whereas, the radio engineer when he is called upon to cure a bad case of static or fading is in about the same position as a doctor in relation to his patient. This makes his profession all the more fascinating and the science dealing with the diseases of radio is making rapid strides.

One of the important steps in exploration of short waves was taken when the Radio Corporation installed in a temporary manner six short wave transmitters in its commercial long wave stations to be used as supplements to the regular service. These transmitters were, to begin with, operated in the neighborhood of 100 meters. Similar transmitters were installed by the associated European companies. The first impression from this new service was the short wave transmitters gave remarkably good communication at certain times during the hours of darkness, whereas, in day time, the service was totally unreliable if any signals could be heard at all. Some of these transmitters were kept in regular service whereas others were modified in order to explore possibilities of improved results. Thus it was found when the wave length was below 50 meters the night

*Radio Consulting Engineer, General Electric Co.

signals became weaker but on the other hand, service could be given during daylight hours. Tests with still greater reduction of wave lengths of a range between 15 and 30 meters proved it was often impossible to give good service across the Atlantic Ocean at mid-day in the summer. The stations which are giving the best all around service at the present time operate at a wave length of about 40 meters.

So favorable have these results been the Radio Corporation is now installing a chain of short wave stations to cover the Pacific Ocean supplementing the two long wave transmitters in the Hawaiian Islands. This new chain of stations will include the Philippine Islands. The conditions for wave propagation over the Pacific Ocean are notably different from those on the Atlantic Ocean and as a whole, easier. It is, therefore, confidently expected a good short wave service will be established over the Pacific. The findings on the Atlantic circuit in regard to wave length will not necessarily apply to the Pacific Ocean and the stations will be built in such a way that the best operating conditions can be determined experimentally. It is, however, possible to make a reasonable forecast of expectations based upon the extensive experimental data which is already on hand and which is rapidly accumulating.

New Antenna Systems

EXPERIMENTAL stations built by the General Electric Company in Schenectady for the purpose of exploring these possibilities are now capable of operating with seven transmitters simultaneously with different wave lengths and different types of radiators, and observations from these transmission tests are being made all over the world. The object of these tests is partly to explore the propagation characteristics of different wave lengths and partly to make final tests of comparison between various types of radiators. Three types of radiators are used in these comparisons but these are the result of a sifting process conducted on a smaller scale in which a great many other antenna systems have been explored and at least temporarily discarded. The radiators which are now being compared are:

The straight vertical antenna oscillating at a harmonic frequency.

The horizontal antenna with an over-all dimension of one-half wave fed in the middle through a transmission line.

The series tuned horizontal loop.

All these three radiators have one feature in common. Radiation is projected at a high angle upwards. They may therefore all be classified as high angle radiators. It has been found only the high angle radiation is useful in reaching great distances. The high angle radiator has therefore the double advantage of economy of energy and the absence of objectionable signal strength in the neighborhood of the station.

The first type of antenna radiates a vertically polarized wave of the same general character as the waves that have been used heretofore in long and intermediate wave stations. It differs from

old type of radiation only by being a pure high angle radiator whereas the old type of stations radiated a ground wave as well as a high angle wave.

The second type of antenna, the half wave doublet, is an intermediate form. At right angles to its length direction, it radiates a horizontally polarized wave, and in its length direction it radiates a high angle vertically polarized wave. Thus in its length direction it has a radiation of the same character as that emitted from the vertical high angle radiator, whereas, in the broadside directions, it emits a wave of different type.

The third antenna system, the horizontal series tuned loop, emits a horizontally polarized radiation in all directions.

For the analysis of the characteristics of high angle radiation, we are particularly

Mr. Alexanderson's article shows research cannot always be centered upon one problem. The question must be attacked from a variety of angles. The receiver and the transmitter has had close study on the part of the amateur and professional, but propagation of the wave was not made the subject of inquiry and experiment until comparatively recently.

In the pioneer days of wireless telegraphy Mr. Alexanderson was concerned with the extremely long waves, on the order of 5000 to 20,000 meters, for the arc and alternator transmitters. The advent of the vacuum tube as a creator of an oscillatory current at a trifling cost compared to the huge investments on long wave apparatus, soon caused the big radio interests to give careful thought to short waves and tube transmitters. There is still a great deal of work to be done, but progress is constantly being reported.

—The Editor.

indebted to Commander A. Hoyt Taylor of the Navy Department, who has made extensive tests and furnished valuable data on the so-called "skip" distance of the wave. He has found the distance skipped by the wave, which means the length of the trajectory required for the high angle radiation to come down again to earth, depends upon the wave length, day and night conditions, and summer and winter conditions, the general rule being that the shorter the wave, the greater is the skip distance.

Measure Wave Propagation

CHARACTERISTICS of the horizontally polarized waves have been explored in the neighborhood of the station in Schenectady up to about ten miles and also by measurements in the various stations of the Radio Corporation. For measurements of wave polarization at long distance we are indebted to Mr. Greenleaf Whittier Pickard who during last summer and fall made systematic tests of the radiation from Schenectady as well as generally explored the conditions of wave polarization. His findings have been presented to the Institute of Radio Engineers and it may be sufficient to mention he has shown in the short wave range the horizontal component of polarization is usually twice as strong and sometimes ten times as strong as the vertical wave. He has also shown fading

conditions are different in the horizontal and the vertical plane.

Mr. Pickard has also shown the wave does not maintain its original plane of polarization because the reception appears to be of the same nature regardless of whether the wave is radiated with a horizontal or a vertical polarization. These findings are in agreement with the original observation which led us to study horizontal polarization when it was found a horizontally polarized wave from Schenectady was received with greater intensity on Long Island than the ordinarily vertically polarized wave although in both cases a vertical receiving antenna was used.

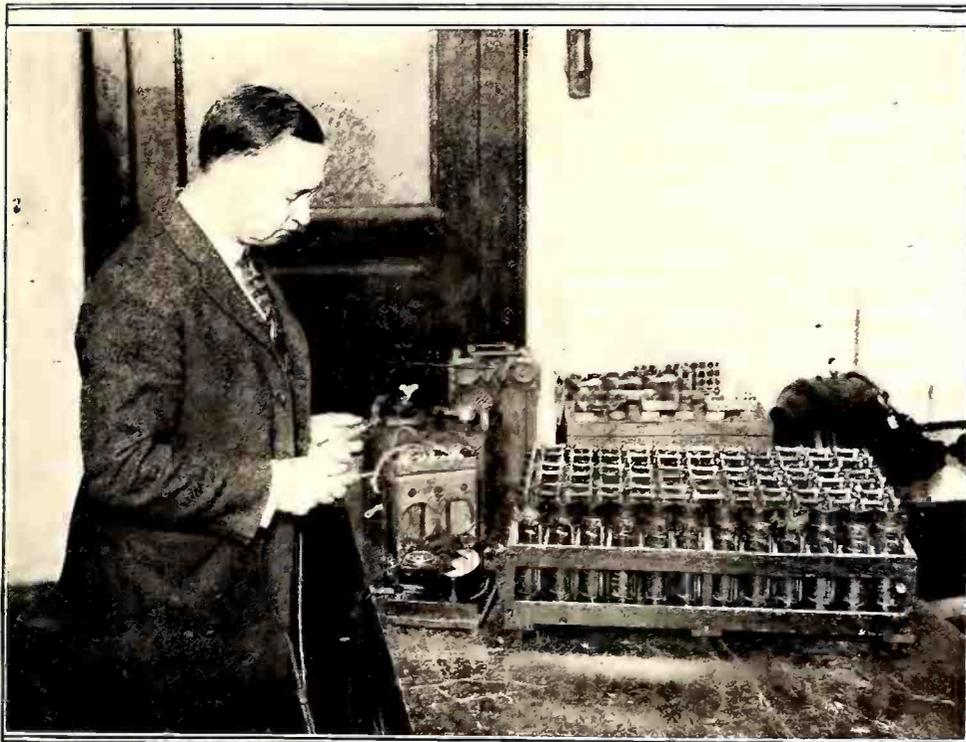
Phenomena of Wave Polarization

EXPLORATIONS of wave polarization in the neighborhood of the station have brought out many peculiarities which have not yet been fully explained. So for example, it is found at a distance of about ten miles from the horizontal loop radiator, the wave comes down with an almost vertical direction of propagation. For those who believe in a reflecting Kenelly-Heaviside layer, this would appear to be good evidence because it might be assumed the wave has been radiated straight up from the station and is reflected directly downwards. A loop receiver under those conditions gave no orientation of the station whatever, because the signals came in apparently equally strong from all directions when the loop was rotated around its vertical axis. This would indicate the wave besides being vertically propagated was circularly polarized.

Similar observations at a point only a few wave lengths distant from a horizontally radiating loop show the wave comes down nearly vertically but yet with a definite slant towards the station. Tests with a loop receiver gave in this case a distinct orientation but the station appeared to be located at right angles from the direction where it really was.

One of the loop radiators used in these tests is round, another is about one-sixth wave length wide and two wave lengths long. These horizontal loop radiators also differ from the ordinary types of antenna by radiating on the magnetic component of the wave. An ordinary long wave antenna creates an electrostatic field around the station whereas the magnetic counterpart of the magnetic energy is confined to a tuning coil. In the series tuned loop radiator this process is reversed. A magnetic field is created around the antenna, whereas, the electrostatic counterpart of the oscillations is confined to artificial condensers inserted at regular intervals in series with the antenna conductor. One advantage of confining the electrostatic field to artificial condensers has been found to be the fact the antenna is much less subject to fluctuations in its natural period due to swaying of the wires in the wind. The radiation produced by these loops has a pure horizontal polarization. The oblong loop projects its principal radiation 45 degrees upwards broadside to its own length direction. Reception tests have

(Turn to page 48)



The author is shown making voltage tests on two kinds of wet batteries, the sulphuric acid and the alkaline type.

Storage Batteries

ENTER DAILY LIFE OF MILLIONS

*Chemical Processes in Both
Wet and Dry Cells Pro-
duce the Electric Current*

By DR. GEORGE W. VINAL

batteries, including dry batteries and other forms, which cannot be restored to their original condition by a charging current after they have been discharged. Primary batteries and storage batteries each have a field of usefulness. In this article, storage batteries will engage our attention.

Great Variety of Uses

WITHIN the past ten years, storage batteries have entered into the daily life of millions of people. Small batteries for a great variety of purposes have been developed. They furnish the power to crank our motor cars, and they have brought the blessings of electric light to isolated farm houses. Many of you are doubtless using storage batteries at the present moment to operate your radio receiving sets. There are other uses for storage batteries, less familiar perhaps, but none the less important. Industrial trucks and tractors equipped with storage batteries are playing an important part in handling economically the commodities within our factories, mines and warehouses. Storage batteries find exacting use in telephone central stations.

The railroads employ storage batteries to light the Pullman cars and coaches, while still other storage batteries at intervals along the track, are passed by unnoticed as they operate the signals and interlocking switch mechanisms, contributing to the speed and safety of the traveler. Submarines pass beneath the waves, driven by the storage batteries that form an essential part of their equipment. And lastly there are the huge cells of the "Stand by" batteries in the power stations of congested districts whose only function is to stand and wait. They wait for emergencies that seldom come when they must pour their enormous store of energy into the distributing lines. There is something uncanny in the stillness of a room filled with these great cells, and one receives the impression that here as elsewhere power and quietness go hand in hand.

Between the tiny storage cell in the plate circuit of your radio set, furnishing at the most a small fraction of an ampere, and the cells of the biggest standby battery which may be called upon for 40,000 amperes, there is a wide variety of sizes and kinds of storage batteries having characteristics adapted to the service that they render.

The storage battery industry may be

THE word "battery" immediately suggests a variety of meanings. Some will think of a group of guns; others of the pitcher and catcher on a baseball team; while those more electrically inclined will picture in their minds some form of dry battery or storage battery. The word battery implies a group acting as a unit whether the group be of guns, or ball players, or cells to furnish an electric current.

Each electric cell in its simplest form consists of two unlike materials, which we call the electrodes, immersed in a solution called the electrolyte. The electrodes may be two different metals, or a metal and carbon, or a metal and an oxide of a metal. Even dry cells have an electrolyte for in spite of the name it is quite essential they be sufficiently moist inside.

Chemical processes in both dry cells and storage cells produce the electric current. The chemical changes which occur in storage batteries are said to be reversible, because a discharged battery may be restored to its original condition by a charging current of electricity and the same materials are used over and over again. Storage batteries are sometimes called secondary batteries to distinguish them from the class of primary

said to have begun with the pioneer experiments of a Frenchman named Planté about 65 years ago. Progress was slow during the early days. It is recorded two years' time was then required for the formation of the best batteries, although others said to be inferior in performance were completed in three months! How many of us would be using batteries to crank our automobiles today if it took three months now to make a battery?

Pasting Process

TWENTY years after Planté's experiments, the pasting process for making the plates was discovered. The names of Brush, an American, and Faure, a Frenchman, are linked with this discovery which simplified and cheapened the cost of making storage batteries. About this time also dynamo-electric machines became available for charging the batteries which had formerly been charged by the current from primary batteries. Developments since that time have been rapid.

Another type of storage battery having different materials and an alkaline solution was produced at a later date. This battery is familiarly known as the Edison storage battery. So we have two types of storage batteries of commercial importance at the present time which may be designated as the lead-acid batteries, and the nickel-iron or alkaline batteries. This brief talk relates primarily to the former type of battery.

The production of storage batteries reflects our modern tendency to do things electrically. Production figures are sometimes expressed as the aggregate weight of the batteries. On this basis the output of factories in the United States for 1909 was doubled in 1914 and this in turn was trebled in 1919. We can imagine still greater things for 1925. The increasing use of the automobile, the telephone, the radio and the farm lighting plants have been large factors in the growth of this industry.

The storage battery is often regarded as a box of mystery, so it is worth while to spend a few minutes to look inside. The battery usually consists of several cells exactly alike, connected together, so it will be sufficient to examine one of them. Within the container of the cell are two groups of plates, each with a terminal that projects through the cover and to which the wires or connectors of the outside circuit are attached. One group of plates is dark brown. These are the positive plates and the brown material is lead peroxide. The other group of plates is grey. These are the negative plates consisting of lead in a spongy condition.

Plate Material

CLOSER examination of the plates shows that the brown material of the positive plates and the grey material of the negative plates, which we shall refer to as the active materials are supported by a frame work, called the grid. This is a casting of lead with which a small percentage of antimony has been alloyed. The grids are "pasted"

by pressing into the openings a material, having the consistency of mortar, which is prepared by mixing oxides of lead with some such solution as dilute sulphuric acid. Very often inquiries about the preparation of this paste are received, but no general formula can be given, because the method of preparing the paste must be adapted to the physical and chemical characteristics of the oxides and these vary considerably. After the paste has been applied to the grids, it sets like a cement and the plates are then ready to be formed. The formation process is carried out in tanks of dilute sulphuric acid through which an electric current passes. One set of plates is electrolytically oxidized to lead peroxide, while the other set is reduced to metallic lead in a spongy or porous state. This process of manu-

The writer of this illuminating article is author of a treatise "Batteries" in addition to being the battery expert at the Bureau of Standards at Washington.

His story will appeal to many fans on account of its clear treatment of a subject which has been seldom discussed except perhaps in the list of instructions accompanying storage batteries, and then only in a brief manner.

facture sounds reasonably simple, but there is more to the story. The art of the successful battery manufacturer is based on knowledge founded upon his experience, on his technical control of materials and processes, and on the developments of scientific research.

When the plates are assembled they are interleaved so the positive and negative plates alternate. Separators are placed between the plates. These prevent the plates of opposing polarity from being in metallic contact, while freely permitting the electric current to flow through the solution.

The separators are thin sheets of wood or they may be rubber in some cases. Threaded rubber separators are thin sheets of rubber through which pass several hundred thousand threads like tiny wicks.

How It Is Done

THERE is more of the porous active material in the plates of each cell than we can make use of. Only a portion of it, 20 to 40 per cent, takes part in the charge and discharge process. When the cell discharges, the sulphuric acid of the electrolyte combines with the active material of the plates forming lead sulphate. This is a necessary part of the process and does not harm the cell. The lead sulphate is finely crystalline and quite invisible to the naked eye. As the discharge progresses, this lead sulphate gradually fills the pores and covers the active material making a barrier between the plate and the electrolyte, which, because of the loss of sulphate, becomes weaker. We notice the specific gravity of the solution goes down. For these and other reasons the discharge has to stop

before all the active material has been used. When the battery is recharged this lead sulphate is easily broken down, the electrolyte returns to its former strength and the active materials of the plates are restored to their original condition. The formation of lead sulphate in the guise of sulphation is the boggy-man to frighten the radio fan, the automobilist and others who use these batteries. Like most boggy-men it is not so very dreadful after all. When trouble does occur, it is generally the result of neglect to charge the battery or the wrongful addition of acid when *only water* should be used to replenish the solution.

Patent Medicines

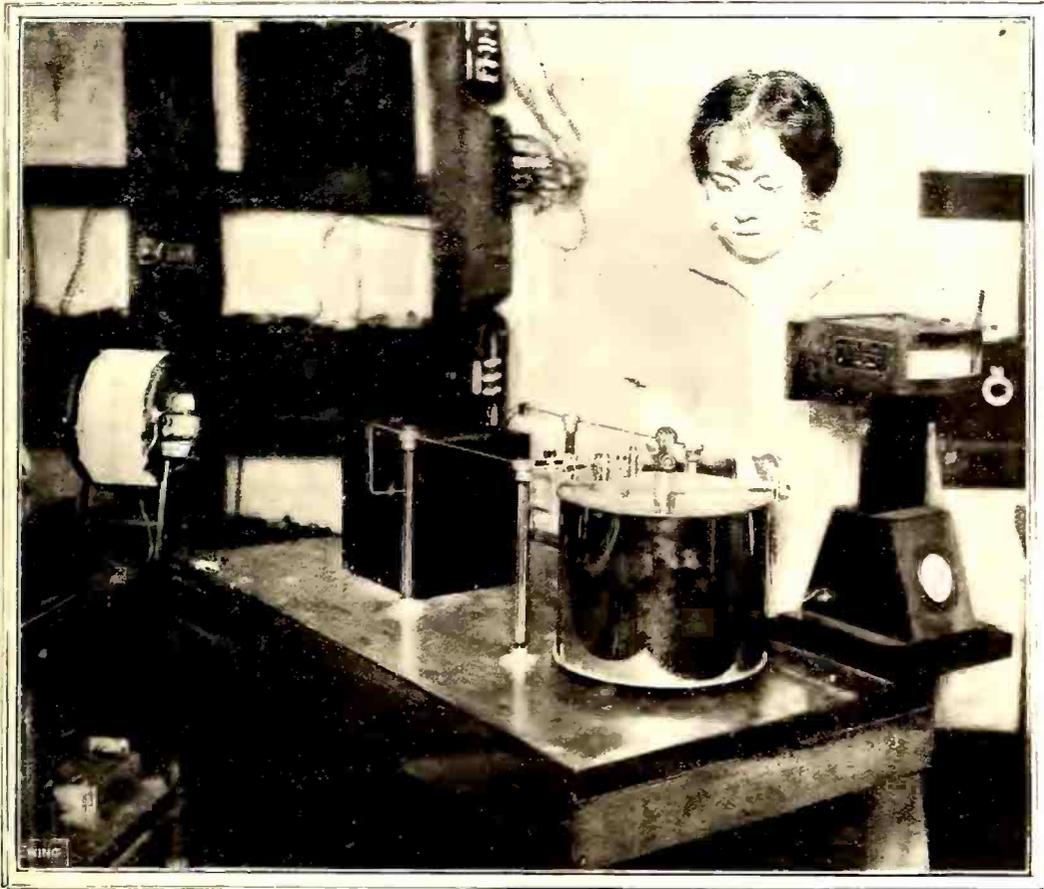
WE FIND almost as many patent medicines for storage batteries as for human beings, but changing the solution in a storage battery or the addition of more acid does not charge it. The battery may be spurred on to give a little more current because the plates retain a surplus of the active materials, but this does not prove it has been charged. Only the electric current transforms the products of discharge back into the useful active materials of the plates to be used over and over again.

The purity of the electrolyte is essential to the successful operation of the battery. This has long been known, but only recently has science devised a new means for making accurate measurements of the effect of the various impurities. Now we can measure the effect of some impurities present to the extent of only a few parts in a million. Exact measurements have a real significance in the preparation of specifications for the small batteries, and more particularly the large batteries.

Systematic care is generally all that is needed to keep a good battery in working condition for a reasonable length of service. (1) It requires charging by a direct or rectified current at regular intervals. On an automobile the charging is done automatically by a generator driven by the engine, but radio batteries, lighting plant batteries and many other types require charging by other means. The bearings on your car can squeak when they need oil, but your battery has no voice to call for charging, therefore regularity in attention is desirable. (2) The solution will diminish in time, some of the water evaporates from it and more is driven off by electrolysis during charging as the gases oxygen and hydrogen, which are the components of water. Therefore only water is required to replenish the solution. Distilled water is preferred, clean rain water or melted ice made from distilled water are also suitable. Tap water varies so much in purity from place to place and from one time of the year to another that no general statement about its suitability can be made. (3) Keep the battery clean and dry. Acid spilled on the terminals will usually start corrosion. This may be stopped by cleaning them with a cloth dampened with diluted ammonia water and then using a little vaseline to protect the metal parts.

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Government Uses New Method for Standardizing Frequencies



Miss Grace Hazen, assistant physicist at the Radio Laboratory of the Bureau of Standards shown with instruments she used in developing new method of standardization of radio frequencies.

Lissajous Figures Made By Two R. F. Circuits Can Be Seen on Oscillograph Screen

By S. R. WINTERS

AS THE term Bureau of Standards implies, the establishing and maintaining standards of performance is one of the chief functions of this branch of the federal government. The scientific yardstick is applied to the art of radio communication no less than to other sciences. Recently, the radio laboratory of the Bureau of Standards developed a new method of standardizing radio frequencies. And, surprising it may be to know that this highly technical achievement is credited to two women—Grace Hazen and Frieda Kenyon, assistant physicists.

The oscillograph—an instrument used in recording and indicating alternating current or other electrical oscillations—and cathode rays—employed in generating X rays—were adapted to the service of formulating primary standards of radio frequency. That is to say, a

cathode-ray oscillograph, together with a wave meter, a tuning fork, and three radio generating outfits, were used in determining the absolute values of radio waves. L. M. Hull, formerly of the Radio Laboratory of the Bureau of Standards, but now of the General Electric Company, had previously demonstrated the principle that two radio-frequency generating circuits could be kept sufficiently constant to produce and maintain a definite pattern or figure on the screen of a cathode-ray oscillograph.

The wave meter employed was of a standard design, consisting of a variable air condenser with fixed mica condensers, which could be connected in parallel with the wave meter, and six interchange-

able inductance coils. A tuning fork, operating at a frequency of 1,024.2 cycles a second, was used. This was driven by a vacuum-tube generating equipment in the absence of mechanical contact. The radio-generating circuit could be adjusted in resonance with the tuning fork. A transformer across the coil in the plate element of the radio circuit acted in the capacity of producing a voltage of the frequency of the tuning fork in the cathode-ray oscillograph. The other plates on the cathode-ray tube were connected to a second vacuum-tube generating outfit. The stream of electrons, commonly seen as a bright spot on the screen of the oscillograph, was deflected in a horizontal direction by the voltage on one pair of the plates and in a vertical direction by the voltage on the other plates.

(Turn the page)

The Lissajous Figures

WHEN the two voltages are applied simultaneously, a blurred rectangle appears except when there is a simple ratio between the two, is a scientific principle which had been previously discovered. Then, according to what is known in scientific circles as a Lissajous figure, this ratio is shown. These Lissajous figures also serve in guiding the adjustment of the second or low-frequency radio generating equipment with the known multiples of the frequency of the tuning fork. The wave meter is then adjusted in resonance with the low-frequency generating set, the setting of the variable condenser being read for this known frequency. By this method of procedure, the wave-meter settings were determined for frequencies between 3.5 and 20 kilocycles a second.

The standardization of higher frequencies than those just mentioned involved the use of a third or high-frequency generating equipment. The low-frequency generating set was adjusted in the ordinary way to the desired frequency of the tuning fork. Then a switch was thrown, breaking the connection between the tuning fork and the oscillograph, and the high-frequency voltage was brought to the oscillograph on the plates perpendicular to the plates having the low-frequency voltage. The high-frequency generating equipment was adjusted to a known multiple of the low-frequency generating set, using the oscillograph to determine the ratio. Thus the range of observations was extended from 3.5 to 400 kilocycles per second. Higher frequencies—from 450 to 620 kilocycles—were invaded by means of a circuit constituting a coil of 392 microhenries inductance with the variable air condenser. By other modifications of the circuit, calibration curves were drawn from 13.1 to 4,900 kilocycles.

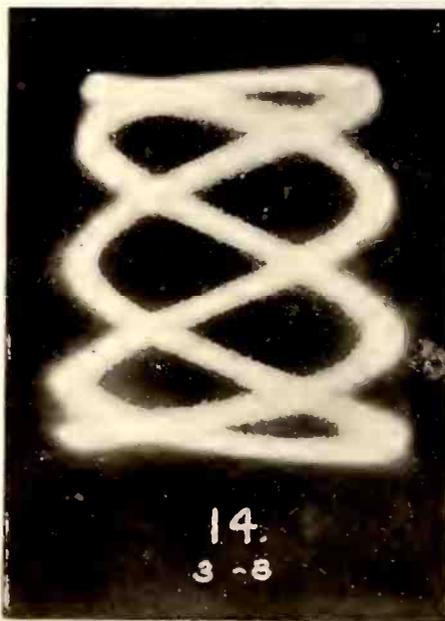
The range of standardization in this manner embraced that of the variable air condenser in connection with each of the six inductance coils. However, the low-frequency range was extended by 3.5 kilocycles by means of fixed mica condensers of 0.001 to 0.015 of a microfarad, these being connected in parallel with the variable condenser. In this instance, the calibration curve had to be plotted directly, due to the fact the capacity of the mica condensers could not be disassociated from the frequency. Frequencies obtained by direct comparison with the tuning-fork generating outfit, being a part of the tuning-fork frequency, were widely separated with respect to percentage. Thus it was necessary to take intermediate readings of frequencies in order to plot the calibration curve. This was accomplished by stepping down from the previously calibrated circuit, of coil and condenser having a range of 13.1 to 3.8 kilocycles. Consequently, calibration curves were drawn from 3.5 to 4,900 kilocycles a second.

The Oscillograph

THE cathode-ray oscillograph used in this new method of radio-frequency standardization is shown in one of the photographs. Fifteen thousand

volts or more were applied to the cathode of these tubes. The stream of electrons thus caused to flow was confined by a diaphragm with a single opening to afford a small bright spot on the fluorescent screen. Alternating electric fields from the radio generating units were applied at right angles to each other, and the stream of electrons by means of condenser plates. As illustrated in one of the diagrams, there is shown the oscillograph circuit with the supply of current and rectifying device. A 220-volt, 60-cycle alternating current line, and two transformers supplied the high voltage which was rectified by two kenotron-rectifier tubes. A choke coil was employed in the oscillograph circuit and the anode of the tube was grounded through a water resistor of two megohms.

The first cathode-ray tube employed was one meter long. It was evacuated to a high degree, more than 20,000 volts being required to yield a bright spot only one millimeter in diameter. The second cathode-ray tube was 75 centi-



HERE is what is known as a Lissajous Figure seen on the screen of the oscillograph. Many interesting forms can be traced by varying the frequencies of the oscillators.

meters long, and was operated at about 18,000 volts. It required a concentrating coil of 500-ampere turns to curtail the size of the bright spot to one and one-half millimeters in diameter. The condenser plates used in deflecting the voltages to the tube were copper-foil strips 1.5 by 9 centimeters in dimensions. They were placed directly on the glass between the diaphragm and the bulb.

The generating outfits used had a range from 3.4 to 5,000 kilocycles. The three units were identical, each employing one 250-watt electron tube. The voltage for the plate element was derived from high potential batteries, affording a constant current of small value. From 500 to 700 volts were applied to each generating unit from separate batteries, thus avoiding reaction. Cur-

rent for the filament element of this 250-watt vacuum tube was derived from two 30-volt, 4-ampere batteries. These were operated in parallel, thus giving a steady supply of electric energy. These three generating sets were provided with two sets of inductance coils and three variable condensers, with capacities ranging from 0.002 to 0.05 of a microfarad on coarse adjustments. Fine adjustments were obtained by means of variable air condensers with capacities from 300 to 1,000 micro-microfarads, these condensers being equipped with slow-motion screws. The generating equipment was shielded by wire-screen cages, which were grounded. The condensers were equipped with long handles, made of insulating material leading through the screened cages. The wire leads were enclosed in grounded metal cases, and the batteries were shielded.

Has Novel Features

THE wave meter used, although a standard design developed by the Bureau of Standards, has several novel features. It has a maximum capacity of 0.0012 of a microfarad. The resistance is practically nothing, owing to the absence of solid insulating material other than three short glass rods. These insulate the fixed plates from the moving plates of the condenser and also from the case. The dielectric is well-nigh exclusively made up of air. A slow-motion device permits of extremely fine adjustments of condenser. The four fixed mica condensers—with capacities of 0.001, 0.002, 0.004, and 0.008, respectively—may be connected in parallel with the variable condenser singly or in other combinations. There are six inductance coils, five of which are single-layer coils of hexagonal cross section. They are contained on frames of laminated phenolic material made as open in construction as feasible. This, in a manner, gives the coils air cores. They are wound with silk-covered radio-frequency cable, each strand of which is continuous. The coils have inductances of 10, 57, 392, 2,460, and 5,440 microhenries, respectively. A circuit comprising a crystal detector and sensitive galvanometer indicates resonance. The wave meter is mounted on a rubber-tired truck, having ball-bearing swivel wheels. The variable and fixed condensers, together with the lead support, are fastened to the top.

"The cathode-ray oscillograph has been shown to be a satisfactory and extremely precise means of obtaining frequency ratios for establishing values of radio-frequencies in terms of an audio-frequency," concludes the Bureau of Standards in a summary of this new method of radio-frequency standardization. "The primary standard wave meter of the bureau was standardized in terms of the frequency of a tuning fork having a frequency of 1,024.2 cycles per second by this means. The method as used was somewhat elaborate, requiring the simultaneous use of three electron-tube generating sets and a cathode-ray tube. The limitations in the accuracy attainable appear to be entirely in the audio-frequency source used as the basis of measurement and in the wave meter."

Radio Plays Part in Boy Scout Work

*Seventy-five Per Cent
of Members Have
Receiving Sets and
Make Good Use
of Them*



By LYMAN F. BARRY*

IN THE many activities of boy scouts, radio plays a very important part. From the very earliest days of the organization, great stress has been placed on the importance of radio in the scout program. Away back in 1914 when radio broadcasting was little known, thousands of scouts were studying the scout handbook and wiring up crystal receiving sets and learning the code. How well they learned it was shown when in the great war, the government made use of thousands of operators who had learned their code in scouting. Official figures of the Boy Scouts of America now show 75 per cent of all scouts have radio receiving sets. A very large proportion of them are interested in transmitting and on these pages are described the sets used by troop 503, Manhattan, New York city, in their radio work.

The aim is to have every scout in radio communication with the troop headquarters so the communication system will be entirely independent of the telephone, mail or other system and in time of emergency will enable the troop to mobilize smoothly and efficiently and thereafter keep in communication with a local headquarters station. The CW transmitting station is of ample power to reach every part of the city. At least half of the members of the troop now have radio sets and these are being revamped so they will tune down to 176 meters on which the sending station operates. A fixed condenser of .001 mfd. in the ground lead and a shortened antenna have proved satisfactory in most cases. This has also improved broadcast reception in some cases as the shorter aerial tunes more sharply and eliminates much interference. At a scheduled hour, messages are sent out daily for the scouts to practise copying. The speed is slow—about 8 words per minute—so even the new scouts can pick up the signals or at least a few letters and they soon improve. At the weekly meetings, scouts hand in reports of the messages and points are given to the scout copying the messages without mistakes. At the end of every six months, prizes are

awarded the scouts who have the most points. If any mobilizations or special notices are necessary they are sent out at this time. Every scout has the telephone number of the scout nearest him who hasn't a set, so that the whole troop can soon be put into motion for a special hike, meeting or an emergency. At least one neighboring troop has installed a transmitting and receiving set and intercommunication with this troop is also worked on a schedule.

In addition to the permanent stations at the homes of the members, a portable station is in use which is very efficient. Honeycomb coils are used for inductances and all wave lengths from 50-5,000 meters can be covered. It is a single tube set operating from self-contained dry batteries. Even without an aerial, it will receive broadcast stations for 15-20 miles and for a radius of over a mile will pick up signals from the troop transmitting set without any aerial at all. The ground connection is attached to a radiator or water pipe and anywhere in a radius of a mile or so, the scout can then be in direct communication with headquarters. One WD 12 tube was used. This is a standard regenerative circuit and too much A battery should not be used or it will howl badly and upset the neighboring listeners for many blocks. For portable use in the field, it is, however, of proved excellence. For this work, a ribbon aerial is stretched between two trees and the troop is no longer ten miles away from the city but right next door to all the world.

Broadcast Band

COIL 100 (100 turns of wire) is suitable for the broadcast wave lengths. Coil 35 is used for 175 meters and coil 400 will tune in the powerful Navy station NAA at Arlington, Va. on 2650 meters. From this standard time signals and weather forecasts may be obtained daily at 12 noon and 10 P. M., Eastern Standard Time.

The connection and operation of the transmitter is not difficult. The Scoutmaster is operating the station shown in the photograph on this page. A Standard CW transformer is used to supply 375 volts for the plate of the tubes. It is planned to replace this with a 200 or 300 volt storage B battery so the operation of the set will not be dependent on the current from the city supply. Three or four husky B batteries may be placed here instead and will give good results. In this set a UV 202 5-watt transmitting tube was used, but the broadcast fan may try his UV 201 A or any other 6 volt tube and will find this very efficient when operated from his usual storage battery. The 5 watt tube is lit from an 8 volt step down transformer.

