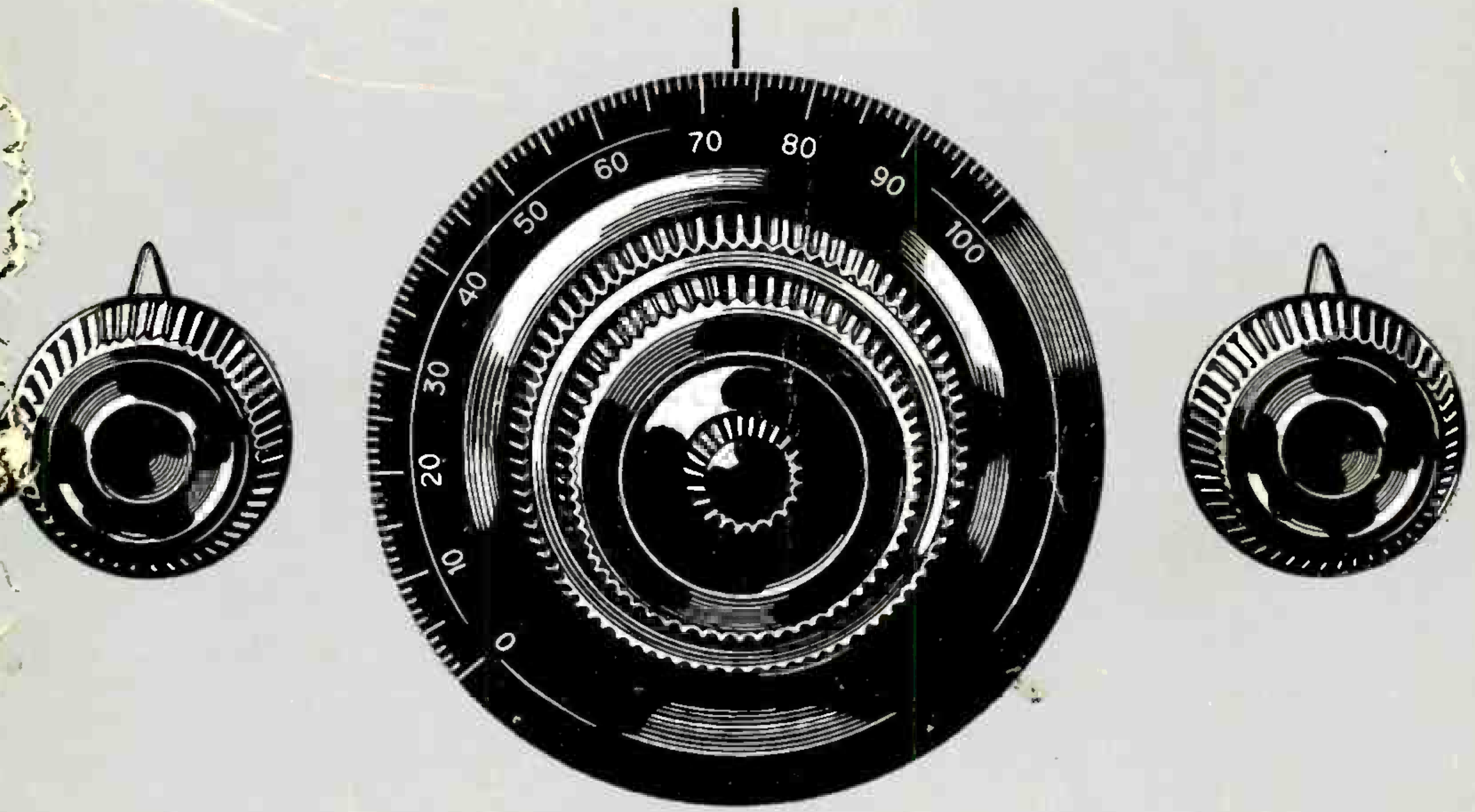
Popular Radio

with which is combined The Wireless Age

Edited by KENDALL BANNING

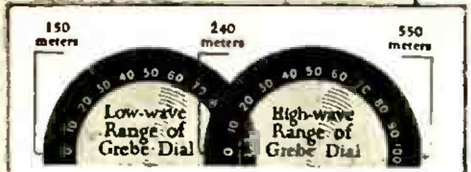
25¢

* DECEMBER · 1925

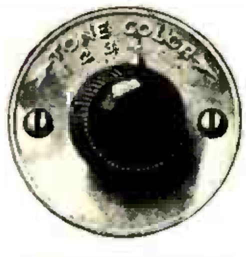


—In this Issue—

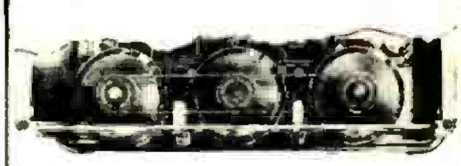
HOW TO BUILD THE NEW LC-26 BROADCAST RECEIVER



The high-wave reception range of the Grebe dial (B)—from 550 down to 240 meters—equals the practical tuning range of the usual receiver. The low-wave range of the Grebe dial (A) provides additional reception down to 150 meters.

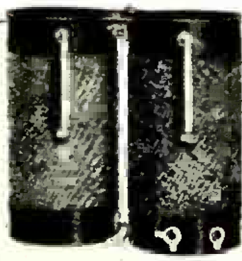


Grebe "Colortone"



Flexible Unit Control

One dial operates two or all three; or dials may be adjusted separately, at will.



Grebe Binocular Coils
Reg. U. S. Pat. Off.
and
Low-Wave Extension Circuits

The Three Outstanding Radio Advances of 1925

YOU could not give or receive a finer Christmas gift than the Grebe Synchrophase.

Last year Grebe developed the fieldless *Binocular Coils* and *S-L-F Condenser.* This year even greater strides have been made in radio reception.

With the *Grebe "Colortone"* the quality of sound can be kept absolutely true and clear and is always under the listener's control, independent of the loud speaker's influence. This tone control also makes it possible to reduce, to a great degree, disturbances due to static and to suppress considerably the high-pitch frequencies caused by heterodyne interference of one station with another.

The *Low-Wave Extension Circuits* have widened the reception range so that over 100 low-wave stations not reached by other receivers can be tuned.

Flexible Unit Control gives one, two or three-dial control.

Both in range and quality of reception, the Grebe Synchrophase is far in advance.

Ask your dealer to demonstrate, then compare Grebe reception with that of other receivers

A. H. Grebe & Co., Inc., 109 West 57th Street, New York
Factory: Richmond Hill, N. Y.
Western Branch: 443 So. San Pedro St., Los Angeles, Cal.

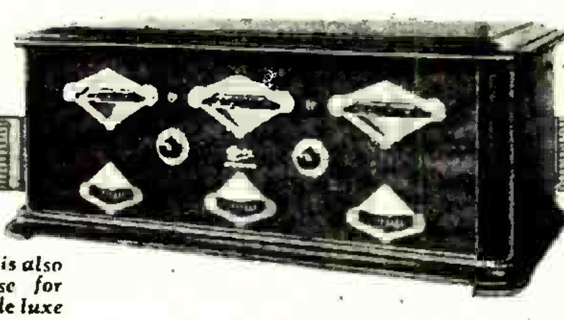
The GREBE SYNCHROPHASE
TRADE MARK REG. U.S. PAT. OFF.

This company owns and operates stations WAHG and WBOQ; also low-wave re-broadcasting stations, mobile WGMU and marine WRMU

"Take the lead and set an example of diligent toil."
—*Confucius*

Much toil and great diligence have made the Synchrophase worthy of first rank in radio receivers.

Doctor Mu



The Synchrophase is also supplied with base for batteries and in a de luxe Console model.

All Grebe apparatus is covered by patents granted and pending.

Pages with the Editor

This is the time of year when the radio fan —particularly the experimenter—is searching the most diligently for the "best receiver in the world."

* * *

Everyone demands a receiver that gives "truthful reproduction." Nearly everyone demands a circuit that is highly selective. Nearly everyone wants a receiver that is easy to tune. And a great many want to get long distance.

* * *

To develop a circuit that will meet these requirements better than they have ever been met before has been the aim of the Popular Radio Laboratory ever since it created the famous Cockaday Four-circuit Tuner—of which about a million have been built from designs furnished by this magazine.

* * *

For the past nine months the staff of the Popular Radio Laboratory has concentrated upon this task. During this period a need was found for radio parts that were better than anything on the market. So new and better parts were designed and built—and the radio art has been advanced and the broadcast listener has been benefited by just so much.

* * *

At last the task was completed. And the complete report of it, including specific and detailed "how-to-build" plans, is contained in this number—beginning on page 495.

* * *

It has been the unanimous opinion of the experts who have listened to this set and tested it that it represents the very latest and best word in receiver set design; that it furnishes the experimenter and the home-builder with the most efficient receiver that has ever been placed at his disposal.

* * *

Among the outstanding features of this set are:

It gives the clearest and most truthful of reproduction;
It is super-selective;
It is easy to tune;
It is capable of getting great distance;
It will not radiate;
It is beautiful in design;
It is easy to build—at a cost for parts not in excess of $63.50.

* * *

In this receiver (designated as the LC-26), Popular Radio has reason to believe that it has made an outstanding and substantial contribution to the radio art.

* * *

For so long has Popular Radio been identified as "the magazine with the silver cover" (a cover scheme that this magazine originated nearly four years ago) that one would ordinarily conclude that this distinguishing feature would be reserved by other periodicals for Popular Radio alone.

* * *

Perhaps, however, with the purpose of basking in a reflected prestige, at least two foreign radio magazines have recently copied the silver cover idea. The first to do so was a French magazine; the latest to do so is *"Osterreichischer Radio Amateur,"* an Austrian monthly edited by Professor Anton Zeemann. Not only has our Austrian contemporary copied the silver cover, but it has even copied the June, 1925, design itself—even to the white lettering of the title and the black circle that contains the price-mark!

* * *

An Australian and a Japanese radio magazine have gone further; they have reprinted entire articles from Popular Radio—without credit, of course.

* * *

If imitation is the ultimate of flattery, Popular Radio is being overwhelmed with praise by our European imitators.

* * *

"The new issue of Popular Radio, which is the first of the combined issues of Popular Radio and *Wireless Age*, is certainly wonderful. I did not believe it possible to improve Popular Radio, so I am pleased to say that it was really a pleasant surprise. You certainly have my sincere good wishes for an increased membership, and I trust that your circulation will continue to grow right along."

—C. W. Riley, Jr., *Cincinnati, O.*

* * *

Irish wrath was wreaked upon the head of the Editor when Popular Radio for September reached its readers on the Emerald Isle. And all because of a little paragraph that was headed "The Irish Still Squabbling Over Their One Proposed Station," based upon an article which reached us through a news agency.

* * *

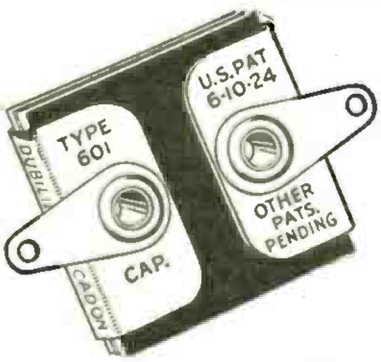
"In the first place," protests Mr. Scott Hayward of Dublin, "the Irish are not squabbling, so there is no controversy at all concerning the question of broadcasting. And secondly, there are *two* proposed stations—not only proposed but decided upon—one for Dublin and one for Cork, in addition to the Irish station established for a considerable time at Belfast.

* * *

"Furthermore, I would point out that the question before the Dail was whether Irish Free State broadcasting should be State controlled or left to private enterprise. State control was decided upon and the decision annoyed certain people who wanted the British Broadcasting Company to operate stations in this territory. I can only assume that it is by one such person that you have now been misinformed.

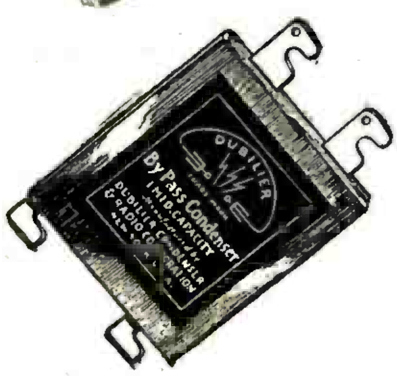
(Continued on page 6)

Buy with Confidence Dubilier Devices

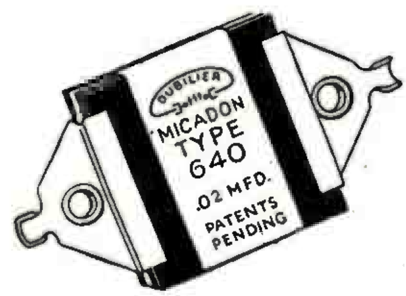


Micadon—the standard fixed condenser of radio.
35c to 75c

Ducon—the standard antenna socket plug. . . **$1.50**



By-Pass Condenser — smooths out fluctuations of "B" Battery current.
75c to $3.75



Micadon 640—the ultimate in accuracy and efficiency. Capacities .00025 to .02 Mfd.
40c to $1.75

Dubilier

CONDENSER AND RADIO CORPORATION

(*Continued from page* 4)

POPULAR RADIO'S AMATEUR SHORT-WAVE TRANSMITTING STATION

This short-wave transmitter and receiver is in operation in the laboratory at the home of Mr. Taylor, of the POPULAR RADIO *staff. Using a single 7½-watt tube (UX-210), this transmitter has carried on reliable communication over a distance of 1,000 miles* IN DAYLIGHT. *An article on its construction will appear in "In the Experimenter's Laboratory" of the February issue. The receiver shown at the left is that described in this department of the November issue but with another stage of audio amplification added; it has logged amateur stations in New Zealand, Australia, South America and a number of European countries. Its range is in excess of 10,000 miles.*

"THE erection and operation of the Dublin and Cork stations," continues Mr. Hayward, "are in the hands of the Minister of Posts and Telegraphs, who received the assent of the Finance Minister to his plans. These proceed satisfactorily. A Dublin site has already been acquired at the McKee Barracks and the erection is expected to commence very soon. The Minister for Posts and Telegraphs has recently announced that he will carry on this promise to have the Dublin broadcasting station working by Christmas."

* * *

THE Editor is not only glad to publish Mr. Hayward's correction but also to congratulate the people of the Irish Free State upon the Christmas present that is on its way to them.