The secondary inductance consists of 30 turns of bell wire on a 3 1-2 inch cardboard coil, tapped at the 14th turn as shown. Bakelite or a hard rubber tube might be slightly better. The antenna inductance is 15 turns of bell wire on a three inch coil placed at the end of the secondary coil.

To tune, the condensers are turned until the flashlight lamp of the wavemeter glows brightest. After burning out several lights, it was found the 16 volt Christmas tree bulb with a miniature base was better. When the lamp lights up brightest when the key is pressed, it is short circuited with the 2 point switch shown and the current flows directly through the hot wire ammeter to the ground. After the transmitter is oscillating the wave length of the signals is carefully checked. This is made by connecting a flashlight bulb in series with a condenser and coil making a wave meter. This coil is 3 inches in diameter and wound with 17 turns of insulated wire. The condenser is an ordinary variable of rugged construction and of .001 mfd. capacity. The range covered is from about 20-500 meters. However only the band in the middle of the scale is very accurate. This gives greatest

(*Scoutmaster, B. S. A. Radio 20H)

accuracy on 100-300 meters, the waves most used in the higher amateur wave band and the lower broadcast band.

Checking the Wave

THE coil is brought near the coil of the transmitting set and the condenser dial rotated until the bulb on the wavemeter glows brightly (if it is held too near it will burn out). When the exact point is located, the reading in degrees is noted and by referring to the calibration chart for the wavemeter, the exact wave length may be determined. The normal wave length is marked directly on the dial so it may be easily tuned to.

The real receiving work is done on a short wave tuner using a low loss coupler. It has proved very efficient and amateurs in all parts of the country have been heard. There is nothing very unusual about the circuit. It is a simple regenerative circuit with one stage of audio frequency amplification. Great care was taken to solder all connections securely and make all leads as short as possible. The coupler proved exceptionally sensitive to short wave amateur signals. On the short wave broadcast stations, the set also proved very efficient. It is difficult to tune in KDKA here in New York with my loudspeaker when using a neutrodyne on five tubes because of the strong local interference. However, by tuning to their short wave (about 61 meters) on this two tube set, the signals could be heard throughout the room when connected with the loudspeaker.

Foreign Low Wave Signals

THERE are many foreign stations operating on these low waves. However, amateurs as far away as Alabama and the middle west come pounding in like locals so the interference and critical tuning required makes it difficult to pick up foreign stations except in the early morning hours. To the broadcast fan who has not delved beneath the surface, the splendid work being done on these low wave lengths is almost a fairy tale when he hears it for the first time. Perhaps he has noted from newspaper reports that radio communication was kept up with Bowdoin and MacMillan while the polar ship was in the frozen North and that the Rice expedition in Brazil kept in touch with the United States through radio and even was heard in Wellington, New Zealand, 8,500 miles away. But all these unusual results were secured through using short waves around or below 80 meters. And the next big scientific expedition which is headed for Balboa is reported to be planning to use a transmitter which will operate as low as 10 meters.

The amateurs are getting together and suggesting that European amateurs should work on different wave lengths from America so that the signals may not interfere with each other. We used to think of Tasmania as one of the far corners of the earth but now United States amateur operators have heard these distant amateurs chatting away on a wave length of forty meters.

This is the type of results that are

being obtained regularly on low wave lengths with simple receiving sets such as the regenerative receiver just described. Is it any wonder that thousands of Boy Scouts are carried away by the lure of radio and spend a large part of their time building sets and learning the code.

The author has received dozens of requests from radio fans for information on where to get a set that will be really efficient on all wave lengths. That is that can tune down to say 20 meters and up to around 5,000 meters where the big transatlantic stations may be heard. There have been numerous attempts to meet these conditions, but no really successful set has been built which can do such work and do it efficiently. Multi-wave receivers using interchangeable inductances are perhaps as near a solution as anything but few scouts have

There is no question of the fact our younger generation has gone, and is going, into the communication sciences with greater interest than ever before. This may be traced, perhaps, to the lure of radio and the fact apparatus is made better and costs less from year to year.

Every youngster has the wanderlust in his blood and radio in many cases satisfies that craving for distance which otherwise only travel could give. And like the automobile business, in radio it is hard to even conceive of the saturation point ever being reached.

The Editor.

found them really efficient when using the lower wave lengths of around 40-80 meters.

Set for Each Wave Band

THE logical solution of the problem seems to be to have a different receiving set for each band of wave lengths. This has been our attempt and the various sets used by our scouts are connected so by simple switching devices any one of them may be instantly thrown in the circuit. The 5 tube neutrodyne may be plugged in for getting broadcast music or lectures on the loudspeaker, the short wave set may be instantly thrown in for amateur wave lengths below 200 meters and the portable receiving set when not in the field may be thrown in circuit by a few switches. As this uses honeycomb coil inductances, any wave length may be reached. Arlington time signals on 2650 meters can always be received on this set using a single dry battery tube. The other sets work from a storage battery and separate B batteries are used for each set. The transmitter is grounded on a radiator which was found most efficient and the receiving sets all grounded on a water pipe. The transmitter operates from 110 volts alternating current and may be instantly connected as it is entirely independent of the receiving circuit connections.

Changing from Set to Set

THERE are many of the multi-point switches on the market. The one in use at 2-OH consists of a celluloid dial which is numbered. By connecting each receiver to a different number, the aerial may be switched to any set simply by turning to the proper number. This is a splendid scheme for the BCL who wants to compare different sets. A crystal set, 1 tube regenerative, neutrodyne, reflex, superheterodyne or other set may be instantly connected to the aerial and the comparative results ascertained showing the relative loudness, quality, selectivity, etc.

This method was used in connecting up the studio rooms of one of the largest radio stores in the city. The author had only three aerials available but by connecting them in this manner, the purchaser could come in and listen to practically any set in the store as 5 sets were hooked on each aerial through a switch of this type. If in doubt how to build this layout or construct the sets, take this article to your radio dealer or a local amateur and he will soon get you started on the right path.

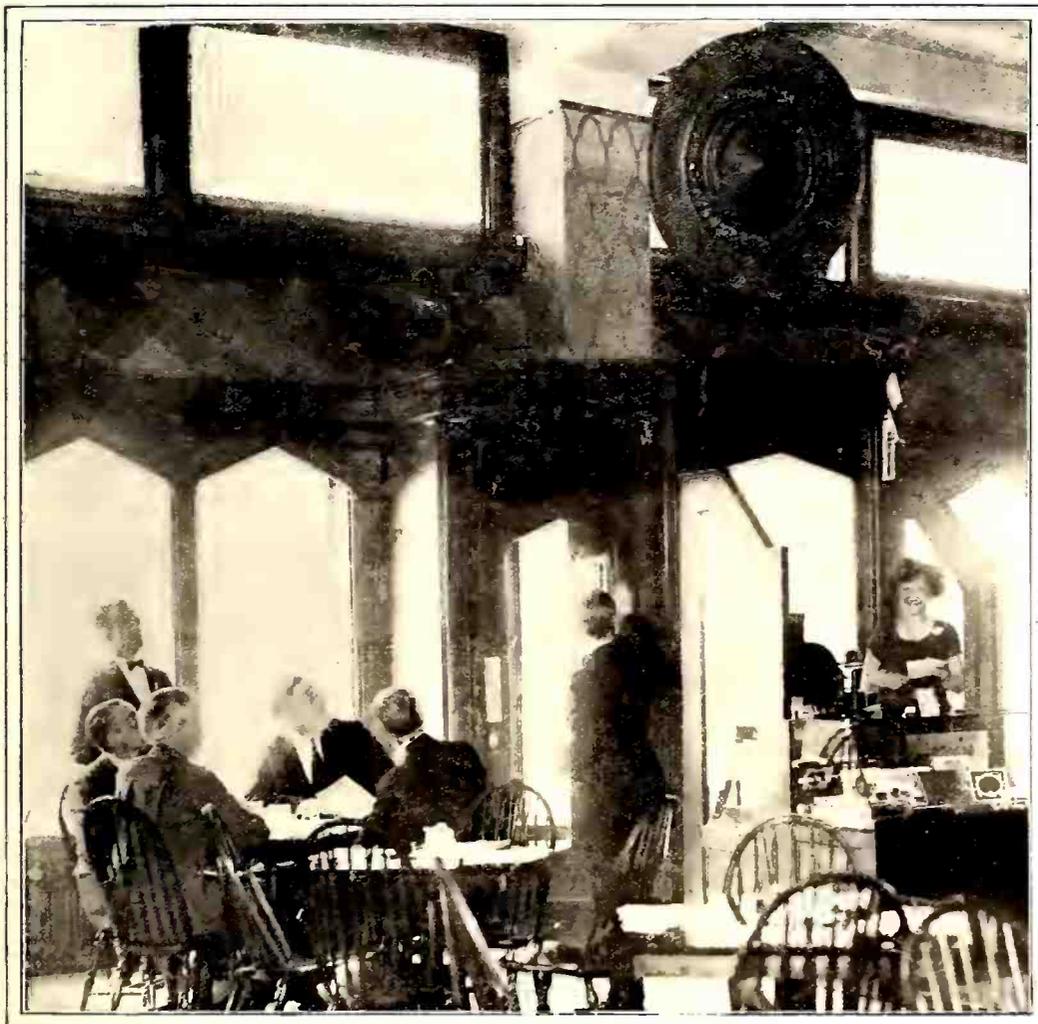
Want a Short Wave Receiver?

FOR the benefit of Boy Scouts and others who are interested in receivers for the short wave bands we are listing below a few suggestions as to descriptions which can be found in various issues of RADIO AGE.

A short wave receiver capable of tuning from 20 to 200 meters is described in the Pickups and Hookups section of the September RADIO AGE, pages 43, 44. The inductances for the Weagant variant shown on page 44, may be wound single layer on an insulating tube, or may be wound on pegs to form air insulated coils. The coils may be spaced or wound close together. With the former method the distributed capacity is less, although some means must be adopted to keep the spacing uniform and constant. The use of twine between turns can be used if wound tightly so the wire and cord will not slip. The use of bell wire, or No. 18 annunciator, has always proved good for low loss construction, the dielectric between the wires being two layers of cotton, paraffined. The number of turns for the various bands is shown in the article which begins on page 43 of the September RADIO AGE.

Another receiver which may be used on the short waves is that described on page 17 of the May issue of RADIO AGE by Ray G. Piety, only the inductance which is designed for covering the broadcast band, should be altered to take care of the amateur strata.

Plug-in inductances, ever popular with the amateur, are quite frequently used in the construction of sets to cover both the broadcast and amateur band. The General Radio Co., and Silver-Marshall, Inc., have plug-in types of inductances which should be of interest to the transmitting fraternity. The coils made by the latter concern are described in a receiver in this issue, page 23.



Patrons of this restaurant are apparently very much interested in the loud speaker over the doorway. The author is the white haired radio enthusiast at the left, in uniform.

Do Radio Dreams Come True?

An Attempt Is Made to Settle the Sound Reproduction Question

REMEMBER when radio broadcasting of music became an accomplished fact? What dreams it inspired: Instead of well-worn phonograph records, there would be the voices of prima donnas who were actually singing at the moment, somewhere. The ensemble of symphony orchestras would expand our hall room into an auditorium where men in evening dress and beautifully gowned ladies sat in stately rows surrounded by the atmosphere of culture.

By ARMSTRONG PERRY

Statesmen would discuss for us the problems of international politics. College professors would unfold to us the wonders of the universe. Life, in all its fullness, would be opened to us at the turning of a radio knob.

Anything we heard via radio in those days was marvelous. Then came the itch for distance, the craze for the well-

filled log. The set-makers played us to the limit, making us buy five, six or nine tubes and expensive up-keep. The phones grew heavy on the head and made creases in our scalps. The ear pieces got all wet. Horns began to yawn at us from every shop window. "Get 'em on the loud speaker" became the dealers' slogan. Their tribe increased and they swallowed us, head, feet and pocketbook. Some of the devices they sold us were loud, but few of them were

speakers. Neither were they singers, nor yet players of instrumental music. They produced a great variety of sounds, some of which could be identified but few of which were pleasing. The only thing that saved radio was the fact that the salesmanship, directed from the start by amateurs with a hobby for experimentation and construction, broke us in as builders of sets. There is a great difference between results obtained with a ready-made device and the same kind of results secured by means of one that we build ourselves. The things we make seem good, because life's values are determined by what we put into a thing more than by what we get out of it. We even like some of our own children whom the neighbors say are really not worth while. Then some of us, not scientifically minded, tired of building radio sets and twisting knobs. The love for music that is music returned. We began to wish that some of the money tied up in expensive equipment were available for concert tickets and dances. The radio business continued to flourish without us, for there is a fool born every minute and optimism is the spirit of the age. The fact that the broadcasters learned to transmit music in a way that made perfect reproduction in a distant home possible, so far as the transmission was concerned, only increased the aggravation. The candy is no good if you have to fish it out of the mud.

Really Reproduces Music

BUT now—gee whillikens and likewise hot dog!—a radio loud speaker has appeared that really reproduces music. The double bass booms out as loud and rich as though the bald headed Dutchman with the big fiddle stick were sawing the catgut (must have been a very large cat) before your very eyes. The tweedle-dee of the E-string when the first violin poises a trembling pinkie way down at the big end of the neck is just as tweedle-dee-ie as if his very superior manners were being displayed for a crowd at the auditorium with us in the front row. The drums sound like drums instead of like the iceman hammering the kitchen door with his tongs. Every little thing about the orchestra is just exactly the same as where it is, except that there is a blending that cannot take place when the violins are next to the footlights and the tuba just inside the door from the stage into the alley.

The new loud speaker has a perfectly grand name, Titanafam. The first half comes from the Titans who, if you remember your mythology, were very big folks. The second half of the name comes from the same root as the name of the partition in your tummy and the name of the thin thing that you bend when you poke your lead pencil into the telephone receiver so you can hear better. It means a very large diaphragm.

The Titanafam is four feet in diameter and looks like the shields the supers carry in grand opera, only better. It is very ornamental and it is only a question of time when it becomes the motif or something in the decorations of flats from Wiscasset, Maine to Port Angeles

on the Pacific. It will be a relief when decorations do something besides collect dust, won't it!

The Poor Inventor

DON'T ask me what kind of works it has. I asked the inventor and I am almost well now, but I don't want to be interviewed on technical subjects. It seems that he has spent about forty years being buffeted by sound waves. He couldn't get it out of his head that he could do to Sound what the lawyers did to Rhinelander, expose its most intimate secrets. Finally, after he had made thousands of models of different

Jumping into the sound reproduction argument is somewhat akin to being the innocent bystander in a free-for-all neighborhood fight, but Mr. Perry, who has written this story, is apparently unafraid of the topic he is handling.

If all ideas on sound reproduction were alike there would be but one loud speaker on the market. If everyone's musical ear were attuned in the same manner, there would be only one brand of piano, while a single make of phonograph would suffice for the world if everybody's conception of sound purity were identical. But the fact remains sound reproduction, despite the work being done in its behalf, is still a moot question.

For verification of this fact merely visit the homes of your friends and witness their divergent tastes in their selection of any musical or radio instruments.

The Editor.

things that didn't work, and worked out formulas until he was crosseyed, he discovered, as Adam did, that the greatest things are essentially simple, and that the more complicated a thing is the harder it is to handle, like a woman. His Titanafam is so simple that if anyone gets a squint at its inwards he is likely to go right off and try to make one himself. It he could, this inventor—his name is Hopkins, but we call him Hop for short—wouldn't care so much, but he has found out that anyone so crooked as to try to imitate another man's invention is too crooked to see straight how to do it. The result is that the imitations look enough like the original to fool the public, but the way they act gives the original a bad name. So when you ask Hop what's inside his Titanafam he hits you on yours and yells: "So is your old man!"

By following the wires back you find out that the Titanafam is connected to a neutrodyne radio receiver. At least that is the receiver they use at Columbus Spa in New York, where the first Titanafam shown to the public gives you the music from the Waldorf Astoria while you eat just as good grub as they serve at the Waldorf but at prices within the reach of Christians. Six or seven tubes

run the whole outfit and I'll bet an "A" battery to a grid condenser that you could hear the music five miles away if it was out where the two-passenger sedans pull into the shady lanes and run out of gas.

Look For Speaker

UP AT THE Columbus Spa it is fun to sit in the balcony and watch the new customers come in. The first thing they do is to look for a table. As soon as they are settled and have rubbered around to see if the other folks are wise to them, they look for the orchestra and the dance floor. They can't see either one and they make up their minds that these must be up in the balcony. They go up to have a look and are fooled again. Nothing there except tables and there isn't a chance of getting them away from the old customers except between two o'clock and noon. By this time, some waiter points to the Titanafam, which hangs from the ceiling by a string, looking like a big button off a winter coat and playing like a 100-piece band. They say "Oh!" and go back to their table, which the waiter is protecting so he will get a good tip. Maybe they heard the announcer before this but didn't recognize him because they could understand what he said, which is seldom the case, as you know, with most loud speakers.

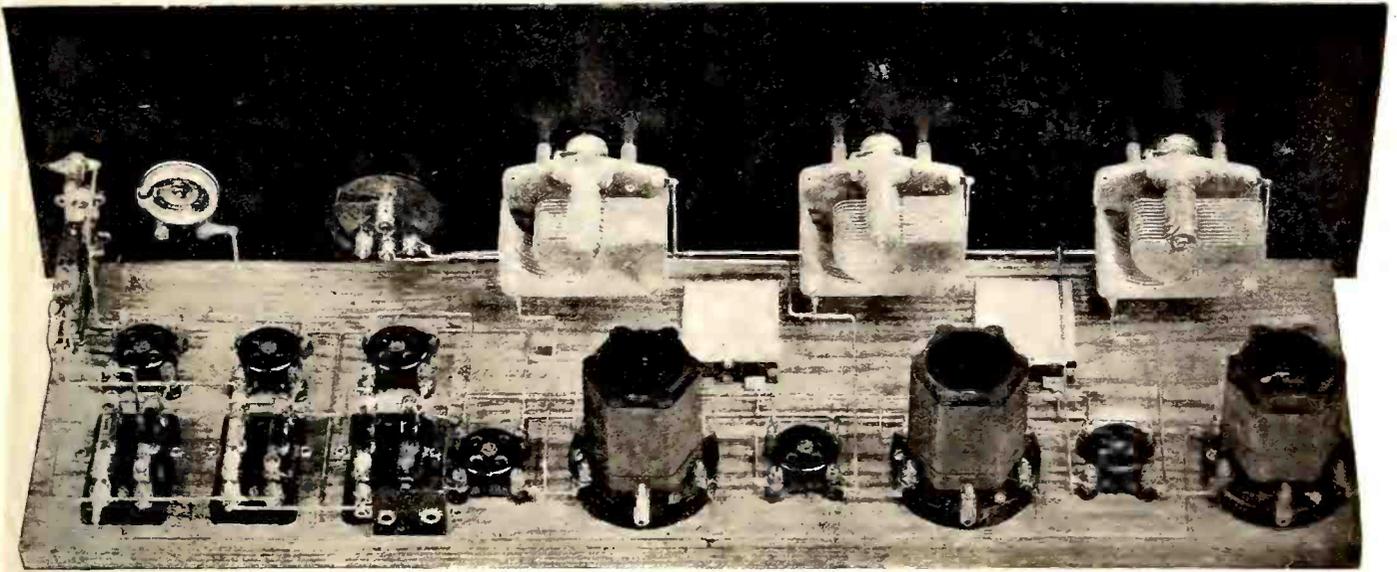
Even the waiters like the Titanafam, and when a waiter likes anything in his own beanery you know it's good. One of them was fired for being all wet too many times. I met him in his new place and he said he didn't mind losing his job, he could always get another job, but none of the other places had Titanafams.

This Hopkins invented the Actuelle, which is used on phonographs. That was one of the steps that led up to the Titanafam. The Titanafam works with a phograph just as well as it does with a radio, but I like it better with radio. When you play it with a phonograph and put on a Caruso record it is so true to life that you have to fill your face with sphagetti for a muffler while you bawl because he's dead. Hop is said to have invented the cone type loud speaker, also, which is wonderful until you hear the Titanafam.

Volume Overpowers Static

YOU know interference. After I found out the orchestra at the restaurant was only a loud speaker, I began to listen in for static or something to cuss at, just from habit, but there was none. I don't know whether it is cut out like an appendix or overpowered like the voice of an empire when he calls a strike on the first man in the home team's batting order. Anyhow, it is not there.

The Titanafam has made radio dreams come true. As soon as enough can be made to supply all the restaurants, halls and other places where people come together, the very best that the broadcasters can give us will be passed on to the public. I heard the Harvard-Yale game from a Titanafam. It was so realistic that I got to shoving, as you do in the grand stand when one team is making its last stand and the other is bucking the line.



Plug-in Inductances Afford Maximum Receiver Efficiency

FOR some time past, the writer has felt it should be possible to design a radio receiver possessing all of the valuable features of the best super-heterodynes.

The receiver to be described made its initial bow to the radio public during the fall of 1925. At first glance, the set does not seem at all original, since it consists merely of two stages of tuned radio frequency amplification, followed by a detector tube and two audio amplifiers. The circuit is a combination of the best points of all receivers, carefully executed with regard for the most recent discoveries, and the fund of information gained by the writer and his assistants through contact with many experimenters.

Since one of the first requirements was wavelength flexibility, it was necessary to devise a method of shifting inductances for different wavelength bands. This made necessary the designing of interchangeable coil forms possessing a form factor suitable for all frequencies to be handled. For the higher frequency bands, the turns are spaced, while on coils for waves longer than the present broadcast band, the turns may be bank wound. Six contacts are provided on a reinforced ring at the bottom of each coil, upon which are mounted six studs in which the ends of the windings terminate, and which in turn make contact with springs in a special six-contact socket, so keyed that a coil cannot be inserted incorrectly. In order to change a wavelength band, it is necessary only to remove the coils from their sockets and insert ones of different inductance values—an operation consuming about 10 seconds.

The condensers used with these inductances are of the type giving an approximately straight line frequency variation, or a uniform kilocycle variation for each dial division.

Two stages tuned r. f., detector and 3 stages resistance coupled amplification are described

By *McMurdo Silver*

No Neutralization

NEUTRALIZATION, which is nothing more than fixed oscillation or regeneration control, could not be used. This is because the r. f. amplifier, for a given frequency band, would have to be neutralized at the shortest wave to be received in that band so the amplifier would not oscillate. Sensitivity would be obtained then only at the lower end of the wavelength band. In this connection, the now popular circuits employing a stage of tuned neutralized r. f. amplification and a regenerative detector were considered. In them, due to reaction, regeneration in the detector circuit tends to assist the neutralized r. f. amplifier. This being at best an indirect solution of the problem, the r. f. amplifier in this design was made highly regenerative, with an increase in sensitivity, since a much stronger signal could then be delivered to the detector tube, the efficiency of which varies with the square of the applied voltage. This means that, with a given signal applied to the detector, doubling the strength of the signal will increase the detector response four times. In the new receiver, due to reac-

tion, the detector circuit is rendered practically as sensitive as if direct regeneration were employed, through the reactive effect of regeneration in the r. f. amplifier.

The method of regeneration control employed is practically new and consists of a variable high resistance in shunt with the grid circuit of the second r. f. tube. Customarily, a grid biasing potentiometer is employed which is extremely inefficient at short waves although satisfactory at long waves as in a super-heterodyne; or a series B battery resistance. The latter, the most popular method, is unsatisfactory, as it merely controls oscillation by reducing the effective amplifier plate voltage. This process is bound to detune the set in a measure, as well as throw the amplifier tubes entirely off their proper operating characteristic if a C battery is employed, as should be done. In the system used, a variable resistance of 500,000 ohms is shunted across the tuned circuit feeding into the second tube's grid circuit. The probable average operating resistance of the tube is about 150,000 ohms, so the resistance is so far in excess of this that selectivity is not affected. Due to careful design of the circuit, it is only necessary to decrease the value of shunt resistance to not less than 300,000 ohms to get excellent oscillation control. Obviously, this method will not affect selectivity to the detrimental extent that any other method would.

Due to the extremely low losses of the three tuned circuits, the overall amplification curve resembles that of a band-pass filter, such as is used in carrier telephone work; in some cases for separation of carriers—not 10 kc. apart as in radio—but only 3 kc. apart. This is the ideal response curve.

Every Fan Should

Eliminate Audio Distortion

ALTHOUGH to a great many of us radio enjoyment seems to consist chiefly in tuning in faint DX stations and hearing their call letters announced, probably a majority of radio fans realize the successful amplification of signals, wherever they come from, is the more important part of reception.

From this point of view, any obstacle which prevents the loud speaker from delivering radio entertainment that is an exact duplicate of the music or voice in the broadcasting studio may be regarded as a cause of distortion. Of course, it is possible the sending station does not transmit properly but such an occurrence is so extremely rare in practically every instance ruined tonal quality may be blamed upon the receiver.

Indeed, quality is spoiled to a much greater extent than is generally realized, I believe. Very few receiving sets are capable of amplifying the incoming modulations without alteration. Audio frequencies may be cut off entirely before they get to the loud speaker; certain of them may be amplified to a greater extent than others; other audio sounds not a part of the modulations may be tacked on to them.

Correct Procedure

IT IS QUITE hopeless to guess at the possible reasons for the distortion, for they may be very numerous. A systematic check-up by the fan on his entire equipment, with a critical ear, is needful. Let us glance over a short list giving the general locations of radio distortion:—

1. The radio frequency amplifier
2. The detector
3. The audio frequency amplifier
4. The loud speaker

This list omits mention of the broadcast station, of course, since that is beyond the control of the listener. The superb tonal quality broadcast by any important station is quickly proved to anyone's satisfaction by a short session listening with a pair of headphones and a crystal detector.

Then let us consider the radio frequency amplifier first, if one has such.

This time we are unconcerned with tuning defects, interference, etc., but are interested solely in audio distortion, or rather, its elimination. The only way in which a radio frequency amplifier can cause audio distortion is by such extremely sharp tuning that the "side-bands" wherein the overtones are found are cut off. This occasionally occurs in three dial sets where all three dials are set accurately at resonance. Over-feedback or regeneration causes this extra selective tuning and it may be avoided by a simple readjustment of the dial. A "pinched" and nasal quality is the usual evidence of over-sharpness.

Thus the R.F. amplifier is easily disposed as seldom capable of introducing distortion (not counting squeals!) into the

Most of poor quality traced to r.f., audio, detector, or loud speaker; not fault of transmitter:

By Brainard Foote

modulations. Next we treat of the detector. This ordinarily reproduces truthfully and it is at this point that our experimental work must commence. If you have no detector jack whereby you can listen to the detector output on headphones alone simply connect a pair of insulated wires to the phone cord tips and make contact with the primary binding posts of the first audio trans-

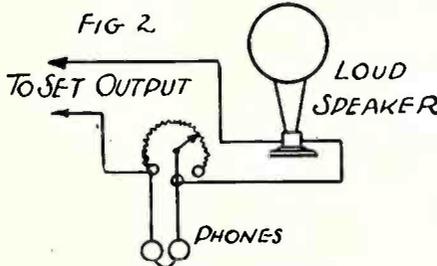
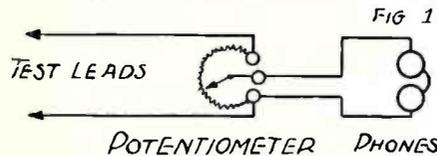


Fig. 1—A simple test circuit, with a 400 ohm potentiometer and headphones, for locating distortion in the amplifier. The potentiometer permits the volume to be adjusted to the same value as in the detector output. Fig. 2—Judging the amplifier output is a different matter. Since the same current traverses phones and speaker, this hook-up helps you find out whether distortion takes place in the amplifier or in the loud speaker.

former. (This assumes a transformer-coupled set).

Listen attentively to the tone quality. Note the beat of the drums, the traps, cymbals, bass viols, bass saxophones and likewise direct your attention to the very high tones—the violins, flutes, etc. Notice how superior the reproduction is to the loud speaker's performance? This is what we shall endeavor to explain and correct.

It is possible the detector will operate poorly. Try two or three different tubes there and allow the best one to remain. Do not use a large by-pass condenser, for this is apt to decrease the volume and eliminate the high pitches considerably.

Also tune out the station and note whether the detector is quiet. If there is too much hissing noise or any crackling, it is possible the grid leak is imperfect. Try another one, of good make, and of about 2 or 3 megohms resistance. Noises of this sort that arise in the detector are perhaps more easily heard by using the amplifier and loud speaker, without a station tuned in. If crackling or spitting sounds are heard, try removing the detector from its socket. Should the noise cease, you may be certain it arises in the detector and a defective grid leak is the most common cause. Once in a while dirt gets into the grid condenser and causes similar noises.

The First Audio Stage

WHEN you are sure the detector "detects" clearly, quietly and gives you real music in the headphones, try the first audio stage. To do this, where there's no jack, connect the test wires to the phone cords across the primary winding of the second audio transformer. Note whether all is clear now. You will probably observe, if you have a good ear, that the drums and traps are suppressed somewhat and that the very high tones do not come in so well. This, of itself, is merely a sign that the transformer is not a very good amplifier of all frequencies, although in certain cases of the better grade of transformer the amplification will be musically satisfactory.

A small audio transformer has insufficient number of turns of wire to "tune" to the low audio tones, even though efficient for high notes. But, on the other hand, a transformer having enough turns for low notes usually has so much distributed capacity in its winding that the high notes are cut off. It takes a very fine transformer indeed to amplify the entire musical register evenly. Of serious distortion the first stage seldom is the cause. If you observe that sudden loud bursts of music cause "blasting" of the phones it may simply be due to too much volume.

Fig. 1 illustrates a simple test circuit wherewith the phone volume can be adjusted to the same point as was used in criticizing the detector's performance. A 400 ohm potentiometer is the basis of control. Note that the headphones are bridged between the movable arm and one of the end contacts. After volume is "toned down" to a reasonable value, listen again. If there is still blasting present on strong notes the tube is a poor one, the transformer is poor and may have too high a ratio or the tube requires a "C" battery. Be very sure the blasting is not present in the detector before placing the blame on the first audio stage, however, for it may, in rare cases, originate at the studio.

When the first stage operates satisfactorily, tackle the second and last stage. Little need be said about a three stage

audio amplifier, since there is no real need for such an amplifier, where transformers are used, when the initial volume is sufficient. It is an insensitive set indeed that calls for three transformer-coupled audio steps after it! In criticising the second audio stage, use the connections given in Fig. 2. The phones are run in series with the loud speaker so that the same current passes through both instruments. Note the potentiometer is connected in a slightly different fashion here, in order to minimize the resistance in the output circuit.

Second Step

ONCE more listen on the detector and renew your notion of what the output should sound like. Then switch back to the amplifier quickly. Note whether you can hear as distinctly as before, when the volume is made the same. Listen for the bass notes, the drums, and so on. Are they as prominent as before? If so, congratulate yourself, for you have a very unusual audio amplifier that uses transformers for coupling. Keep in mind the important fact the very same current passes through the loud speaker that traverses the phones. Hence, if that current produces clear sounds in the headphones it should do likewise in the speaker. Of course, the latter must be connected with the right polarity and have its diaphragm adjustment made correctly, if it has one.

If there is any distortion present that you do not notice in the phones, you may be sure the fault lies in the loud speaker and the only suitable remedy is to get a better one. In the majority of cases, though, you will find distortion in the phones, too, and you'll then have evidence that the trouble lies in the second stage. Possibly the transformer steps the voltage up too much, not only for the tube input but also for even amplification. The inevitable result is blasting (a confused crashing effect) when a number of notes are sounded together or when the orchestra reaches a strong peak and all instruments seem to resound at once. The blasting effect is also noticeable on a solo number, soprano especially, when there seem to be sudden increases and decreases of volume, although the detector output reveals no such fault.

Perhaps a better tube will remedy the trouble. Certainly, if the volume is so great as to be more than sufficient for an average room—loud as a phonograph, for instance, the use of a power tube like the UX 112 or the UX 120, will bring a very fine improvement. The ordinary UV 201A tube and particularly the UV 199 or WD 12 is incapable of operation at phonograph volume without causing distortion. Hence a "power tube" is the best solution—far superior to substitute schemes like push-pull amplifiers, using tubes in parallel and the like.

Transformer Changes

OF COURSE, it is essential to employ a proper amount of "C" voltage with all amplifier tubes. It sometimes happens a poorly constructed cone speaker, especially those having no external adjustment, fail to operate clearly when a "C" battery is used. The trouble is the

armature of the unit strikes against the magnets and causes rattling, and the cause of that is a reduction in plate current. In some instances shrinkage of the parchment cone slackens the strain on the unit. With a speaker acting in this way nothing can be done short of taking the unit apart or returning it to the dealer or manufacturer.

Having done all that is possible in the way of employing "C" batteries, power tubes and good transformers of liberal dimensions (so as to have plenty of wire and core iron) and some distortion remaining, the final remedy is to change the method of amplification used in the loud speaker stage. Fig. 3a illustrates the common transformer system and Fig. 3b shows how it can be switched over to a choke or impedance system in a few moments. At 3a the transformer is shown in its common connections, with the binding posts similarly labelled. At 3b the primary winding is omitted altogether and the secondary winding employed as a choke or impedance. This eliminates the transformer "step-up" and con-

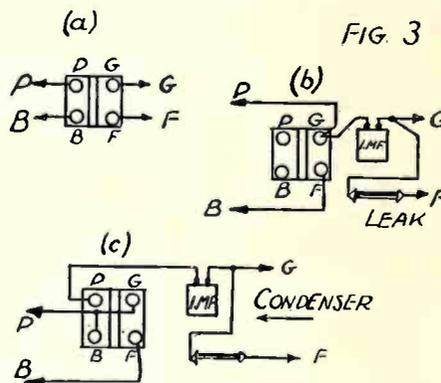


FIG. 3—Re-connecting an audio transformer to become an impedance (choke). A blocking condenser and low resistance grid leak are required. At (c) the transformer becomes an impedance having a slight voltage step-up.

sequently decreases the volume a little, but the volume loss is not as great as it might appear on account of the fact that although the step-up is lost, the plate circuit of the previous amplifier tube has a large winding in it, where it had only a small one before.