* * *

"I THINK that POPULAR RADIO is the best radio magazine in circulation; one feature that I like especially is your system of having all the reading matter together, apart and separate from the advertisements. I think that your magazine is as nearly perfect as possible."

—ROBERT G. DENMEAD, *West Liberty, O.*

* * *

"I HAVE had great admiration for your magazine since its first appearance," writes Mr. D. R. Clemons, an instructor in radio in Valparaiso, Ind., "and have always hoped that I could some day succeed in locating an article with you. There is a certain dignity about your pages that gives one a feeling of security in accepting the facts published there."

* * *

ACCOMPANYING Mr. Clemons' letter was the manuscript of an excellent article on coils—one of the best articles on the subject that POPULAR RADIO has ever seen. And as it is based upon the author's original study, it contains valuable information that is not generally known.

* * *

THIS article will appear in a coming issue of this magazine—and it will be presented in a form that will meet with the approval of even the author himself!

* * *

"ALL broadcast listeners should be appreciative of POPULAR RADIO's courage in protesting against the invasion of the home by militant religionists," writes Ames Nowell of Boston, Mass. "Religious services and lectures, *per se*, have a legitimate place in the radio world, but there is a limit to all good things."

Kendall Banning

Editor, POPULAR RADIO

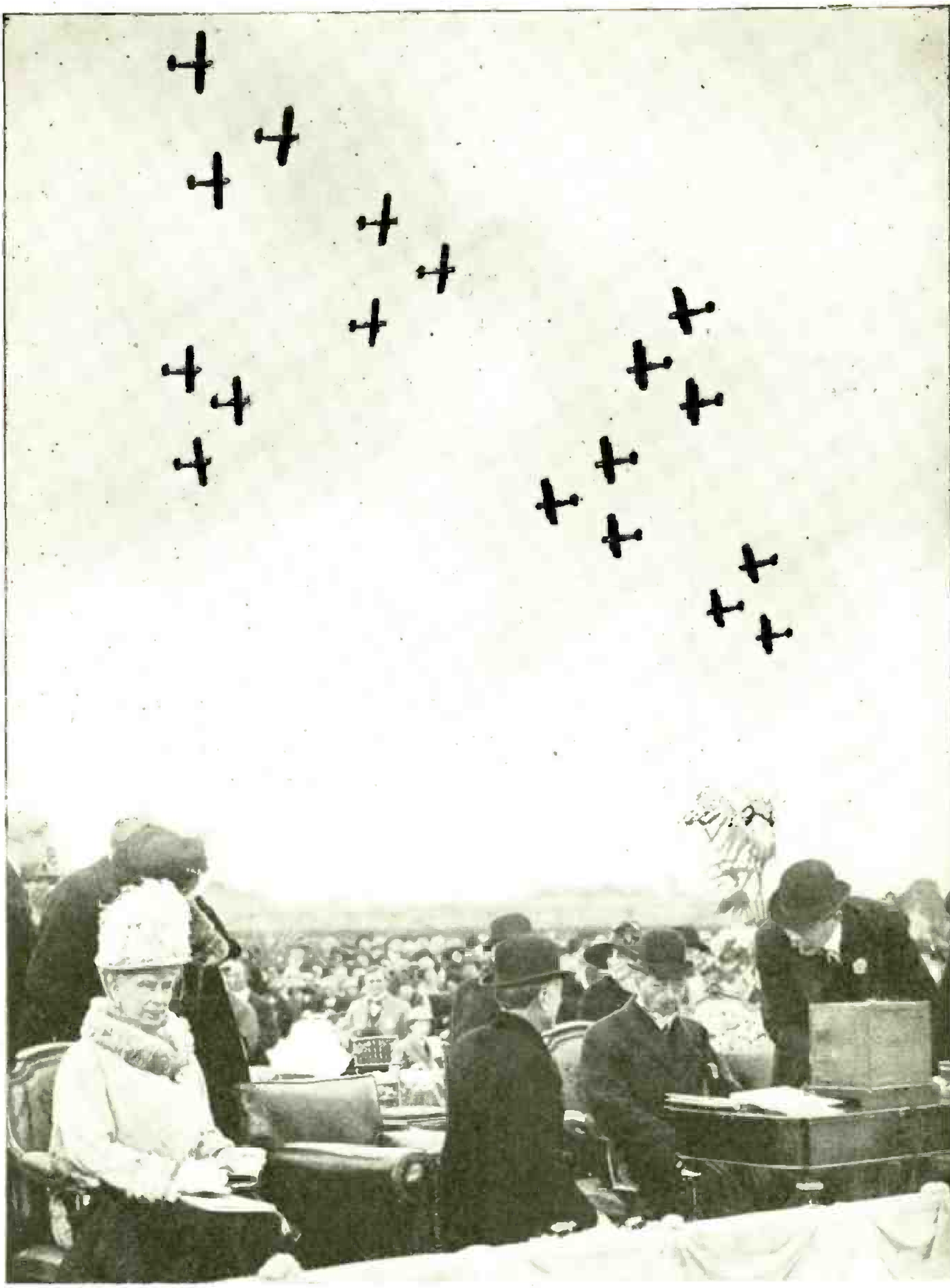

EVEREADY HOUR
EVERY TUESDAY AT 9 P. M.
Eastern Standard Time
For real radio enjoyment, tune in the "Eveready Group," broadcast through stations—
WEAF New York
WJAR Providence
WEEI Boston
WTAG Worcester
WFI Philadelphia
WGR Buffalo
WCAE Pittsburgh
WSAI Cincinnati
WWJ Detroit
WCCO Minneapolis St. Paul
WOC Davenport
KSD St. Louis
For radio economy
EVEREADY Radio Batteries are noted for their long service and economical operation. They are made in different sizes and types so that every radio user can enjoy the economy and convenience to be had by fitting exactly the right Eveready to his receiver. Five of the dry-cell types of Eveready Radio Batteries are here illustrated and described to make it easy for you to decide just which will give the longest and most economical service on your set. A dealer near you sells Evereadys.
Manufactured and guaranteed by
NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario
EVEREADY
Radio Batteries
—they last longer
EVEREADY COLUMBIA IGNITOR DRY CELL
FOR RADIO, IGNITION AND ALL GENERAL PURPOSES
No. 764
Portable
22½-volt
Vertical
Price
$1.75
Eveready Columbia Ignitor "A" Battery, the proven dry cell for all radio dry-cell tubes 1½ volts
EVEREADY
RADIO "B" BATTERY
Layerbilt
No. 779
22½-volt
Large
Vertical
Price
$2.00
No. 771
4½-volt
"C"
Battery
Price
60 cents
No. 486
45-volt
Layerbilt
Extra-large
Vertical
Price
$5.50

Popular Radio's Admirable Accomplishment

"It *has been my good fortune to be closely connected with teaching and writing science for some years, and I know, therefore, how difficult it is to present technical subjects in interesting yet authoritative ways.* Popular Radio *is doing this admirably; it deserves high praise for this accomplishment."*

David Grimes

DAVID GRIMES, INC.



Keystone View Co., London

The King Issues His First Radio Commands to the Air Fleet

Seated before the microphone, King George V directed for a few moments the movements of the airplanes that flew in military formation as part of the program of the Aerial Pageant recently held at Hendon, England.

Popular Radio

WITH WHICH IS COMBINED "THE WIRELESS AGE"

VOLUME VIII DECEMBER, 1925 NUMBER 6

HOW TO BUILD THE NEW

LC-26 RECEIVER

COST OF PARTS: *About $63.50*

RECEIVING RANGE: *New York to Los Angeles (2,700 miles) in experimental tests, but maximum range not yet determined*

This new receiver is the latest and most valuable contribution that has yet been made by the POPULAR RADIO LABORATORY to the radio art. It has been in course of development for nine months. In its present form, as described in this article, it is recommended as the most efficient receiving set that has ever been placed at the disposal of the radio experimenter. And it may be built at home at a cost for parts that brings it within the means of the average pocketbook.

—EDITOR

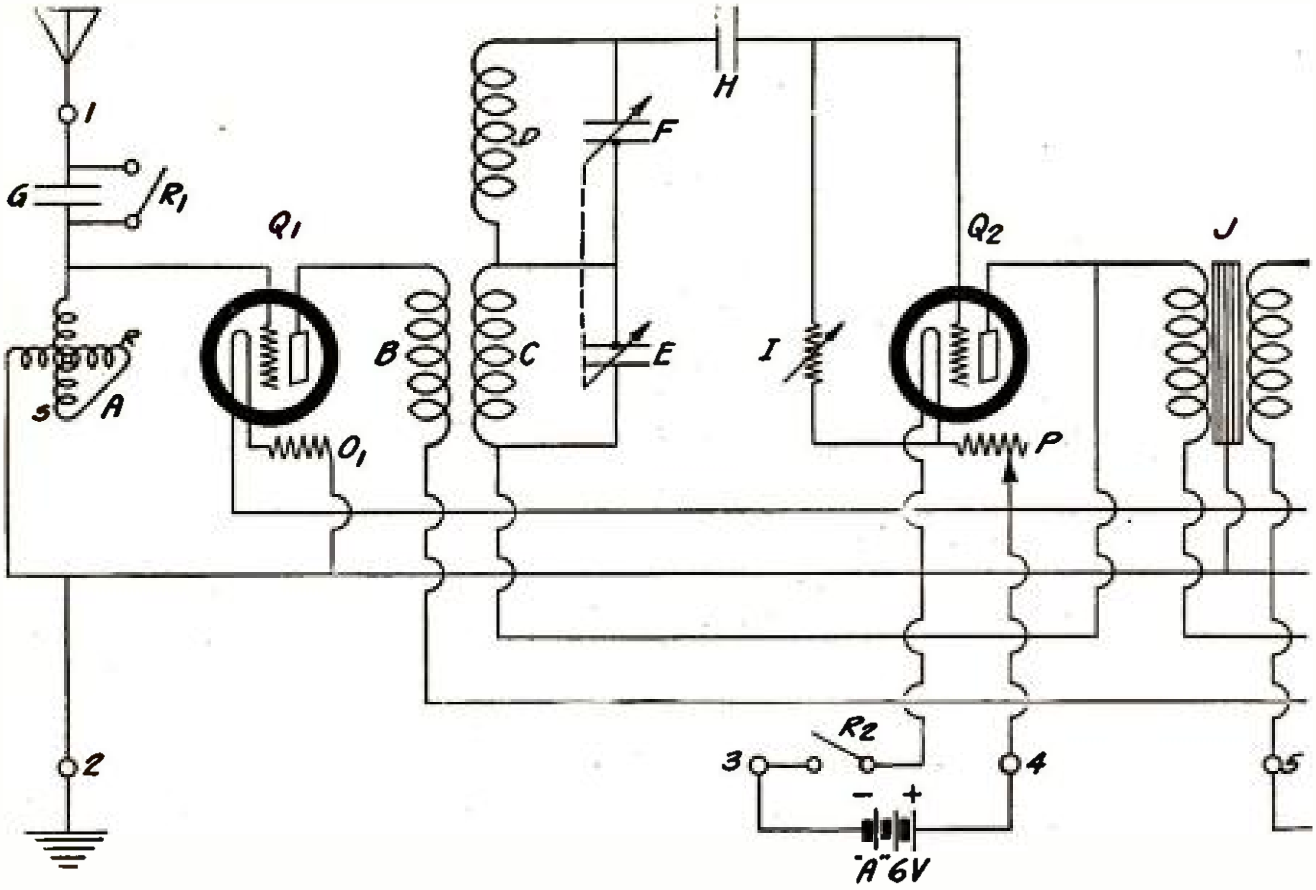
By LAURENCE M. COCKADAY

WHEN preparing a design for a popular receiver for the home-builder of radio sets, the most important item for consideration is the quality of reproduction.

Ask the ordinary layman what he considers the most important factor in a receiving set and he will almost always reply, "Clarity of reproduction of speech and music."

Ask the radio experimenter this same question and he will tell you that quality reproduction can be obtained only by using some form of non-distorting amplification, such as impedance or resistance-coupling, and a really good loudspeaker such as one of the cone type speakers.

Ask the same question of the trained engineer and he will answer carefully. He will tell you that truthful reproduction from a receiver depends upon a number



of obscure phenomena in both receiver and reproducer operation. We may study and analyze these considerations in the order in which they appear.