To isolate the grid of the last audio tube from the "B" voltage and at the same time to transmit to the grid the voltage impulses built up across the coil G-F or the secondary, a large fixed condenser is used between. Although a condenser as small as .004 mfd. will work quite well, the one mfd. size is preferable as it handles the entire musical range better. A grid leak of about $\frac{1}{4}$ megohm or as low as .1 megohm (in cases of strong volume) is shunted from grid to the "C" minus to maintain the grid at a suitable negative potential. This system not only gives more even amplification of all frequencies but it eliminates the blasting to a large extent.

Other Methods of Amplification

THE impedance or choke coil system of audio amplification is highly desirable where one wishes to take ad-

vantage of its excellent tone amplification and at the same time economize on the amount of "B" battery on hand. If introduced throughout the set, the old transformers may be used in the manner illustrated in Fig. 3b or regular impedance coupling units obtained. These are designed to allow a slight voltage step-up without loss of quality. The experimenter who likes to monkey around with amplifying stunts may wish to try for this voltage step-up with his old transformers. If so, the system shown in Fig. 3c is suggested. The primary and secondary windings are run in series. It may be necessary to reverse the primary connections so the two coils will not be opposed to each other, but a trial determines this easily.

Now that the audio amplifier has been "doctored" somewhat so as to remove causes of blasting, extraneous noises and all possible distortion, criticise it again by comparing the detector output with that of the amplifier, using the connections of Fig. 2 once more. Once again compare the low and high notes at both points. It is quite likely that, although the improvement is considerable, there is plenty of room for more.

Here is the point at which we run up against the requirement for a system that will amplify all frequencies impartially. The only one that we know about so far is the resistance-coupled method. The fact it amplifies all moderate frequencies to a very nearly equal extent is attested to by its use as the intermediate frequency amplifier in numerous superheterodyne sets for 3,000 meter work. The resistance-coupled amplifier is not very useful for frequencies much higher than that and for that reason it is not often employed for broadcast wavelengths. Yet in England and on the Continent, it is very common to employ a resistance-coupled radio frequency amplifier for high frequencies from 200 to 600 meters. This points out how well the resistance method suits all frequencies. The audio field is its particular place of excellence, however.

Its drawbacks are several—the need for a high "B" battery voltage (around 150 volts), the need for three tubes as with impedance coupling to secure volume comparable with that of a two step transformer amplifier, difficulties with resistors and leaks and the problem of operating the detector satisfactorily. I am not attempting to provide resistance coupled data here, as it is readily available commercially and numerous articles have already appeared on the subject. Suffice it to remark, however, that those who seek the perfection of audio amplification should investigate the resistance system. It requires more "B" battery to start with, but uses less "B" battery current, so that the battery expense is no worse than with a 2 step transformer amplifier. High grade resistors are plentiful, too, so that, as with the impedance system, the radio set may be built over into a true musical instrument at no very prohibitive cost.

Loud Speaker

SO FAR we have omitted mention of loud speaker quality. It is a fact that few loud speakers put forth frequencies
(Continued on page 58)

Enter the Radio Detective



THE FIRST radio detective car has been put into service by the United States supervisor of radio in the eighth district, which comprises New York, Pennsylvania, West Virginia, Ohio and the lower peninsula of Michigan.

The special body contains all of the apparatus necessary to locate radio interference or unlicensed stations, to test wave lengths and examine amateur operators.

One of the first trips the car made was from Detroit to Charleston, W. Va., where a leak in a power transmission line put all of the radio receivers in the town out of commission and almost stopped the local sale of radio sets.

There are three complete receiving sets, one for short wave lengths down to 40 meters, one induction receiver to locate leaks in power transmission lines, and one superheterodyne for 50 to 3,500 meters, designed and built by the Department of Commerce. A transmitter of 100 watts and 80 meters will broadcast over a range of 200 to 300 miles. There are 24 cells of 155 ampere hour storage batteries, which are designed to charge from a rectifier when in the garage or from the generator on the car when in motion.

Because of the weight of the storage batteries and other special equipment the car weighs 6,300 pounds and has special springs to carry this load.

Various wave meters, watt meters, an omnigraph for giving operators' examinations, a typewriter and other equipment make this car a traveling office.

What the Broadcasters are Doing



Rochester Goes Into WGY Radio Link

ROCHESTER was brought into the great broadcast chain of WGY, when the Schenectady station radiated a program by the Rochester Little Symphony Orchestra, conducted by Eugene Goossens. This program marked the opening of a new studio by WHAM, the Rochester station which is operated jointly by the Democrat and Chronicle and Times-Union, newspapers of that city.

In extending its wire lines to the western part of New York State, to Buffalo, Rochester, Syracuse and Utica, WGY has made it possible for radio stations in those cities to greatly expand the listener-area. In the case of Rochester, WGY broadcast simultaneously, with the home station, WHAM. Stations in Buffalo, Rochester and Syracuse may also, on occasions, take programs from WGY, either those originating in Schenectady or at the other cities wire-connected to the Schenectady studio. WGY, by means of its wire to New York, is able to tap the musical resources of that city, in cooperation with WJZ. The New York station in turn is connected to Washington, D. C., where WRC has a wire-network reaching out to theater, hotel, church and auditorium. To the New York wire network of WJZ, and the system of WRC in Washington and vicinity WGY adds a great system which embraces practically all of large cities of the state. Stations in any of these cities are thus in a position to broadcast a program which originates in any other city in the system, from Washington to Buffalo.

In offering the Rochester Little Symphony Orchestra, WGY is introducing an organization which is sure to take its place among the very best orchestra on the air. Mr. Goossens, the conductor, is also head of the Rochester Philharmonic Orchestra, and is widely known in musical circles, not only as conductor, but as composer. He was recently invited by Serge Koussevitsky, to conduct the Boston Symphony Orchestra and has accepted an invitation to be guest conductor of the New York Symphony Orchestra for a series of six concerts.

Other contributions of Rochester to the programs of WGY will be weekly concerts by the Eastman Theater Orchestra Wednesday and Friday nights.

BILL HAID, banjoist with the Coon-Sanders Original Nighthawk orchestra, who broadcasts from KYW. "Banjo Bill," as he is known to the radio audience, has a nifty line of chatter which goes with his banjo playing. Bill is responsible for the pronounced strum in the dance music broadcast from the Insomnia Club from 1 to 2 a. m. He also broadcasts frequently from KYW's Congress studio.

Cincinnati Symphony to Broadcast Concert Series

CINCINNATI'S Symphony Orchestra will be on the air once a month during the series of twenty community radio concerts being broadcast in the name of the community of Cincinnati through station WSAI. Arrangements have been made whereby the orchestra, with Fritz Reiner directing, will be featured in three more of the community radio programs.

The engagement of the Symphony orchestra was in response to popular demand among radio listeners throughout the American continent who heard the orchestra in the inaugural community program.

Contest for National Radio Play Started

FOR the purpose of securing better radio programs a national radio play contest has been launched through the joint efforts of the Drama League of America and WLS, the Sears-Roebuck Agricultural Foundation station, Chicago.

To the victor in the contest will be given \$500 in cash and silver loving cup.

A second prize of \$200 will be awarded to the runner-up and for the third best \$100 will be given. Any man, woman, or child in the United States is eligible to submit manuscripts of their plays. The contest will be conducted under the auspices of the Drama League, the prizes donated by WLS. All manuscripts must be received on or before February 1, 1926.

As soon as the best play has been selected by a committee of experts chosen by the Drama League, preparations will be immediately made to produce the prize-winning play, to be broadcast from WLS and many other stations of the country by a special company.

Jazz Reaches Deaf Ears Via Bone Conduction

JAZZ music for the deaf! Will this be an announcement on radio programs of the future? Is it possible that those without hearing are to have the pleasures of music?

These questions are brought up by an unique investigation being conducted by a famous Chicago aurist in cooperation with Paul Ash, noted jazz leader and radio star of KYW. The renowned ear specialist—who forbids use of his name until his experiments are completed—became interested in the subject when shown a number of letters received by Paul Ash from his "fans" who attend his jazz shows at McVickers theater.

Miss Mabel M. Bedford, 2129 W. Twenty-first St., Chicago, one of the writers, said although she is deaf she "hears" Paul Ash's jazz band at the theater. She explained it is the only sound she could hear. Opera performances fail to reach her.

Confirming this strange phenomenon is another letter from Miss Ellen Carlson, 4659 Sheriden Road, Chicago, in which she also tells of enjoying Ash's jazz music although she is deaf. Several other similar reports have been received and ushers at the theater say a score or more of apparently deaf persons are seen in the theater every day.

Ash is of the belief there are certain jazz strains which set up vibrations which are "felt" by the deaf. He feels by experimenting in this connection he may devise a program of music to bring new cheer into the lives of those who have lived in eternal silence.

The noted ear expert believes this a case of "bone conduction" of sound. He thinks that the pronounced rhythm of Ash's jazz music—emphasized by beating of the drums and piercing notes of the "hot cornet" playing—reach the supposedly deaf through their bodies. In the near future this theory will be put to the test by Ash broadcasting over KYW a special number and asking deaf persons to "listen" in and report to him what they "hear."

Seven Languages to be Heard in Church Service

SEVEN languages will be heard in the special addresses broadcast from Station KFUE of the Concordia Lutheran Church on Sunday, January 24, the opening night of the International Radio Week Period, according to announcement.

With listeners in all parts of the world straining their ears for American stations who will transmit special programs for overseas auditors during this week, it is expected the addresses of these seven students of Theology at Concordia Seminary will be heard in practically every country in Europe, North and South America, as well as in England and Scandinavia.

The speakers, who will bring their broadcast at 11 o'clock central standard time, or at the end of the silent hour, will be:

Prof. F. Pieper, D. D., in German;
Prof. W. H. T. Dane, D. D., in English;
Prof. J. T. Mueller, in Spanish;
Rev. G. Majoros, in Slovak;
W. Wolf, in French;
Anthony Messina, in Italian;
E. Ylvisaker, in Norwegian.

KFUE broadcasts on the highest wavelength allotted to American Broadcasters, 545.1 meters, and has already been heard at a number of distant points.

New Broadcaster in Sydney, Australia

LOCAL manufacturers have just completed a new broadcaster for the Sydney Trades Hall, in the city of that name, Australia, which will operate on 280 meters with 1500 watts power. The apparatus is capable of employing as high as 4000 watts and utilizing a 100 meter channel, Trade Commissioner Babbitt reports to the Department of Commerce. The station and practically all the radio equipment are products of the dominion. It is the sixth broadcaster in the city.

For local consumption it is planned to use the 280 meter wave but for long distant transmission the shorter, 100 meter wave, will be employed. During recent experiments on this wave length by a prominent radio experimenter named Schultz, a private station was received in America, where it is credited as the loudest Australian short-wave station. Two receiving sets are used by the station, one for wave lengths between 200 and 2,000 meters, the other for short waves below 30 meters.

Here's Chance to Get Peruvian Station

RADIO station OAX of Lima, Peru, will broadcast special programs for the benefit of American radio fans during the five days of the International tests. These programs will come in the hour ten to eleven central standard time on a wave length of 380 meters.

Listeners believing they have heard this station are invited to write or telegraph the Radio week committee at 1133 Broadway, New York City, specifying the number heard and the exact minute, for confirmation.

WLS Signs Up Chicago Little Symphony

OFFICIALS of WLS have signed the Chicago Little Symphony orchestra for a series of concerts, in addition to those given from this station during the past several weeks. The new contract of WLS with the Chicago Little Symphony orchestra, which is the original little symphony organization in Chicago, calls for nine more performances from WLS between January 1 and March 19, 1926. There will be four concerts in January, three in February and two in March. More concerts may be added at a later date.

Believing the radio public would enjoy good music by one of the best musical organizations in the United States, great effort was put forth to secure the Little Symphony orchestra. With the cooperating of Director George Dasch and business manager, Karl Schulte, the orchestra was induced to give radio a tryout. This was proved successful in the minds of the men who compose this great musical organization, declared Edgar L. Bill, director of WLS.

"WLS is pleased to offer this great musical attraction to the radio listeners," said Mr. Bill. "We believe radio has something for all musical organizations, whether it is grand opera or a jazz band. It is largely a matter of presentation. Most of the radio audience like good music. That has been proved. The same audience dislikes to have a good program spoiled by the improper presentation and it is not fair to great musicians, such as compose the Chicago Little Symphony, that the performance should be marred in any way. It has been through the cooperation of Director Dasch and Manager Schulte that WLS has been successful with the Little Symphony and we feel radio can handle any musical presentation in the same satisfactory way.

Zanesville Bans Vibrator Battery Chargers

ZANESVILLE, Ohio, is trying to keep the ether free from interference, forbidding the use of vibratory battery chargers during broadcast reception periods.

An ordinance recently passed rules that battery chargers of the vibratory type for charging radio batteries shall not be operated between the hours of six p. m. and 5 a. m., and that offenders shall be held guilty of misdemeanors and may be fined not more than ten dollars.

American Amateurs Get New Phone Channel

RADIO amateurs have just been given authority to use the 85.66 to 83.28 meter, or 3500 to 3600 kilocycle, band for radio-phone broadcasting, as well as the old channels between 170 and 180 meters.

These bands being well below the broadcast wave lengths should not cause any interference for the listening public but assure the transmitting amateurs a new road through the ether for their experimental and communication phone work as well as their code messages.

Turkey in the Straw Versus 3 o'clock Songs

"TURKEY in the Straw" has lately been revived by the radio and holds as high a place on the air as "Midnight Waltz" and other later fox-trots. Radio has made it possible for people who danced to the old-time fiddlers a generation or two ago to repeat the performance in thousands of communities of the United States.

Barn dance teams have sprung up all over the country and are looked on with much favor as a quaint attraction in the tunes which strike the hearts of millions.

Dr. Humphrey Bate and his barn dance orchestra have in the period of a few weeks become very popular with the listeners to WSM, Nashville, Tennessee, owned and operated by The National Life and Accident Insurance Company. The Doctor is well-known in Nashville, having graduated from Medical College there many years ago. He is now a practicing physician in Castalian Springs, Tennessee. His hobby is the harmonica and guitar. With him appear the following performers: Aloyone Bate, his daughter; Walter Loggett, Oscar Stone, and Bert Hutchison.

During Dr. Bate's programs, messages are received from all over the country requesting "Pop Goes the Weasel," old-time schottishes, Virginia reels, and scores of other tunes used in barn dances.

KFJR, Portland Oregon, After Record

RADIO station KFJR, the Eastmoreland Broadcasting station of Portland, Oregon, operating on a wavelength of 263 meters expects to set new station records during International Radio Week, January 24 to 30, as their transmitter has just been overhauled and put in first class condition for the tests.

A special program is scheduled for Tuesday night, January 26th, running from midnight to 1:30 Pacific time when some of the leading musicians of this section will present a program "Music from the Old Masters." Many radio listeners in the east will be on the air quite late this evening listening for the International test stations and they will be well repaid if they tune in KFJR in the later hours when no doubt many listeners will add numerous distant stations to their string.

Successful DX

THE special program for two thousand New Zealand listeners broadcast on December 14 from WBBM, Chicago, proved successful despite the very unfavorable conditions under which the test was made, according to cablegrams received by Charlie Garland, director of WBBM, following the test.

The program, which was made up of request numbers from New Zealand listeners, was broadcast at the invitation of prominent New Zealand radio listeners who had reported reception of the aftermidnight program from WBBM with great clearness and volume.

Humorous Experiences of an Announcer

In which the trials and tribulations of the announcing gentry are detailed

By CLARENCE JOHN INGRAM

TO THE person who today pulls the filament switch of a modern radio receiver, and then tunes in one of the really high class stations which provide the varied daily programs, the one thing which impresses (if anything causes serious thought concerning the studio workings) is the smoothness, and timetable like precision with which one feature after another is sent out through "Mike." It probably never enters the mind of most listeners that operators, announcers, and studio managers, encounter experiences and situations which would try the patience of Job, were he among us today; or else, if viewed through the eyes of the late Mark Twain, prove as humorous as anything ever written by the Mississippi flatboatman.

I first faced a microphone as an announcer back in the trail blazing days of radio, in December of 1921 to be exact, and have been afforded many a chuckle, when in retrospect I mentally reviewed experiences I had while engaged in the interesting pastime of "giving artists—real and alleged—the air."

When I first faced the "vast and unknown radio audience," which was after all not so vast at that time, at Station XYZ (which of course were not the call letters) radio was almost unknown to the general public. In a vague way it was known of as something closely akin to Black Magic, by means of which ships were able to communicate with one another when in distress.

At this period in the development of broadcasting to ask an artist to give a radio program was to arouse a serious doubt as to your mental state. True, this skepticism was soon replaced by conviction and enthusiasm, but one experience I had at that time is worth retelling.

Wouldn't Believe It

FOR obvious reasons I must give fictitious names but in all other respects this story is true. In the city where station "XYZ" was located there was a male quartette with an international reputation. I arranged for a concert by this quartette. On the night of their appearance everyone who possessed a receiver, and who was within range of "XYZ", had headphones on anxious to hear the singers in their radio debut. After the quartette had put over several numbers in their inimitable style, and the telephone number of the station had been announced several times, (it was the proper thing to do in those hectic days) the station phone was kept busy by listeners calling to commend the singers. These reports were acknowledged "over the air" and of course the members of the quartette heard the various names announced.

Among the many who phoned in were personal friends of the singers, some of whom were unknown to those of us at the station. This, it would seem, was proof positive that the music was "going out." I noticed that one member of the quartette, we'll call him "Harry Miller" because that isn't his name, seemed to be unimpressed and wore a cynical expression. The others were apparently elated with the success of their radio debut, and as name after name of friends came in "via telephone," their joy increased.

The program ran for an hour and at its conclusion we were all as happy as children on Christmas morn—that is all except "Harry Miller." After I had thanked the members of the quartette for about the sixth time and had lauded them to the skies, just as they were leaving the studio "Harry Miller" turned and said, "You can't kid me, I don't believe a damn note ever left this room!" . . . When I revived the quartette was gone.

This quartette subsequently appeared frequently for me at "XYZ" and apparently "Harry Miller" became convinced, for he never again accused me of trying to "kid him." Only a few weeks ago I tuned in one of the local stations and listened to this quartette, and heard "Harry Miller" sing a solo. It gave me a hearty laugh when it brought back to mind "Harry's" introduction to radio.

Not In Repertoire

ANOTHER time we were broadcasting a joint recital by a young soprano, "Bessie Boyce" we'll call her, (she is now a headliner in musical comedy,) and "Thomas Reynolds," operatic tenor. Both were extremely nervous and this nervousness seemed to increase as report after report was acknowledged. Among the reports received were some making the usual request for special numbers. In acknowledging these reports between numbers I indulged in a bit of good natured "kidding", more to place the young singers at their ease than to appear "funny," and said, among other things, "perhaps we can prevail upon one of the singers to render the 'Flower Song from Pillsbury' for us," and turning to "Bessie Boyce" I added, "Will you oblige Miss Boyce?" However this sally had the opposite effect from what I had hoped for "Miss Boyce" became completely a victim of panic and stammered, "I don't know that aria very well but "Mr. Reynolds" does." I turned inquiringly to "Mr. Reynolds," whom I discovered had become as red as the proverbial beet and was nervously toying with his watch chain. "How about it Mr. Reynolds?" I asked, and to my surprise my young tenor friend said in all seriousness, "I'd

be glad to but I haven't the music with me."

This experience merely shows how panic will seize artists, who ordinarily are completely at ease before large audiences, when they face the microphone for the first time. Both of these artists knew there was no such musical composition as the "Flower Song from Pillsbury," but in their eagerness to please, and nervousness in facing the "mike", the name of the selection requested failed to register upon their minds.

Sunday evenings at "XYZ" we broadcast a half hour radio chapel service. We sought to give each denomination an opportunity of conducting these services, and invited all to participate. The various pastors of the city gladly cooperated, prepared special sermons and brought their choirs and organists to the studio. These services became a popular feature, and we received a request from a certain religious sect asking that they be given the opportunity of conducting one of their services at the station. We cheerfully agreed and arranged a date for them.

On the appointed day they arrived at the studio and were given the usual instructions concerning the distance to stand from the microphone, etc. When the proper time arrived I made the customary preliminary announcements and introductions and the service opened.

There were ten in the group, five men and five women, to conduct the service, and I thought at the time that their individual and collective appearances left much to be desired. However, if they had a message to deliver and were engaged in the Lord's work who was I to pass judgment, though secretly I was thankful for the blindness of radio.

Phonograph Saves The Day

THE service opened with a hymn by entire 'ensemble.' What this lacked in musical quality was perhaps compensated for by the fervor of the singers. As I listened to their opening rendition I experienced a sinking sensation. But I consoled myself with the thought that possibly their service would improve as they "warmed up."

They "warmed up" alright but there was no improvement, at least not from my viewpoint! The opening hymn concluded their "pastor" delivered an extemporaneous prayer, in which he asked for everything except the New York Central Railroad, following which the most weebegone female of their group attempted an alleged soprano solo of an anthem. It was terrible, but I was comforted and able to bear it by recalling to mind what the early Christian martyrs

(Continued on page 44)

*A Radio
Entertainer
Who
Makes
His
Repertoire*



*Conform
to the
Wishes
of
Air
Listeners*

He feels perfectly at home with WBBM

TO THE readers of Radio Age who have formed the habit of spinning their dials to 226 meters, the pleasing voice of Maurice B. Silverman has become an established institution. His ability to adapt his song and style to fit the program is responsible in a great measure for the well deserved popularity he has attained.

Mr. Silverman, like Charlie Garland, the genial director of WBBM, attempts to select his repertoire in accordance with the requests from his audience.

And so in response to the demands of a number of his admirers we present this opportunity of peering beyond the microphone into the life of the popular entertainer.

But let Mr. Silverman tell about it in his own way:

“**B**BROADCASTING gets into the system” he said. “I suppose a good and terse description of why I enjoy it is to say I get a great big kick out of it. I have been singing as far back as I can remember. In fact, when I was a youngster, my ambition was to be an actor. I don’t know why, because nobody ever accused me of having talent that the world would pay a price to see and hear. Anyway, I never did quite realize my ambition, except to take part in amateur theatricals—mostly singing parts. Now I’m an advertising man. Who knows—perhaps broadcasting and advertising to me were synonymous.

“It was just one of those little incidents that got me to be an air bug. I was tun-

ing in long distance stations one evening and I got some strange sounds on new dial readings. I thought surely I had Honolulu—until the announcer brought me back close to home. In fact, it was so close that I could see the towers from my back porch. You guessed it. It was station WBBM. A day later I quite casually remarked to a friend who resides in the Broadmoor Hotel where the station is located, I would like to sing over the air. In a few days I got a call to c’mon over. I went to the home of Mr. Atlass, owner of the station, stood before the mike, and—there you are.

“There are peculiarities about some voices that make them suitable for broadcasting. I have heard singers with beautiful, melodious voices, and these same singers went ‘flat’ over the air. I am fortunate in having put my stuff over via the microphone route. When asked to sing otherwise, I invariably beg off. I don’t like to spoil the illusion. I’ve been successful as a broadcast entertainer. Why take a chance?

“The fascinating part about singing to the great audience of invisible listeners is that you are ever wondering how they are receiving your offerings. The silence of the studio, and the businesslike manner in which the work around the studio is conducted, gives the performer little encouragement. But when letters come in from far off places, that’s where the real thrill begins. And when your friends meet you and thank you for entertaining them, it makes you feel as though you are

really doing something worth while. It helps a fellow keep in touch with his relatives, too. That’s a great time saver— isn’t it?

“**W**BBM is a habit with me. With a few exceptions, I have done all my air singing from that station. It’s a home-like place to me. I feel I have a personal interest in it and in all the members of the staff—and in Leslie and Ralph Atlass, too. They own the station, you know—and they are a couple of dandy boys. I’ve been dividing my time between the studios at the Broadmoor Hotel and Stewart Warner. I feel perfectly at home in both places.

“What kind of songs do I prefer to sing? Well, you see, a singer likes to please his entire audience. So I do a bit of everything—adapt myself to the nature of the program that holds sway at the time. I have had streaks when I featured the Irish melodies of Olcott. Again, I get a craving to see how I can put over a few melodies of McCormick. Then I will do some real jazzy stuff. And then I try the character numbers with a sandwich of poetry recited for the sake of variation. I really like the songs that enable me to interpret the composers’ thoughts. ‘Waiting for Ships That Never Come In’ is a number I have been requested to repeat several times. But my aim is to try and please the listeners. In fact, that is the chief incentive of everyone who broadcasts. That’s why we always appreciate receiving communications by wire, mail or phone.”

Chicagoan Witnesses KFI's Auditions

Relates method used by this station in picking its radio talent.—By Lindsay McPhail

"PUSH the elevator button 'R' and get off when the elevator stops," says pretty Miss Brundage in the main floor offices of the Earle C. Anthony Motor Co. in answer to my query as to the location of hostilities of Radio KFI. Yes, folks, Radio KFI is just the way they announce it out on the West Coast, or RADIO KHJ, or RADIO anything, just as brief and to the point as possible.

To go on, the elevator did stop, sure enough, right at the radio studio on the fifth floor, and I alighted from the self-service elevator to find the busiest radio station I had ever seen in my life.

A radio singer, Miss Delbridge, was singing a grand opera aria, with my good

friend, Les Adams, at the piano. I stepped a few paces around to the outside right of the studio proper, into a room where at least twenty people were waiting, some standing, some seated. Soon Miss Delbridge had finished singing her song—but, to my surprise, there was no attempt made to announce her. However, in a minute or two a deep voice shouted out over the Mike, "Miss Hansen in the studio, please!"

"My stars!" says I to myself, says I, "what a dizzy way to conduct a program!" Still, I soon realized what I took to be a broadcast program was nothing but a tryout for talent. Yet, why was I supposed to know that?

Surely enough, this was Friday—"Audition day" at Radio KFI. RADIO KFI—don't forget that. Friday afternoon from two to five is the tryout session of this important station. A very rigid test is put to each "ham" attempting to become an "artist". I'd hate to appear before this jury of entertainment—for it's *cruel*. At least two of the announcers, one of them a program director, sit outside the studio, right in amongst the future victims, and cut the poor tryout acts to pieces. Miss Hansen, who you remember was called into the studio in the last paragraph, was an elocutionist. She elocutioned. "Terrible, Horrible, Impossible!!!" came in grunts from the jury outside; "sounds like a peddler trying to sell his last peck of potatoes!" Then, a few minutes later, the same "Jury" was breathing easier. "Ah, not so bad" was their tone, as Miss Morgan sang her song; Miss Morgan was young, sweet, beautiful, of long titian tresses, but that's not the reason Glen Rice, chief announcer and director of Radio KFI, said "Not so bad"—she really *could* sing, and was later signed up to sing for the station for three months.

"Mr. Schmidt," came over the Mike once more from Les Adams, "come into the studio, please." Mr. Schmidt was a violinist with the usual line of the "punk" performer, and he started in with the usual talk of "I vas vunce in the Pittsburgh Symphony Orchestra," (just once!) and then "My chee string iss yet a little damp;" then, "accompanied Madame Schoemaker-Tack in concert from New York to Chicago." (Then he had to walk back to New York.)

"ALL right, all right, but you're not there now," came Adams' reply; "you're in Radio KFI. Let's go!" and then Schmidt played, or rather sawed vigorously, keeping the rosin manufacturers in business for fair. Just then a funny thing happened. In the midst of this terrible operation, two of the violin strings broke simultaneously. One flew back and hit Schmidt in the eye. "Got in Himmel!" came over the Mike—in German—and whatnot in English. Needless to say, Schmidt was not hired. They "took his telephone number," which is the diplomatic way of saying "Not so good." All the foregoing is to show how critical Radio KFI is when it comes to picking new talent. Out of twenty aspirants, only three entertainers were picked this day!

Inside the studio of KFI there are no drapes to be seen. The studio is ordinary sized, a Chickering grand piano is in evi-



The Park Sisters, June and Frances, ukelele and vocal duet artists.



A group of employes at KFI.

dence, the ceiling or "roof" is sort of semi-hexagon in shape, and the walls from half way up to the top are covered with monkcloth, one thickness, with nothing but a colored plaster wall from this same half-way point to the floor. The ceiling is quite high, at least twenty feet. On the east wall is a large green light, in sight of every one, and over it a sign reading "WHEN THE GREEN LIGHT IS BURNING EVERY SOUND IS BROADCAST BY RADIO," and on the south wall one reads: "OUT OF COURTESY TO THE ARTISTS WHO PERFORM THERE WILL BE NO SMOKING PERMITTED IN THIS STUDIO," and so on.

"COME on back to our operating room," spoke up hospitable Glen Rice at this time. "I'm sure you'd like to see the room and meet our operators." Back into the operating room we went (sounds like a convention of doctors, doesn't it?) and here we met friendly (they're all friendly in California) F. W. Lilly, the chief engineer. Mr. Rice left me to Mr. Lilly, who went on to explain the operating devices in the huge room, where there really are three rooms in one. These three rooms are the control room, the largest of the three, the transmitter room, and the generator room, which contains a set of three motor generators and a power switchboard, with a spare set of generators in case of accident to the main set.

There is an item of human interest which I think should be mentioned here, out of courtesy to this station. An operator sits at a loud speaker on the small table, seemingly enjoying the KFI program in sway, but he's not. He is a special code operator, and picks out the

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Louise Klos, harpist.

Find Fifty-Three

Sources of Radio Interference

POWER companies in the United States are paying a great deal of attention to radio interference and means of preventing it, according to E. P. Peck, vice-president of the Utica Gas and Electric Co., at Utica, N. Y., who recently addressed members of the Utica Radio Association on this subject.

One of the points developed by Mr. Peck is the list of probable causes of interference as outlined in this story, and where possible the remedy. These causes were tabulated as a result of a great deal of work on the part of the power companies and allied interests, all of whom have an interest, direct or indirect, in radio reception.

The causes outlined, of which there are 53 so far, are as follows:—

Sources of Interference

In Receiver or Apparatus Connected To It.

1. Improperly tuned receiver
2. Loose connection in receiver or broken wires in head-phone or loud speaker cord
3. Defective grid leak
4. Defective tuning condensers—momentary shorting of condenser plates
5. Fixed condenser with defective insulation
6. Discharged or weak batteries
7. Loose connections at batteries
8. "B" battery eliminators: electrolytic type under certain conditions
9. Bad socket
10. Bad tube

From Apparatus In Same House with Receiver or in Neighbor's House

11. Vacuum cleaners
12. Sewing machine motors—any commutator motor
13. Violet-ray machines
14. Ozonators
15. Door bells and buzzers
16. Switching of lamps or other electrical devices
17. Electrical heating pads with thermostat control
18. Oil burners using spark ignition—certain types
19. Washing machines with split-phase type of motor—starting switch defective
20. Battery chargers; vibrating type
21. Battery chargers; electrolytic type—under certain conditions
22. Elevator controllers and motors of the commutator type
23. Bad contact in switch, fuse, socket, or other device
24. Hum caused by having radio receiver or its wiring near lighting wires

From Outside Sources

25. Atmospheric static
26. Regenerative receivers
27. Sign flashers
28. Commercial wireless (code) station
29. Amateur wireless stations
30. Induction coils
31. Electric street cars
32. Defective rail bonds on street railway systems

Recent address of E. P. Peck, Vice-President of Utica Gas and Electric Co., gives wealth of useful information

33. Heterodyning of broadcasting stations
34. Overlapping of broadcasting stations
35. Telephone ringers
36. Induction from telephone and telegraph lines
37. Motion picture machines using arc lamp
38. Motors and generators of the commutator type
39. Electric welding apparatus
40. X-ray machines
41. Static machines
42. Static produced by belts
43. Electrical manufacturing processes
44. Induction from high potential circuits
45. Arcing wire in trees and other grounded objects
46. Leaking insulators on power circuits
47. Defective lightning arresters—power circuits
48. Loose street lamp in socket
49. Bad contact in switches
50. Lightning arresters
51. Smoke or dust precipitators
52. Defective transformer
53. Defective street light rectifiers

Not all Sources

THIS does not cover all possible sources of trouble by a great deal. However, in this list, it is seen that there are ten possible kinds of trouble that can be caused by your own receiver or the apparatus connecting to it. There are fourteen kinds of trouble that may occur in the electric equipment in your own house or in the neighbor's house. There are thirty sources of trouble that ordinarily are outside your house, and of these nine may be in the power company's lines or equipment. The power company is very desirous of locating and correcting every case of radio interference caused by its lines or equipment. The power company, however, is organized for the purpose of delivering electric service to its customers at the lowest possible cost, and they cannot incur unjustified expenses. Your power company would be subject to severe criticism if it incurred large expenses for things entirely outside its normal business. You can see from the list of probable causes of interference, only a small fraction of the troubles experienced by broadcast listeners are due to the power company's equipment.

The power company cannot undertake to correct radio troubles not caused by its system, and it should not be called on to investigate sources of trouble over which it has no control. Each one of you has the duty of finding out whether the trouble is caused by your own set or by something in your own house before you call on the power company. If you are not capable of making the necessary simple tests, or do not care to make them, you should call on the radio dealer who supplied your set for this assistance and you should expect to pay him for his work.

The Canadian publication on interference has covered these tests quite well, and the following quotations are made from their report. It is strongly recommended you make these tests yourselves in case you are experiencing interference, other than static, to your reception.

Try These Tests

FIRST TEST: To determine if the noise in the receiver is due to a fault in your receiver or is actually interference coming in on the air. Disconnect your aerial and ground wires. If there is no reduction in the intensity of the noise while the broadcast music is stopped by the disconnection, the probability is that the source of the noise is in your own receiving set, in the form of a loose connection, faulty batteries, or defective tubes.

Shake your ground wire near the ground connection to make sure that the noise you hear is not caused by a bad connection at this point.

Second Test: To determine whether the interference originates in your own house lighting circuit.

From cases of interference investigated it has been found that a great number of these are of a purely local nature, originating in such sources as a lamp loose in its socket, or a loose plug of a heater, or from faulty household apparatus. While the interference is continuous, open your main house-lighting switch for a few seconds, at the same time listening in on the receiver. If the interference stops when the switch is open, the source of the interference is probably in your own circuit. This test should be repeated several times, however, as there may have been a misleading coincidence with something occurring outside at the instant this switch was opened. Many sources of interference do not start again immediately as the switch is closed, so that observations taken at the instant of opening the switch are more reliable than those taken at the instant of closing it.

Third Test: To determine the extent of the area affected by this interference.

When you are assured that the interference comes in on the air and does not originate in your own set or in your own house-lighting circuit, you should communicate with others in your district who have Radio receivers. Great care should

(Turn to page 55)

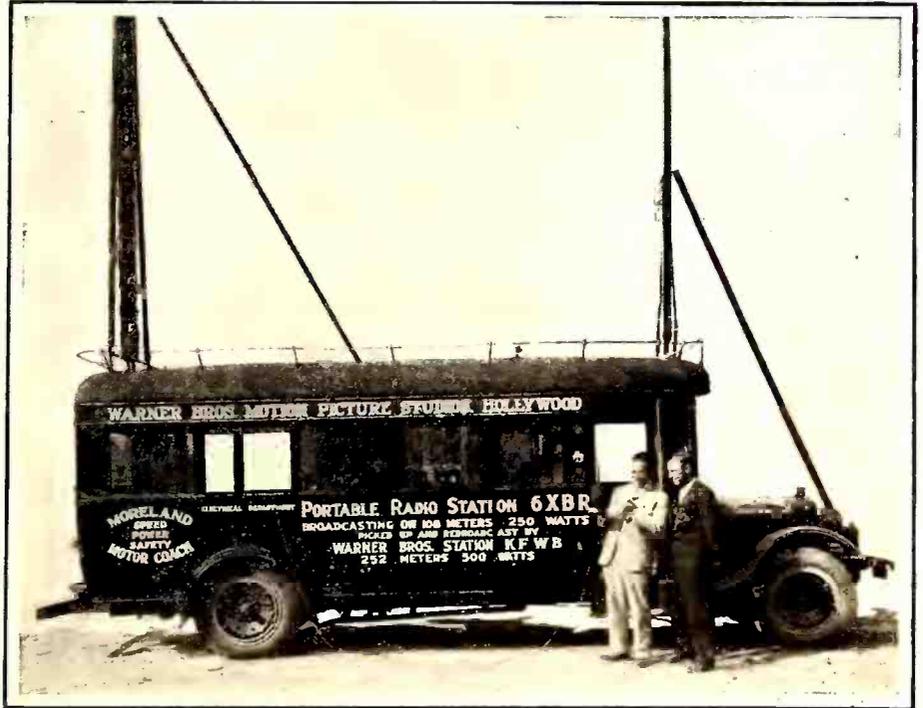
Two Views of Warner Bros. Portable Transmitter 6XBR

THE portable radio broadcasting station of Warner Brothers' motion picture studio and Radio KFVB is the largest of its kind to be built. The Department of Commerce has issued call letters 6XBR on 108 meters, 250 watts of power.

The set has been operated under all conditions and has shown its worth in every way. It fills a long felt want for a station on wheels. It can be run out and set up in a few minutes' notice. It can also be brought to play in less than fifteen minutes after reaching its destination.

The apparatus is mounted on a Moreland motor coach, which is twenty-two feet long, behind the dash, and gives ample room for the 4 panels and the transmitter.

The antenna system consists of two collapsible towers that fold down against the top of the truck, and when extended reach the height of forty-five feet at the high end—twenty-five feet at the low. The wires are brought down in a fan and fastened to the lead in insulator. The counterpoise runs around the top edge of the truck, being left open in front. The transmitter is of two hundred and fifty watts, using coupled Hartley circuit. A maximum amount of coupling is used to keep the wave steady and sharp. The antenna circuit is detuned thirty-three per cent in order to keep the wave steady. The tuned grid and plate circuit was given consideration but it was thought the Hartley circuit properly



6XBR Ready to broadcast. Charlie Wellman, left, manager and announcer at Warner Brothers' radio station KFVB, Hollywood, California, and Frank N. Murphy, Chief Electrical Engineer, right.

placed would give better results. Constant current (Heissing) system of modulation is used with the usual success. A fifty watt act as a speech amplifier

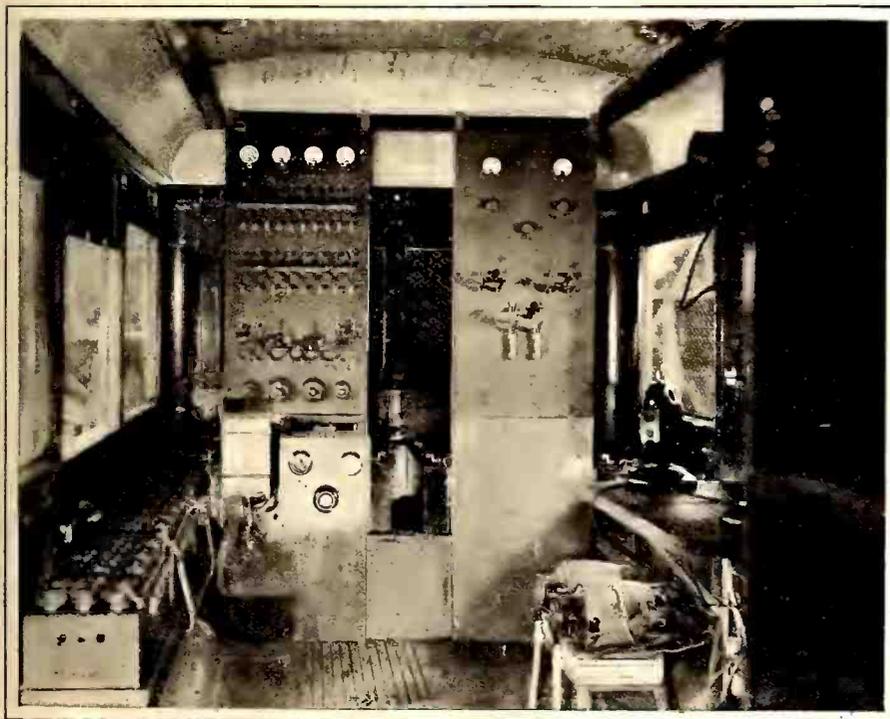
for the 250 watt modulator. The speech amplifier is coupled to the modulator by the use of transformers. This stage of amplification is very much like the ordinary receiving set except that the transformers are built to carry 1,500 volts and the added volume of voice which is needed to modulate 250 watts.

The input panel uses two stages of power amplification with a third stage when needed. These stages are impedance coupled to give better and clearer amplification. This panel delivers about ten watts of energy to the fifty watt speech amplifier. A 500,000 ohm potentiometer controls the volume of the input panel. A jack and plug arrangement is used in all circuits to test the plate current. Two microphones may be used and a switch is provided for changing from one to the other. A separate panel controls the power for the generators. A fourth panel controls the entire power supply.

The two generators are supplied with 24 volts direct current and deliver 1,500 volts D.C. running at 6,000 R.P.M. Four hours of steady service is had from one charging of the batteries. Jelly batteries are used throughout, both for the generators and filament.

Particular care was taken to run all wires in the truck whether from batteries to tubes, or from one panel to the other in lead, covered cable all of which are grounded. This keeps any radio frequency out of all the circuits.

(Turn to page 60)



Warner Brothers' portable radio station 6XBR. Closeup of battery racks charging panel, generators and power panel.

ANNOUNCEMENT

The 1926 Radio Age Annual Is Now Ready

TO MOST RADIO FANS the Radio Age Annual needs no introduction. Thousands of fans from all over the world have been waiting for this announcement of our 1926 ANNUAL, and we have a great treat in store for them.

Many pages of blueprints of the most successful hook-ups of the year, along with complete descriptions of these sets. Technical articles on every phase of radio written by unbiased radio experts. Photographs and illustrations by the score. A complete list of broadcasting stations with a log you can easily fill. These are just a few of the things that will make the RADIO AGE ANNUAL for 1926 the most talked of and widely read book about radio.

The price of this book is \$1.00. If after receiving your copy you are not completely satisfied, return the Annual and we will refund your dollar. For the past two years our Annuals have been sold on a money-back-if-not-satisfied guarantee. Out of the many thousands of copies sold only one came back! (You can't please everyone.)

The number of copies available is limited. Use the coupon below and be sure of getting the 1926 RADIO AGE ANNUAL as soon as it is off the press!

To those fans who have never before been the proud owners of a RADIO AGE ANNUAL we are making a special offer. For only \$2.50 we will send the 1926 ANNUAL, and include also a copy of the 1925 ANNUAL and a copy of the 1924 ANNUAL. A complete library of three years activity in set building and technical writing. Don't miss this opportunity to add to your knowledge of radio. Use the Coupon below.

Everything from the smallest to the largest, the simplest to the most complex circuits known to radio. A technical library; a how-to-make book that has no equal; a book you will be proud to own. The RADIO AGE ANNUAL for 1926.

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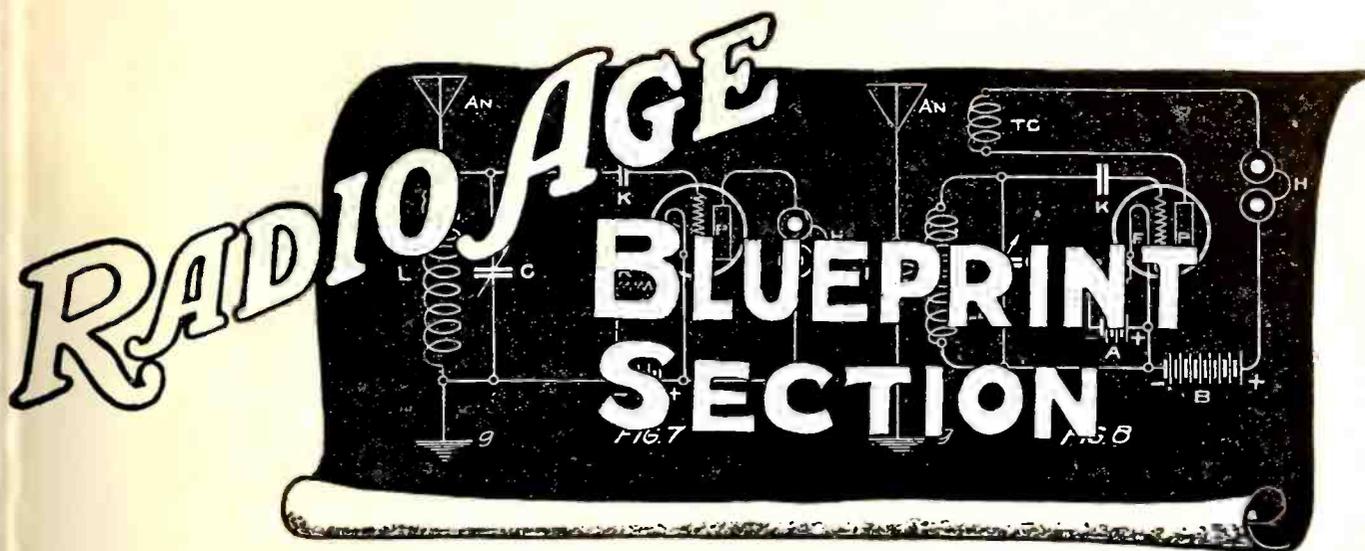
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 \$2.50 for one each of the 1924, 1925 and 1926 ANNUALS.

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2-26



1001 Hookups Possible With

Universal Test Board

By JOHN B. RATHBURN

RADIO experimenters who enjoy trying out the various receiver hook-ups published from time to time will find the universal test board a very convenient and rapid method of making connections. Really, it is a modification of the old time "bread-board" system which has been used by experimenters for years, but as the principal elements of the receiver circuit are mounted permanently on the board, and pin jacks are used for making the connections, it avoids the delay and nuisance of tightening wires under binding posts or of soldering. Connections that formerly took hours because of the time consumed in connecting wires to the apparatus can now be made in a few minutes by inserting the tip plugs into the small connection jacks.

As now arranged, the board will accommodate any radio receiver circuit containing from one to six tubes, and designed for operation on the ordinary band of broadcasting wavelengths. Three variable condensers which can be utilized for tuning operations and rheostats for controlling the filament current are built directly and permanently into the board as they are essentials of nearly every receiver hook-up. The same is true of the sockets, battery connections and instruments for measuring the current and voltage. Tuning inductances were not included in the present layout for the reason that such coils are sometimes specially wound for the circuit being tested and also for the reason that it is often required to make tests on the coils themselves which would be impossible

with standard coils mounted in place. The same applies to the audio frequency transformers, which are not shown, for sometimes resistance coupled audio stages are required in place of the transformer coupled type, and in such a case, the transformers would be decidedly in the way.

Simplification of the board has as much to do with its successful application as its completeness in regard to equipment, and while we might have shown a sample of every type of radio unit mounted in place, yet so much apparatus would have complicated the board to such an extent as to make its use very difficult, thus at least partly defeating the primary object of the board. Too much apparatus, permanently installed, is as bad or worse than a deficiency.

Every amateur knows the danger and difficulty of using odd lengths of annunciator wire or cotton covered magnet wire in making connections, and possibly all of us have at some time blown out a tube or wrecked a coil because of defective insulation on such wires. The insulation always had a way of fraying off unexpectedly and left a bare section of copper that was almost sure to cause trouble sooner or later. In the Universal test board this difficulty is overcome by the use of braided rubber covered fixture wire, similar to that used in the wiring of chandeliers or similar lighting fixtures, and with this insulation one may be sure of protection against plate voltage shorts on as high as 350 volts. Phone tips are then soldered to the ends of the fixture

wire for contact with the jacks, and after the end of the braid is carefully waxed there will be no danger of fraying.

Connection is made from point to point by inserting the tips into the jacks of the mounted apparatus or into the numerous blank spares placed around the panel at convenient intervals. At points where more than one connection is likely to be made to the terminals of the apparatus, double jacks are connected in parallel. This is true of the variable condenser connections and similar places. Spare jacks for parallel connections are inserted between the condenser unit groups so intermediates or bypass condensers can be quickly inserted.

General Layout of Panel

ALAYOUT scheme was followed which corresponds closely to the unit sequence of a radio frequency circuit, that is, arrangements were made for the tuning units at the left end of the panel in accord with most schematic diagrams, while holes were drilled at the right hand end for the audio frequency equipment. Thus, starting at the left hand edge, come the three variable condensers with connections and holes for the tuning inductances, with the rheostatic controls at approximately the center of the panel. At the right hand or output end are the Amperites for fixed control of the audio frequency tube filaments and the output posts.

A schematic diagram showing the connections of a typical five tube hook-up

(Turn to page 39)

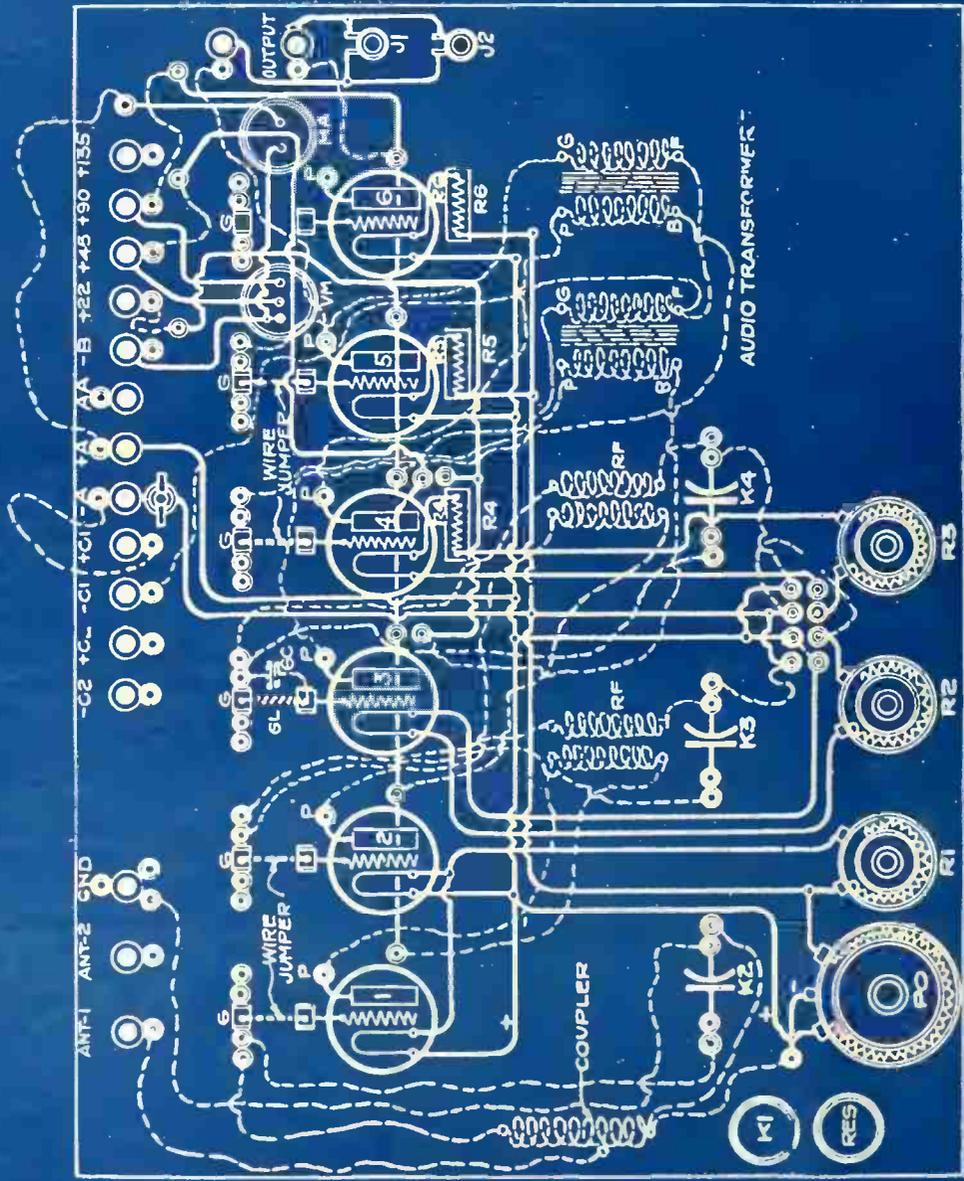


FIG. 1
SCHEMATIC WIRING PROBLEM
 FULL SOLID LINES SHOW PARTS AND WIRING PERMANENTLY INSTALLED. DOTTED LINES INDICATE PARTS AND WIRING TEMPORARILY CONNECTED FOR TESTING AND EXPERIMENTAL PURPOSES.

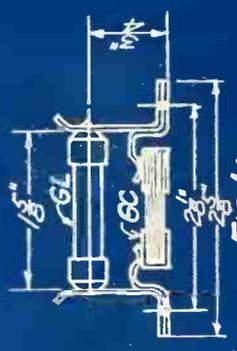


FIG. 1A
GRID LEAK COND. MFG.

(Continued from page 37)

is shown on the first blueprint, Fig. 1. It should be understood that this diagram is only one example of the thousands of circuits possible on the board, and that it is essentially for the purpose of illustrating the use of the device in making experimental hook-ups. For this reason only the permanent parts of the board are shown in full heavy lines while the temporarily attached parts and also the wiring are shown in dotted lines to distinguish the test parts from those temporarily installed.

To distinguish the wiring connections from the outlines of the temporary parts, the wires are shown as wavy irregular dotted lines, terminated at either end by the small triple circles that indicate the connection jacks. Drawn in this way, it is easy to understand the part that the jacks play in the connection of the circuit. At other points will be seen the spare and unconnected jacks that have not been used in this test circuit but which may be useful in some other type. Battery binding posts are located along the back (Upper) edge of the panel so that they will be out of the way of the operator when he is working on the panel, but at the same time so that they will be in full view at all times.

Each of the battery binding posts is marked with its nature and voltage in the usual way with extensions brought down to the main through busbar which run the full length of the panel. The filament current is taken in at the posts marked (—A) and (+A) with an auxiliary post (AA) used in cases where 8 volt tubes are used in the amplifying stages, and a special jack (JA) is installed for making this connection when necessary. A battery switch (SW) in the (—A) line cuts off the battery current. It is becoming very common practice to employ two filament voltages since the new eight volt power tubes have been placed on the market, hence the 8.0 volt line is brought down into the audio frequency stages only, or so that it can be connected to the last two tube sockets at the right.

"B" battery connections are shown for 22.5 volts, 45.0 volts, 67.5 volts, 90 volts, and 135 volts, but the later voltage is only run as far as the last two audio stages for obvious reasons. Next to the "A" posts come two sets of connections for the "C" battery, one set marked (—C1) and (+C1) being for biasing the audio stages while (—C2) and (+C2) are for the radio frequency circuit when this division is to be supplied with a battery bias in the grid return circuit. There are circuits in which more bias batteries are used, but such cases are not common. Both Jacks (J1-J2) and binding posts are placed in the "Output" at the right so that any sort of connection can be had with the phones or loud speaker.

Negative B Return

ONE problem that was difficult to solve was that problem involved in making the interconnections between the "A" and "A" batteries that occurs in every circuit. For example, in some circuits the (+A) and (—B) are connected together while in others the connection is made between (—A) and (—B).

Actually it does not usually make a great deal of difference in a receiving set which connection is used, but for the sake of conforming with the various diagrams a permanent cord tip is connected to the (—B) post which can be plugged into either tip jack connected to the (—A) or (+A) posts. As shown, the cord from (—B) is plugged into the (+A) jack. A third jack (J5) is connected to the (—A) post so that it can be connected to ground as is generally necessary in the majority of circuits. It is in use in the circuit illustrated.

Two antenna connection posts (ANT-1) and (ANT-2) are provided for tapping into the primary circuit of the antenna coupler. Two are necessary with the present day single circuit antenna inductance which is generally provided with one tap for broad tuning and one antenna tap for sharper tuning. The ground post at (GND) needs no further comment except that it is provided with three jacks.

All sockets are of the standard Navy type. When the UV-199, UX-120 or other odd base tubes are employed it will

Here is the Answer to the Radio Fan's Prayer!

In this article Mr. Rathbun has considered the wishes of many Radio Age readers and presented a simple, yet effective, method of making tests of various circuits without having to do an endless amount of wiring and connecting of wires and apparatus.

By means of the Universal test board described in these pages any reader who has any curiosity as to the values of the many circuits he reads about, may readily test their worth and assure himself a maximum of pleasure and education while going through the process.

be necessary to use adapters. Any socket can be used independently or as many may be used as required—five in the circuit illustrated. While theoretically, a rheostat should be supplied with every socket, yet this led to so much complication that a compromise was decided upon. According to conventional practice, the two radio frequency stages are operated by one rheostat, hence the rheostat (R1) was used to control the first two tubes, marked (1) and (2). As the third tube (3) is generally a detector, it is given an independent rheostat (R2) which controls this tube alone and which may also be used when the tube is acting as a detector without any preceding radio frequency stages.

With a circuit employing three stages of radio frequency the tube (3) is no longer a detector and tube (4) now takes its place. This made the rheostat (R3) necessary for the independent control of tubes (4), and this acts in combination with the Amperite (R4) which is used when tube (4) is an audio amplifier. The remaining audio tubes (5) and (6) are

controlled by the two Amperites (R5) and (R6) for the audio tubes are seldom critical and operate satisfactorily on fixed resistor. As the Amperites allow the full permissible potential on the filaments, the rheostat (R3) simply modifies the action of the Amperite, (R4), reducing the current below normal as may be required with a detector tube.

All grid and plate connections on the sockets are provided with jacks so that they may be connected to the proper part of the circuit, regardless of the relative position of the tube itself. When it comes to a question of polarity in regard to the "A" battery connections, as in the case of the detector tube in which the positive side of the filament must be connected to the grid return, separate jacks are provided which allow the (3) and (4) tubes to be connected either to the positive or negative "A" line as may be required for the proper bias. At (GL) and (GC) are clips for the connection of grid leaks and grid condensers, a set of clips being at each tube where condensers and leaks may be required.

In certain classes of circuits, grid condensers and leaks are used in the radio frequency and audio frequency tubes as well as for the detectors. In amplifying a negative bias is always required, and when the arrangement of the tuning condensers is such that the direct bias through the grid return no longer reaches the grid, then leaks must be provided from "—A" line or from a biasing "C" battery. For this reason, every tube has its condenser and leak clips.

Fig. 1A shows how the condenser and leak clips can be made out of thin sheet brass when they cannot be obtained at your local radio store. A flat Muter type condenser (GC) is held by grooves in the clips while the usual cartridge type leak (GL) is held by depressions sunk in the tops of the clips.

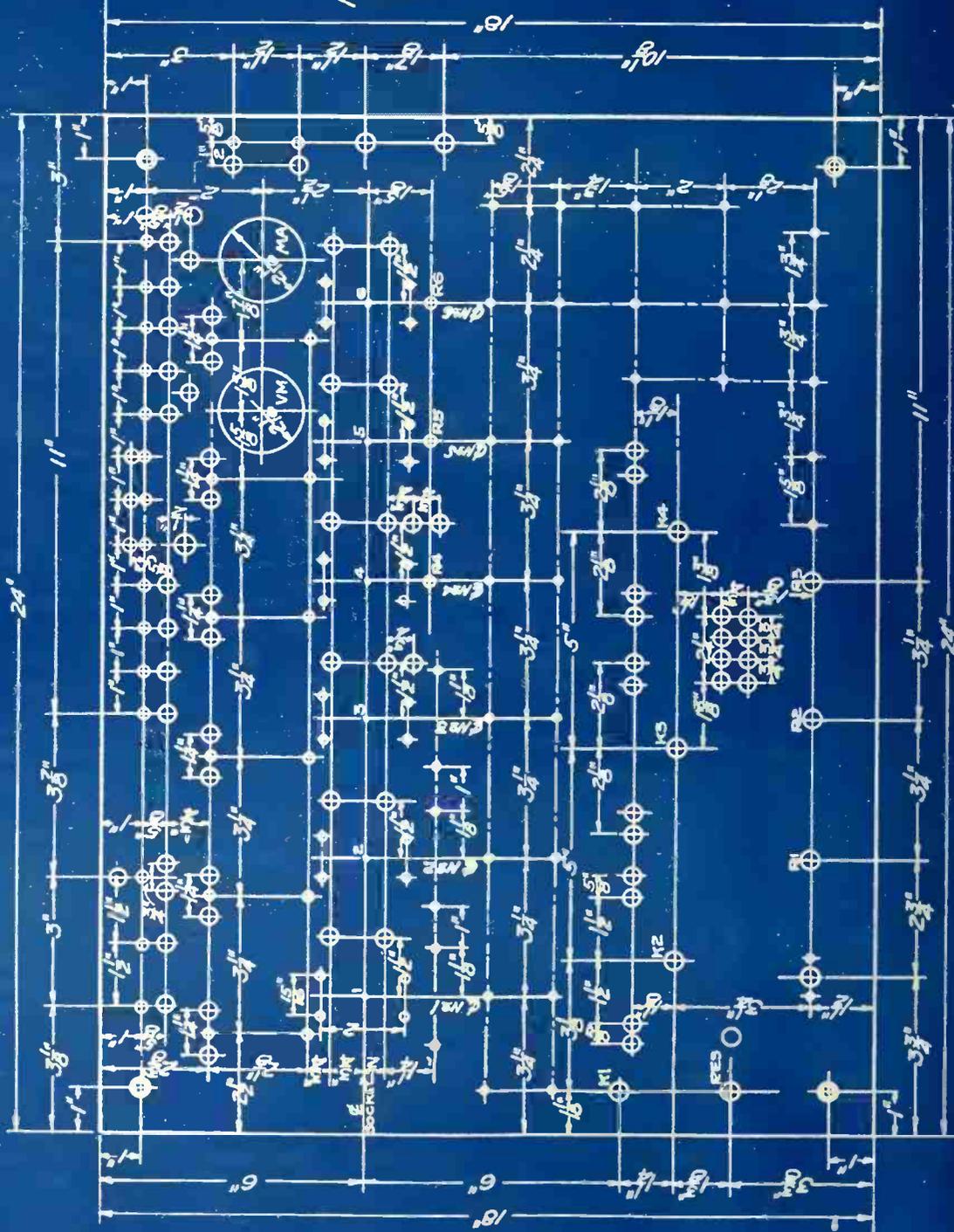
Plate Potential Jacks

CURRENT from the various "B" battery lines is taken from a number of jacks located at various advantageous points, as near the radio frequency and audio frequency stages. There are at least as many connections to the "B" lines as there are tubes, but all of the connections are of course not taken from the same line. As a rule, the radio frequency tubes work best on 45 volts of "B" battery, the detector on either 22.5 or 45 volts while the audio frequency tubes require from 90 to 135 volts for the best performance. When resistance coupling is used in the audio stages it is almost universal practice to use 135 volts on the last three tubes. The layout of the "B" bus-bar has been based on this practice.

Simple "idle holes" have been provided at different points for bolting down the temporary apparatus. Such holes are indicated by single full circles instead of the three concentric circles used for indicating the jacks. In testing, only one or two holes will be all that is necessary for the attachment of the apparatus.

In making comparisons between different hook-ups and to determine the output energy and "space current" of the tubes, it is necessary to include a

(Turn to page 42)



NOTE!
 ALL HOLE CENTERS ARE TO BE
 LOCATED FROM THE CENTERLINES
 OF THE APPARATUS OR FROM THE
 TOP AND LEFT HAND EDGES OF
 THE PANEL.

FIG. 2
 PANEL DRILLING DIAGRAM
 THESE DRILLING DIMENSIONS ARE TRUE ONLY
 FOR TYPES AND NAMES OF APPARATUS SPECI-
 FIED IN THE BILL OF MATERIALS.

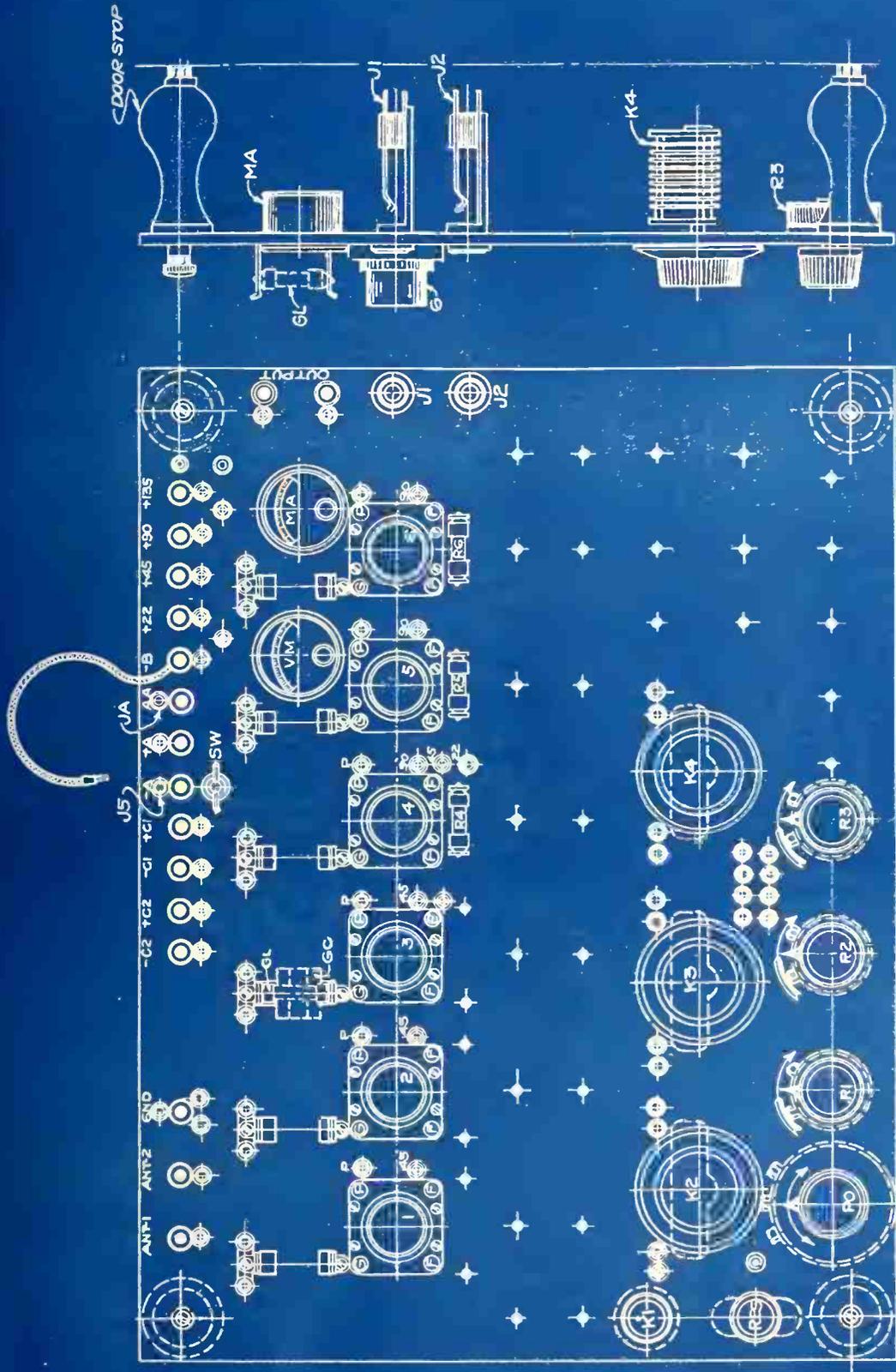


FIG. 3A
END ELEVATION

FIG. 3
PLAN VIEW (LOOKING DOWN ON TOP)
PARTS ALL IN PLACE BUT PERMANENT WIRING NOT INSTALLED. AVOID HAVING METAL CURRENT CARRYING PARTS ABOVE FACE OF PANEL IN WIRING SPACE.