1. *Amount of radio-frequency amplification.* This is important in the reception of local signals, for if the radio-frequency amplification is too great on a signal of great intensity, the detector tube will not function properly as a rectifier and distortion will be introduced to the audio-frequency amplifier with consequent poor reproduction:

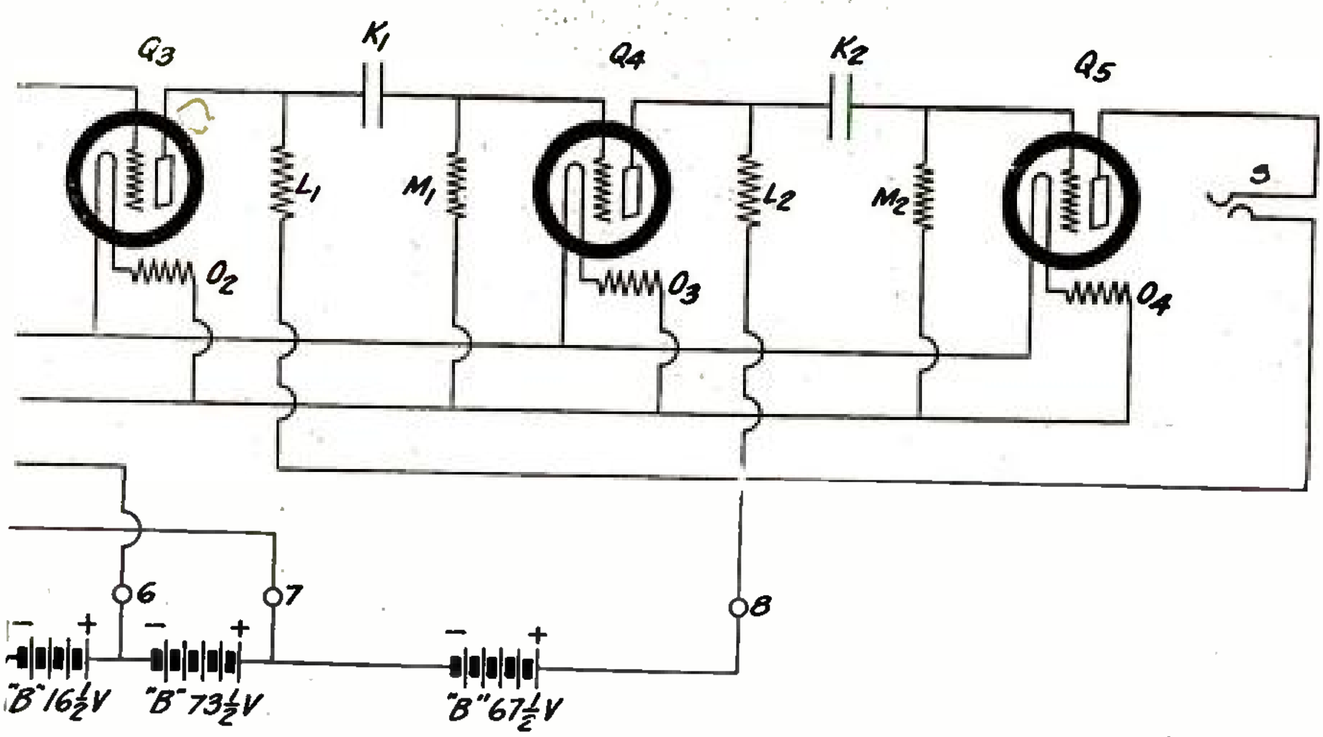
2. *Straight-line audio-frequency amplification.* The second characteristic which must be incorporated into a receiver is the ability of the audio-frequency amplifier to amplify or strengthen signals of all frequencies by approximately the same amount. In other words, a signal of 75 or 100 cycles should be amplified by the same amount as a signal of 1,000 cycles or so. This is one of the most common forms of trouble in the ordinary receiving set. High tones and tones of medium pitch are usually amplified to somewhere near the same intensity, but the ordinary transformer design in the past has neglected to a large extent the signals below 150 cycles. This dropping out of the lower frequencies from speech and music heretofore received and amplified by the common receivers has resulted in a thin and screechy tone which is not natural. An amplifier should therefore bring out the low-frequency characteristics.

3. *Adequate output power.* An amplifier of straight-line-frequency characteristics when used with a sensitive receiver must have an amplifying tube in the last stage of large enough capacity so that it will be able to furnish the power necessary for reproducing the low tones which are received. This is also one of the garden-variety of faults which is found in receivers today. To reproduce a low tone (below 150 cycles) there is required thousands of times as much energy applied to the ear as necessary to reproduce high tones of 2,000 or 3,000 cycles to the same intensity. A larger tube must be used in the output stage.

4. *Proper biasing of the grids through-*

THE COMPLETE CIRCUIT DIAGRAM

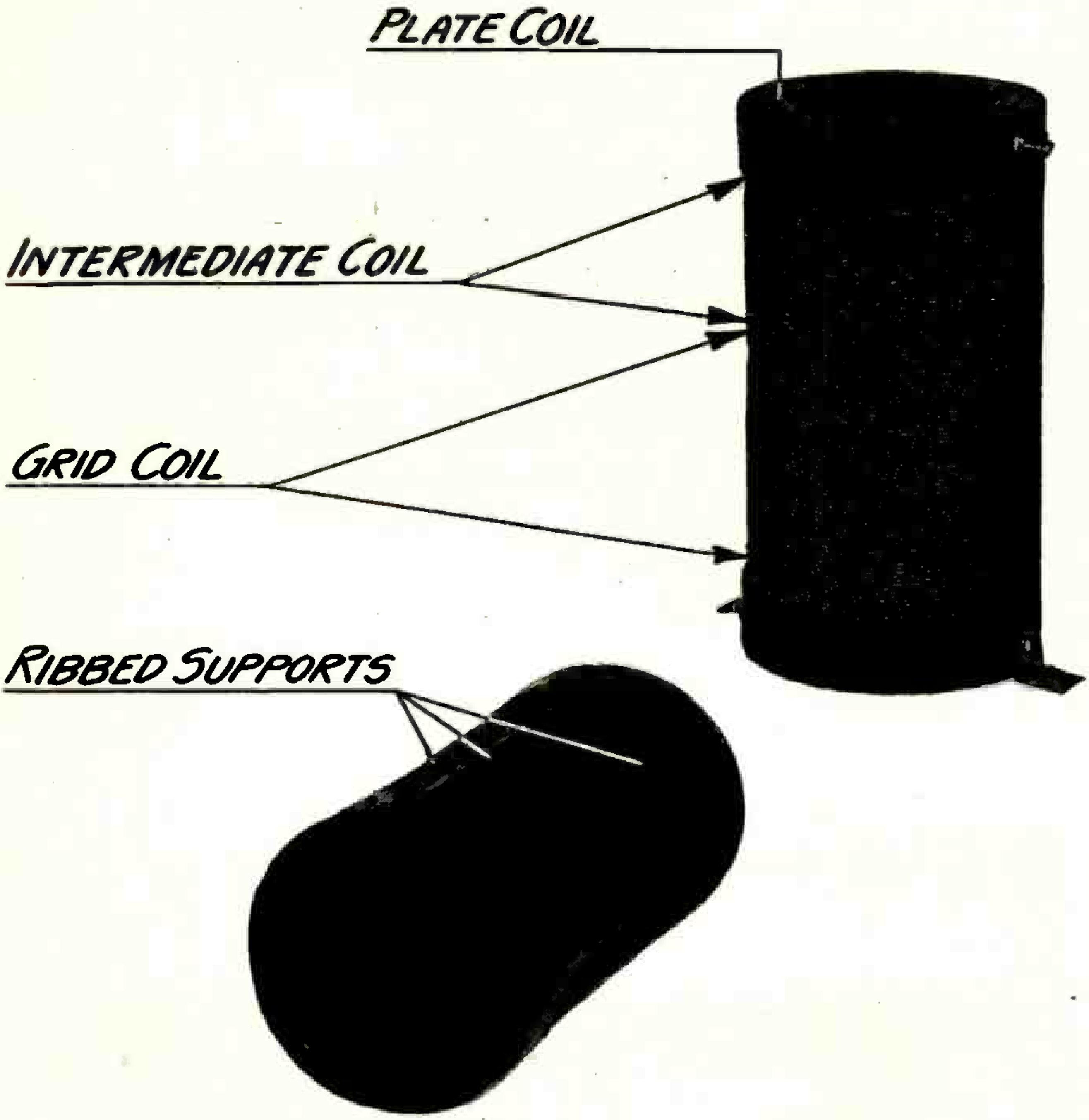
FIGURE 1: *This is the hook-up for the new LC-26 Broadcast Receiver. Notice that all of the symbols for the instruments bear designating letters which reappear in the list of parts and throughout the text and the following illustrations; this eliminates the possibility of mistakes in construction and wiring up.*



From a photograph made for POPULAR RADIO

NINE MONTHS OF RESEARCH WERE SPENT IN DEVELOPING THIS RECEIVER

FIGURE 2: *In this picture, the author is shown with one of his assistants at his experimental work in the laboratory. This development work lasted over a period of more than nine months before the final circuit design was completed and a receiver produced combining such great radio-frequency amplification with really lifelike tone reproduction.*

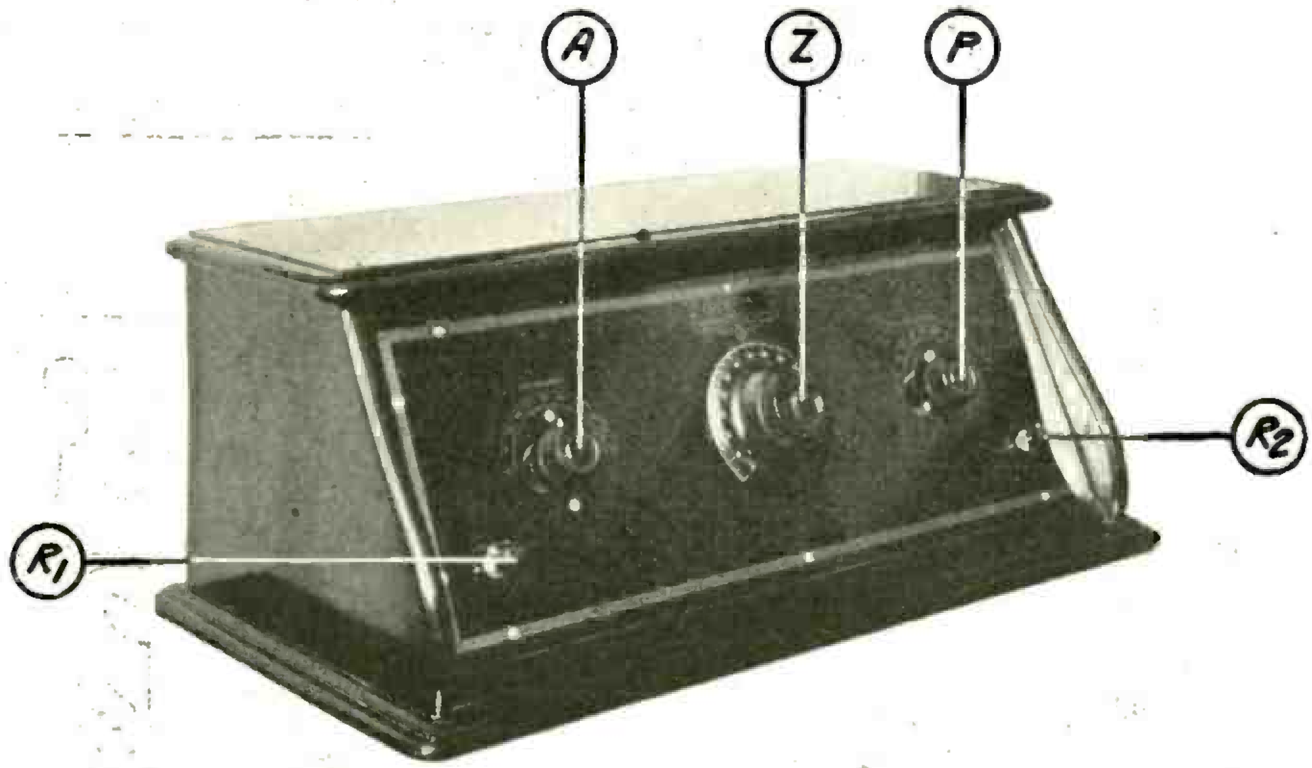


THE NEW TYPE OF INDUCTANCE USED IN THE SET

FIGURE 3: *In this type of winding, known as Octaform, the wires touch the insulating support only on the ridges which constitute but a small percentage of the total periphery area. This reduces the distributed capacity and the losses to such an extent that the efficiency of the coil is greatly increased over that of an ordinary solenoid.*

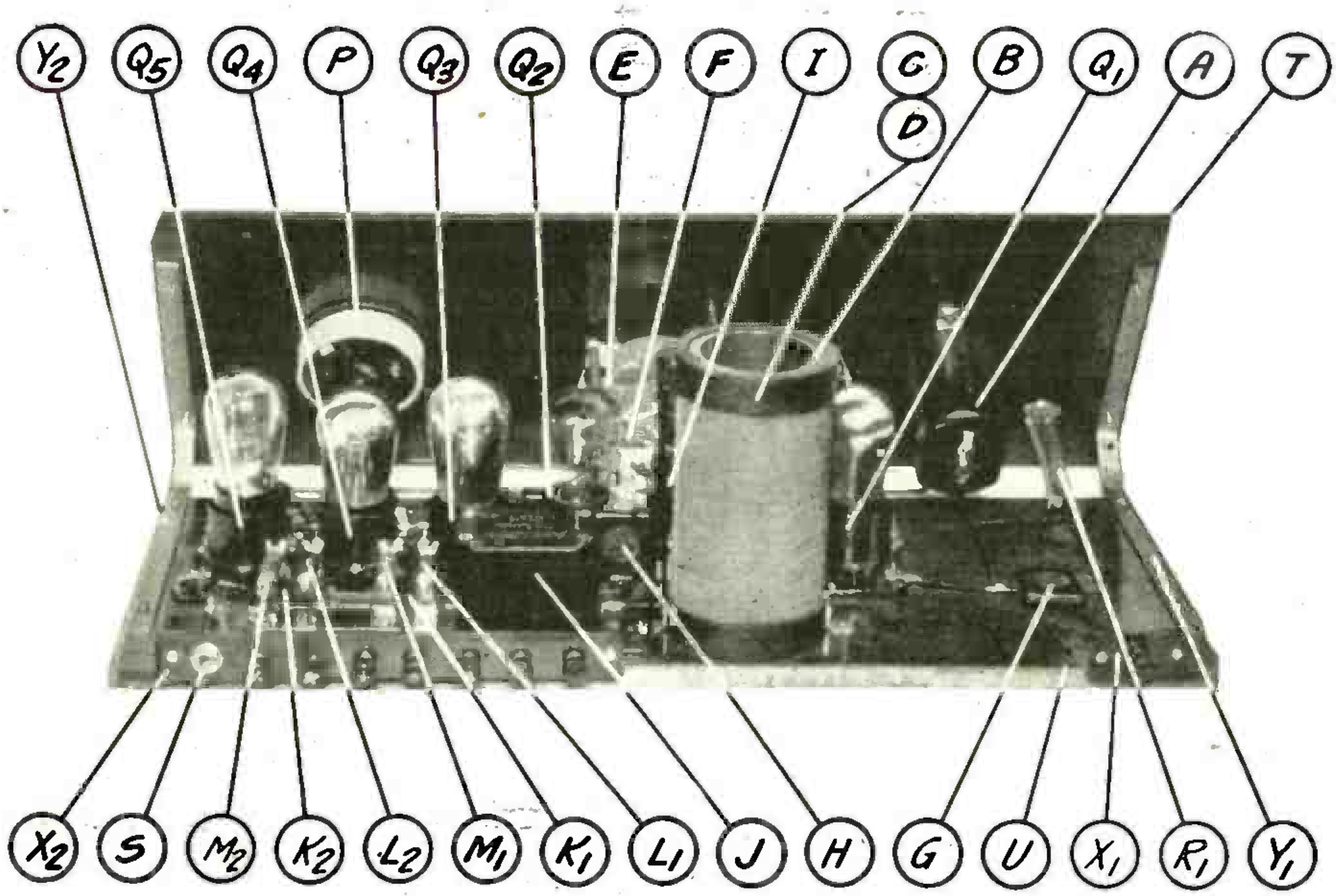
out the receiver. Especially in transformer amplifiers, the matter of grid bias is extremely important, and exceptionally so on the last stage. This is true also from an economy point of view. In the resistance-coupled type of amplification this fault is not so evident as a biasing effect may be easily obtained by means of the grid-leaks and coupling condensers which are necessary to this form of amplification.