(Continued from page 39)

milliammeter (MA) in the output circuit or at a point where all of the plate current flows through the meter. The milliammeter is shown at (MA) connected in the (-B) line, hence in this position all of the current passes through (MA) no matter what "B" voltage may be used at that time. Other connections can be used for special conditions, but for all around service it has been found that the present arrangement is best.

A known "B" battery plate voltage is imperative for making comparisons between different circuits as the volume of sound depends largely upon the potential on the plates. With weakened batteries or unknown plate voltages an entirely wrong idea may be had of the capabilities of a receiving set, and undoubtedly many excellent circuits have been unjustly condemned because of a weak "B" battery used at the time of the tests. For this reason, a two scale Weston "B" battery voltmeter has been installed at (VM), so arranged that the voltage can be read at any point on the "B" lines, and by means of the two scales can be made to record high or low voltages accurately.

The (0-50) volt scale is used for the 22.5 and 45 volt "B" lines. By turning the button to the other side of its travel the instrument reads voltages up to 100 volts. By means of jack connections between the 90 volt and 135 volt lines, the voltmeter reads the difference between 90 and 135 volts or 45 volts when the batteries are in good condition. To determine the voltage on the 135 volt line, add the voltages found by the latter method to the voltage of the 90 volt line. Of course, a 150 volt scale meter would avoid this complication, but unfortunately voltmeters with a 150 volt scale are rather difficult to obtain on the open market.

Potentiometer Control

DOWN near the lower left hand corner is found a potentiometer (PO) by which the tube bias potential can be regulated on radio frequency circuits. It is shown connected into the first radio stage of the illustrative circuit thus affording a means of controlling free oscillations in the radio frequency stages. The outer binding posts of the potentiometer are connected permanently across the "A" battery lines as usual, but the center post going to the slider member is provided with a jack so that the variable potential can be connected at any point desired, either to the front tube or any other tube in the circuit. Any resistance can be used, but a 400 ohm potentiometer is probably the best.

Two jacks are provided for each of the variable condenser connections for at least two connections are generally made to these devices. The condensers are placed well up toward the back of the board so that working room for the attachment of the inductances will be clear of the condenser dials. It is always advisable to use verniers on these condensers so that sharp circuits can be accurately tuned, but in the present board only plain dials are shown with verni-knobs of the contact type.

One midget condenser (K1) of the

variable type is shown at the left hand end of the panel by which loop regeneration can be controlled in receivers of the superheterodyne type, or it can be used in any one of the many types of circuits where a variable condenser of approximately 0.00045 mfd. is used for controlling the free oscillations of the radio frequency stages. At (RES) is a variable high resistance such as the Bradleyohm used in some circuits for the control of free oscillations. Generally, the range of resistance for this purpose is 10,000 to 100,000 ohms.

Variable Condensers

FOR tuning the radio frequency transformers and the antenna coupler there are the three variable condensers

LIST OF PARTS

- 1—18"x24"x1-4" Formica panel.
- 6—Benjamin "Clearatone" standard tube sockets.
- 3—0.00035 mfd. Erla "Equispace" variable condensers.
- 68—Yaxley Midget jacks for pin connectors.
- 68—Yaxley Midget cord tip connectors for the above jacks.
- 18—Eby binding posts, plain.
- 1—General Radio 400 ohm potentiometer, Type 214A.
- 25—Fixture wire for cord connectors.
- 1—Erla battery switch.
- 2—Carter "Imp" Rheostats, 6 ohms resistance.
- 2—Carter "Imp" Rheostats, 25 ohms resistance.
- 2—Amperites and mountings for 201A tube control.
- 2—Sets of grid condenser and leak mounting clips.
- 2—Muter 0.00025 mfd. fixed grid condensers.
- 2—Muter 0.0005 mfd. fixed grid condensers.
- 1—Weston Milliammeter, 50 volt scale. Panel type.
- 1—Weston Two Scale Voltmeter, 0-50 and 0-100 scales. Panel type.
- 1—Midget condenser, variable.

(K2-K3-K4) located beneath the panel with the shafts projecting above the upper surface for the attachment of the dials. In the majority of cases a capacity of 0.00035 mfd. is sufficient for tuning most of the commercial coils to the broadcasting range of wavelengths hence this size of Erla variable condenser was used, but in any case it is always possible to substitute the 0.0005 mfd. size when required without much derangement of the connections. The condensers used on the trial board are of the straight-line frequency type.

For the convenience of the intending constructor, a list of materials is attached which gives the size and make of the parts used in the construction of the experi-

mental board. This, of course, does not include the parts of the demonstration circuit shown by dotted lines.

Panel Drilling

IN THE second drawing, Fig. 2 is a drilling diagram showing the center to center dimensions used for the holes drilled in the experimental board and for the particular makes of apparatus listed in the bill of materials. When any other make of parts is used this drilling may be changed to agree with the templets of the parts at hand, but in general, the center to center location of the parts themselves should remain in practically the same position.

In the four corners of the panel will be seen holes that are to be used for the attachment of the legs on which the panel is supported. These legs are made from wooden rubber tipped door stops which provide plenty of clearance for the parts hanging below the board. They can be obtained at almost any hardware store or carpenter shop.

Several of the parts are dismantled and the clips are connected direct to the panel. For example, the clips for the Amperites come ready mounted on a strip of insulation when received from the dealer, but to save space the clips are removed from the strip and placed on the panel direct. The tube sockets are mounted entire without dismantling any of the parts, and the Benjamin sockets shown on the panel have shock absorber attachments which make dismantling rather a difficult if not undesirable proposition. Please note that the Erla variables are provided with two holes, one for the main shaft and bushing, and one for a small pilot screw that prevents the condenser from swinging around the main mounting.

Assembly of Board

FIG. 3 shows all of the parts in position but unwired. The dotted lines indicate all parts below the panel in this drawing for this is a plan view looking down on the apparatus, hence the dotted lines must not be confused with the dotted lines used for indicating wires. The supporting legs are indicated by four large circles at each corner of the board with the nuts in full lines. There should be no difficulty in understanding this drawing.

At the right side of the plan view is an elevational view taken from the side which shows the legs, the variable condensers and the rheostats hanging beneath the panel.

Completely Wired Assembly

THE next step in the progress of the construction is the wiring of the assembly as in Fig. 4. This is identical with Fig. 3 with the exception that all dotted lines in Fig. 4 indicate wires run across the bottom of the panel. Foreign wiring to test parts is not shown of course in this view which is meant only to show the permanent wiring. This should be studied in connection with the schematic diagram of Fig. 1.

The permanent wiring on the bottom of the panel is flexible rubber covered

(Turn to page 44)

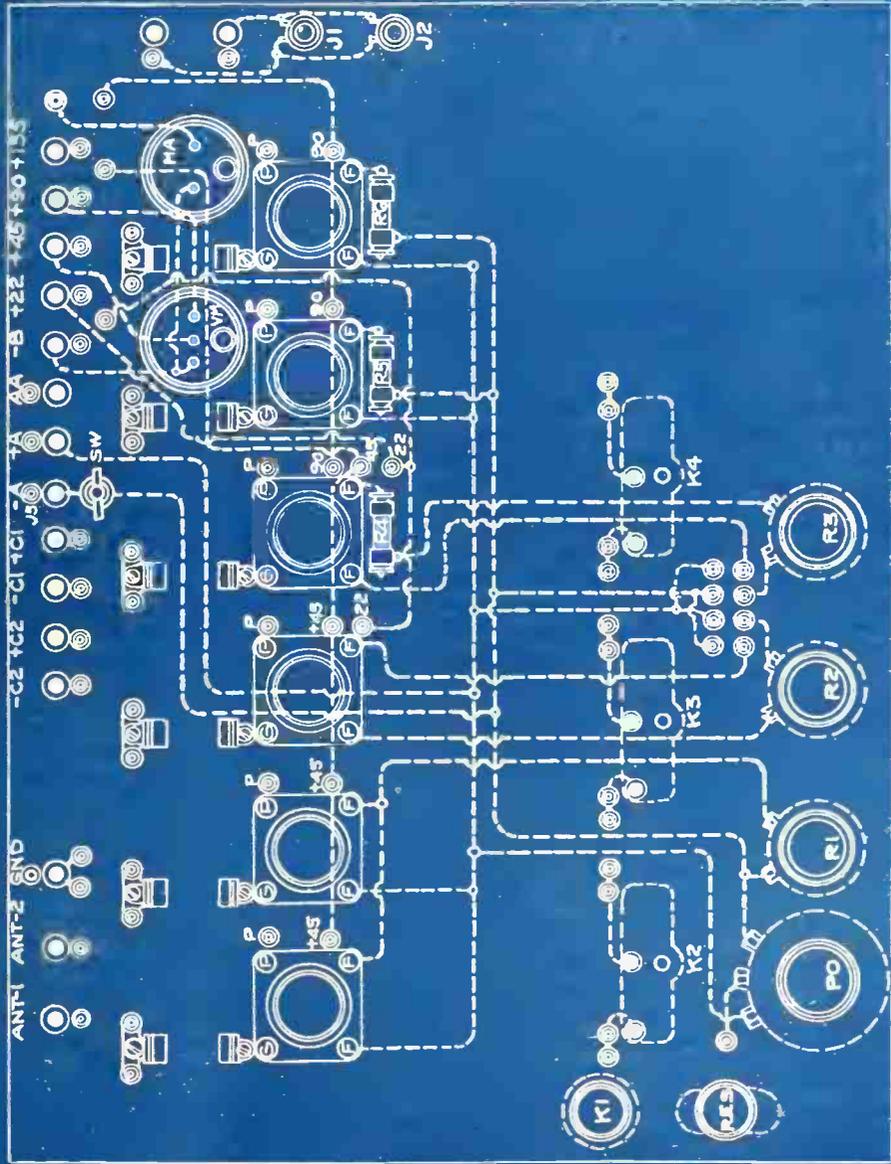


FIG. 4
 PERMANENT WIRING DIAGRAM
 DIAGRAM ABOVE SHOWS CURRENT DISTRIBUTION WIRING PERMANENTLY IN PLACE BELOW THE PANEL.

(Continued from page 42)

wire provided with lugs or eyes soldered at each end. The eyes are then tightened down under the connection screws affording an excellent contact of low resistance and yet one which can be removed with less effort than the conventional type of busbar soldered connection used in the general run of receiving sets. The use of flexible rubber insulated strand also makes it possible to change the connections around without regard to the layout of the apparatus when desired, and without danger of short circuits.

You should be particularly careful to make sure that all connections are firm and clean, and that the jacks are properly connected to the leads. Poor contacts may lead to false conclusions in making a test by introducing an unknown degree of resistance or may cause an actual open circuit.

Both the meters have polarity, and care should be taken that the current passes through the instruments in the proper direction. If the polarity should be reversed there is danger that the needle will be bent or that other damage will be done to these delicate parts. The positive pole of the battery should go to the positive side of the instruments, and the wires should be kept clear from the meters or at least should not be run across the backs.

Testing With the Board

WHEN connecting the board up in position make sure that you have a good ground, made to a cold water pipe wherever possible and to a steam or hot water heating pipe when no other ground is convenient. A good ground is one of the essentials of proper circuit work. Many experimenters have two or even three aeriels, each of a different length so that the effect of aerial length on the tuning of the sets can be studied. While good light is an essential, yet be careful in bringing a drop light in the vicinity of the panel as the cord is likely to cause inductive noises—particularly if an alternating current supply is used.

All batteries should be kept up in first class condition, and storage "B" batteries are highly desirable for the reason that they can be kept up to voltage at all times. A dropping battery voltage, either "A" or "B" may cause a decided difference in the results obtained by a hook-up. The battery charger should be kept at a considerable distance from the board, in another room if possible. Almost any make of charger kicks up a considerable stray field which will cause noises in the circuit. A "B" battery eliminator can be used with good results providing that the eliminator is kept at some distance from the testing panel, for like the battery charger, the eliminator may also be the cause of a 60 cycle hum.

You Cannot Afford to Miss the Priceless Hookup Ideas in the "Annual" for 1926.

Pin your dollar to the coupon on Page 36 and get your copy. First edition just off the press.

Humorous Experiences of An Announcer

(Continued from page 30)

had suffered in the same cause. Then followed the sermon by their "pastor." Or rather, to be exact, the sermon started but remained unfinished as far as the radio listeners were concerned (if there were any left) for the "pastor" had hardly gone beyond the "brethern" stage when he opened a broadside against sin in general, and his listeners' shortcomings in particular, which made me tremble for the safety of our transmitting tubes! This was my cue. I saw a light and realized that we had invited a band of religious fanatics to jam the ether through the medium of our mike. Slipping unnoticed from the studio I rushed to the control room, and in less time than it takes to tell it had conspired with our about-to-pass-out operator to end the agony of our invisible friends. We cut off the microphone leading to the studio. Fortunately we had a phonograph in the control room (at that time a necessary part of a station) and for the balance of that period the phonograph did yeoman service, while our fanatical friends worked themselves up to a religious fever heat in the studio, ignorant of the fact that they might as well have been alone on a desert isle.

At the end of their "service" I made the expected announcements before the studio mike (to make it look good) while my partner in crime continued to broadcast "Kitten on the keys," and other popular numbers from the control room. I was very laudatory in my remarks before the mike (the religious band was all about me eagerly taking it all in) I could afford to be, for the mike was still disconnected. We never heard from this sect again and I've often wondered, well, many listeners wrote to the station that they enjoyed the phonograph.

This happened in 1921 when it was all too new for us to be careful about who we booked for a program, but I had a somewhat similar experience only last February at Station—we'll call it UVW. This station was much given to jazz orchestras. The owner believed jazz pleased a greater number of listeners than did any other sort of program.

Now the woods, and apparently the cities too, seem to be filled with jazz orchestras. Good, bad, and very bad! In our eagerness to fill up many hours a week we naturally used many orchestras and felt reasonably safe in booking them at least once without first giving them an audition. Wrong, I know, but we did it. On one of our late programs we had booked an orchestra, so called. They were to play from 11 p. m. until midnight. When they arrived—there were seven members—and I had placed them about the studio according to the best placement of the various instruments, I was struck by the apparent youthfulness of the members, and also by the absolute absence of music stands and music. I made inquiry and learned that "they didn't need music." Which proved to be

true. No amount of musical copy could have helped. They all played by ear—they said they did—but I later became convinced all were suffering from defective hearing.

Didn't Need Music

After introducing the orchestra they opened their program with "I wonder what's become of Sally?" At least they said they were going to play that selection, but I, after listening for a while, knew why Sally had gone away. Station "UVW" had been guilty of some very bad programs but nothing that had ever gone out from there before could be compared to the manner in which these youthful musicians (?) wondered about Sally's whereabouts!

While they were still searching for Sally I went to the control room and advised the operator to send word to me later at the studio that "a transformer had burnt out and we'd have to sign off." I returned to the studio just before the first number was finished, and while I was announcing the name of the orchestra and what they had just played, the operator came in a tremendous hurry and informed me, (loud enough for the orchestra members to hear) "A transformer just burnt out and we'll have to sign off!" We did sign off, right then and there, but no announcement was made to the listeners that mechanical difficulties were the cause! They already must have known!

Sometimes the joke has been on the listeners though they were not aware of it. I recall one night at "XYZ" when we were holding a "radio party." There were about thirty-five artists present, refreshments were on hand in abundance—the policeman on the beat had come in and helped serve the refreshments—and we had broadcast everything we could think of that might entertain our listeners. This was early in 1922. Someone was passing a dish of oranges about the studio and on the impulse of the moment I grabbed two of them and went to the mike. In a very formal manner I told my listeners that one of the vocal artists present had an accomplishment few suspected; he was an expert juggler, and we were about to make an experiment that should prove most interesting. We were going to have this artist juggle five billiard balls directly before the microphone and if they would listen attentively they would hear the balls strike his palms. I then called for some music by the pianist and holding an orange in each hand directly before the mike I struck them together, keeping time with the music. After I had done this through several bits of music, all of different tempo, on a signal from me all present in the studio burst forth with loud applause amid a lot of laughing. It was all done in the spirit of fun and we forgot it the next moment, but imagine our surprise when phone call after phone call came in tell-

(Turn to page 52)



Pick-ups and Hook-ups by our Readers



THE material appearing under the title "Pickups and Hookups by Our Readers" in RADIO AGE, is contributed by our readers. It is a department wherein our readers exchange views on various circuits and the construction and operation thereof. Many times our readers disagree on technical points, and it should be understood that RADIO AGE is not responsible for the views presented herein by contributors, but publishes the letters and drawings merely as a means of permitting the fans to know what the other fellow is doing and thinking.

Conducted by Fred Hill

Single tube regenerative sets still bring home the signals in the opinion of Paul A. Williams, 1154 24th St., Moline, Ill., who submits a lengthy DX list in quest of the DT button.

Maurice J. Hindin, 1834 Winfield St., Los Angeles, Calif. finds the best way to get Eastern stations is to use his short wave set and tuned in on KDKA, WGY and KFKX on their short wave transmitters. These waves apparently reach the coast much more readily than the higher ones and with less local interference.

Mrs. Amelia Schrepper, 161 Newton St., Brooklyn, N. Y., makes use of the single tube reflex set described in the December, 1924, Radio Age and reports excellent results on stations as far west as KFI, despite the barrage of locals from New York.

Night time reception is not good enough for William B. Barron, Jeanette, Pa., so this correspondent spends his time in getting KOA, WSMB, WMBF and WHAD in the daytime.

N. H. Wilson, P. O. Box 111, Thorburn, N. S., Canada., reports Porto Rico, WKAQ, in addition to the south-west and western stations. Another case of an ideal location, probably; wish we could live up in N. S. for a while and get rid of regenerative neighbors.

We add another booster to the list when reading the letter of Charles Grimm, 2504 East St., Pittsburgh, Pa., who is tickled pink over his results with the three tube regenerative set published on page 39 of the December Radio Age. He picks up WTAM and WEAR in daylight, which he states is quite an accomplishment for a resident of Pittsburgh.

James Hile, 1808 Harvey Ave., Klondike, Ohio, made a restricted field receiver from the blueprints in the October Radio Age and logs everything far and near, according to a letter received, giving the DX list.

Harold Weiler, 534 East 145th St., Bronx, New York City, N. Y., gives results of his set made from recent articles in Radio Age, this particular one having the plate circuit tuned with

DIAL TWISTERS

Mrs. A. Schrepper.....	161 Newton St.....	Brooklyn, N. Y.
W. B. Barron.....	General Delivery.....	Jeanette, Pa.
J. C. Haley.....	112 N. 17th St.....	St. Joseph, Mo.
Frederick Whiting.....	114 Neptune Ave.....	New Rochelle, N. Y.
Frank E. Baker.....	1011 Jennings St.,.....	Sioux City, Iowa
Kilbourn Snow.....		Concord, Mich.
Everett A. Sherman.....	2025 K St.....	Univ. Place, Neb.
John Kullberg.....	1300 Ventura St.....	Kingsburg, Calif.
Rodney Wirtz.....	Box 1862.....	Bisbee, Ariz.
Karl V. Miller.....		Waterloo, Iowa
Paul A. Williams.....	1154 24th St.....	Moline, Ill.
N. H. Wilson.....	P. O. Box 111.....	Thorburn, N. S.
Charles Grimm.....	2504 East St.....	Pittsburgh, Pa.
Maurice J. Hindin.....	1834 Winfield Ave.....	Los Angeles, Calif.
James Hile.....	1808 Harvey Ave.....	Klondyke, Ohio
Harold Weiler.....	534 East 145th St.....	Bronx, New York.
R. Page.....	549 Grace St.....	Woodstock, Ont.
W. F. Magee.....	614 Armoney St.....	Niagara Falls, Ont.
Robert L. MacDonald.....	940 Worthington St.....	Springfield, Mass.
George S. Ballinger.....	809 W. Washington St.....	Greenville, S. C.
William H. Boyce.....	3609 Euclid Ave.....	Cleveland, Ohio
W. J. Edmonds, Jr.....	11 Kirtland St.....	Whitehall, N. Y.
J. M. Guyol.....	5213 Spalding Boul.....	St. Louis, Mo.
Ed Braun.....	6029 Warwick Ave.....	Chicago, Ill.
H. W. Roszel.....		Grassie's, Ont., Can.

the variometer, familiar to fans who have been in the game more than six months or a year.

All the attic aerials in the world are not confined to the big American cities, for here we have R. Page, 549 Grace St., Woodstock, Ont., Canada., using a one lungler, regenerative, and bringing in anything desired. He also believes the best is none too good and for that reason is a regular reader of this magazine.

A Michigan fan, Kilbourn Snow, at Concord, Mich., tells us there are so many stations in Chicago he would not like to spread his blanket in this city. But he needn't worry for the local fans tell us even the Chicago stations blanket themselves. Mr. Snow's DX list entitles him to a DT button for which he has been pining for sometime.

Using a three circuit tuner and WD 12 tubes, Everett A. Sherman, 2025 K St., University Place, Neb., reports excellent

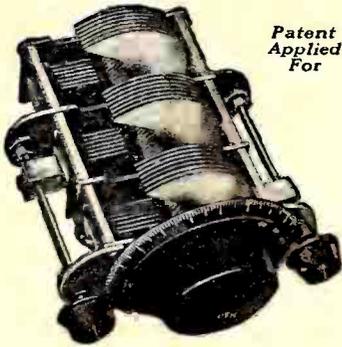
results on long distance operation. His list spans the continent pretty well.

Californians listening East seem to have better luck than Easterners listening West, according to the list of John Kullberg, 1301 Ventura St., Kingsburg, Calif., who gives an excellent list of stations picked up on a one tube, WD 12, set.

Bisbee, Ariz., comes to the fore in the person of Rodney Wirtz, Box 1862, reporting quite a flock of Eastern stations and the usual run of Western transmitters. Apparently there are no dead spots in Bisbee even if residents of other parts of the state do have trouble with reception.

Some people are never satisfied and this seems to be typified by Karl V. Miller of Waterloo, Iowa, who runs as high as four stages of audio with 199 tubes, getting unusual volume and tone according to his communication. The list of distant reception is a worthy one and shows much patience in dialing.

ONE DIAL CONTROL



United Scientific Compensated Multiple Variable Condenser

If you want to build the best Tuned Radio-Frequency set you ever heard, and with only a one dial control, or if you want to convert your old three dial set into a one-knob control, use a United Scientific Compensated Multiple Condenser. Result—greater sensitivity and selectivity quicker and easier tuning, more volume and better tone.

United Scientific Compensated Multiple Condenser .00035 is specified for the Radio Age model receiver described in this issue.

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Write for FREE diagram of One Knob Hook-up.

Equipped with genuine Bakelite dial and two knobs . . . **\$13.50**

We Also Manufacture Straight Line Frequency Condensers, One Hole Mount Rheostats, Potentiometers.



80 Fourth Ave.
NEW YORK CITY

A. J. Secor, 228 Laurel Ave., Bridgeport, Conn., is doubling back on his radio trail, after a four years' survey and trial of the "dynes" of all varieties and vintages. He started out with the single circuit a long time ago and is now using one again, but revamped in such a manner as to make him more than content with his lot. Mr. Secor is using a wave trap in series with the antenna lead to the receiver. It is an inductively coupled affair, with six turns on the primary of the wave trap, which is hooked in series with the antenna and the set. The primary of six turns is wound over the secondary, the secondary inductance being on a three-inch diameter tube wound with forty-five turns of wire. Bell wire, known as No. 18 annunciator, may be used for both coils with good results. The secondary is wound on the tube first; then the primary. The ends of the secondary are spanned by a .001 mfd variable condenser. This wave trap, which follows conventional design as far as small loss is concerned, should not be placed inside the cabinet but far enough away to be out of inductive relationship with the balance of the set. By its use the single circuit is readily converted into a selective set. Another feature of the receiver described by Mr. Secor is the use of a grid leak in series with the secondary of the last audio, permitting the use of three stages of audio amplification without howling.

Wearing a dial off his single tube set did not prevent J. C. Haley, 112 North 17th St., St. Joseph, Mo., from sending in a long list of DX stations. This radio enthusiast was so certain he would have a long list of stations he saved one of the election ballots of the 1924 primary election and noted all the stations on the back. The ballot is twenty-one inches long, so our readers may readily see the harvest the old reliable one-lunger yields when properly manipulated.

We would like to call the attention of our readers to the frequency log which appears immediately after our list of broadcast stations in this and succeeding issues of Radio Age. The list is made up with the highest kilocycle (lowest wave) at the top of the page, then the corresponding wavelength in meters. After that a large enough space for you to fill in many of the stations you hear on that wave, and finally three columns for your use in logging your set. We believe this feature will be especially attractive to anyone who likes the idea of logging a station so as to be able to return to it at will.

Frederick Whiting, 114 Neptune Ave., New Rochelle, N. Y., braved the perils of sleeplessness and furnishes a list of 128 stations logged. These were probably secured previous to the recent New York election, otherwise the list would have been large enough to go on our Missouri friend's ballot.

Tell them you read it in Radio Age



ANYONE CAN MAKE BIG MONEY

Just Showing This 40 to 550 Meter Set

The most phenomenally successful radio set ever built is creating a sensation with the public in its wonderful performance. Thousands of men are making fortunes just showing this amazing New Set to their friends. Get our plan at once, while territories are open. No obligations.

TWO AMAZING NEW FEATURES

AMBU FIVE has a sub-panel inlaid with copper-shot into grooves making assembly a simple matter. Connections are automatic and everlasting. 105 points of contact, yet only 4 soldered connections.

AMBU FIVE has interchangeable ALLWAVE coils. Operator can bring in stations broadcasting on wave lengths of from 40 to 550 meters. Ordinary sets do not go below 200 meters.

Worth	\$115
You Sell For	\$75
Your Profit	\$32

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1926 Catalog of RADIO BARGAINS

Save 1/3 to 1/2



The World's Largest Exclusive Radio Mail Order House Will Send You This Wonderful Book FREE!

64 illustrated pages containing thousands of bargains in radio sets, semi-finished sets and radio kits of all styles, sizes and approved circuits. 5-tube sets as low as \$29.50. Beautiful models of the very latest designs and types. Elaborate console models with loud speakers built right in cabinets of genuine mahogany and walnut. All sets guaranteed. Coast to coast receiving range. Also contains everything in radio supplies, including batteries, chargers, loud speakers, transformers, condensers, rheostats and any other parts you may want for improving your set or building a new one. Guaranteed saving to you of 1/3 to 1/2.

The Biggest 5-Tube Value on the Market

Positively the world's greatest 5-tube radio bargain. Regular \$75.00 value. Our large quantity production enables us to sell this set for only \$29.50, fully built and wired in beautiful mahogany cabinet of latest design with sloping Bakelite panel of Satin finish, handsomely etched and engraved as illustrated. Constructed of the finest low-loss condensers, coils and sockets. Bakelite baseboard panel and dials. Price for set only..... **\$29.50**
Transportation charges extra. Shipping weight 25 lbs.

This set with all accessories, including the famous American Bell Loud Speaker with adjustable unit, 2-45 volt "B" batteries, one guaranteed 100 Ampere Hour storage "A" battery, cable for battery connection, 5-201A tubes, Aerial and ground equipment, and everything complete ready to set up and operate. Nothing else to buy. Price..... **\$59.75**
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AMERICAN RADYNOLA 5 TUBE SET

\$29.50



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Columbia Grand 5-Tube Console Set

\$57.95

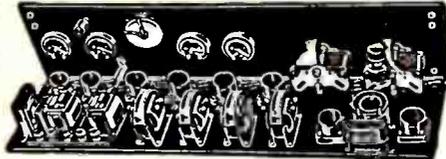


Beautiful Walnut Cabinet in two-toned effect. Two door panels inlaid with highest grade burl walnut. Cabinet is 39 inches high. Top measures 13x37 inches. Equipped with high-grade built-in loud speaker with adjustable unit. Large, roomy interior for holding all batteries, books, etc. The Columbia Grand is a 5-tube tuned radio frequency receiver. Coast to coast receiving range. Tune in stations desired—very selective. Has latest type, low-loss condensers, coils and sockets. Bakelite baseboard, sockets and dial knobs. Dials are beautifully etched in gold on walnut finish bakelite panel. Price for set only, fully built and wired—\$57.95.

Transportation charges extra. Shipped by freight or express. This set with all accessories, which include 2-45 volt "B" batteries, one guaranteed 100 ampere hour storage "A" battery, 5-201A tubes, multicolor cable for easy battery connection, aerial and ground equipment, instructions for setting up and operating—everything complete, nothing else to buy—\$84.95
Transportation charges extra. Shipped by freight or express.

Semi-Finished 8-Tube Super-Heterodyne

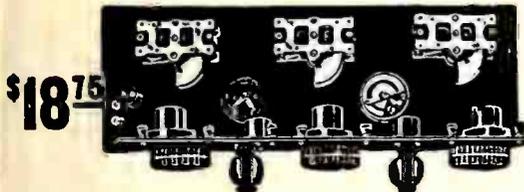
\$43.75



World's Famous 8-tube Super-heterodyne. Fully mounted on panel and baseboard. Comes completely assembled ready to wire and operate. We have testimonials from thousands of builders of this set. Some have received foreign stations on loop aerial. Unsurpassed in volume and tone quality. Low-loss straight line frequency condensers, vernier dials, finest quality rheostats. Matched Columbia long wave transformers. Requires only three screws for attaching panel and baseboard and set is ready to wire and operate. 7x30 panel. Price of set only \$43.75.

Requires following accessories to complete this set: 7x30 cabinet, 8-201A tubes for storage battery operation or No. 199 tubes for dry cell operation, 100 Ampere hour storage battery, 2-45 volt "B" batteries, loud speaker, center tapped loop aerial. All these items are listed in our catalog, at a tremendous saving. Our semi-finished sets come with all parts mounted on panel and baseboard ready for wiring. Do not fail to send for our catalog. Remember—we are the largest exclusive radio mail order dealers in the world and carry the best of everything in radio. We save you 1-3 to 1-2 on everything in radio. Detailed descriptions appear in our catalog.

Semi-Finished 5-Tube Radio Frequency Set



This special offer is astounding the radio world. Coast to coast reception on loud speaker. Low-loss condensers and sockets. Highest quality transformers. Bakelite rheostats. All wiring concealed under Bakelite baseboard. 7x18 panel—fits into any standard 7x18 cabinet. Complete instructions for operating. Guaranteed saving to you of \$50.00. Price of set all mounted, \$18.75. Cabinet of same model as American Radynola pictured above \$3.65 extra.

Our line is complete, includes all popular sets, such as Superheterodyne, Neutrodyne, Ultradyne, Reinartz, Regenerative, Radio Frequency, Browning-Drake, Super-Heterodyne Reflex and all other latest circuits. Kits, sets and parts by well-known manufacturers such as Frost, Howard, Baldwin, Brandes, Western Electric, Columbia and others.

ULTRADYNE

Complete parts for 8-Tube Ultradyne receiver, without cabinet, complete with blueprint, instructions and diagrams

\$45.85

NEUTRODYNE

Genuine Licensed Neutrodyne kit of parts come fully assembled on the panel and baseboard with complete instructions ready to wire

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ULTRA-AUDION

One-tube Ultra-Audion. Wizard of radio. Fully assembled and ready to wire, with instructions

\$6.35

COCKADAY

3-tube Cockaday kit of parts, fully assembled on panel and baseboard ready to wire

\$15.85

BROWNING DRAKE

4-tube complete low-loss parts

\$32.40

REMLER 8-TUBE SUPER HETERODYNE

Complete parts for Best 45 Kilocycle Super-Heterodyne Genuine Remler parts

\$49.50

HARKNESS

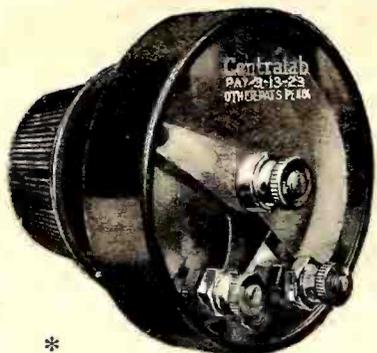
2-tube reflex kit of parts, fully assembled on panel and baseboard, ready to wire, complete instructions

\$16.95

Catalog includes list of broadcasting stations, general radio information and facts about our free service division. Write for it today.

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Every article exactly as represented. Every article tested before shipping. Complete satisfaction guaranteed.



**Centralab
Radiohm
for Oscillation Control**

Get full efficiency from your set by installing a Centralab Radiohm. Provides perfect plate circuit control of oscillation.

By controlling oscillation with this little unit, you can hold that sensitive regenerative position which immediately precedes the oscillation point, without distortion or loss of selectivity. Think what a boon to clear, true-tone reception this is!

Provides smooth variation of resistance from zero to 200,000 ohms. Used as a standard unit in several leading sets. Price: \$2.00—at your dealer's or mailed direct.

**Centralab Modulator
for Volume Control**

This improved type of potentiometer takes the "rough spots" out of volume—smooths out powerful "locals" as well as difficult "DX." It provides noiseless control of volume from a whisper to maximum. Used in audio circuits with any transformers or with Thordarson "Autoformer." Price: \$2.00 at your dealer's—or mailed direct.

Write for literature describing these and other Centralab Radio Controls.

Central Radio Laboratories

24 Keefe Ave., Milwaukee, Wis.



**New Wave Propagation
Technique**

(Continued from page 14)

proven it is superior to the vertical radiator. From the elementary theory of directive radiation it would be possible to calculate a quite sharp directivity diagram for this antenna. Such a result was, however, not expected in reception tests at long distances because experience with a variety of types of directive antenna systems had proven whereas the theoretical directivity diagram can be easily confirmed in the neighborhood of the station, the distant measurements do not bear out the elementary theory. The reason for this seems to be while the antenna sends out a radiation as calculated, there is an additional radiation which is projected almost vertically upwards and then scattered in all directions by the upper layer of the atmosphere. Signals may, therefore, be received at distant points in directions where the elementary theory shows it should be zero. A good deal more evidence must be collected before any definite conclusions can be drawn regarding these secondary phenomena because each case of evidence is usually subject to several interpretations. We have, however, good reason to hope in a not distant future such a mass of evidence will be available that valuable conclusions may be drawn which will have important bearings not only on the development of radio but on fundamental questions in allied sciences.

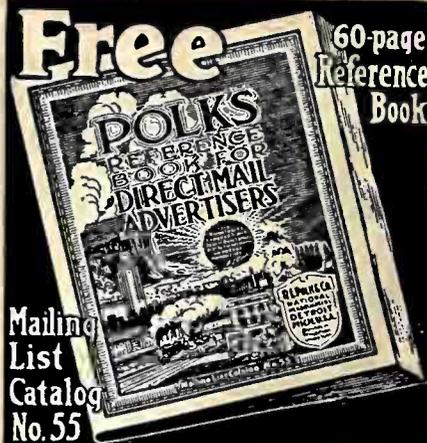
Practical Conclusions

FROM the point of view of the practical radio engineer, it is a satisfaction to be able to state enough has been learned to create a new and promising field of radio communication as evidenced by the decision of the Radio Corporation to proceed with its chain of short wave stations in the Pacific ocean. The stations which will thus be built will have antenna systems of the type classified as short wave high angle radiators. Which one of the three types discussed above will be adopted will depend upon further results from the comparative tests now in progress and also upon final tests in the stations when installed. So far these tests have shown the horizontally polarized radiation is superior to vertical radiation.

I have a mechanical model, made up for studying wave polarization in the General Electric laboratory. The model consists of weights suspended in such a way they are free to move in all directions. Twenty-two of these weights are arranged in a row and connected together by rubber bands. Each weight is suspended from a yoke and an equal weight hung on the other side of the yoke to serve as a counter weight. A screen is set up so as to hide the counter weight and avoid confusion in observing the wave motion. This model was set up especially to study the twisting of the plane of polarization and the experiment has strikingly confirmed the theory which it was intended to illustrate. This theory is briefly the following:

(Turn to page 56)

Tell them you read it in Radio Age



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FOR DIRECT MAIL ADVERTISERS**
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**No Radio Complete
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NOW you can select stations at will, cut out interference and undesired stations—tune in loud and clear. Wonderful results with any tube or crystal set. Over 150,000 sold. Partially absorbs static.

\$1 Postpaid
Amazing Results, Better Reception Guaranteed or We Refund Your Dollar

ORDER TODAY
Dollar Bill Will Do
TWO BIG BANKS Testify To Our Reliability.

**Select Stations
At Will**
Try this Radio Wonder at our risk. Nothing to add—attach in 2 minutes to aerial. No tools—no extra tube or battery—Doesn't disturb present log. Order today—money back if you say so.

FREE Complete Steinite Literature.
Steinite Famous 1500 Mi. One-Tube Set \$6;
Crystal Set \$8; Crystals 50c—3 for \$1; 5-Tube Set —\$29.75.

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**BIG DISCOUNTS
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Dealers, get our big catalog before you buy. Huge stocks of standard radio parts, sets, kits at rock-bottom wholesale prices. Special offer on sets, tubes, batteries.

FREE CATALOG SETS PARTS KITS

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New Power Tube



An interesting feature of the new Mogul 5V-C power amplifier tube put out by the Van Horne Co., and certified by Musselman, is an adapted base, in addition to the conventional tube base, on which are mounted four terminals for inclusion of higher B and C voltages than found in the normal sets without having to alter the wiring.

The type of construction is shown in the above picture. Two binding posts are provided for the additional B voltage which is applied independently of that already on the set, and the other two posts are for the C battery, used in order to conserve plate current and keep the tube operating at the proper portion of its characteristic curve.

BECOME A RADIO EXPERT
 in 3 MONTHS
STUDY AT HOME

Our unique home-study course in practical radio engineering makes you an expert quickly. You devote spare-time hours to fascinating study of world's greatest science. We show you how to earn as you learn, to get into this big-pay field on the ground floor. Full equipment furnished free, including Superbon Two radio set. Our training is superior for you learn to make money from the start. **LEARN HOW TO GET THIS COURSE FREE**—Our manual plan shows you how you can get the course free, with good profits besides. Whether you know radio now or not, we can teach you better. If you can read this ad you can study our easy, simple, illustrated lessons and get a diploma as a radio engineer. Thousands of positions with good money open to you. Here is the field that will make you rich if you make good. Get our book, "Millions Untraced". It is free. Write me today and learn how to make \$50 to \$200 a week. I. J. Mandala, SUPERBON RADIO ENGINEERING, Dept. 13, 532 North Dearborn, Chicago, U.S.A.



Pattern 135-C for Radiola Models 20, 25, 26, and 28

Watch—

The Filament of your tubes If burned too high the life of your tubes is shortened: if burned too low your reception is impaired.

Your Batteries

May be the cause of your trouble. They should be checked often. Pattern 135-C instrument is supplied with two cords with phone tips for plugging into the jacks of new Radiolas.

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JEWELL ELECTRICAL INSTRUMENT CO.

1650 Walnut St.

Chicago

26 Years Making Good Instruments

Miniature Broadcasting Set to Test Receivers

AFTER the last wire is soldered and the final inspection has been given the wiring connections, the greatest thrill in radio comes—will it work?

It is not difficult for the average fan to wire the set and tune in a station or two in the evening and find out how the receiver performs. The manufacturer who is turning out hundreds of sets every day has quite another problem on his hands.

The ordinary fan does his radio experimenting at night while there are plenty of stations to pick up. The manufacturer, on the other hand, does his work during the day when the majority of broadcasting stations are silent and when reception is not near as good as during the hours of darkness.

To have a fair factory test a receiver should be operated on all wavelengths just as it will be when placed in the hands of the final owner, states Frank Reichman of the Reichman Company. This is very difficult to accomplish during the day. In our laboratory we were up against the same problem in testing out the new isodyne receivers and solved it by erecting a miniature broadcasting station of our own to operate on 200, 300, 400, 500, and 600 meters, sending out phonograph music for the set inspectors in their sound proof booths.

The amount of power used is just sufficient to operate the receiving sets as they would be under service conditions.

COILS FOR THE SET BUILDER

FRESHMAN and PHANSTIEHL type radio frequency transformers. The most efficient low-loss coils built. Mounts are included.

Each \$.50 Set of Three \$1.25
 All standard advertised parts at 10% to 20% off the list price.

KISSEL-CARMAN Chicago, Ill.
 2215 Archer Ave.

ULTRA-VERNIER TUNING CONTROL

A VERNIER DIAL ON WHICH YOU CAN PENCIL RECORD THE STATIONS. GEARED 20 TO 1. SILVER FINISH \$2.50 - GOLD FINISH \$3.50

PHENIX RADIO CORP., 116 E. East 25 St., N.Y.C.

RADIO AGE ANNUAL FOR 1924—AT SPECIAL PRICE!

Clip the coupon and send it with 50 cents, and the RADIO AGE ANNUAL FOR 1924 will be sent you by return mail.

RADIO AGE, 500 N. Dearborn St., Chicago. Enclosed is 50 cents, for which send me the RADIO AGE ANNUAL for 1924.

Name.....

Address.....

City..... (2-26)

Tell them you read it in Radio Age

The Loud Speaker Sensation!



The KODEL MICROPHONE LOUD SPEAKER

You can't tell the KODEL MICROPHONE LOUD SPEAKER from the microphone the broadcasting stations use—they are exactly alike in size and appearance. The efficient Kodel Sound Unit, with a ingenious new snail-shell horn, mounted inside the microphone case, produces a remarkably clear, full-toned volume. Non-vibrating tone chamber absolutely eliminates distortion.

\$15 model incorporates Kodel, Jr. unit; equipped with large Kodel unit \$20

\$15.00

Radio dealers everywhere have them.

THE KODEL RADIO CORP.
E. Pearl St. Cincinnati, O.

RECEIVERS :: SPEAKERS
HOMCHARGERS

WKRC

Owners of Kodel Broadcasting Station WKRC. Send for program

Free Mailing Lists

Will help you increase sales. Send for FREE catalog giving coplots and prices on thousands of classified names of your best prospective customers—National, State and Local—Individuals, Professions, Business Concerns.

99% Guaranteed 5¢ each by refund of 5¢ each

ROSS-Gould Co. 589N 10th St. St. Louis

PATENTS

PROMPTLY PROCURED
SEND A SKETCH OF
YOUR INVENTION
FREE INVENTION RE-
CORDING BLANK

NAME _____

Z. H. POLACHEK
PATENT ATTORNEY
CONSULTING ENGINEER
70 WALL ST.
NEW YORK

ADDRESS _____
MAIL TO-DAY

U. S. Navy Defends Its Radio Service

NAVAL communication officers feel the recent charges against its radio service are unjust and hasten to defend this service, which now reaches around the world, serving both the government and private needs.

Navigation based upon radio compass bearings admittedly is new and not perfect, but as it is obviously a two-way service, it involves both the sender and receiver, and its success depends greatly upon the calculations of the navigator who receives the radio messages. Errors may occur in reading the bearings and in transmitting and receiving the messages, but they may also appear in the use of these bearings.

In a recent announcement, signed by Captain Ridley McLean, Director of Naval Communications, the following comment on a criticism appears:

"Professor J. H. Morecroft in an article asking, 'What is the matter with the Naval Radio Service,' places blame for the Honda disaster, Shenandoah disaster, and PN-9-1 failure on Navy radio and comments adversely on the handling of distress messages by Navy radio in the vicinity of New York. Notwithstanding Professor Morecroft's preeminent position in the radio fraternity, evidently he has been misinformed as to facts. The facts are briefly:

(a) The Court of Inquiry in the Honda disaster found the radio not at fault, although navigational use of information derived from radio was imperfect.

(b) Radio personnel in the Shenandoah did not survive her loss, but she was in perfect communication with the Navy Department up to within one hour of her loss, at which time she voluntarily shifted to work other stations after receipt of the latest weather report issued.

(c) The equipment of the PN-9-1 was dictated by many considerations besides radio. Investigation, as yet incomplete, indicates that radio in the case of the PN-9-1 furnished adequate information, had proper navigational application of it been made by service ships.

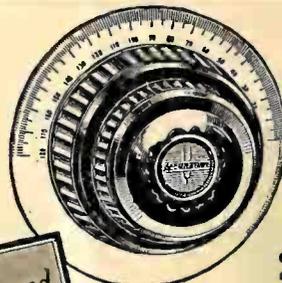
(d) Just prior to Professor Morecroft's article, the Department of Commerce Radio Supervisor at New York, volunteered commendation of the efficiency with which distress work is handled by the Navy at New York, and since his article, commercial radio companies have volunteered similar favorable comment.

"The above incidents emphasize the fact that accurate observation of radio compass bearings is merely one feature in the use of the radio compass. Unless officers apply these bearings systematically, without preconceived ideas as to the location of the vessel, erroneous conclusions are inevitable."

You Cannot Afford to Miss the Priceless Hookup Ideas in the "Annual" for 1926.

Pin your dollar to the coupon on Page 36 and get your copy. First edition just off the press.

Tell them you read it in Radio Age



Pat. April 21, 1925

Other U.S. and Foreign Patents Pending

Geared 80 to 1

Ideal

THE ACCURATUNE
Is ideal for coarse or extremely fine tuning, segregating even those stations now so closely grouped on the lower wave lengths; it brings them in with absolute precision. Volume and clarity are matters of course to the Accuratune. Quickly substituted without alteration of your set.

MYDAR RADIO CO.
17 CAMPBELL ST., NEWARK, N. J.

ACCURATUNE
REGISTERED GEARED 80:1 U.S. PAT. OFF.

RADIO AGENTS WANTED 5 Tube Demonstrator FREE!

Earn \$25 to \$100 a week, part or full time. Everyone a prospect. Complete line standard sets and accessories, \$5 to \$90. Write today for illustrated catalog and exclusive selling plan for live dealers and community agents. 20TH CENTURY RADIO CO., 1021 Coca Cola Bldg., Kansas City, Mo.

BAKELITE PANELS

used by 95% of all set manufacturers. Write for Booklet 31.

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
Chicago Office: 636 West 22d Street



MASTERTONE RADIO TUBES \$2.00
ALL TYPES GUARANTEED

Dealers' Proposition
Dextron Radio Lab.
74 Sterling, Dept. R. A.
East Orange, N. J.

2*

\$3.50



FLINT AUDIO FREQUENCY TRANSFORMER. For all regular hookups, for all stages, for all standard tubes. Substantial—Durable—Easy to install. Volume and clearness fully guaranteed.

FLINT RADIO CO.
1852 Wilson Ave., Chicago

You, too, Can Improve Your Radio Reception

Follow the example set by thousands of radio fans all over the world. Investigate and prove to your own satisfaction that **POWER-PLUS** superiority will bring you what you demand from your radio set. **POWER-PLUS** means Power plus Selectivity, distance and easy tuning.

POWER-PLUS

Surely you want to know more about **POWER-PLUS** Coils and Condensers. Ask our dealer near you—or clip and mail the coupon below. Seven copyrighted hook-up blueprints will be sent to you **FREE**.



A. F. Henninger Corp.,
4507 Ravenswood Ave., Chicago, Ill.
Gentlemen: Kindly send me your folder and 7 copyrighted hook-up blueprints. I understand that they are absolutely **FREE**—and that I am obligated in no way.

Name.....
Address.....
Town.....State.....

\$1.50 for Your Old Radio Tubes

regardless make or conditions, toward purchase of each new standard \$2.50 tube. Positively guaranteed. We do not sell rebuilt or boot-leg tubes. Agents wanted. **Super-Service Laboratories, Dept. 23, Room 58, 39 West Adams, Chicago, Ill.**

Doping Coils Merely Adds to Their Losses

MANY radio fans cannot understand the admonitions they read against the use of shellac, paraffin, and other adhesive agents in the construction of radio inductances. They usually figure the easiest way to hold the springy turns of wire in place is to apply a coat of sticky shellac or to drip wax from a burning candle on them, and they are forced to inquire why such simple processes are so much in disfavor.

The reason is explained in simple language by Edward Spiegler, who says, the application of ordinary thick liquids like shellac and varnish is in no way detrimental mechanically to tuning coils, but has a decidedly undesirable electrical effect, the avoidance of which is one of the chief inductance problems of radio engineers.

Adjacent turns of wire on a coil act like the plates of a condenser. The total effect of a whole winding whose turns are close to each other is like that of a fixed condenser connected directly across the ends of the coil. This condenser or capacity characteristic increases losses and prevents the coil from tuning as sharply as it would if the effect did not exist. In other words, the smaller the overall capacity between turns, the better the coil.

The exact amount of the turn-to-turn capacity depends on the size of the wire itself, on the separation between turns, and on the nature of the material between turns.

Complete list of GUARANTEED PARTS FOR Silver-Marshall Model 1926 "MODERN BROADCAST 6-TUBE RECEIVER"

When building this receiver be sure you use **only the parts specified** and you will have the satisfaction of possessing the finest receiver yet developed.

- 3—S-M 311 .00035 S. L. F. Condensers
- 3—4 in. Kurz Krasch Moulded Dials
- 3—S-M 515 Coil Sockets
- 2—S-M 112A Inductances
- 1—S-M 110A Inductances
- 6—S-M 510 Sockets
- 2—Carter 6-ohm imp. Rheostat
- 1—Central Laboratory 500,000 ohm Modulator
- 3—Daven Resistance couplers complete
- 1—Carter 101 Jack
- 1—Carter 102A Jack
- 1—Carter On-off Switch
- 1—.002 M. F. Condenser
- 2—Doubilier .5 M. F. By-pass Condensers
- 1—7x24 Drilled, Sanded and Engraved Bakelite Panel
- 1—7x23 Oak Base Board, Bus-bar, Screws, Lugs, etc.
- 1—Belden 5-lead color cable

Complete Parts \$49.50 as Specified, Only

Wired and Ready to Use \$8. Extra

- Daven MU-20 Tubes.....\$ 4.00
- Daven MU-6 Power Tube..... 5.00
- Western Electric 540-A.W. Cone Speaker 27.50

We carry all parts for every Silver-Marshall Circuit

Immediate Shipment on all Mail Orders

HEINS & BOLET

48 Park Place, New York

An Index to the Best in Radio Hookups!

How long have you postponed making that favorite hookup of yours because you couldn't find reliable and clear diagrams? We have laid aside a limited number of back issues of **RADIO AGE** for your use. Below are listed hookups and diagrams to be found in them. Select the ones you want and enclose 30 cents in stamps for each one desired.

January, 1924

- Tuning Out Interference—Wave Traps—Eliminators
- Filters
- A Junior Super-Heterodyne.
- Push-Pull Amplifier.

March, 1924

- An Eight-Tube Super-Heterodyne.
- A Simple, Low Loss Tuner.
- A Tuned Radio Frequency Amplifier.
- Simple Reflex Set.

April, 1924

- An Efficient Super-Heterodyne (fully illustrated).
- A Ten Dollar Receiver.
- Anti-Body Capacity Hookups.
- Reflexing the Three-Circuit Tuner.

May, 1924

- Construction of a Simple Portable Set.
- Radio Panels.
- Third Installment of Radio Age Data Sheets.

June, 1924

- Important Factors in Constructing a Super-Heterodyne.
- A Universal Amplifier.
- Adding Radio and Audio to Baby Heterodyne.
- Radio Age Data Sheets.

July, 1924

- A Portable Tuned Impedance Reflex.
- Operating Detector Tube by Grid Bias.
- A Three-Tube Wizard Circuit.

August, 1924

- Breaking Into Radio Without a Diagram.
- The English 4-Element Tube.
- Filtered Heterodyne Audio Stages.
- An Audio Amplifier Without an "A" Battery.

September, 1924

- How Careful Mounting Will Improve Reception.
- One Tuning Control for Hair's Breadth Selectivity.
- Four Pages of Real Blueprints of a New Baby Heterodyne

November, 1924

- Blueprints of a Single Tube Loop Set and a Capacity Feed-back Receiver.
- A 3-Tube Low Loss Regenerator.
- Mastering the 3-Circuit Tuner.

December, 1924

- Blueprints of a New 8-Tube Super-Heterodyne.
- How to Make a Receiver that Minimizes Static.
- A Trans-Atlantic DX Receiver.

January, 1925

- A Six Tube Super-Het.
- An Efficient Portable Set.
- A Tuned Plate Regenerator.
- Making a Station-Finder.

February, 1925

- A Three Circuit Regenerator.
- A Real, Low Loss Set.
- Blueprints of a 3-tube Reflex.

March, 1925

- A 5-Tube R. F. Receiver.
- How to Wind Low Loss Coils.
- A Short Wave Receiver.
- Blueprints of a Two-Tube Ultra Audion and a Regenerative Reflex.

April, 1925

- A 3-Tube Portable Set.
- "B" Voltage from the A. C. Socket.
- An Amplifier for the 3-Circuit Tuner.
- Blueprints of a Five-Tube Radio Frequency Receiver.

May, 1925

- A "Quiet" Regenerator.
- How to Make a Tube-Tester.
- A Unique Super-Het and an Improved Reinarts.
- A Six Tube Portable Receiver Illustrated with Blueprints.

June, 1925

- Reducing Static Disturbances.
- A Seven-Tube Super-Heterodyne.
- Browning-Drake Receiver.
- Overcoming Oscillations in the Roberts Receiver.
- An Ideal Set in Practical Form.

July, 1925

- Learning Tube Characteristics.
- How Much Coupling?
- Blueprints of Conventional Radio.
- Symbols and Crystal Detector Circuit.

August, 1925—50c per copy

- How to Attain Smooth Tuning.
- Alternating Current Tubes.
- Deciding on a Portable Super—
- And a big 60-page blueprint section, in which is contained blueprints of all the basic circuits from which all radio hookups have been developed since the birth of Radio.

September, 1925

- Thirty-one ways to prevent self-oscillations.
- Tuning efficiency with two controls.
- Ideal Audio Amplifier Circuits.
- Blueprint section.

October, 1925

- Auto-Transformer Coupling.
- Some Facts about Quality.
- An Improved Slide-Wire Bridge.
- Blueprints of Circuits Using Single and Dual Controls.

November, 1925

- Super without I. F. Stages.
- A Good Audio Oscillator.
- An Efficient Short-Wave Transmitter.
- Blueprints—Adding R. F. Stages.

December, 1925

- Tuned R. F. and Regeneration.
- Radio Age Model Receiver.
- Inductive Gang-Control Receiver.
- Tuning with Chart Curves

January, 1926

- Radio Age January Model Set.
- A Four-Tube Toroid Set.
- Power Supply Device—Blueprint Feature.
- Finishing Your Radio Cabinet.

Humorous Experiences of An Announcer

(Continued from page 44)

ing us how wonderfully the "juggling" had come over. The letters that were subsequently received almost all praised the "juggling." To this day the singer upon whom I pinned this accomplishment had difficulty in convincing some of his friends that he can't juggle.

All the humor of a studio is not at the expense of artists or the public, for frequently the announcer is IT unintentionally, as the following story will show how I once gave a singer a good laugh—at my expense.

Brought His Barber

A young Italian baritone, who now by the way makes operatic records, was booked to appear at "XYZ". When he arrived I was pleased to note the entire absence of so called artistic temperament. He was a most likable chap, quick witted, humorous, and told me to "go the limit," in my announcements. Now my French and Italian never qualified me as a linguist and in 1922 I experienced much difficulty in getting my Yankee tongue about the various operatic aria titles. The program which this young Italian baritone had prepared was the toughest to pronounce that I had encountered up to that time. After floundering about with a few of them I excused my poor pronunciation and told the "audience invisible" that had I realized how inadequate my Italian pronunciation was I would have brought my barber to do the announcing. At this my Italian baritone friend burst forth into a hearty laugh. In my egotism I ascribed his laugh to the humor of my announcement and felt much pleased with myself. The program went off splendidly and my Italian friend and I parted most cordial friends. Sometime later I learned from another artist that the Italian baritone was a barber! He was earning enough in that way to continue his musical education. I often shudder when I realize what might have happened to the program of "XYZ", or even to myself, that night if the baritone had been afflicted with artistic temperament and the hot blood usually ascribed to the Latins!

Then the various types of artists and entertainers one encounters in a radio studio are a never ending source of amusement. There are the masculine type of women with a "message," and the feminine type of men with a—well you know the type. The mail received at a station is a never-ending source of laughs, yes, and frequently the opposite. But after all a radio studio presents a cross section of life brought to a focus. Human nature is the most interesting, amusing, and all too often the saddest study mankind can indulge in, and to the observer with a will to see, no place presents a greater opportunity for observation than a radio studio. My several years in a studio gave me many a hearty laugh, a few of which I have attempted to share with you. Some of my experiences saddened me—they came through the mail mostly—but I cannot disclose them. They were not so intended and must be kept sacred.

Free 6 Days Trial in your home

Test your talent Free on a BUESCHER SAXOPHONE

See what you can do. We know you can play it. That's why we want you to try. 3 free lessons with each new instrument give you a quick, easy start. Practicing is fun because you learn so fast. Play Jazz in a week, tantalizing music that sets them going. Be the life of the party, always welcome. Get into the big fun. 6 days' free trial, any instrument. No obligation. If you like it pay a little each month. Send now for beautiful free literature. Get our liberal proposition. Send postal today. Address:

Buescher Band Instrument Co. 61
1215 Buescher Block Elkhart, Indiana



\$60. to \$100. Weekly Selling 40 to 550 Meter Set

Spare Time Profits—No Capital
Public wants this Amazing New Set. Coast-to-coast reception. Receives all waves, 40 to 550 meters. Shot sub-panel makes assembly quick and easy. We need distributors everywhere. Demonstration sells. We carry stock. Set sells at half store prices. \$60 to \$100 weekly easily made.
FIVE TUBE DEMONSTRATOR FREE with RADIO TRAINING



Our Special Plan trains you in Radio—gives you a Free Demonstrator Set and appoints you as distributor. The entire cost is less than regular dealer's price for Set alone. Hundreds are making big money in spare time. Get started now while territory is still open. Write Today! Don't miss this opportunity to make a fortune in Radio. Get complete training and sales plan Free! **AMBU ENGINEERING INSTITUTE**
2632 Prairie Avenue Div. 12-XB Chicago, Illinois

A revolutionary step forward~

\$9.75

Complete, nothing else to buy.
Operates at maximum efficiency at all times on either direct or alternating current, any frequency. Noiseless—no hum.
Delivers unlimited current to any re-

FERBEND "B" ELIMINATOR

Now you can supply plate voltage to your Radio Set at a price scarcely higher than new "B" Batteries! Your electric light socket and the new *Ferbend "B" Eliminator* furnish the permanent means of efficient "B" current supply for any set. No need for you to pay more than \$9.75 for a "B" battery eliminator for Ferbend guarantees theirs to be equal or superior to any on the market *regardless of price*. Our price was fixed with the interests of the radio buying public in mind. The result is efficient and permanent "B" current now placed

ceiving set, regardless of number of tubes.

Delivers 100 volts to any set.

Cost of operation less than 50c a year. It lasts indefinitely.

All parts are specially designed and manufactured by us for this purpose only.

Unconditionally Guaranteed

to be equal or superior to any eliminator on the market, regardless of price.

FERBEND Wave Trap

This company also manufactures the famous Ferbend WAVE TRAP—the instrument which has been widely imitated but never equalled. It is the only original and genuine. See advertisement on page 64.

Within Reach of All

The price of this remarkable new unit is spectacular in more ways than one. Besides saving you from \$15 to \$50 it is amazingly low considering the quality and superiority. Surely it marks a revolutionary step forward in radio. Equip your set NOW with this marvelous instrument, and be convinced.

Ask your dealer, or send direct

Until nation-wide distribution is completed it is possible that your dealer hasn't stocked the *Ferbend "B" Battery Eliminator* as yet. So you will not have to wait, we will make shipment direct to you upon receipt of \$9.75, or C. O. D., if desired. Remember, *superior results are guaranteed* or your money back. Be one of the first to own and use the *Ferbend Maxmin "B" Battery Eliminator*. Use the coupon NOW!

FERBEND ELECTRIC CO.
431 W. Superior St. Chicago, Illinois
Tell them you read it in Radio Age

FERBEND ELECTRIC CO.
431 West Superior St., Chicago

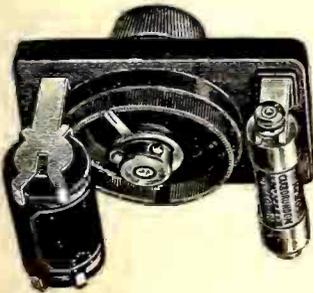
Send at once. I am enclosing \$9.75.
 Send C. O. D.
 Send Literature.

Name.....
Address.....
City.....
State.....

Carborundum Detector With Stabilizing Device

AMONG some of the products of the Carborundum Co., is a stabilizing detector unit, recently released for the radio trade, which may be used in any crystal detector set or in the reflex type of receivers.

The unit, which may be mounted on the panel, electrically controls the resistance of the detector circuit, by varying the potential of a flashlight cell applied to the carborundum crystal; a procedure which will be remembered by old time ship operators, notably those who went to sea with the old Marconi receivers with a huge wire potentiometer for altering the bias applied to the crystal.



Two advantages noted in the use of changing the resistance are: ability to increase detector resistance to gain selectivity without losing energy transfer from antenna circuit, and to determine the degree of damping of the detector circuit in a reflex receiver, which damping may be made to aid regeneration.

The contact on the crystal is permanent, or fixed, while the resistance is the variable factor.

Victoreen Intermediate

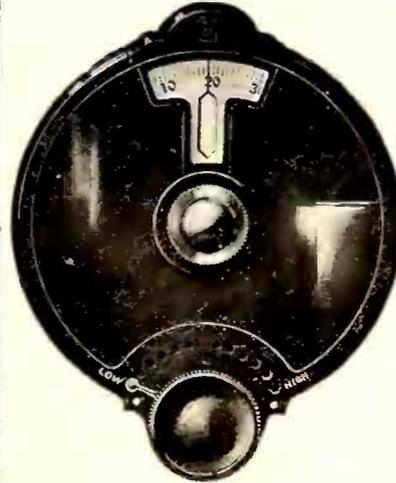


VICTOREEN intermediate transformers, handled by the George W. Walker Co., have a sharp resonance curve. This resonance feature of the coil permits use of an aperiodic primary, prevents interstage oscillation, makes the set more stable and permits the use of a potentiometer as a volume control.

Victoreen coils are adjusted to a precision of one-third of one per cent.

The wave length used assures less interference by harmonics.

NATIONAL Velvet Vernier DIAL Type B, Variable (Patents Pending)



Positive Control—Easily Mounted

YOU control the reduction ratio with this new NATIONAL Type B, Velvet Vernier Dial. And what a difference in the tuning of your set! You'll be astonished.

Easily mounted on the 1-4 in. shaft of any standard type of variable condenser. A screw driver is the only tool you need.

It has the same velvety smoothness, the same freedom from backlash, the same mechanical drive as the NATIONAL'S famous Type A dial.

Write for Bulletin 107 RA

NATIONAL CO., Inc.

W. A. READY, President
110 Brookline St. Cambridge, Mass.

This Aerial Gets Everything But Noise!

KANE ANTENNAE COMPANY, DRAY RADIO LABORATORY 6 EAST LAKE ST., CHICAGO
Precision Radio Apparatus Tests, December 24, 1925

Gentlemen:

As you requested we are enclosing under separate cover a picture of the Kane Antennae you recently installed on the roof of our building, at Lake and State Street, Chicago. As you know, we have never here at the Laboratory been able to get clear reception from distant stations. As soon as we turned on enough power to bring in the DX we of course picked up the electric sign noises, the elevated noises, the telegraph office next door, the street cars, the elevators, etc. Loop sets with their strong pick-up of local noises were particularly bad. For the last couple of months we have been getting letters from our dealers telling us that if we could only figure out some way to install radio sets near power noises with some scheme of Antennae that would bring in the distant station with less of the local noises, that they could sell more sets in difficult places where all makes of radios had proved too noisy for satisfaction. In many cases these dealers could not give decent demonstrations in their own stores. Finally we heard from Henry Stahl and Son, our dealer at Elkhart, Illinois, that they had eliminated the interurban and power line noises at their store by the use of a Kane Antennae. This was what led us to ask you to show what you could do for us at the Laboratory. Last night when we tested out your eighty foot transposed antennae and counterpoise, we were very much surprised. We had distant reception of very good quality. We checked back by using the usual type of ground and the ratio of power noises to music increased several hundred per cent, rendering the reception absolutely unsatisfactory. Then we would switch back again and get very excellent reception. We are enclosing a check in payment of your invoice. We are going to tell all of our dealers about our experience. After all the perfect schemes that we have wasted time in trying, we are glad to grant you the permission of publishing this letter if you care to.

Very truly yours,

DRAY RADIO LABORATORY, By W. R. Dray.

The KANE ANTENNAE entirely eliminates all power noises such as leaky Transformers, Generators, Motor hums, Delco Plants, etc. Power noises cause more trouble than all other forms of Radio interference. Get rid of them NOW by ordering a KANE ANTENNAE.

Get Facts NOW About The Kane Antennae

We will send you working drawing with instructions for erecting this wonderful Antennae for a dollar bill (a check will do). If, after looking over the drawing, you decide you would rather have a factory-built Antennae than build one yourself, we will take back the drawing and allow you full purchase price on an order for an Antennae.

The Special Kane Antennae for Radiola Super-Hets..... \$10.00
The Regular Kane Antennae for all other sets that use a ground connection..... 20.00
Working drawing with instructions for erecting..... 1.00

(Stamps not accepted)

Postpaid to any part of the United States or sent C. O. D. when 25 per cent of price accompanies order.

THE KANE ANTENNAE CO.

Dept. 820B, 3343 W. Monroe St.

Chicago, Ill.

Send 25c for Booklet Telling
How to Build the

Hammarlund Roberts

Hammarlund-Roberts, 1182 Bway, N. Y. C.



NO MORE LOOSE CONNECTIONS X-L PUSH POSTS

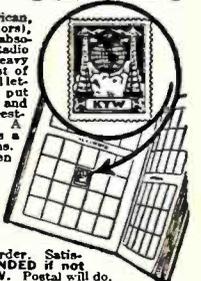
A binding post that really does excel. Looks, action, service, and convenience. Push it down—insert wire—cannot jar loose from vibration. No screwing or danger of shearing off wires. Furnished attractively plated with soldering lug and necessary markings. Price Each.....15 Cents

X-L RADIO LABORATORIES,
2424 Lincoln Avenue N. Chicago

Tell them you read it in Radio Age

FREE RADIO STAMPS

168 Beautiful copper etched American, Canadian, and European stamps (8 colors), each with the call letters of a station, absolutely FREE with each Ideal 48-page Radio Album and Log. Size 8 in. x 11 in. Heavy Covers. Also contains complete list of stations both alphabetically and by call letters. As you hear new stations just put proper stamps in your album. Album and stamps become a permanent and interesting record of the stations you receive. A fascinating hobby. Can be used as a game by taking turns at getting stations. All the rage. You and your children and friends will enjoy it, only \$1.



Send No Money

Just pay postman after album and FREE stamps arrive. We prepay postage if you prefer to pay with order. Satisfaction guaranteed. MONEY REFUNDED if not DELIGHTED. Send order today—NOW. Postal will do. IDEAL CO., Dept. 2022, 365 Wrigley Bldg., Chicago

Use the Log-a-Wave Chart

WITH THE MANUFACTURERS



Colored Pencils Useful for Radio Work

COLOR plays a part of increasing usefulness throughout the engineering world in connection with diagrams, charts and data sheets not foreseen when the old style colored pencil with thick lead was first introduced.

Realizing how many occasions in modern industry and science called for the use of colored pencils with the same diameter as ordinary drawing and writing pencils, the American Lead Pencil Company has originated a new product called the Unique Thin Lead which can be used exactly the same as a black lead pencil—for writing, figuring, sketching, drawing, etc.

Among radio engineers and experimenters, colored pencils have met with special favor as they permit the designation of the various coils, units and circuits by corresponding colors. The same effect is obtained for diagrams as is obtained in working models through the use of vari-colored cable and wire.

Palmer Goes Abroad For Radio Tests

FOR the purpose of cooperating officially in the international broadcast tests before and during the week of January 24 and to listen in at sea during the hours when European stations will send programs for American fans, Eric H. Palmer of the Freed-Eisemann Radio Corporation sailed on the "De Grasse" of the French Line on January 6 and will visit the principal broadcasters abroad.