5. *Proper transformer design.* For a non-distorting receiver, it is extremely important that transformers are designed for the proper stage where they are to be used and for the type of tubes that they are to be used in connection with. Some of the most important considerations here are the input impedance, secondary distributed capacity and the ability of the iron core to withstand saturation with maximum plate current that it will be



THE FRONT VIEW OF THE NEW RECEIVER

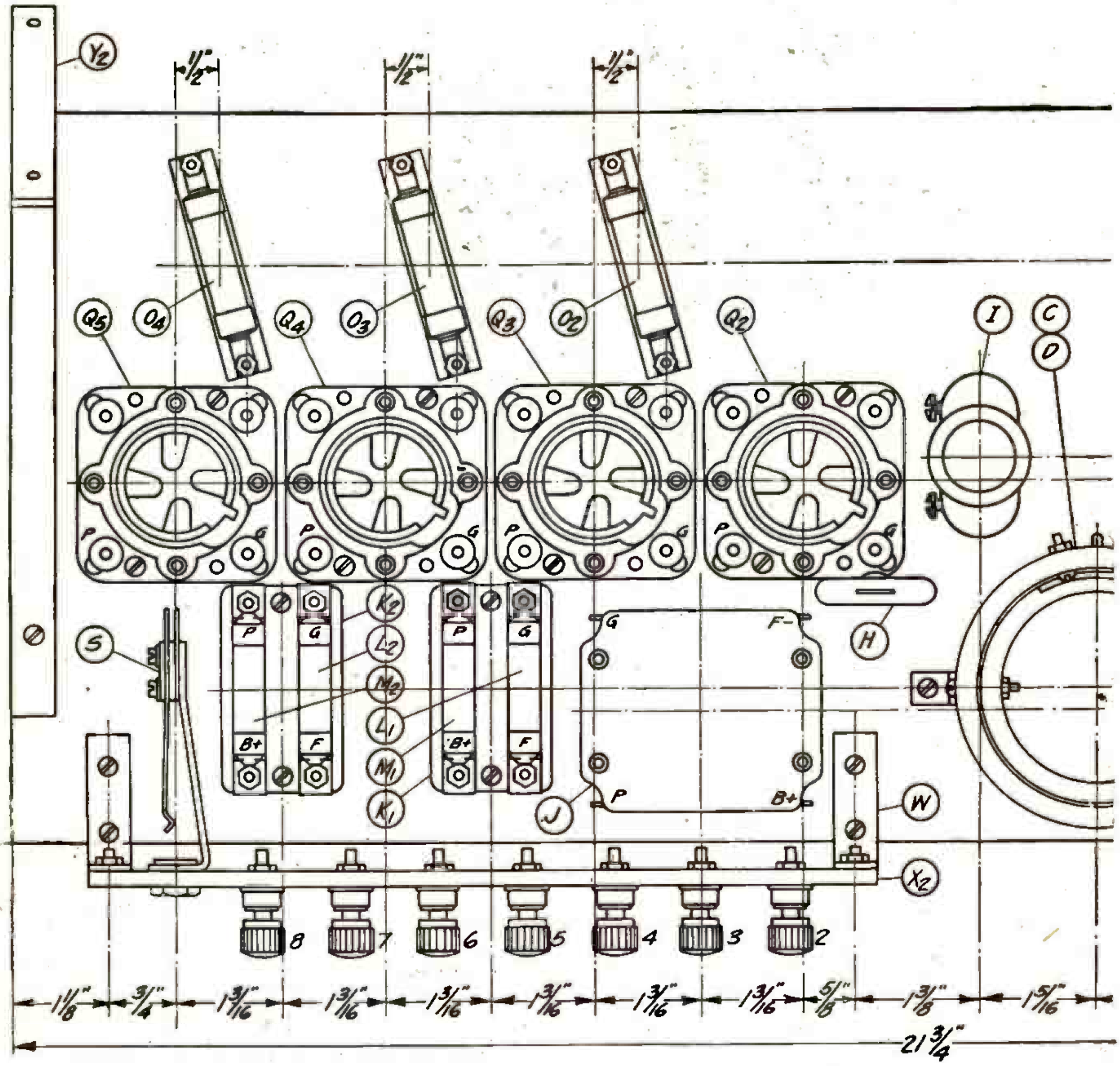
FIGURE 4: *How the set looks from the front. As the dials and knobs are marked with letters which correspond to the instruments to which they are attached, the prospective operator will have no trouble in locating the various tuning controls as they are explained in the instructions for tuning.*



VIEW OF THE SET FROM THE REAR

FIGURE 5: *This picture shows the general arrangement of all the instruments fastened to the panel or base. The exact locations for the instruments are shown in Figure 6.*

D4



THE WORKING DRAWING FOR CONSTRUCTION

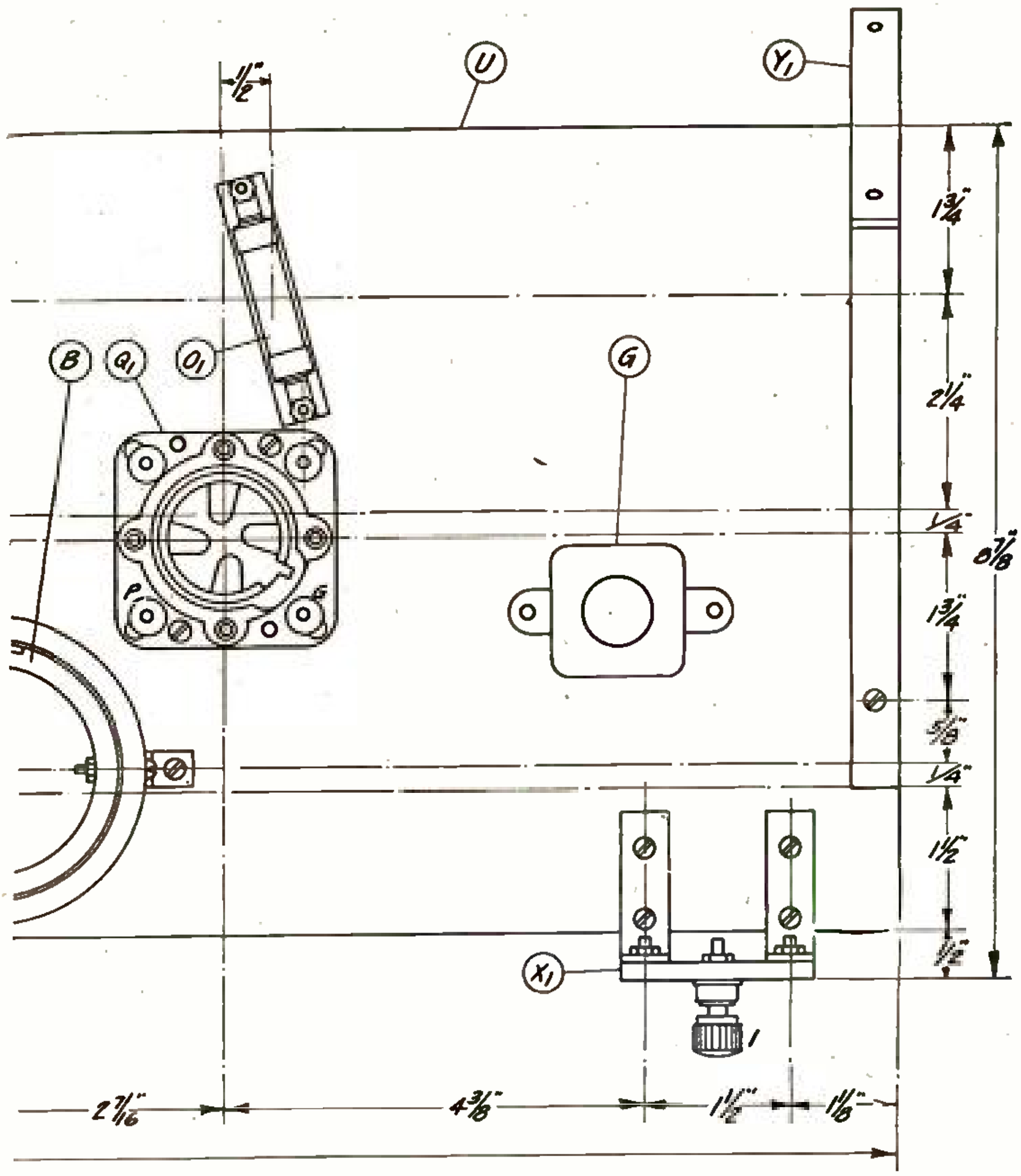
FIGURE 6: *Here are shown the correct positions for the instruments which are mounted on the baseboard. The positions are given center to center, for all instruments.*

subjected to. These considerations are important alike in reproducing low tones with fidelity, and in preventing resonance at high frequencies, which is sometimes liable to produce howling.

6. *Non-distorting loudspeakers.* Another very important consideration is, of course, in the loudspeaker that is to be used for converting the amplified electric energy into sound waves. The device should have the capacity to start in motion a sound wave of low frequency with the same ease that it can propagate a high frequency tone. This, of course, is best realized at the present time by using a large cone-type loudspeaker.

Of course, there are other considerations that enter into an ideal design for a receiving set. Two of the most important of these are (a) simplicity of operation and (b) selectivity.

A receiver to be really popular must approach the single control idea, at least for reception of local signals. An allowance may be made for reception of distant signals in that some slight adjustments are usually found necessary to bring up distant reception to the required intensity for enjoyable reproduction.



The selectivity of the receiver is also extremely important in that it enables the operator to tune in the station he wants without also tuning in the station he does not want.

Then, lastly, we come to another consideration which really is important to a certain group of radio users and that is the matter of radio-frequency amplification—sensitivity. A receiver should be able to amplify at radio frequencies with a ratio large enough to enable the reception of distant signals under any conditions of location. This is important in a large number of cases where people are not situated in a favorable location for radio reception.

During the last ten months the design work on a receiver that incorporates the considerations mentioned above has been in steady progress; this article is written for the express purpose of telling the experimenter and radio fan "how to build the new LC-26 broadcast receiver" that incorporates the principles as outlined.

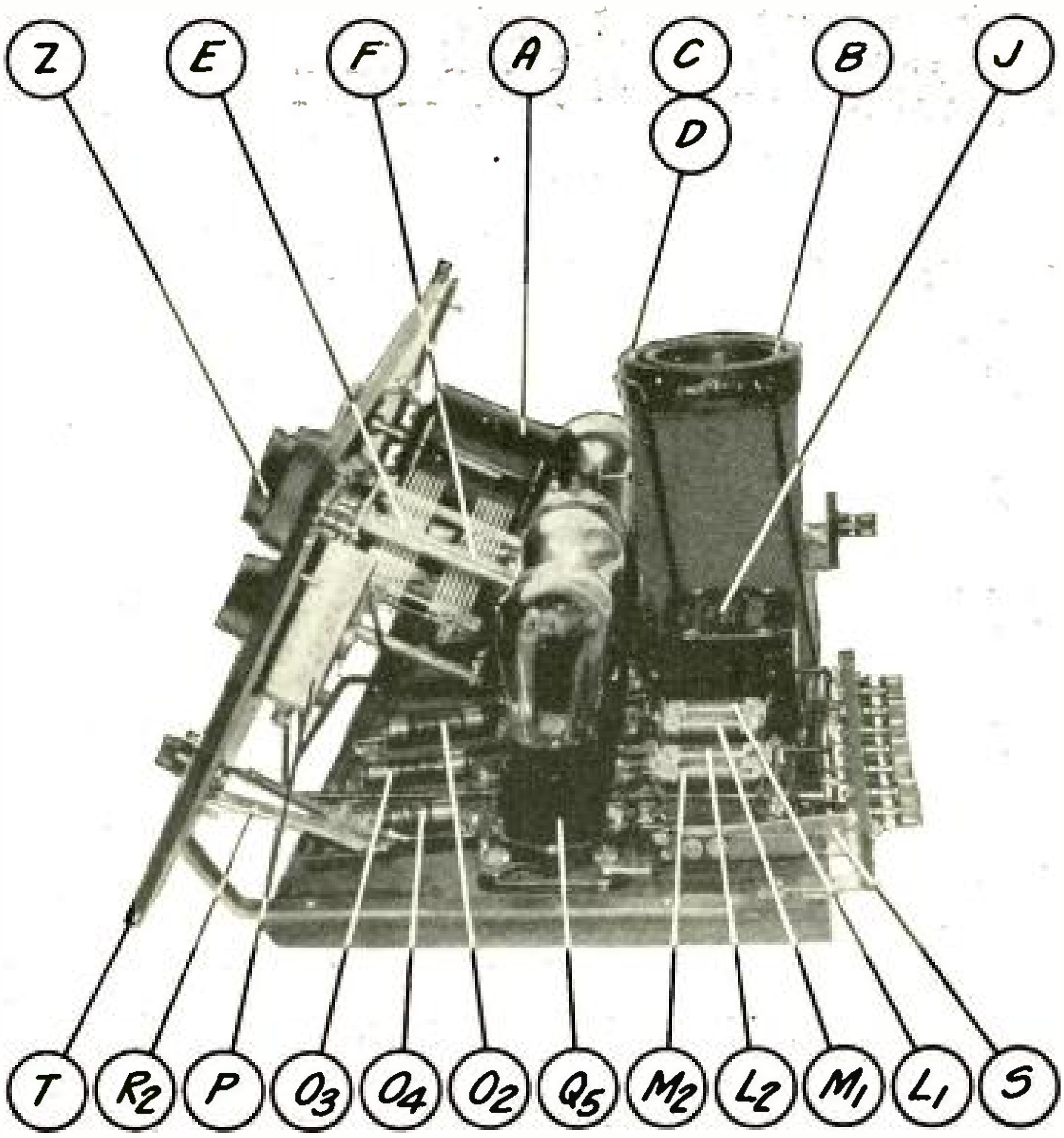
The receiver is, in essence, a single-control receiver that incorporates one stage of radio-frequency amplification, which cannot oscillate and which cannot radiate.

This type of radio-frequency amplification may be used on any antenna from 10 to 200 feet in length with reliable and satisfactory results.

The receiver incorporates a modification of the four-circuit principle as applied to the detector circuit, which gives maximum regeneration control over the whole wavelength range, that is independent of frequency. A new type of coil form known (See Figure 3) as "Octaform" has been used to obtain the highest efficiency in the tuning circuits. This assures not only extremely high radio-frequency amplification but simplified control. It reduces the number of tuning controls over those used with other popular single-stage radio-frequency amplifiers used in connection with a regenerative detector, and this in itself is of course a large advantage.

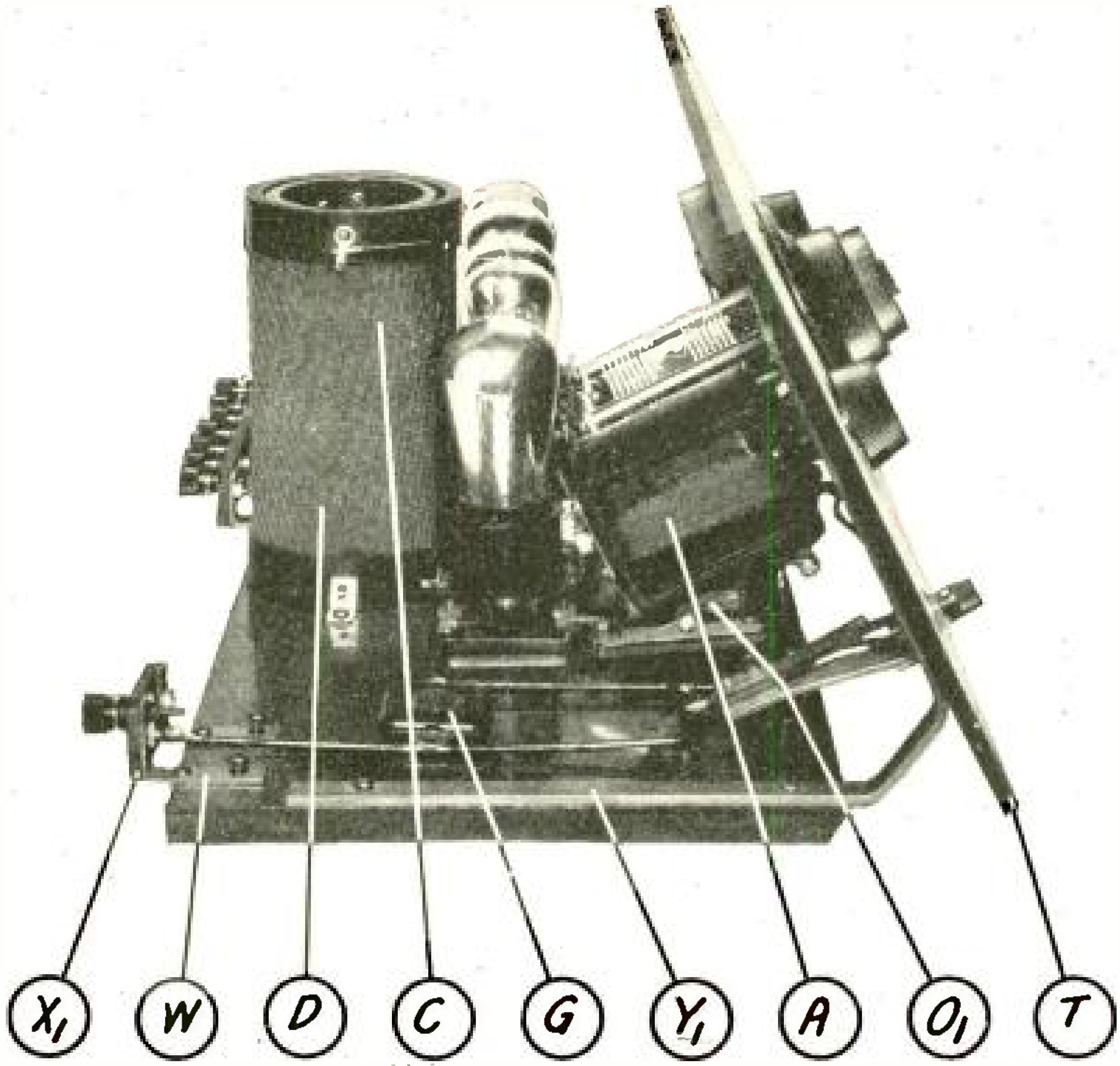
The receiver also incorporates one stage of transformer-coupled amplification with a transformer that is capable of reproducing lower frequencies. This follows the detector circuit so that there is no chance of saturation of the core of the transformer on account of the extremely low plate current that is used in the plate circuit of the detector. Then, follow two stages of resistance-coupled amplification with larger grid condensers, for improving the straight-line-frequency characteristics of these amplifiers over what have been formerly used. And then in the last stage is incorporated a tube of increased output power for handling satisfactorily the low tone energy produced by the receiver.

The "LC-26 broadcast receiver" is de-



VIEW OF THE RECEIVER AS SEEN FROM THE RIGHT

FIGURE 7: *This end view shows the manner in which the panel is held in position by the large brass brackets and the general scheme of mounting the sockets, the resistances and the jack.*



VIEW OF THE RECEIVER AS SEEN FROM THE LEFT

FIGURE 8: *This illustration shows the general manner of mounting the variometer, the coil set, the panel switches, the tube sockets and the small connecting blocks.*

signed to operate at its best when used with a cone-type loudspeaker.

The schematic wiring diagram is shown in Figure 1.

Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter; in this way, the prospective builder of a set may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit.

The same designating letters are used in the text and in the list of parts at the end of the article. (See page 511.)

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up. The experienced amateur, however, will be able to pick out other reliable makes of instruments which may be used with equally good results. But we recommend that the novice follow the list, as the diagrams in this article will tell him exactly where to bore the holes and exactly where to place the connections.*

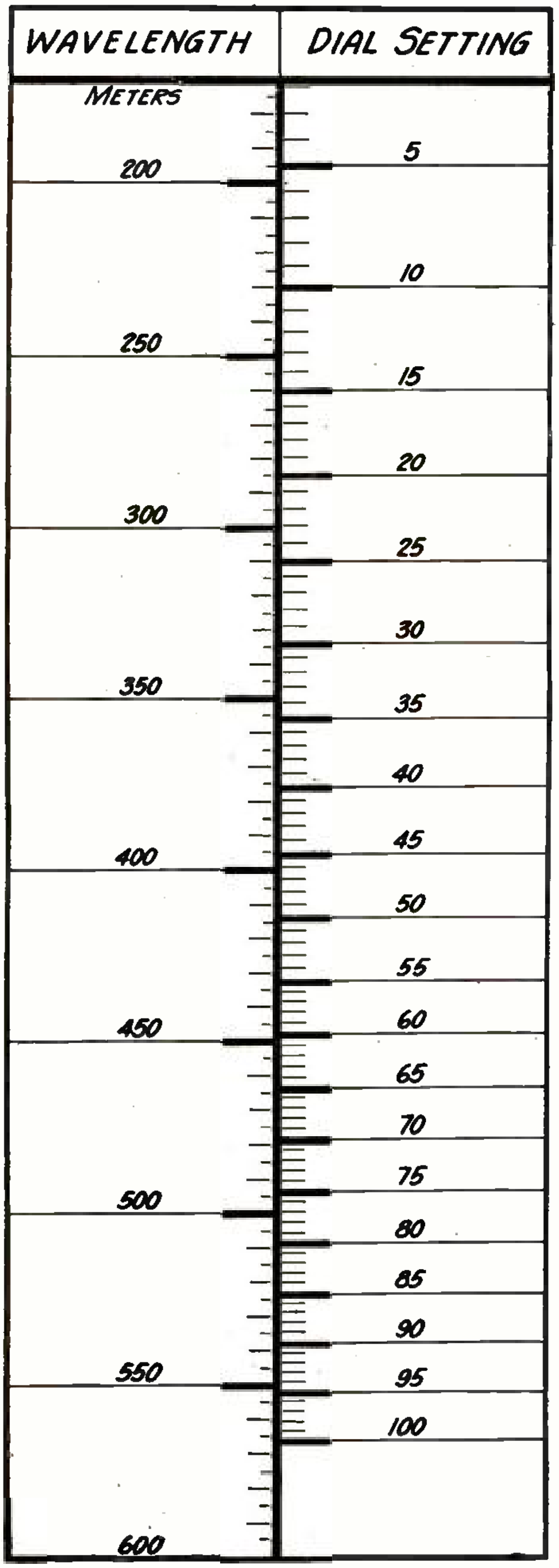
If instruments other than the ones listed are used, the only change that will be necessary will be the use of different spacings for the holes that are to be drilled in the panel for mounting the instruments.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should prepare the panel T. (Shown in Figures 5, 6, 7 and 8.)

First of all, cut the panel to the correct size, 8 by 22 inches. Then square up the edges smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 9. A convenient method for doing this is to lay out all center holes on a piece of paper the same size as the panel; then the piece of paper may be fastened on the panel and the centers marked directly on the panel by punching through the paper with a sharp, pointed instrument.

If all the holes to be drilled are first started



THE NEW TYPE OF TUNING CHART

FIGURE 13: *A new chart that shows you exactly how to tune the LC-26 receiver for any given wavelength.*

with a small drill, one-sixteenth inch in diameter or less, they can be more nearly centered.

The holes outlined with a double circle should be countersunk, so that the flat-head machine screws used for fastening the instruments are flush with the panel. All the rest of the holes in the panel are straight drill-holes. Sizes for the diameters of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the diameter of the screws and shafts of the instruments that must go through the holes.

When the panel is drilled, the builder may give it a dull finish by rubbing the face of the panel lengthwise with fine sandpaper until it is smooth. This process should be repeated, except that light machine oil should be applied during the second rubbing. Then rub the panel dry with a piece of cheesecloth. A permanent dull finish will be the result. Or, the panel may be left with its original shiny-black finish, if care has been exercised, so that it has not been scratched during the drilling.

After the panel has been prepared the experimenter is ready to mount the instruments on it.

If the specified drilled and engraved panel is bought, of course, this work will be unnecessary, as the drilling and finishing are already done by the manufacturer of the panel. The panel in this case is a very beautiful piece of apparatus, as it is decorated with a beautiful border design in gold and the dial positions are marked with inscriptions.

First of all, mount the variometer A on the left-hand end of the panel by means of two screws and nuts inserted through the panel. See Figure 5.

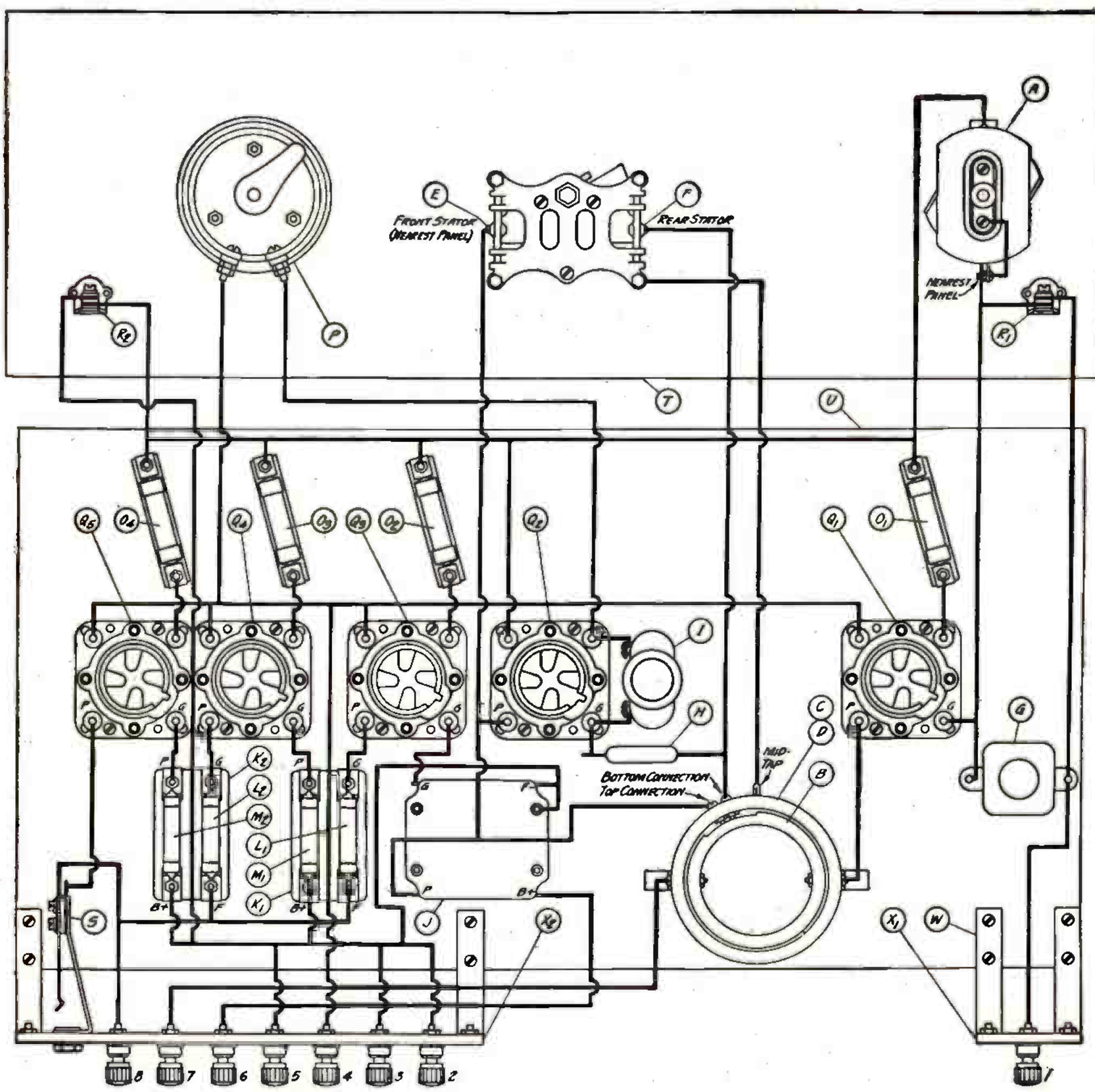
Then, attach small knob to the variometer on the front of the panel by means of the set screw. The knob should be adjusted in the proper position with the rotor turn in a vertical position in the same manner as the stator with the front rotor lead wire pointing to the left when looking at the back of the panel and the rear rotor lead wire pointing to the right. For this position of the rotor, the pointer on the small knob should be horizontally to the left when looking at the front of the panel. This will be the position for smallest inductance.