Mr. Palmer will report by wireless to the tests committee, regarding reception also of stations in the United States, Canada, and Mexico that reach Europe during this important week in radio. Mr. Palmer will install an official receiving station on the steamship "Paris."

National Engineering Co. Has Semi-Assembled Receiver

THE National Engineering Company, just organized, has started production on a five tube tuned radio frequency receiver which will be offered to the public in a semi assembled state.

The set is known as the Huntingdon, built by M. B. Benson, chief engineer for the National Engineering Company. Others connected with the new company are M. M. McCabe, Duluth and Minneapolis, and H. W. Coulter, of Chicago.



W. J. Knapp, President of the National Carbon Company, makers of Eveready batteries, announces the election of Paul P. Huffard as Vice-President and General Manager of the company.

Mr. Huffard began his career in 1905 at the Electrometallurgical Works at Kanawha Falls, Virginia, as chemist, while still a college student. Upon attainment of his degree, he was transferred to the Niagara Falls plant of the Union Carbide and Carbon Corporation, of which he eventually became superintendent. His first position with the National Carbon Company was works manager of the Electrode Plants; later, in charge of production of all the National Carbon Company plants. His present advancement places him in charge of all phases of activities of the National Carbon Company and its associated companies, including the National Carbon Company of San Francisco, and the Canadian National Carbon Company, Limited, of Toronto, Canada.

Crosley Takes Over Assets of Amrad

ANNOUNCEMENT is made that A. Powell Crosley, Jr., president of the Crosley Radio Corporation, has recently purchased the assets of the American Radio and Research Corporation at Medford Hillside, Mass.

A new company is being formed to operate the Amrad organization with Mr. Crosley as chairman of the board, and H. J. Powell, former Amrad president, as the new president and general manager.

Amateurs will remember the development of the S tube for rectification by Amrad as well as the Mershon electrolytic condensers. The new organization is to continue operation in the same location.

Amsco Adds Socket to Its Line of Products

THE newest addition to the line of Amsco products is a universal socket designed to take all sizes of radio tubes, including the standard UX and CX tubes, without adapters.

They click into contact, establishing a positive wipe connection that perpetually renews itself each time the tube is removed and replaced. Connection is possible only in one way—the right way—and the tubes lock into place automatically.

Another feature of the Amsco universal socket is its compactness and light weight. Not a fraction of an inch is wasted.

It is made of mottled green genuine bakelite. All metal parts are of phosphor bronze, electrically tinned for easy soldering.

The base is of the non-skid type, with tiny moulded spikes that prevent twisting out of place—making possible the great convenience of one-hole mounting.

Interest Abroad In Use of Piezo Crystals

EUROPEAN fans, as well as broadcasters, are showing considerable interest in Piezo crystal control for transmitters, wavemeters and some types of receivers, according to a communication from Adam Hilger, Ltd., 24 Rochester Place, London, N. W. 1.

Two stock sizes made at present by the Hilger firm are the 180 meter and the 350 meter type, these being mounted in boxes of insulating material with binding posts at each end.

All-Wave Coils and Shot Panel in Ambu Set

TWO features embodied in the five tube receiver made by the Ambu Engineering Institute, as recently announced, are "All-Wave" inductances for taking care of the band from 40 to 600 meters, and the "shot" method of panel connection where the panel or sub-base is grooved and shot full of molten copper.

This latter process does away with the necessity of bus-bar wiring, since all that is necessary is to put in the panel screws which automatically make the required electrical contact with the copper stream and the apparatus.

53 Sources of Radio Interference

(Continued from page 34)

be taken in making this test to avoid the danger of confusing the interference which originates from different sources, which may appear similar in the receiver.

The most satisfactory way of making this test is for one observer to listen to the interference received on two radio receivers at different points at the same time by means of a telephone system. To carry out this test an assistant at the distant Radio receiver should place his head phone (or preferably his loud speaker) near the transmitter of the telephone in order that the observer at the other receiver may listen at the same time to the interference heard on his own receiver at his right ear, while listening to the interference heard at the distant radio receiver by means of the telephone to his left ear. This test should be continued for a sufficient length of time to observe a number of variations in the nature of the interference.

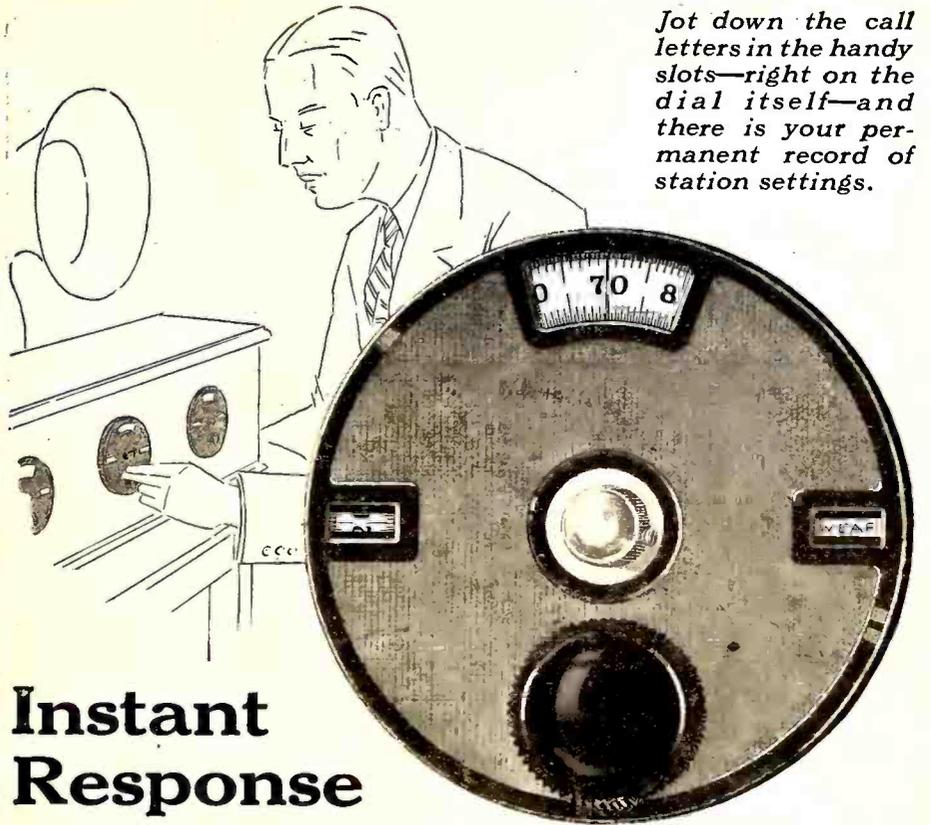
In cases where it is not convenient to use the telephone system for this test, the two observers at distant Radio receivers may keep an accurate log of the interference, but in this case they should first synchronize their watches and record any characteristic change in the interference heard, noting the time accurately to within a few seconds.

Fourth Test: To determine if any suspected source actually causes Radio interference.

In carrying out this test either of the two systems referred to in test No. 3 is suitable. Great accuracy is required in these tests for it has been found that many misleading reports have been received from observers who were not sufficiently accurate in their observations. For instance, interference has been reported to be associated with the switching on of the street lights in cases where the interference actually was produced by another circuit which was switched on every evening about dusk. If the observers in this case had noted the time very accurately, the source of the interference could have been located much more readily.

Fifth Test: To determine where the interference radiates from, by means of a portable Radio receiver.

In cases where a portable receiver is available the source of interference may be very often traced by this means.



Jot down the call letters in the handy slots—right on the dial itself—and there is your permanent record of station settings.

Instant Response

searching dial action for the model set

The designers of the Radio Age Model HX set wanted responsive, supremely accurate tuning, to meet today's conditions. They realized how inadequate old type dials are, to cope with 1926 broadcast congestion. As an essential feature of the Model set, therefore, you find MAR-CO dials. For these are the new-day tuning controls that experts everywhere advise.

They respond to your slightest touch with no suggestion of backlash. By splitting a single degree into hair's breadth divisions, they get stations you now pass over. Until you put MAR-CO dials on the set you're building, or on your present set, you'll never realize what a difference a dial can make!

Nickel-plated, \$2.50
Gold-plated \$3.00
Scales, reading 0 to 100, or 100 to 0, as desired.

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Address.....

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(2-26)

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The 1926 model tuning control

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That Meets the Requirements of Eminent Radio Engineers

Apex Vernier Dials are more than mere "knobs." In reality they are instruments endowed with an ultra degree of efficiency. Their rich elegance of finish lends a touch of striking attractiveness to any set. Precision of production and of operation makes a good set a better set—providing greater range of selectivity—positiveness of control—and utmost simplicity of tuning in most difficult stations. Ratio 12 to 1. Clockwise and counter clockwise. No back lash. Royal Brass Finish 4-inch \$1.50—3 1/4-inch \$1.25. Satin Silver Finish 4-inch \$1.75—3 1/4-inch \$1.50. DeLux Gold (24K) Finish 4-inch \$2.50—3 1/4-inch \$1.85. Your dealer has them. If not, order direct.

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See Patent and Printed Instructions with your device

PREMAX

New Wave Propagation Technique

(Continued from page 48)

We will assume the medium through which the radio waves pass has such characteristics that the velocity of propagation for a vertically polarized wave differs slightly from the velocity of the propagation for a horizontally polarized wave. It is not necessary for the present purpose to try to explain the reason for this difference in velocity. We may assume the reason for it is due to the electrostatic and magnetic effects, to the retarding effect of the velocity of the vertically polarized wave passing close to the earth, or, on the other hand, due to properties of free electrons in the upper atmosphere. Whatever the cause may be, we may assume such a difference of velocity exists and the mechanical model has been constructed so as to reproduce such conditions. The weights on both sides are tied together with rubber bands. Wave motion in the horizontal or vertical planes can thus be studied independently, and these two wave motions may be adjusted for different velocities. A wave started in the vertical plane maintains itself vertically and a wave started horizontally maintains itself horizontally. If, however, a wave is started in a plane 45 degrees between the vertical and the horizontal, it is found the wave motion proceeding therefrom assumes the shape of a cork screw. The straight line oscillation of the first weight is passed along as an elliptical motion which gradually widens into a circle. Then this circle narrowed down again to an ellipse and finally a straight line at right angles to the original line of oscillation. This is exactly in accordance with the theory. The point where the wave has shifted its plane of polarization 90 degrees is the point where the faster of the two waves is half a wave length ahead of the slower wave. From this point on the wave proceeds repeating this peculiar cork screw motion.

The fact the twisting of the wave is due to different velocities in the two planes of polarization can also be demonstrated by this model. For this purpose the rubber bands are added to the counter weights. The effect of this is to change the velocity of propagation in the vertical plane, whereas, the velocity in the horizontal plane has not been affected because only the vertical motion is transmitted to the counter weights by the suspension yokes. The system can thus be adjusted so the velocities in the horizontal and the vertical planes are exactly equal. After this has been done it is found the tendency to cork screw motion disappears and the wave remains strictly in the plane in which it has been started.

Visualize Phenomena

WHILE this mechanical experiment does not bring out any new facts that were not known from the classical theory of wave motion, it helps us to visualize the main phenomena in the radio wave propagation which we are trying to explain. The phenomenon of a constantly shifting plane of polarization which we

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Full, clear, rich tone depends on more than on just good apparatus. It depends, first of all, upon careful, compact wiring. AMPERITE eliminates complicated wiring, avoiding leaks and losses. Requires no attention. Controls the filament perfectly, bringing the utmost out of each individual tube. Permits use of any tubes or combination of tubes. Used in all popular construction sets. Price, \$1.10.

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A regular \$25 loud speaker for \$16. Loud, clear, mellow tone. Bell 13 1/4 in. diameter, horn 22 in. high, equipped with Lakeside Adjustable Unit. Agents wanted, write for particulars.

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discovered experimentally in tests between Schenectady and Long Island can thus easily be explained.

This conception of the wave motion is also a help in explaining the phenomena of fading. There is already much experimental evidence that fading is a phenomenon of interference. In other words, the fading is due to the fact the radio waves arrive at a certain point through two paths. The waves will sometimes add to each other and sometimes neutralize each other. If we keep in mind the observations on the mechanical model that the waves in the two planes can be traced through separately and distinctly, we may conclude the two paths of the radio wave which produce fading are not necessarily two separate physical paths but may be the two paths in the horizontal and the vertical plane of polarization. For further illustration of this we can, in the mechanical model, introduce a detector. If we place this detector at a certain distance from the origin we find the detector gives no response when the system is adjusted for different velocities of propagation, whereas, it gives a maximum response when the system is adjusted for equal velocity in the horizontal and vertical plane. The phenomena of fading has thus been reproduced mechanically through polarization in a single wave path.

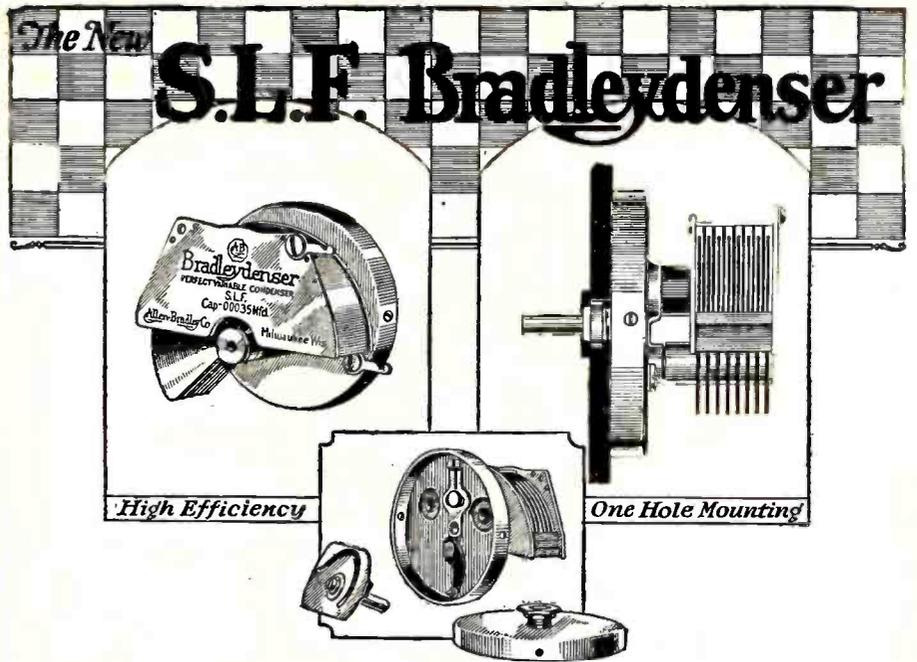
It is not hereby suggested this mechanical equivalent is sufficient to explain the fading in actual radio transmission. It is, however, offered for what it may be worth as a help to interpret the many observations in actual radio transmission which are being accumulated.

Storage Batteries Enter Lives of Millions

(Continued from page 16)

NOW that we have discussed the battery—its active materials, its electrolyte, the formation of lead sulphate and other chemical matters, you will perhaps ask how it stores electricity, and the answer may surprise you that the battery does not store electricity. The electrical energy which the battery receives when it is charged is converted into chemical energy. The chemical energy is stored by the battery, and when we discharge the battery this chemical energy is again transformed into electrical energy. Scientific research has taught us the storage battery obeys the fundamental laws of electrochemistry and thermodynamics. If this conversion of one form of energy into another seems strange it is nevertheless a part of nature's process.

Batteries have been improved notably within recent years. Tests in accordance with well defined specifications show this to be true. Standard methods of rating batteries are being established. Batteries of comparatively light weight for aviation are being developed. Research is playing an important part in this advance.



A Compact Straight-Line-Frequency Condenser

THE new S. L. F. Bradleydenser is the outcome of long, careful research in condenser design. It provides straight-line-frequency tuning over the entire circumference of a 360-degree dial. Stations are widely and evenly spaced over twice the dial-spacing of ordinary condensers. This unique control is obtained by using a special cam on the condenser shaft which provides the straight-line-frequency tuning now demanded by all set builders. The efficiency of the condenser is extremely high, due to the unique construction that practically eliminates insulating material in the condenser.

ANOTHER outstanding feature of the new S. L. F. Bradleydenser is the compact design which eliminates entirely the long eccentric rotor plates, ordinarily used with straight-line-frequency condensers. The Bradleydenser can be substituted for any condenser on a set without interfering with other parts on the panel. The one-hole mounting also simplifies installation. The S. L. F. Bradleydenser is the latest Allen-Bradley contribution to better radio. Be sure to bring your set up-to-date by getting a set of S. L. F. Bradleydensers from your nearest dealer.



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The receiver that brought in stations 6,000 to 8,000 miles distant with loud speaker volume night after night. All records fully verified.

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Story of development and proofs of records sent on receipt of stamped and addressed envelope.

Scott Radio Laboratories
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Dealers and Set Builders, write for discounts

Eliminate Audio Distortion

(Continued from page 26)

equally well. Even when the headphones, connected as in Fig. 2, respond with drums and low notes galore, the loud speaker does not do justice to them, even though showing a tremendous improvement over the previous output. Neither would the headphones, were they pushed to great volume, for their natural period is only slightly higher than that of the ordinary horn speaker. A large cone speaker reproduces bass notes well, but rather slights the high tones.

I use a combination of a large cone speaker and a horn speaker, connected in series and operated on a power tube for real reproduction. A most surprising change greets the ear when either the horn speaker or the cone speaker is used alone, but with both of them high and low tones receive their due. The richness, musical range and grandeur of orchestral and band music is delightful with such a system and even the human voice regains most of its naturalness. The very high tones are likely to cause a rustling sound in a large cone speaker, but it is very easy to eliminate these high tones from the low note speaker completely by simply shunting it with a fairly large fixed condenser. The capacity must be found by experiment, but one between .004 and .06 is suitable. A number of condensers can be put in parallel until the speaker's output is improved by the elimination of the high notes. These are then more properly reproduced on the horn type speaker. The condenser, by the way, is a helpful stunt for the mandolin type low note speaker which I recently described.

Thus loud speaker range has a good deal to do with musical quality and this range depends greatly upon the size of its diaphragm. My own low note cone speaker is a simple affair made out of a cone 20 inches in diameter cut from stiff drawing paper. The actuating unit is taken from a Baldwin phone, with the mica diaphragm taken out and a separate connecting pin run from the tip of the cone to the armature. The spring at the rear of the armature is removed and the armature maintained in a mid-position between the pole pieces by the holding force of the connecting pin and the cone, which is tacked down to a wooden framework.

But, whatever the loud speaker combination has to do with the quality of tone, it is certain the amplifier has a whole lot bigger part to play in it. The series headphone tests outlined are the surest way to locate distortion, for it is so easy to compare the several stages and focus the attention upon the single stage in which distortion occurs.

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PATENTS

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Send sketch of model and description, for advice as to cost, search through prior United States patents, etc. Preliminary advice gladly furnished without charge.

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Chicagoan Witnesses KFI's Auditions

(Continued from page 33)

dots and dashes or the messages of ships on the Pacific, passing up most of the code, however, until his acute ears detect an S. O. S. or distress signal of a ship on the rocks or in some such plight. When this happens, he immediately telephones on a direct wire to coast guards at Wilmington, and advises them as to what he has heard, and if necessary, KFI signs off until the complete identification of the ship has been made by the coast guards. The signing off, of course, being to eliminate interference of code reception. KFI has been operating for a long while, on a small set, and since Dec. 30th, 1924 on their present large set, which is the Western Electric 104 B type, 467 wavelength, with 5,000 watts possible, but only 3,000 allowed on their license.

"You ought to come up tonight about 9 or 10 o'clock and hear our program," advised Mr. Lilly, as I left this interesting operating room, and come up I did. And I was surely glad I did. I had heard a lot of these famous movie folk, and never dreamed of happening right in on them, but the very minute I hopped off the elevator I heard from the suspended microphone "Folks, we are surely glad to have with us this evening Lew Cody and Norma Shearer, regular performers from this studio, and tonight they are to hold a debate as to who ate the apple, Adam, Eve, or WALLACE BEERY!" Needless to say, that wasn't what these screen stars did at all, but they did tell a few very clever stories, and chatted part of a screen scenario, brand new, to their silent listeners all over the world.

As the program continued, with Glen Rice, William Ray and Leslie Adams doing alternative announcing, it was clearly seen how the acid test applied to tryouts, mentioned previously, was a wonderful benefit to this station. In order, these artists of great ability did work of exceptional merit: Miss Louise Klos, symphonic soloist on the harp, Felipe Delgado, a Spanish baritone, known all over California on the stage first of all as a great singer to movie prologues. Then came the favorite Park Sisters, June and Frances, ukelele and vocal duet specialists, followed by another surprise. Blanche Sweet and Mickey Neilsen were discovered stepping off the elevator and were forced into a number, Blanche harmonizing and Mickey at the ivories. They did it beautifully and didn't fight a bit. They were held over until the conclusion of the program and at 11 p. m., Pacific time, friend Rice signed off after a beautiful evening's entertainment.

"SAY, you, before you go I want you to meet—'Des capa blancas figure spitalny Paul ash en centre les cognitas—loook, loook, look! holy smokes!'"

The man Rice wanted me to meet nearly knocked both of us over in his excitement; excitement caused by a cablegram from Spain to the effect that KFI was being heard in that country!

(Turn the page)

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Standardized Adjustable
Radio Enclosures,
Consoles, Tables,
with Built-in Loop,
Speakers Etc.
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Make Your Set Up-to-Date

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(2-26)

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Radio Printers, Dept. 2022, Marengo, Ill.

Chicagoan Witnesses KFIS Auditions
 (Continued from page 59)

Who wouldn't be excited over that? Carl Havilan, publicity man for KFI, who is the size of a minute, had just received the cablegram, and was far too busy and excited to meet me, so I just slipped over to the elevator. As I pressed the button for service, Havilan was still raving about the cablegram, muttering Spanish with a few "hot dogs" and "oh boys" mixed in when Rice put his hand over Carl's whole face to shut him up, and shouted, "All right, all right—but what does it mean, translated?"

"Err—er," stammered Havilan, "your program is coming in beautifully; we are sitting in our Spanish front yard hearing every number clearly over our loud speaker, but 'Yes! We have no bananas!'"

Warner Bros. Portable Transmitter 6XBR
 (Continued from page 35)

Radio 6XBR was built for experimental purposes and to tie up with KFVB on 252 meters. In testing this station out it was found that it reached a class of listeners-in that had been overlooked. That of the amateur, and the BCL who make it a business to listen-in on the ow waves.

In the future 6XBR will reverse operations and rebroadcast KFVB on 108 meters. On the first test, letters were received from as far east as Denver and north to Portland, from those who heard it on 103 meters.

All equipment and mounting was built at the Warner Brothers' Studios, under the supervision of Frank N. Murphy, Electrical Engineer of Warner Brothers Studio.

This portable truck will be used to broadcast all sport events, musical entertainment and programs. These will be put on the air on 108 meters and will be picked up by KFVB, where it will be rebroadcast on 252 meters.

Westinghouse Folder Tells of Uses For Micarta

THE Westinghouse Electric and Manufacturing Company has just issued folder 4690 "Tune in With Micarta" describing the use of Micarta for radio panels. A list of all the different broadcasting stations with their respective wave-lengths is also contained in this publication which may be obtained from any of the Westinghouse branch offices or from the publicity department at East Pittsburgh, Pennsylvania.



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RADIO Storage "B" Battery

12 Cells 24 Volts
Lasts Indefinitely—Pays for Itself

Economy and performance unheard of before. Recharged at a negligible cost. Delivers unflinching power that is clear, pure and quiet. Approved and listed as Standard by leading Radio Authorities, including Pop. Radio Laboratories, Pop. Sci. Inst. Standards, Radio News Lab., Letax, Inc., and other important institutions. Equipped with Solid Rubber Case, an insurance against acid and leakage. Extra heavy glass jars. Heavy rugged plates. Order yours today!

SEND NO MONEY Just state number of batteries wanted and we will ship day order by expressman after examining batteries. 5 per cent discount for cash with order. Mail your order now!

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 Makers of the Famous World Radio "A" Storage Battery
 Prices: 6-volt, 100 Amp. \$11.95; 120 Amp. \$13.25; 140 Amp. \$14.00.
 All equipped with Solid Rubber Case.

World STORAGE BATTERIES

Set your Radio Dials at 210 meters for the new 1000 watt World Storage Battery Station. W.S.B.C. Chicago. Watch for announcements.

Yaxley Pilot Light Switch



Combination Pilot Light and Midget Battery Switch. Indicates whether the set is "on" or "off." The pilot light bulb's-eye is furnished in a choice of red, green or amber. No. 210 without Lamp \$1.00

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HEATH CONDENSERS
 For Real Radio Reception
 Write for Literature

HEATH RADIO & ELECTRIC MFG. CO.,
 206 First St. Newark, N. J.

Maximum Receiver Efficiency

(Continued from page 24)

iron should be heated, the point filed bright, rubbed in paste, and then in solder so it will acquire a coat of tin. Rosin on a joint does not hurt it, providing there is solid solder underneath. Do not try to wire with anything but perfectly straight bus bar rolled flat.

Many constructors prefer to use flexible wire in connecting up sets. In this particular receiver, this is permissible only for the filament battery, and audio amplifier sections. All r. f. amplifier wiring should be of stiff bus bar.

After the receiver has been completed, and the wiring checked against the circuit diagram, it may be connected up. The ends of the color cord are terminated at the batteries, with the exception of the B45 and B90 leads. With these unconnected, a tube inserted in a socket should light, if the switch is on, and the rheostat turned on.

With a water-pipe ground connected to either 1 or 2 of the left coil socket, and a 25- to 40-foot single wire indoor or outdoor antenna connected to whichever post (1 or 2) the ground has not been connected to, the set may be tuned, using the three dials. It should first be operated with headphones. The modulator or volume control should be turned all the way to the right, or at maximum. The antenna coil rotor should be so adjusted its axis is parallel to that of the stator coils. All three dials will read practically alike—that is, they will all be set at within one or two degrees of each other for a given station. Since each dial division may be assumed to represent approximately 10 kc. with S. L. F. condensers, a station might be located approximately as follows:

For simplicity, let us assume zero on the dials equals 500 kc. and 100 degrees equals 1500 kc. Thus, we have 10 kc. per dial division. Suppose we want WHT, 750 kc. (400 meters). Then 500 kc., our lower limit, subtracted from 750 kc.—WHT's frequency—gives us 250 kc., which divided by 10kc.—the frequency variation per dial degree—gives us 25. Thus, setting the dials at 25 degrees plus or minus one or two divisions will tune the set to 750 kc. (400 meters).

Suppose we were using straight line wavelength condensers. The process is different. Our wavelength range covered by 100 dial degrees may be assumed to be 200 to 550 meters, or a range of 350 meters. Thus, each dial division represents 3.5 meters. Suppose we want WHT again, at 400 meters. Then 200—our low wavelength limit—subtracted from 400—WHT's wave—gives 200, which, divided by 3.5—the number of meters per dial division—gives us approximately 57—the setting at which the set will be tuned to 400 meters.

It must be remembered that these figures are at best but approximate, due to unavoidable variation in individual receivers and tubes.



Illustration shows Model 7—5 tubes—“B” battery compartment underneath.

ORIOLE! The Most Amazing Performer You've Ever "Tuned In"

Oriole radio receivers step right out and make astounding records on distant stations—they give exceptional volume—unequaled for clarity and sweetness of tone. The most selective, sharpest tuning set you ever played with—you'll be “sold” on the ORIOLE the minute you turn its dials.

Model 7—5 Tubes, with “B” battery compartment.

Model 7-B—5 Tubes.

Model 7-C—5 Tubes—Console.

Model 8—4 Tubes.

Write for folder illustrating and describing all models.

Dealers: There is some exclusive territory open—ask for details.

W-K ELECTRIC CO.

KENOSHA

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Van Horne-Musselman Adapted Mogul 5 V C Power Amplifier

NEW! The Van Horne-Musselman Mogul 5 V C Tube is the latest and most advanced tube in the Power Amplifier Field.

The Patented Adapter enables you to enlarge the receiving range of your set—increases your loud speaker volume from 50 to 100% and completely eliminates distortion WITHOUT CHANGING YOUR PRESENT CIRCUIT.

Send for detailed information or see your nearest dealer.

JOBBER—DEALER

Write for our cooperative merchandising plan

THE VAN HORNE CO.

Factory and Sales Office

286 Center Street

Franklin, Ohio (near Dayton)

Tell them you read it in Radio Age

Correct List of Broadcast Stations

(Corrected up to January 7)

KDKA	Westinghouse Electric & Mfg. Co.	East Pittsburgh, Pa.	309	KFXF	Pike's Peak Broadcasting Co.	Colorado Springs, Colo.	250
KDLB	Radio Electric Co.	Devils Lake, N. Dak.	246	KFXH	Bldgco Radio Company	El Paso, Texas	242
KDYL	News-Hotel	Salt Lake City, Utah	246	KFXJ	Mountain States Radio Distributors, Inc. (Port. sta.)	Denver, Colo.	216
KOZB	Frank E. Seifert	Bakersfield, Calif.	210	KFXM	Neches Electric Co.	Beaumont, Texas	227
KOZI	Electric Supply Co.	Wenatchee, Wash.	360	KFXR	Classen Film Finishing Co.	Oklahoma City, Okla.	214
KFAB	Nebraska Buick Auto Co.	Lincoln, Nebr.	341	KFYX	Mary M. Costigan	Flagstaff, Ariz.	205
KFAO	McArthur Bros. Mercantile Co.	Phoenix, Ariz.	273	KFYF	Carl's Radio Den	Oxnard, Calif.	205
KFAF	A. E. Fowler	San Jose, Calif.	217	KFYJ	Chronicle Publishing Co.	Houston, Texas	238
KFAJ	University of Colorado	Boulder, Colo.	269	KFYR	Rossau-Meyer, Inc.	Bismarck, Dak.	248
KFAU	Independent School Dist.	Boise, Idaho	10	KGO	General Electric Co.	Oakland, Calif.	361
KFBB	E. A. Buttrey & Co.	Havre, Mont.	275	KGTT	Glad Tidings Tabernacle	San Francisco, Calif.	234
KFBC	W. K. Azzbill	San Diego, Calif.	224	KGU	Marion A. Mulrony	Honolulu, Hawaii	Beach 270
KFBK	Kimball-Upson Co.	Sacramento, Calif.	248	KGW	Portland Morning Oregonian	Portland, Oreg.	491
KFJL	Leese Bros.	Everett, Wash.	224	KGY	St. Martins College	Lacey, Wash.	246
KFBS	School District No. One	Trinidad, Colo.	238	KHJ	Times-Mirror Co.	Los Angeles, Calif.	405
KFBV	Bishop N. S. Thomas	Laramie, Wyo.	270	KHJ	Louis Wasmer	Seattle, Wash.	373
KFCB	Nelson Radio Supply Co.	Thioles, Ariz.	269	KJBS	J. Brunton & Sons	San Francisco, Calif.	220
KFCF	Frank A. Moore	Walla Walla, Wash.	256	KJR	Northwest Radio Service Co.	Seattle, Wash.	384
KFDO	St. Michaels Cathedral	Boise, Idaho	278	KJS	Bible Institute of Los Angeles, Inc.	Los Angeles, Calif.	293
KFDM	Magnolia Petroleum Co.	Beaumont, Texas	316	KLDS	Reorganized Church L. D. S.	Independence, Mo.	441
KFDX	First Baptist Church	Shreveport, La.	273	KLS	Warner Brothers Radio Supplies Co.	Oakland, Calif.	250
KFOY	South Dakota State College	Brookings, S. Dak.	273	KLX	Tribune Publishing Co.	Oakland, Calif.	508
KFDZ	Harry O. Iverson	Minneapolis, Minn.	231	KMA	Rossau-Meyer, Inc.	Portland, Oreg.	287
KFDL	McFarland & Frank Co.	Portland, Oreg.	246	KMA	Max Seed & Nursery Co.	Shenandoah, Iowa	236
KFEK	Augsburg	Minneapolis, Minn.	261	KMJ	Fresno Bee	Fresno, Calif.	234
KFEL	Winner Radio Corp.	Denver, Colo.	254	KMMJ	M. M. Johnson Co.	Clay Center, Nebr.	229
KFEQ	J. L. Scroggin	Oak, Nebr.	268	KMO	Love Electric Co.	Tacoma, Wash.	250
KFFP	First Baptist Church	Moberly, Mo.	242	KMOX	Voice of St. Louis	St. Louis, Mo.	208
KFFEY	Bunker Hill & Sullivan Mining and Concentrating Co.	Kellogg, Idaho	235	KNRC	C. B. Juneau	Los Angeles, Calif.	206
KFGB	Heidbreder Radio Supply Co.	Utica, Neb.	224	KPL	Los Angeles Evening Express	Los Angeles, Calif.	337
KFGB	Chickasha Radio & Electric Co.	Chickasha, Okla.	249	KPL	Electric Agricultural College	Los Angeles, Calif.	273
KFGH	Nelson Radio Supply Co.	Stanford University	270	KOAC	Oregon Agricultural College	Corvallis, Oreg.	260
KFGQ	Crary Hardware Co.	Boone, Iowa	226	KOB	New Mexico College of Ag. & Mechanic Arts	State College, N. Mex.	349
KFH	Hotel Lassen	Wichita, Kans.	268	KOCH	Central High School	Omaha, Neb.	258
KFHA	Western State College of Colorado	Gunnison, Colo.	252	KOCW	Oklahoma College for Women	Chickasha, Okla.	252
KFHH	Ambrose A. McCue	Neah Bay, Wash.	261	KOL	Monarch Manufacturing Co.	Council Bluffs, Iowa	278
KFHL	Penn College	Oskaloosa, Iowa	240	KPO	Hale Bros. Presbyterian Church	San Francisco, Calif.	428
KFIF	E. C. Anthony, Inc.	Los Angeles, Calif.	429	KPPC	Electric Agricultural College	Pasadena, Calif.	229
KFIO	Benson Radio Institute	Portland, Oreg.	249	KPRC	Houston Post-Dispatch	Houston, Texas	273
KFIP	North Central High School	Spokane, Wash.	266	KPSN	Star-News Publishing Co.	Pasadena, Calif.	316
KFIQ	First Methodist Church	Yakima, Wash.	256	KPT	H. B. Read	Portland, Oreg.	213
KFIU	Alaska Electric Light & Power Co.	Juneau, Alaska	226	KQV	Douglas-Day-Hill Electric Co.	Pittsburgh, Pa.	275
KFIZ	Daily Commonwealth	Fond du Lac, Wis.	273	KQW	Charles D. Herrold	San Jose, Calif.	231
KFJB	Marshall Electrical Co.	Marshalltown, Iowa	248	KRE	Berkeley Daily Gazette	Berkeley, Calif.	256
KFJC	R. B. Pagan (Episcopal Church)	Junction City, Kans.	249	KRC	California State Agricultural College	Mantahan, Kans.	341
KFJD	National Radio Manufacturing Co.	Oklahoma City, Okla.	261	KSO	Pulitzer Printing Co.	St. Louis, Mo.	256
KFJI	Liberty Theatre (E. E. Marsh)	Astoria, Oreg.	246	KSL	Radio Service Corp. of Utah	Salt Lake City, Utah	300
KFJL	Hardsag Manufacturing Co.	Ottumwa, Iowa	242	KSO	A. A. Berry Seed Co.	Clairina, Iowa	242
KFJM	University of North Dakota	Grand Forks, N. Dak.	278	KTAB	Tenth Ave. Baptist Church	Oakland, Calif.	333
KFJR	Ashley C. Dixon & Son	Portland, Oreg.	263	KTBI	Bible Institute	Los Angeles, Calif.	294
KFJY	Tunwall Radio Co.	Fort Dodge, Iowa	246	KTBR	Brown's Radio Shop	Portland, Oreg.	263
KFJZ	Southwest Baptist Theological Seminary	Fort Worth, Texas	254	KTHS	American Radio Telephone Co., Inc	Seattle, Wash.	306
KFKA	Colorado State Teachers College	Fort Collins, Colo.	254	KTNT	W. Arlington Hotel Co.	Hot Springs, Ark.	273
KFKU	The University of Kansas	Lawrence, Kans.	275	KTNT	N. Baker	Muscatoine, Iowa	256
KFKX	Westinghouse Electric & Manufacturing Co.	Hastings, Nebr.	288	KTW	First Presbyterian Church	Seattle, Wash.	454
KFKZ	F. M. Henry	Kirkville, Mo.	226	KUO	Examiner Printing Co.	San Francisco, Calif.	250
KFLD	Paul E. Greenlaw	Franklinton, La.	234	KUOM	State University of Montana	Missoula, Mont.	244
KFLP	Everett M. Foster	Cedar Rapids, Ia.	256	KUSO	University of South Dakota	Vermillion, S. D.	278
KFLR	University of New Mexico	Albuquerque, New Mexico	254	KVO	University of Texas	Austin, Texas	231
KFLS	St. Francis	San Antonio, Texas	246	KVOO	The Voice of Oklahoma	Denver, Colo.	273
KFLV	Swedish Evangelical Church	Rockford, Ill.	229	KWG	Portable Wireless Telephone Co.	Stockton, Calif.	248
KFLX	George Roy Cloud	Galveston, Texas	240	KWKC	Wilson Duncan Studios	Kansas City, Mo.	236
KFLZ	Atlantic Automobile Co.	Anita, Ia.	273	KWKH	W. G. Patterson	Kennewood, La.	261
KFMB	Christian Churches	Little Rock, Ark.	254	KWSC	State College	Pullman, Wash.	349
KFMQ	University of Arkansas	Fayetteville, Ark.	300	KWWG	City of Brownsville	Brownsville, Texas	278
KFMR	Morningside College	Spix City, Iowa	261	KYO	Electric Shop	Honolulu, Hawaii	270
KFMS	St. Francis	St. Joseph, Mo.	246	KZM	Westinghouse Electric & Mfg. Co.	Oakland, Calif.	248
KFMC	Carleton College	Northfield, Minn.	337	WAAD	Preston D. Allen	Oakland, Calif.	250
KFNF	Henry Field Seed Co.	Shenandoah, Iowa	266	WAAB	Ohio Mechanics Institute	Cincinnati, Ohio	248
KFNG	Wooten's Radio Shop	Coldwater, Miss.	254	WAAC	Chicago Daily Drivers Journal	Chicago, Ill.	278
KFOA	Rhodes Department Store	Seattle, Wash.	454	WAAB	Omaha Grain Exchange	Omaha, Nebr.	278
KFOB	Chamber of Commerce	Burlingame, Calif.	226	WABC	Asheville Battery Co., Inc.	Asheville, N. C.	254
KFOJ	Moberly High School	Moberly, Mo.	242	WABI	Ist Universalist Church	Bangor, Me.	240
KFOK	Echophone Radio Shop	Long Beach, Calif.	238	WABZ	Connecticut Agricultural College	Sorris, Conn.	263
KFOO	Latter Day Saints University	Salt Lake City, Utah	236	WABO	Lako Avenue Baptist Church	Rockton, N. Ind.	478
KFOP	Rohrer Elec. Co.	Marshfield, Ore.	240	WABQ	Haverford College, Radio Club	Haverford, Pa.	261
KFOR	David City Tire & Electric Co.	David City, Nebr.	226	WABR	Scott High School	Toledo, Ohio	263
KFOT	College Hill Radio Club	Wichita, Kans.	231	WABW	College of Wooster	Wooster, Ohio	207
KFOX	Board of Education, Technical High School	Omaha, Nebr.	248	WABX	Henry B. Joy	Mt. Clemens, Mich.	246
KFOY	Beacon Radio Service	St. Paul, Minn.	252	WABY	John Magaldi, Jr.	Philadelphia, Pa.	242
KFPG	Garretson and Dennis	Los Angeles, Calif.	238	WABZ	Coliseum Place Baptist Church	New Orleans, La.	275
KFPH	City of Berlin	Greenview, Ohio	246	WAAC	Allen T. Simmons (Allen Theatre)	Baxter, N. Dak.	275
KFPM	The New Furniture Co.	Greenview, Texas	242	WAFO	Albert B. Parfet Co.	Port Huron, Mich.	275
KFPR	Los Angeles County Forestry Dept.	Los Angeles, Calif.	231	WAHG	A. H. Grebe & Co.	Richmond Hill, N. Y.	316
KFPT	Cape & Johnson	Salt Lake City, Utah	286	WAIT	A. H. Grebe Co.	Taunton, Mass.	229
KFPW	St. Johns M. E. Church	Cartersville, Mo.	258	WAIU	American Insurance Union	Columbus, Ohio	294
KFPY	Symons Investment Co.	Spokane, Wash.	266	WAMD	Hubbard & Co.	Minneapolis, Minn.	244
KFQA	The Principia	St. Louis, Mo.	261	WAPI	Alabama Polytechnic Institute	Auburn, Ala.	248
KFQB	The Seawright Publishing Co.	Fort Worth, Texas	254	WABC	American Radio & Research Corp.	Medford, Mass.	261
KFQC	Radio Orch.	Burlingame, Calif.	231	WABD	Worcester University	W. Lafayette, Ind.	275
KFQP	G. S. Carson, Jr.	Iowa City, Ia.	224	WABC	Clemson Agric. College	Clemson College, S. C.	331
KFQU	W. Riker	Holy City, Calif.	217	WBAC	The Dayton Co.	Minneapolis, Minn.	417
KFQW	C. F. Knerim	North Bend, Wash.	216	WBAK	Pennsylvania State Police	Harrisburg, Pa.	275
KFQZ	Taft Products Co.	Hollywood, Calif.	226	WBAO	James Millikan University	Decatur, Ill.	270
KFRB	Hall Bros.	Beveille, Texas	248	WBAL	Consolidated Gas & Elec. Co.	Baltimore, Md.	246
KFRD	City of Paris Dry Goods Co.	San Francisco, Calif.	238	WBAO	James Millikan University	Decatur, Ill.	270
KFRU	Stephen Gilgole	Columbia, Mo.	500	WBAP	Worham Charter Publishing (Star Telegram)	Fort Worth, Texas	478
KFRV	United Churches of Olympia	Olympia, Wash.	219	WBAY	Erner & Hopkins Co.	Columbus, Ohio	292
KFSG	Echo Park Eran. Assn.	Los Angeles, Calif.	275	WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.	256
KFUL	Thomas Grogan & Bros. Music Co.	Galveston, Texas	258	WBAY	Western Electric Co.	New York, N. Y.	492
KFUO	Concordia Seminary	St. Louis, Mo.	545	WBBA	Plymouth Congregational Church	N-wark, Ohio	226
KFUP	Fitzsimons General Hospital	Denver, Colo.	234	WBBL	Grace Covenant Presbyterian Church	Richmond, Va.	229
KFUR	Julius Brunton and Sons Co.	San Francisco, Calif.	234	WBBM	Atlas Investment Co.	Chicago, Ill.	226
KFUS	Peets Barber	San Diego, Calif.	224	WBBS	Baker A. B. O'Brien	Wilmington, N. C.	275
KFUT	Louis L. Sherman	Oakland, Calif.	256	WBPP	Peoples High School	Petoskey, Mich.	238
KFUV	University of Utah	Salt Lake City, Utah	261	WBRR	People's Pulpit Assoc.	Rossville, N. Y.	273
KFVU	Colburn Radio Labs.	San Leandro, Calif.	224	WBSS	First Baptist Church	New Orleans, La.	252
KFVO	McWhinnie Electric Co.	San Pedro, Calif.	205	WBXX	Ruffner Junior High School	Norfolk, Va.	222
KFVE	Film Corporation of America	St. Louis, Mo.	240	WBYY	Washington Light Infantry Co. "B" 118th Inf.	Charleston, S. C.	268
KFVH	Clarence B. Juneau	Hollywood, Calif.	208	WBZN	Foster & McDonnell	Chicago, Ill.	266
KFVJ	First Methodist Church	Independence, Kans.	258	WBDD	Janet Laundry Co.	Grand Rapids, Mich.	266
KFVK	Whan Radio Shop	Manhattan, Kans.	219	WBEG	Boys Electric School	Takoma Park, Md.	222
KFVL	Headquarters Troop, 56th Cavalry	Houston, Texas	240	WBGA	Jones Elec. & Radio Mfg. Co.	Baltimore, Md.	254
KFVN	Carl E. Bagley	Welcome, Minn.	227	WBNY	Shirley Katz	New York, N. Y.	210
KFVO	F. M. Henry	Kirksville, Mo.	226	WBQO	A. H. Grebe & Co., Inc	Richmond Hill, N. Y.	236
KFVR	Moonlight Ranch	Route 6, Denver, Colo.	244	WBR	Pennsylvania State Police	Butler, Pa.	286
KFVS	Cape Girardeau Battery Station	Cape Girardeau, Mo.	224	WBRC	Bell Radio Corporation	Birmingham, Ala.	248
KFVW	City of Radio Corp.	San Francisco, Calif.	238	WBRE	Baltimore Radio Exchange	Wilmington, Del.	246
KFVY	Radio Supply Co.	Albuquerque, N. Mex.	250	WBZ	Chamber of Commerce	Charlotte, N. C.	275
KFVZ	Glad Tidings Tabernacle	San Francisco, Calif.	234	WBZ	Westinghouse Electric & Mfg. Co.	Springfield, Mass.	333
KFWA	Browning Bros. Co.	Ogden, Utah	261	WBZA	Westinghouse Electric & Mfg. Co.	Boston, Mass.	242
KFWB	Warner Bros.	Hollywood, Calif.	252	WCAC	Connecticut Agricultural College	Mansfield, Conn.	275
KFWC	L. E. Wall	Upland, Calif.	211	WCAD	St. Lawrence University	Canton, N. Y.	263
KFWF	St. Louis Truth Center	St. Louis, Mo.	215	WCAG	Kaufmann & Baer Co. and The Pittsburgh Press	Pittsburgh, Pa.	461
KFWG	F. Felting, Mfg. Co.	San Diego, Calif.	254	WCAL	Nebraska Wesleyan University	University Park, Pa.	284
KFWI	Radio Entertainments, Inc.	South San Francisco, Calif.	228	WCAL	St. Olaf College	Northfield, Minn.	347
KFWM	Oakland Educational Society	Oakland, Calif.	207	WCAP	A. A. and A. S. Brager	Baltimore, Md.	275
KFWO	Lawrence Mott	Avalon, Calif.	211	WCAP	Chesapeake & Potomac Telephone Co.	Washington, D. C.	464
KFWU	Louisiana College	Pineville, La.	238	WCAR	Southern Radio Corp. of Texas	San Antonio, Texas	263
KFWV	Wilbur Jerman	Portland, Oreg.	213	WCAS	W. H. Dunwoody Industrial Institute	Minneapolis, Minn.	280
KFWX	Bertram O. Heller	Big Bear Lake, Calif.	203	WCAT	State College of Mines	Rapid City, S. Dak.	240
KFXD	Santa Maria Valley Railroad Co.	Santa Maria, Calif.	203				
	L. H. Strong	Logan, Utah	205				

*Wavy not definitely assigned.

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All for a Quarter!

Table listing radio stations and their locations, organized in two columns. Each entry includes a call sign (e.g., WCAU, WCAK, WCBW) and the name of the station or its parent organization, followed by the city and state. The list covers a wide geographic area, including stations in the Northeast, Midwest, South, and West.

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List Price
\$27.50



Dealers and Jobbers
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Wire or Write.

Just Hear A QUAM RADIOVOX

With the Silver Drumhead Diaphragm

IT is far superior to any other loudspeaker in tone quality, volume and enunciation, due to an entirely new principle of diaphragmatic construction—the Silver Drumhead.

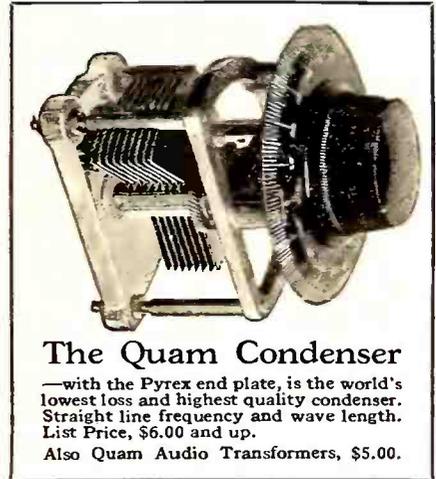
This Silver Diaphragm is only three one-thousandths of an inch in thickness, stretched tightly over a brass ring and adjusted to a sensitivity that responds to the slightest impulse. A small silicon steel disc is welded to its center to receive the impulses from the magnets. The extreme thinness of the silver, coupled with its well known musical qualities and tuning to the proper pitch, permits it to vibrate so fast that its reproduction of speech and music is perfect and sets an entirely new standard in radio reproduction.

Non-vibrating, semi-hard rubber horn, finished in mahogany and cast aluminum tone throat in russet crackle, make for a beautiful appearance as well as perfect reproduction of sound.

Manufacturers—Write us for our special proposition on Quam Radiovox Units. They will improve your receiving sets 100%.

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—with the Pyrex end plate, is the world's lowest loss and highest quality condenser. Straight line frequency and wave length. List Price, \$6.00 and up.
Also Quam Audio Transformers, \$5.00.

100% Better Tone!

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Resistance-Coupled Audio



The Mountford R. C. Kit makes it possible for anyone to build a Resistance-Coupled set or to change their transformer audio to Resistance-Coupling and obtain 100% better tone, greater distance, and sharper selectivity. The Mountford R. C. kit is the result of exhaustive laboratory experiments, and possesses exclusive features that make it the most efficient R. C. Kit on the market. Packed complete with Hook-Up Diagrams. At your dealers or post-paid upon receipt of price. **\$6.50**
Also ask your dealer for Mountford Plunger Type Variable Grid Leak, Price 50c.
Regular Discounts to Distributors.
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Allen Bradley Designs Compact S. L. F. Condenser

THE Allen-Bradley Company of Milwaukee has designed a compact straight line frequency condenser, a feature of which is a cam which converts a symmetrically shaped condenser into an S. L. F. condenser, and distributes stations uniformly over a 360 degree dial. The new Bradleydensen can be mounted in place of practically any ordinary condenser. The uniform spacing of stations over a 360 degree dial facilitates close tuning.



The one hole mounting makes installation easy. The plates are of brass and soldered to provide highest conductivity. Rotor plates are grounded.

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* Asterisks * placed in advertising space denotes manufacturers have submitted samples of their products to Radio Age-Institute and these products have passed the Institute tests.

CLASSIFIED ADVERTISEMENTS

If you have anything to buy or sell, don't overlook the value of RADIO AGE'S classified advertisements. Many such messages have paved the way to independent incomes.

The classified advertising rates are but ten cents per word for a single insertion. Liberal discounts are allowed on three, six and twelve-time insertions, of five, fifteen and thirty per cent respectively. Unless placed through an accredited advertising agency, cash should accompany all orders. Name and address must be included at foregoing rates and no advertisement of less than ten words will be accepted.

All classified ads for the March issue must be sent in by February 1.

ADVERTISING SERVICE

QUEX Sales Letters Get More Business. Write him today. Quex, 4418 Michigan Ave., Chicago.

AGENTS WANTED

FORDS. 60 miles on one gallon of Gas. It has been proven such mileage can be made. AIRLOCK guarantees to increase gas mileage; also prevents radiator boiling in summer or freezing in winter. Cools, Fuels, Decarbonizes the Ford motor. Splendid territory open. AIRLOCK PRODUCTS, Box 703G, Willow Street, Long Beach, Calif.

RADIO—Join our sales organization and make big money. We want a man in every county to sell well advertised sets and parts made by the leading manufacturers. Widener of Kansas City makes \$150.00 weekly. You can do as well or better. Write today for catalog, and discounts. Name your county. Waveland Radio Company, Div. 52, 1027 No. State St., Chicago, Ill.

MANUFACTURER'S AGENT calling on Radio-Electrical Jobbers, Chicago and vicinity, has opening for 3 additional lines carrying volume business, as we cater to large jobbers. Edelstein, 1804 McCormick Bld., Chicago.

Man wanted for this territory to sell wonderful value men's, women's, Children's shoes direct, saving consumer over 40%. Experience unnecessary. Samples supplied. Big weekly permanent income. Write today Tanners Mfg. Co., 1334C St., Boston, Mass.

550 WEEKLY EVENINGS. DEMONSTRATING A super selective 6-tube radio set. Selectodyne Radio Co., Dept. M-325 West State, Rockford, Illinois.

RADIO SALESMEN and SET BUILDERS in every county write Grenzer Radio, 1479 Hodiament St. Louis, Mo.

AGENTS

AGENTS: 100% PROFIT; WONDERFUL LITTLE article. Something new; sells like wildfire. Carry in pocket. Write at once for free sample offer. ALBERT MILLS, Manager, 5794 American Bldg., Cincinnati, Ohio.

"B" BATTERIES

100 VOLT EDISON TYPE "B" BATTERY, knocked down. Parts and plans—complete, \$12.50. Lane Mfg. 2937 W. Lake, Chicago.

BATTERIES FOR SALE—Four 24-volt "Main" Storage "B" Batteries, never used, shipped and ready to wire for \$38.00. First order gets the batteries. Address Box B, Radio Age, 500 N. Dearborn St., Chicago, Ill.

BUSINESS OPPORTUNITIES

\$100 weekly up. We want experienced Radio men to operate branch assembling plants. Part or whole time. Barfield Radio Co., 13 Tillery Street, Dept. A R, Brooklyn, New York.

CRYSTALS

Supersensitive Galena Crystals: Pound 75c prepaid. ALKEMITE. All sensitive Crystals 50c. Buskett, Geologist, Joplin, Missouri.

Classified ad copy for the March RADIO AGE must be sent in by February 1, 1926.

DOGS

BEAUTIFUL REGISTERED BULL PUPS \$15. Bulldogs, 501 Rockwood, Dallas, Texas.

HELP WANTED

RADIO SALESMEN and SET BUILDERS—We need you and you need us. If you are reliable and well known in your community, we will appoint you our representative and furnish you with standard well advertised sets and parts at prices that will enable you to sell at a handsome profit. Write at once for catalog and sales plan. Waveland Radio Co., Div. 53, 1027 N. State St., Chicago, Ill.

MEN wanting forest ranger, railway clerk and other government positions, write for free particulars of exams. Mokane, Dept. B-33, Denver, Colo.

MEN WISHING TO ENTER DINING, SLEEPING CAR SERVICE AS CONDUCTORS, PORTERS, WAITERS, WRITE 123 RAILWAY EXCHANGE, KANSAS CITY.

INVENTIONS

NEW IDEAS WANTED—Well known Radio Manufacturer whose products are nationally advertised and sold everywhere wants new Radio device to sell. Will pay outright or royalty for idea or invention which is really new and saleable. Address: Mr. R. F. Devine, Room 1101, 116 West 32nd St., New York, N. Y.

MUSIC

"MUSIC COMPOSED" TO WORDS. BAUER BROS., (formerly of Sousa's Band), Oshkosh, Wisconsin.

PATENTS

FOR SALE: U. S. and Canadian Patent on an Attachment for Phonographs; is the most beautiful invention of the age. Address Chas. F. Smith, Huff, N. Dak.

RADIO

FIFTY CENTS REMITTED MONTHLY SUBSCRIBES following Radio Electric Lists—Radio Age, Radio News, Science and Invention, Electrical Journal. Complete list free. Others in lists of four same. Spencer Shield Agencies, West Los Angeles, Calif.

B BATTERY ELIMINATORS—BUILD YOUR OWN cheap; no hum; acid or anything to get out of order; blueprint and instructions; 50 cents, money order or cash. Web Radio Co., Dept. A, 5823 Calumet Ave., Chicago, Illinois.

A PRACTICAL TUBE RECEIVING SET FOR \$10. Postpaid, less phones and tube. Complete with phones, tube and battery, \$18.00. J. B. RATHBUN, 1067 Winona St., Chicago, Ill.

Standard solderless radio Jacks. Binding post attachments. Double circuit. One dollar bill. Postpaid. Clinton Seward, Jr., New Paltz, New York, N. Y.

Three Cosmopolitan Phusiformers, each \$5.50, book of instructions included. F. A. Mall, Triopi, Iowa.

15 to 25 per cent discount on nationally advertised sets and parts. Every item guaranteed. Tell us your needs. IMPERIAL RADIO COMPANY, Delaware, Ohio.

RADIO SETS. Our prices save you money. Lists free. The Radio Shoppe, Box 645, East Liverpool, Ohio.

\$1.00 For Your Old Tubes regardless of make or condition towards the purchase of each new Standard \$2.50 tube. Positively guaranteed. We do not sell rebuilt or bootleg tubes. Order today. Luxem & Davis Mfg. Co., 6229 Broadway, Chicago, Ill.

RADIO

AT LAST! The Radco Static Eliminator. Eliminates 50 to 90% Static. Many satisfied users. Write for particulars. Radio Specialties Company, Sioux Falls, South Dakota.

RADIO CIRCUITS

SPECIAL FOR FEBRUARY

The Reinarts Radio Booklet, by Frank D. Pearne, fully illustrated, and RADIO AGE, for \$2.50. Price of Booklet alone is 50c. Send check, currency or money order to RADIO AGE, 500 N. Dearborn Street, Chicago.

RADIO DEALERS

DEALERS—Write for our illustrated catalog of reliable Radio Merchandise. Rossiter-Manning Corporation, Dept. D, 1830 Wilson Ave., Chicago, Ill.

RADIO SUPPLIES

HAVE YOU SEEN THE NEW DIALITE, THE UNIQUE lamp that lights up your panel and adds a decorative touch to any radio set? Retail at \$2.75, complete. Send for folder and dealer's proposition on this fast moving article. Also, we are distributors for the famous Knurled Walnut Cabinets, the most beautiful cabinets made. American-Universal Radio Co., 6255 Broadway, Chicago, Ill., Box 11.

SALESMEN WANTED

Make \$100 WEEKLY in spare time. Sell what the public wants—long distance radio receiving sets. Two sales weekly pays \$100 profit. No big investment, no canvassing. Sharpe of Colorado made \$955 in one month. Representatives wanted at once. This plan is sweeping the country—write today before your county is gone. OZARKA, INC., 126 F Austin Ave., Chicago.

66 MILES ON 1 GALLON—SCIENTIFIC GAS SAVER. All autos. 1 free to introduce. Critchlow, A-90, Wheaton, Illinois.

MANUFACTURERS OF NEW AND IMPROVED STATION finder and vernier tuning-dial want live salesmen to call on radio trade. Excellent side-line; good commissions; exclusive territories. Westerland Corporation, Dobbs Ferry, New York.

STAMPS

STAMPS, 50 varieties, Africa, Brazil, Peru, Cuba, Mexico, etc., 10c. 50 different U. S., 25c; 1,000 mixed, 40c; 1,000 hinges, 10c. List free. C. Stegman, 5950 Cote Brillante, St. Louis, Missouri.

WIRELESS

WANT TO MEMORIZE THE WIRELESS CODE? The Coryden Snyder Code Method, Patented, is quickest. Send 50c coin, stamps or M. O. to C. G. Snyder, 1423 Elm Dale Ave., Chicago, Ill.

TELEGRAPHY—Morse and Wireless—taught at home in half usual time and at trifling cost. Omnigraph Automatic Transmitter will send on Sounder or Buzzer, unlimited messages, any speed, just as expert operator would. Adopted by U. S. Govt. and used by leading Universities, Colleges, Technical and Telegraph Schools throughout U. S. Catalog free. Omnigraph Mfg. Co., 13 F Hudson St., New York.

PERSONAL

LONELY HEARTS: Exchange letters; make interesting new friends in our jolly club. Eva Moore, Box 908, Jacksonville, Florida. Enclose stamp.

Radio Age Classified Ads Bring Results

KC	Meters	STATIONS	DIALS		
			1	2	3
1480	202.6				
1470	204.0				
1460	205.4				
1450	206.8				
1440	208.2				
1430	209.7				
1420	211.1				
1410	212.6				
1400	214.2				
1390	215.7				
1380	217.3				
1370	218.8				
1360	220.4				
1350	222.1				
1340	223.7				
1330	225.4				
1320	227.1				
1310	228.9				
1300	230.6				
1290	232.4				
1280	234.2				
1270	236.1				
1260	238.0				
1250	239.9				
1240	241.8				
1230	243.8				
1220	245.8				
1210	247.8				
1200	249.9				
1190	252.0				
1180	254.1				
1170	256.3				
1160	258.5				
1150	260.7				
1140	263.0				
1130	265.3				
1120	267.7				
1110	270.1				
1100	272.6				
1090	275.1				
1080	277.6				
1070	280.2				
1060	282.8				
1050	285.5				
1040	288.3				
1030	291.1				
1020	293.9				

KC	Meters	STATIONS	DIALS		
			1	2	3
1010	296.9				
1000	299.8				
990	302.8				
980	303.9				
970	309.1				
960	312.3				
950	315.6				
940	319.0				
930	322.4				
920	325.9				
910	329.5				
900	333.1				
890	336.9				
880	340.7				
870	344.6				
860	348.6				
850	352.7				
840	356.9				
830	361.2				
820	365.6				
810	370.2				
800	374.8				
790	379.5				
780	384.4				
770	389.4				
760	394.5				
750	399.8				
740	405.2				
730	410.7				
720	415.4				
710	422.3				
700	428.3				
690	434.5				
680	440.9				
670	447.5				
660	454.3				
650	461.3				
640	468.5				
630	475.9				
620	483.6				
610	491.5				
600	499.7				
590	508.2				
580	516.9				
570	526.0				
560	535.4				
550	545.1				

(Copyright, 1928)

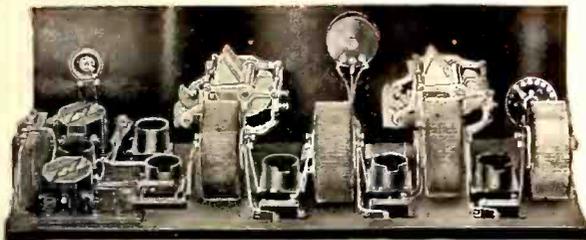
BREMER-TULLY LEADERSHIP UNTOUCHED

Fall—with its annual promises of revolutionary improvements is GONE.

Early Winter—the period of *test* and *trial*, when the public sorts out the *fit* from the *failures*—puts the stamp of approval on the real and the “bargain counter” label on the guess work—HAS DONE ITS WORK

and January to June is here—the big six months when we all settle down to constructive enjoyment—bringing our parts and circuit up to the latest—secure in the knowledge that tomorrow or next week is not going to make them obsolete—*if we choose wisely.*

You Don't Have to Be An Expert to Know That the B-T Reputation Has Increased With Every Month



5 or 6-tube Counterphase Kits are furnished; also separate Torostyle transformers for 4-tube set described in Jan. Radio Age.

THE COUNTERPHASE

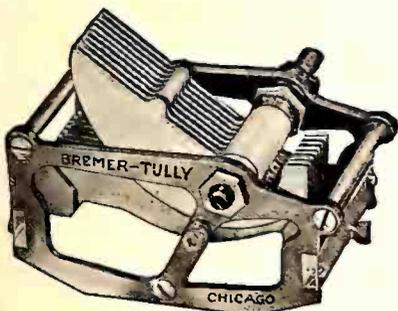
is the only new circuit of the season—and the greatest. Wiring is made easier than ever before.

Nine color diagrams leave no room for error. Drilled and Engraved Panels, either Formica or metal are available.

For a less expensive 5-tube Set the NAMELESS is still unequalled.

B-T AUDIO TRANSFORMERS

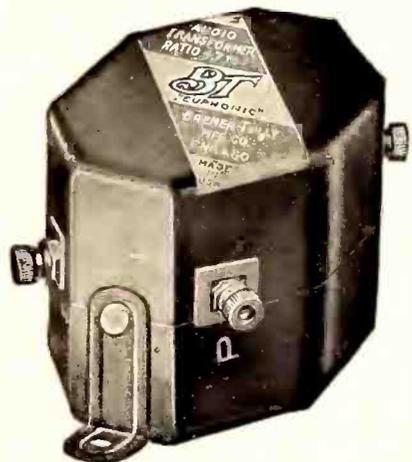
have proved to be one of the season's greatest successes. The reason is obvious. The EUPHONIC is not just another machine-shop creation. It's a real radio instrument, with 20 years' experience behind it—the same experience that developed the Nameless and Counterphase.



Demand Euphonics,—save money,—and at the same time get all the high notes and low notes plus greater tone quality than you can find in any other way.

B-T CONDENSERS

have led for years. There is no indication evident that their quality has yet been equalled. The more you learn about condensers the more you appreciate the B-T. For your own protection examine B-T Condensers carefully before you make another Condenser purchase.



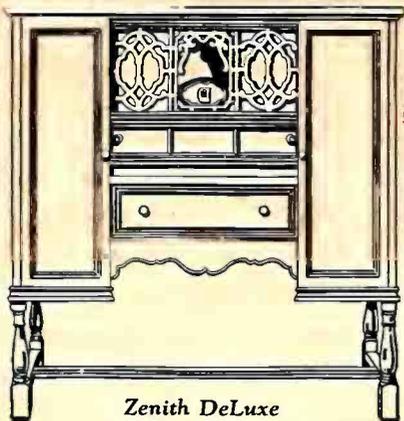
2.2 to 1—\$5.00
4.7 to 1— 5.75

STRAIGHT LINE FREQUENCY
.00025 \$5.50
.00035 5.75
.0005 5.75
Also made in Straight Line Wave Length and Tandem

BREMER-TULLY MFG. COMPANY

532 So. Canal St.

Chicago



Zenith DeLuxe
Colonial Model

Zenith DeLuxe Art Models are equipped with multiple built-in loud speakers, Bates Rotary Log, illuminated dial and single control specially constructed Zenith radio circuit . . . In Colonial, English, Italian, Chinese and Spanish period style. Priced from \$500 to \$2,000.

Super-Zeniths from \$240 to \$355.

Other Zeniths \$100 and \$175.

The Only Place to Buy a Radio is in the Home

If we could give only one piece of advice to a prospective radio purchaser, it would be this—Never put down a dollar on a radio instrument until you have proved its performance in your own home.

Radio instruments differ in *range*, in *selectivity*, in *ease of control* and notably in *Tone Quality*.

"Clarity of tone" and "faithful reproduction" are phrases which have almost lost their meaning, so grossly have they been abused. Yet real tone quality in a radio instrument is a priceless asset. Think of what "tone" can mean in a violin and you'll have a fair basis for comparison. Of two violins one may sell for \$25 and be overpriced; the other for \$10,000 *and well worth it*. Yet the only essential difference is in *Quality of Tone*.

Zenith frankly aims to make the best radio instruments that can be made—then, and then only, to affix a price.

The Super-Zenith—priced from \$240 to \$355—is a long-distance instrument. MacMillan—twelve degrees from the North Pole—talked with the world every night over Zenith Radio. Yet Zenith makes no claims for distance—*except by comparison*. The Super-Zenith brings in distant stations with surprising readiness.



But—prove its simplicity of operation, *with your own hand on the dial*.

The Super-Zenith was perfected in an experimental laboratory in what is probably the worst radio pocket in

Chicago, the near North Side. It was built to give extraordinary selectivity—and it does. But before you put down a dollar for a Super-Zenith, prove its selectivity in your own home.

Values are *values*. Zenith does not make radio sets for the bargain counter. It has too much regard for its reputation to do that.

Yet every Zenith owner—whether his Zenith cost him \$100 or \$2,000—will tell you that his Zenith (and that is the way he speaks of it) is the greatest radio value in the world.

Call at the nearest Zenith Service Station—there's one in your neighborhood—and select the style you prefer. Then test it in your own home—in *side-by-side comparison with any other radio instrument on the market*. No obligation. Simply tell the Zenith dealer where you live and the evening most convenient.

They Cost More—But They Do More



ZENITH RADIO CORPORATION
Straus Building Chicago