Next, mount the double variable condenser, E and F, on the panel so that the rotor plates will swing upward when they are not in meshed position. (Shown in Figures 5, 7 and 8.) Then attach the dial Z by tightening the set screw on the shaft. Be sure that the three screws that mount the condenser EF are countersunk slightly below the surface of the panel so that they do not interfere with the felt on the dial.

When this is finished fasten the rheostat P to the panel by means of three screws as shown in Figures 4, 5 and 7 and attach the small knob on the front of the panel.

Next mount the two jack switches R1 and R2 on the panel as shown in Figures 4, 5, 7 and 8.

This completes the construction work on the panel and you are ready to mount the instruments on the baseboard. The baseboard is supplied with the cabinet, and it should be taken



THE PICTURE DIAGRAM FOR CONNECTING UP THE VARIOUS INSTRUMENTS

FIGURE 9: *The upper rectangle represents the panel and on it the instruments are drawn just as they appear. The lower rectangle represents the baseboard and the instruments are drawn in about their relative positions. The wires drawn in heavy black lines show the exact way to run the wires to connect the instruments and parts after you have mounted them according to the instructions given.*

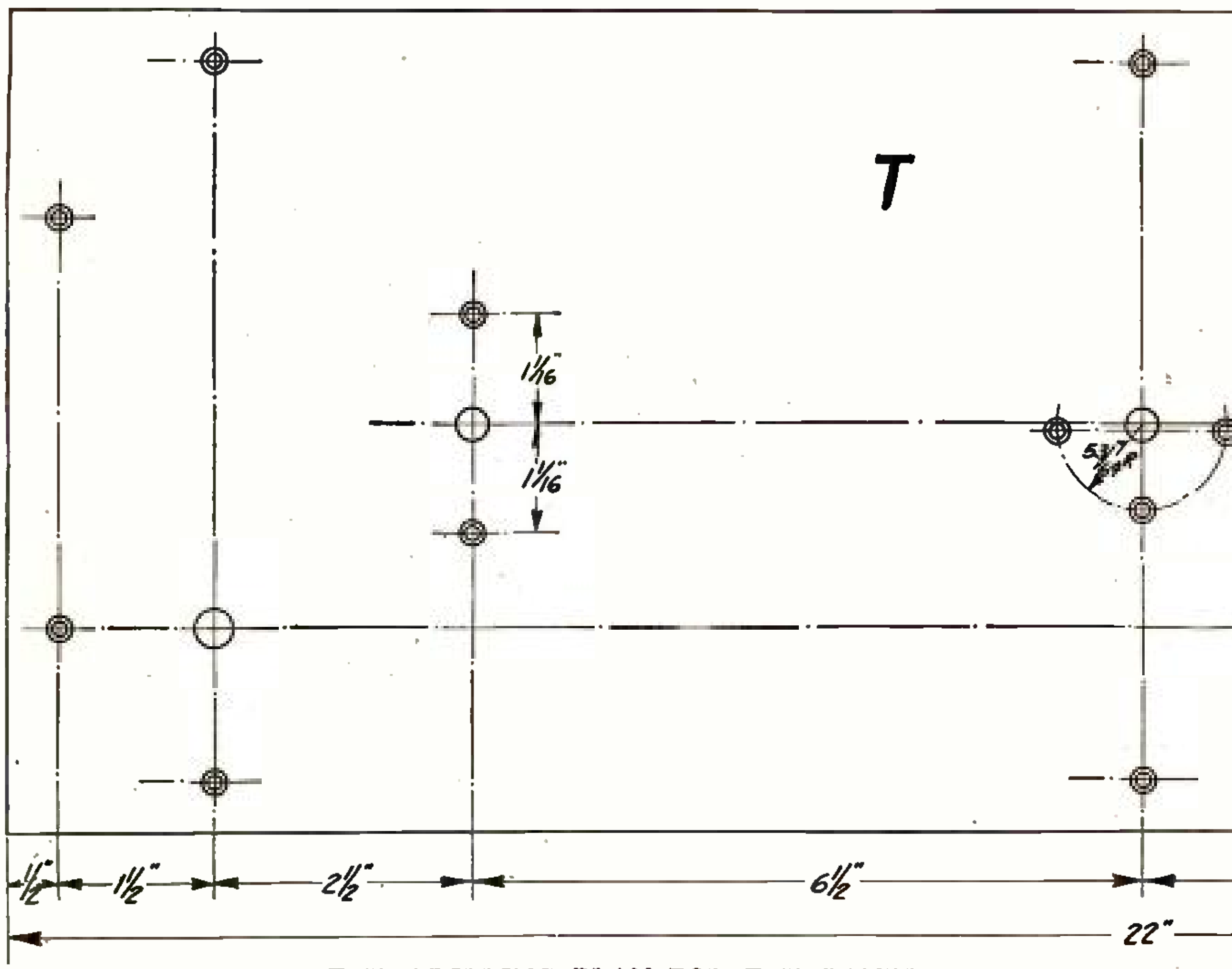
out and the instruments mounted on it as shown in Figure 6, which is the working drawing for construction.

First mount the five sockets, Q1, Q2, Q3, Q4 and Q5 in their respective places as shown in Figures 5, 6, 7 and 8.

Next attach the four amperites O1, O2, O3 and O4 in their respective positions as shown clearly in Figure 6. All of these instruments are to be screwed directly to the baseboard. Next fasten down the two resisto-couplers K1 and K2 as shown in Figure 6. Be sure that these are turned so that the terminals marked P and G face the tube sockets in such a position that the P terminal on the resisto-couplers faces the grid terminal on the sockets and the G terminals on the resisto-couplers face the plate terminals. This is the reverse of the way the resisto-couplers are ordinarily used as they are usually inserted between the sockets but in this position they take up too much room.

Next mount the coil-set B, C and D in proper position as shown in Figures 5, 6, 7 and 8 with the terminals pointing toward the front of the set. The coil may be fastened down by means of two screws inserted through the small brass brackets at the bottom of the coil.

Then, mount the audio-frequency transformer J in place as shown in Figures 5, 6 and 7. Be sure that the terminals are pointing in the



THE DRILLING PLAN FOR THE PANEL

FIGURE 10: *This drawing shows where to drill the holes for mounting the instruments. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk. Always start drilling holes in the panel with a small drill—one-sixteenth is a desirable size.*

direction indicated in Figure 6.

When this is done the work on the sub-panel may be left for a while and the two connection blocks X1 and X2, the dimensions of which are shown in Figure 14, should be prepared and the binding posts attached. The small brass brackets may then also be screwed tight to the block and the jack S mounted on the larger block X2.

Now fasten down the two blocks, X1 and X2, on the sub-base U by means of four screws inserted through the brass brackets into the baseboard.

Then, prepare the two large brass brackets, Y1 and Y2, which are to be used for attaching the main panel T to the base U at the proper angle; the dimensions for these angles including the drilling and bending are also shown in Figure 14. Be sure that you have the angles made with the correct drilling holes and bends so that the panel will fit evenly. Then mount the panel in position on the brackets. This had best be done by slipping the baseboard U in position in the cabinet with the brackets Y1 and Y2 attached and then fastening the panel in position with four screws. You are now ready to start on the wiring as the construction work is completed.

How to Wire the Set

The design of this set is such that the wiring of the grid circuit of each of the five tubes is made extremely short and is isolated from other parts of the circuit. In fact, this idea has been employed throughout and the leads are so arranged that the shortest connections may be used. As this is the case, the set should be wired with bus-bar.

Either a tinned-copper, round bus wire or an insulated round bus wire such as "Celatsite" may be used for the connection. All connections should first be shaped so that they will fit. They should then be soldered in place. Refer to the wiring diagram in Figure 1 and more specifically to the picture diagram in Figure 9 for the exact way in which to run the wires.

Start wiring up by running a connection from binding post No. 1 to the right-hand side* of the antenna series condenser G and continue

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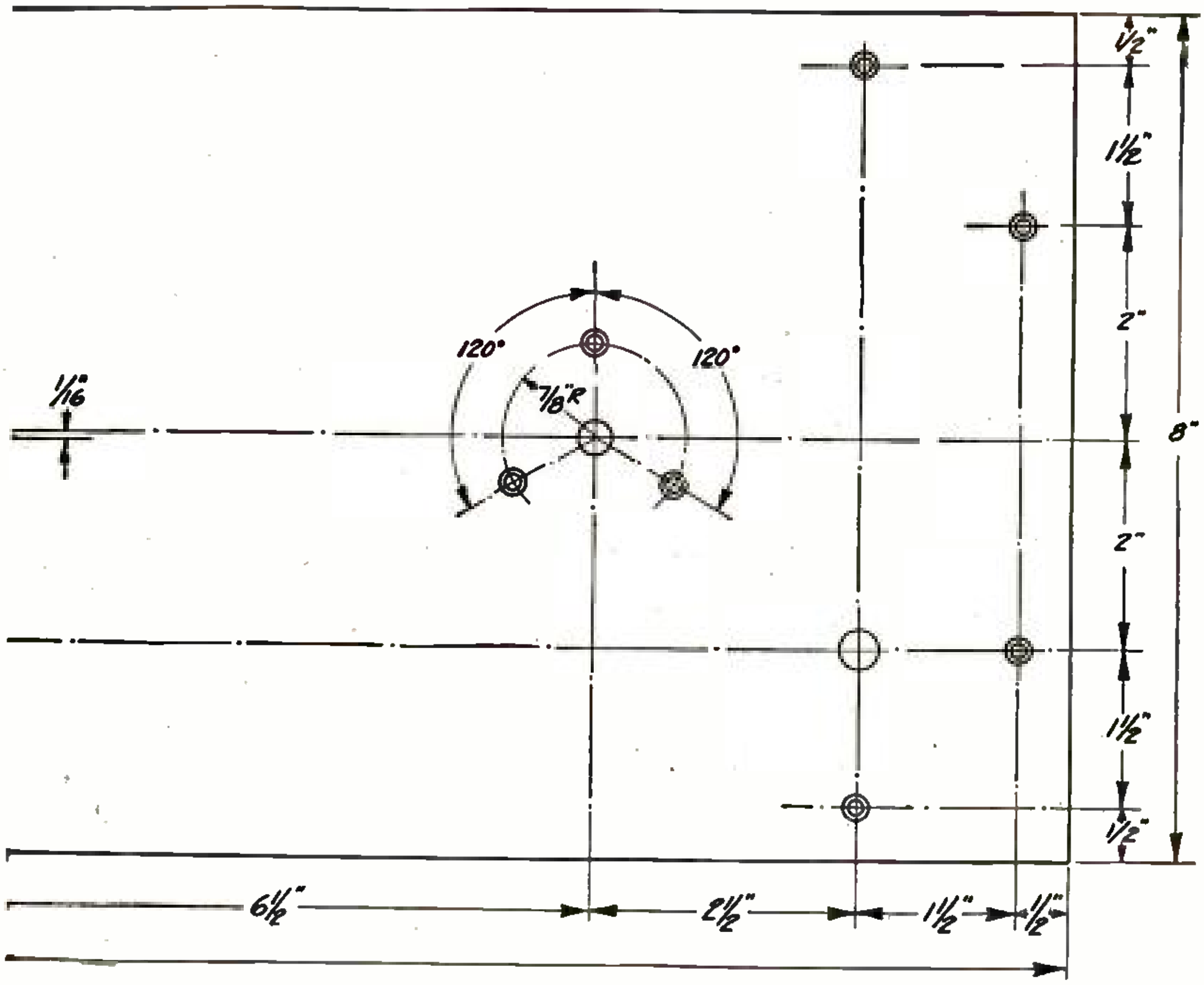
*The front connection on any instrument refers to the side of the instrument nearest the panel and right and left refers to the constructor's right and left as he sits facing the back of the set in wiring up.



it on from there over to the top terminal of the jack switch R1.

Next connect a wire to the front bottom connection of the stator of the variometer A and extend it over to the left-hand terminal of the condenser G.

Then run this over to the right rear connection of the socket Q1. This terminal is the grid terminal of the socket. Then run an extension of this same wire over to the bottom terminal of the jack switch R1.

Next connect a wire to the bottom screw of the metal bracket that holds the variometer A on to the panel over to the front connections of the amperites, O1, O2, O3 and O4 and end it up at the bottom terminal of the jack switch R2.

Then run another extension of this wire over to the front left connection on the socket Q2.

Next run a wire from binding post No. 2 over to binding post No. 3, extending it over and attaching it to binding post No. 5 and from here over to terminals marked B+ on the two resisto-couplers K1 and K2 and from here in between the two resistances L2 and M2 and in between the two sockets Q4 and Q5 and attaching it to the top terminal of the jack switch R2.

Next, solder the connections between the back terminal of the amperite O1 and the right front terminal of socket Q1. Do the same with amperites O2, O3, O4 and sockets Q3, Q4 and Q5 respectively.

Then solder one terminal of the grid condenser H to the right rear terminal of socket Q2 and run a connection between the remaining terminals of the condenser H and the bottom connection on the coil BCD and extend this wire over to the right-hand stator connection on the rear unit of the variable condenser E and F.

Next run a connection from the rear terminal of the grid-leak I to the right rear terminal of the socket Q2.

Then run a wire from the front terminal of the grid-leak I to the right front terminal of the socket Q2 and extend this wire over to the right-hand terminal of the rheostat P.

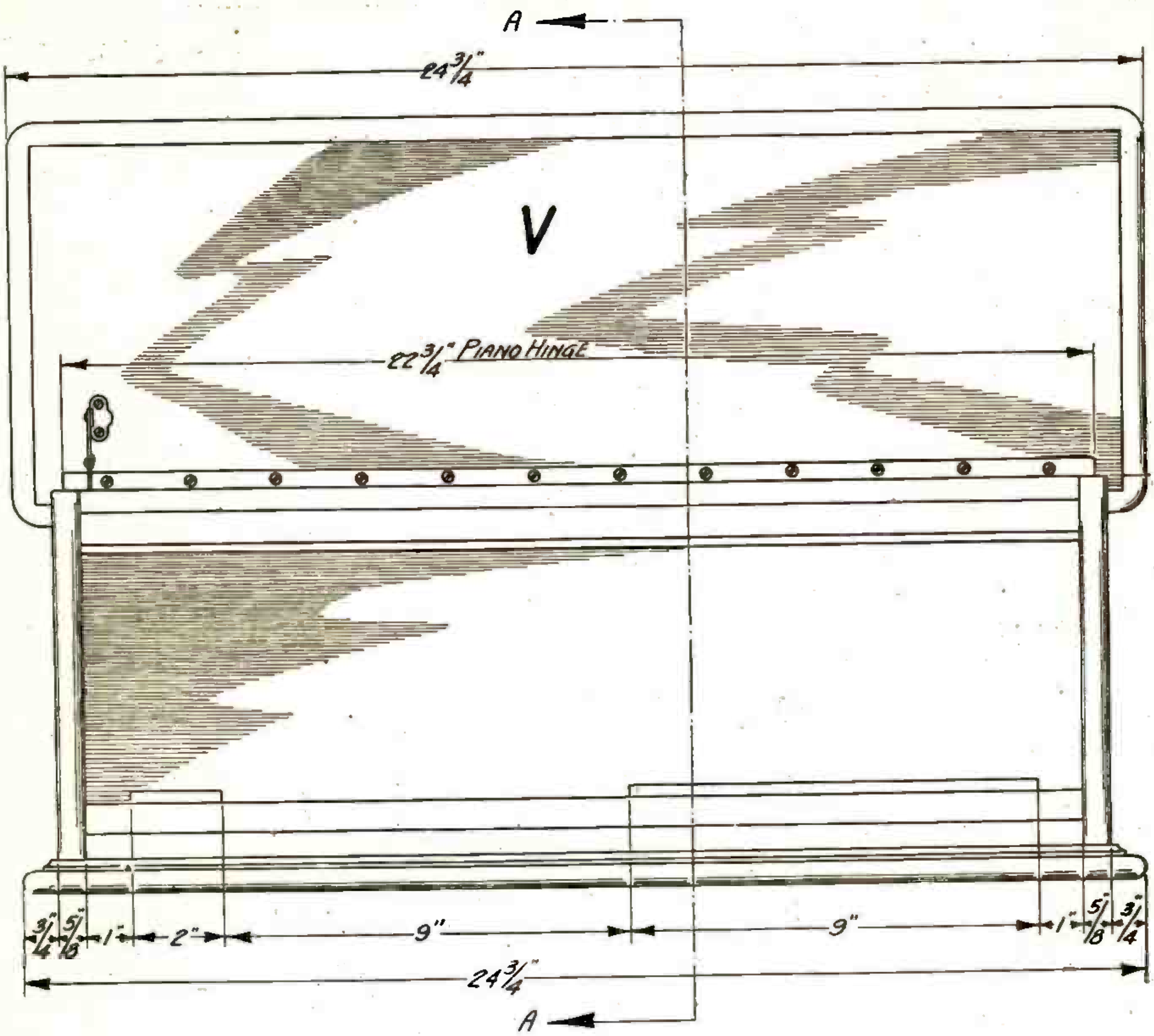
Next run a wire from the front left terminal of the socket Q1 extending it to the front left terminals of sockets Q3, Q4 and Q5.

Then run an extension of this wire from a point between sockets Q3 and Q4 back between the sockets and between the two resistances L1 and M1 and attach it to binding post No. 4.

Another extension of this main wire should be run to the left-hand terminal of the rheostat P.

Next run a wire from the top front terminal of the coil BCD down to the left rear terminal on the socket Q2 and extend this wire to the terminal marked P on the transformer J, and run a further extension of this wire between the two sockets Q2 and Q3 and attach it to the left-hand stator terminal of the front section of the condenser E and F.

Next attach a wire to the terminal marked B+ of the transformer J and run it over to



binding post No. 6. Now attach a small wire to the right rear terminal on socket Q3 and extend it over to the terminal marked G on transformer J.

Then connect a wire from the terminal marked F– on transformer J over to the wire connecting binding posts No. 2 and No. 3.

Next solder the connections between terminal G on the resisto-coupler K1 to the terminal marked P which is the left rear terminal of socket Q3.*

Next solder the connection marked P on the resisto-coupler K1 to the terminal marked G which is the right-hand rear terminal of the socket Q4. Then do the same thing with the two sets of terminals on resisto-couplers K2 and the plate and grid terminals of the sockets Q4 and Q5.

Next run a wire from the top left-hand connection to the coil BCD and extend it down and to the left attaching to binding post No. 7. The top right-hand terminal of the coil BCD should be run down and connected to the left rear terminal of socket Q1. The front middle tap on the coil BCD should then be run down and extended forward to the bottom screw on the frame of the condenser E and F which attaches to the two rotors.

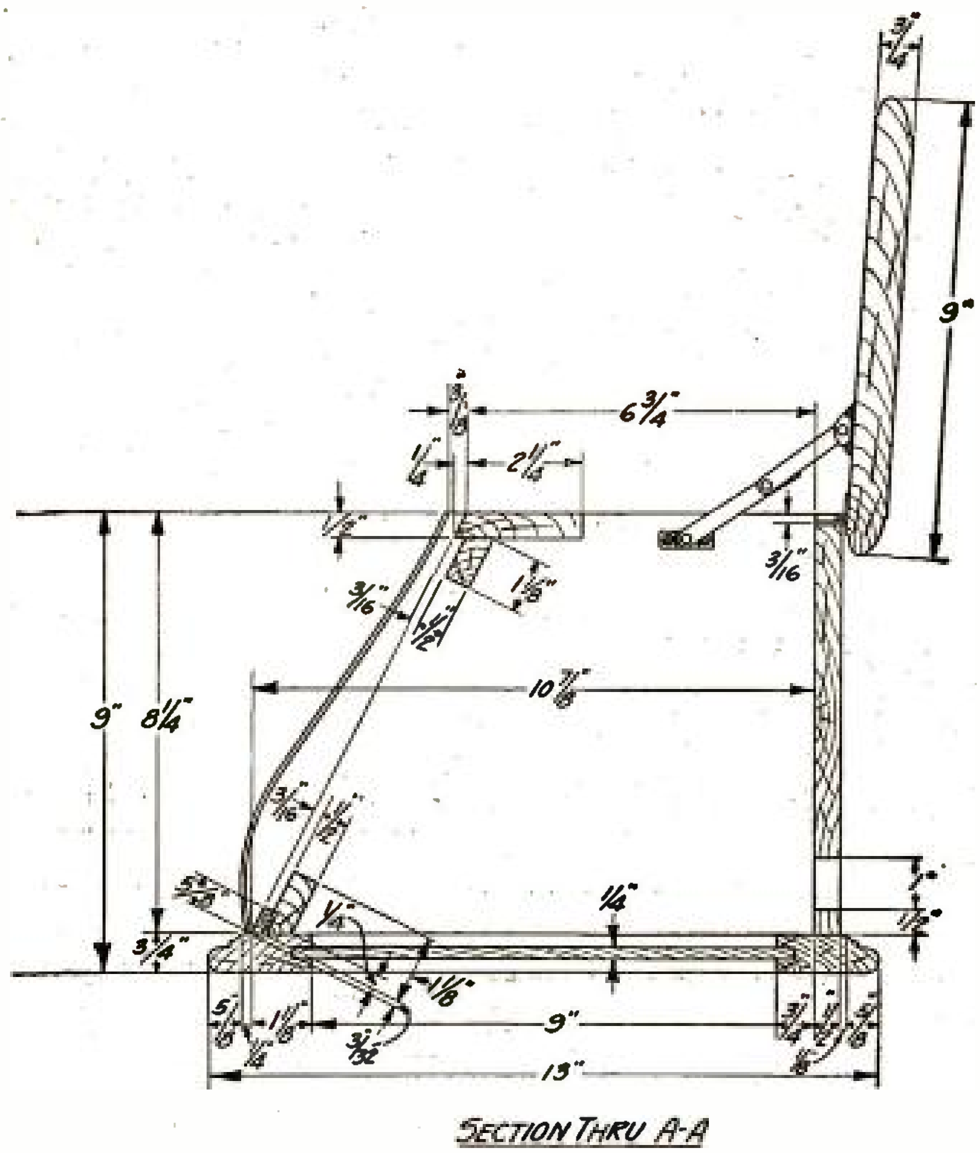
Next run a wire connecting the two terminals marked B+ on the resisto-couplers K1 and K2 and extend this over and attach it to the adjacent part of the wire running to binding post No. 5. Then you can connect the two terminals marked F on the resisto-couplers K1 and K2 with a wire that extends also over to binding post No. 8 and to the top terminal of jack S. The bottom terminal of the jack S should connect to the left rear terminal of the socket Q5. This completes the wiring and the set is ready to be installed.

How to Install the Set

After the wiring has been completed the set should be inserted into the cabinet. In placing the set into the cabinet grasp the baseboard and turn it so that it is in a vertical position with the large coil BCD pointing at the cabinet.

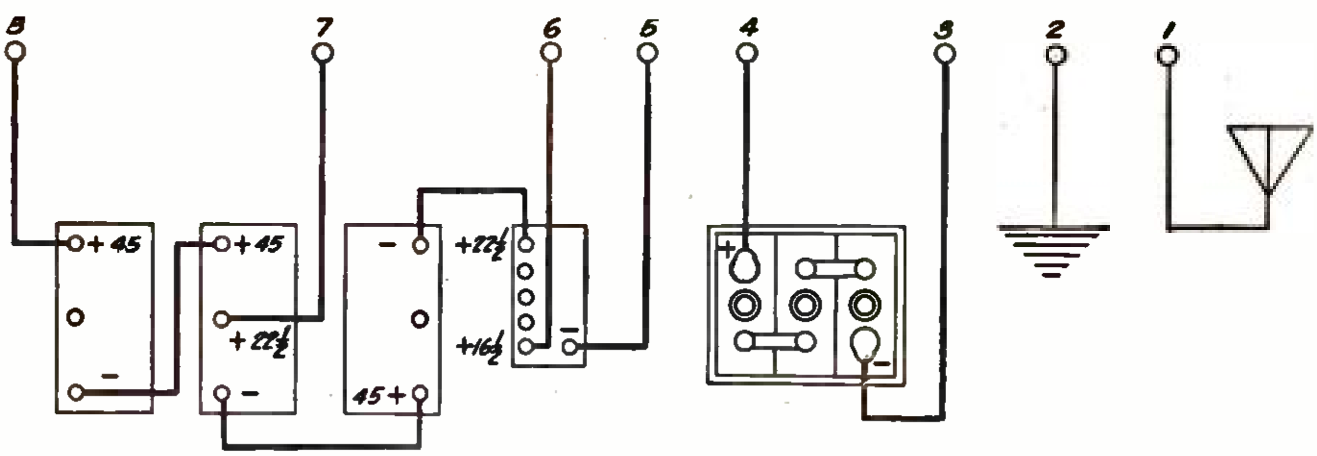
Then with a circular motion insert the coil

*Notice that the resisto-couplers are used in a reversed order and that the plate resistances are used in a position shunting terminals marked G and F while the grid terminals are used in a position shunting P and B+. This in no way affects the operation of any of the instruments but it facilitates the wiring and makes a much more compact job.



THE DIMENSIONS FOR THE CABINET

FIGURE 11: *This diagram (which contains the top, front, and side measurements for the walnut cabinet) may be turned over for construction to a competent cabinet maker who can build it from these directions exactly the right size for the panel.*



HOW TO HOOK UP THE BATTERIES

FIGURE 12: *This drawing prevents the builder from making mistakes in connecting the batteries to the terminals of receiver. Follow these instructions and the set will be hooked up correctly because the terminals shown in the wiring diagrams are marked with designations that correspond with the numbers given here.*

underneath the upper ridge on the cabinet and gradually bring the baseboard U to a horizontal position again. This is the only way that you can get the set into the cabinet. Make sure that the battery connection blocks fit exactly in the two rectangular holes cut in the back of the cabinet for them and push the whole unit back into place tightly so that you can screw in the six wood screws that hold the panel in place.

Then insert the three amperites O1, O2 and O3 in their proper mountings and place O4 in its proper mounting. Place the four Bradley units L1 and L2, M1 and M2 in their proper positions as shown in the diagram.

Next insert a UV-201-a tube in the socket Q1 and use the same type of tubes with sockets Q3 and Q4. In socket Q2 use either a UV-200 or a C-300 "soft" detector tube and in socket Q5 place a UX-112 power tube.

The batteries, antenna and ground connections are now ready to be attached. If you are using the set with an aerial over sixty feet in length, turn the jack switch R1 to the left. If you are using a short indoor aerial of less than this length, turn this switch to the right. The "off" position for the battery switch jack R2 is to the left and the "on" position is to the right. This switch should be left off when the set is not in use.

Next connect the batteries and the antenna and ground connections exactly as shown in Figure 12.

Then insert the loudspeaker plug in the jack S and you are ready to use the set.

Operating Data

First turn on the rheostat P a little over half-way and then turn the battery switch R2 to the right and all the tubes should light.

Next revolve the dial Z to the proper setting as indicated by the tuning chart in Figure 13 to the particular wavelength that you wish to receive. This should immediately bring in the station you want to hear. The small dial which controls the variometer A may then be used as a volume control for bringing up the strength of signals to the desired volume. The small dial on the rheostat P should then be adjusted for the best quality. This dial will also affect the selectivity of the receiver. When tuning for distant stations it should be set a little higher than when receiving locals.

The loudspeaker recommended should be one of the cone-type that will reproduce the low tones that really make broadcast reception enjoyable. The author uses a Western Electric 540 A.W. or a Bosch "cone" for this purpose.

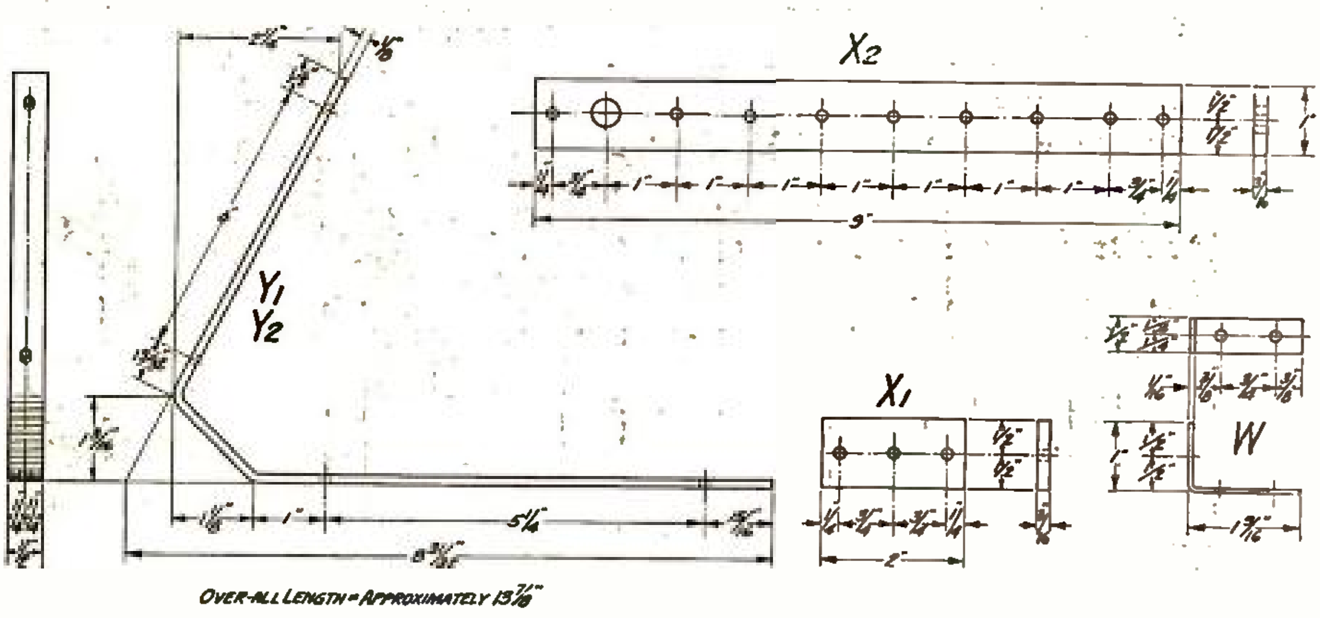
The grid-leak I should be adjusted by turning the knob in an anti-clockwise direction until it is turned all the way up and then turn slowly back until there is a click heard in the loudspeaker, at which point the knob should be turned down slightly farther about an eighth of a turn.

Then the final adjustment should be made on a distant station when it will materially affect the amplification that the operator can obtain. Do not turn this grid-leak down too far, however, as it will broaden tuning and affect the selectivity and sensitivity.

It is recommended that wherever possible this set should have both a regular outdoor antenna and a short antenna. When static conditions are too poor for reception on the outdoor antenna, the indoor antenna can be switched on and the small switch R1 turned over to the right. Never tune in a station with more volume than is suitable for the size of room in which the receiver is used.

In turning off the set all that is necessary to do is to turn the jack switch R2 to the left when the batteries will be disconnected and the filament circuits broken.

This receiver cannot radiate into the antenna



DETAILS OF THE BRASS BRACKETS AND THE CONNECTION BLOCKS

FIGURE 14: *This drawing gives the necessary data for making the insulated blocks on which the binding posts are to be mounted. It also gives the dimensions for the large and small brass brackets that are used to fasten the large and small panels to the baseboard.*

and therefore it cannot disturb the user's neighbors.

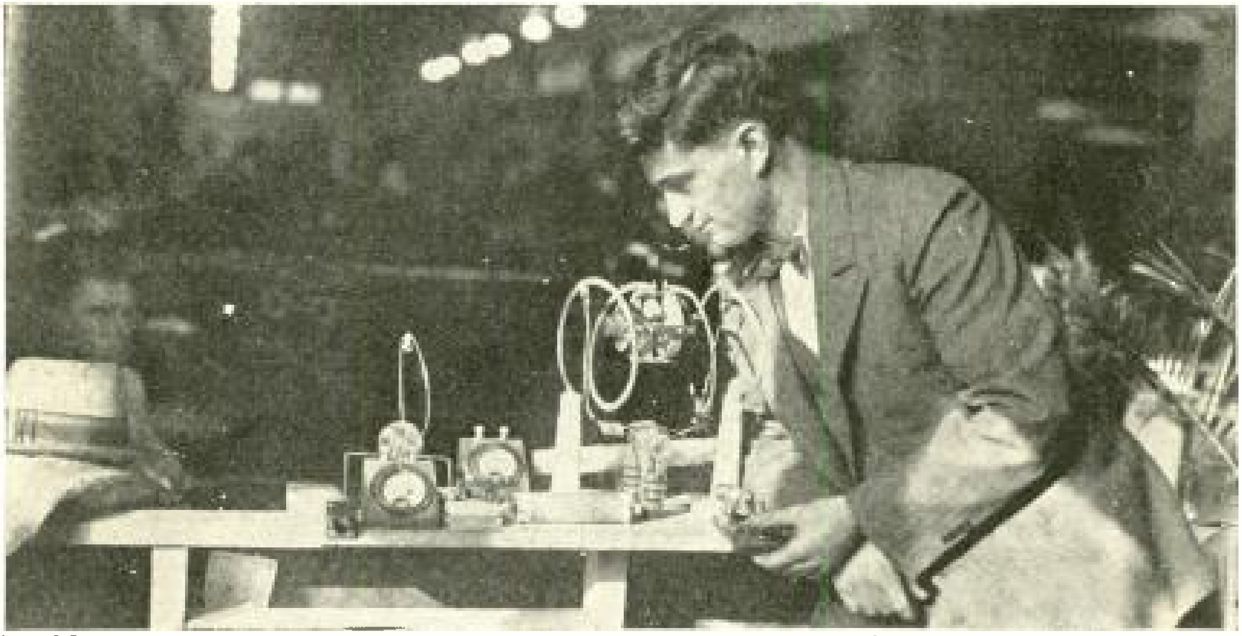
For local reception the antenna may be left off altogether and the ground wire disconnected from its usual place and attached to the antenna binding post No. 1. The set will then tune in the usual manner and all the local signals may be brought in with loudspeaker strength.

After the operator has become familiar with the tuning chart and the dial settings for the tuning dial Z he should have no difficulty in tuning in the local stations or in fact, any of the distant stations within range while local stations are broadcasting.

In New York City the author uses this receiver and finds it easy to tune in KDKA and WJAR while the local stations WAHG and WGBS are going full blast. It is also easy to tune, in New York City, the Philadelphia stations WOO and WIP, the Chicago station KYW, and the St. Louis station KSD while WEAF and WNYC are on the air. This is a good test for selectivity as the reader will note if he compares the wavelengths of these various stations. During the whole summer all of the main middle west stations and quite a few west coast stations have been picked up and held during the local transmission in the evenings with loudspeaker volume and fine tone quality when the static conditions were not too great. The sensitivity and tone quality of the receiver are really remarkable.

Here Are the Parts You Will Require—

A—General Radio variometer, type No. 269 equipped with General Radio small rheostat knob;
B, C and D—plate, intermediate and grid coils of Precision Octaform coil set;
E and F—Amsco special double-unit condenser, No. 1814, each section .0003 mfd.;
G—Micamold fixed condenser, .00015 mfd.;
H—Micamold fixed condenser, .00025 mfd.;
I—Bradleyleak, ¼ to 10 megohms;
J—Amertran De Luxe audio transformer for first stage;
K1 and K2—Daven resisto-couplers (new type which incorporates .1 mfd. condenser concealed in base);
L1, L2 and M2—Bradleyunits, type 250-R ¼ megohm;
M1—Bradleyunit, type 500-R, ½ megohm;
O1, O2 and O3—Amperites No. 1A;
O4—Amperite No. 112;
P—General Radio rheostat, type No. 214A, 7 ohms equipped with General Radio small rheostat knob;
Q1, Q2, Q3, Q4 and Q5—Benjamin standard "Cle-ra-tone" sockets;
R1 and R2—Carter jack switches No. 2;
S—Carter open circuit jack No. 101;
T—Universal decorated panel, 8 by 22 inches;
U—hardwood baseboard (furnished with cabinet);
V—Corbett special sloping-panel cabinet;
W—small brass brackets (See Figure 14);
X1—antenna connection block, 1 inch by 2 inches (See Figure 14);
X2—battery connection block, 1 inch by 9 inches (See Figure 14);
Y1 and Y2—large brass brackets (See Figure 14);
Z—Fynur vernier control knob and dial;
Eight Eby binding posts



Kadel & Herbert

AN EXPERIMENTAL ONE-METER TRANSMITTER

The range of this set is quite as limited as its wavelength, however, since it reaches only to the small receiving set on the left. When the transmitting key is pressed the small bulb at the top of the Hertzian loop lights up to show visibly the reception of the signals.

Where Fortunes Wait

Inventions that are needed in the field of radio

A Re-chargeable "B" Battery

1. A "B" battery that may be charged at home by inserting a new supply of chemicals—thus avoiding the necessity of purchasing a new battery.

* * *

A Tube-filament Renewer

2. A device that will enable the radio fan to renew, without great expense, the burned-out filaments of his vacuum tubes.

* * *

A Self-tuning Receiver

3. A complete receiving set with an automatic dial device, similar to the automatic telephone, that will tune in electrically the broadcasting stations by merely dialing the station call letters.

* * *

A Filament Current Supply from the Lighting Circuit

4. A really satisfactory method for obtaining proper filament supply for vacuum-tube receivers that are used as a source of power to the alternating current lighting lines and that can be attached to any receiving set without change in the receiver design.

* * *

A Simple Static Eliminator

5. A device that can be used in conjunction with a receiving set that would eliminate static and yet not increase the number of controls necessary for tuning in the signal.

* * *

Vacuum Tubes Without Filaments for Amplification

6. A new principle for obtaining a pure electron stream in a vacuum tube that will be modulated by an externally applied current, without the use of a filament or batteries.

* * *

A Solution to Super-regeneration

7. A circuit modification of the Armstrong super-regenerator which will obtain full benefit of super-regeneration without critical operation and without distortion.

From a photograph made for POPULAR RADIO

TESTING OUT A SET-UP THAT EMPLOYS SINGLE-CONTROL

In this picture is shown a working model on the experimental bench of the single-control circuit shown in Figure 2. The designating letters attached to the instruments are the same as those shown in the diagram.

HOW TO IMPROVE

Broadcast Reception

VIII: How to Increase Operating Distance

This series of tuning-circuit articles was prepared by one of the most experienced radio engineers in the world *for the special benefit of the broadcast listener.* The preceding seven articles of this series include: "The Effects That Occur in the Transmitting Station," August, 1924; "Helpful Hints on Tuning," September, 1924; "Oscillations in the Receiver," October, 1924. "Noises That Come in With the Waves," January, 1925; "Cutting Down Spark Interference," February, 1925; "Increasing the Selecting Power of Your Receiver," April, 1925; "How to Reduce Interference," October, 1925.

By JOHN V. L. HOGAN

WE have seen in the preceding articles of this series that one of the most effective ways of reducing station interference, including both "crosstalk" from broadcasting stations and code signals from spark transmitters, is by the use of the inductively-coupled tuned antenna circuit.

This improvement ordinarily complicates the operation of a receiving set by introducing an additional tuning element, such as a variable condenser that requires separate adjustment. It has been found entirely feasible, however, to simplify the control of such a multiple-tuned-circuit receiver by equalizing or matching the circuits and using multiple condenser or inductor units that will adjust the tuning of all the circuits with one motion.

In the September article I described the simultaneous control of the series type of tuned antenna circuit and a tuned secondary circuit connected to the input terminals of a simple audion detector receiving set. This particular form of tuned antenna circuit is most effective when fairly large antenna systems are used for the reception of relatively high-frequency (short) waves.

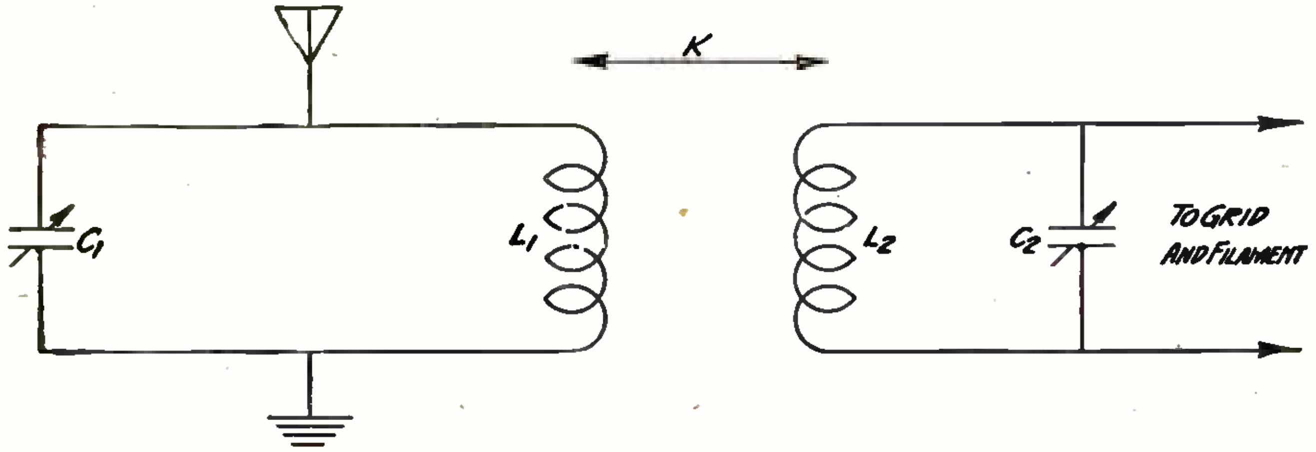
When the strength of the signal wave as it arrives at the receiving point is great enough to permit one to substitute a smaller antenna, some additional freedom from interference and "static" or strays is obtained by that change alone.

The combination of the small antenna with separate tuning of its circuit is extremely helpful in overcoming quite severe interference difficulties, and thus may be of substantial aid in "getting distance;" but the series connection of the tuning condenser above referred to is no longer satisfactorily efficient. If broadcasting waves are to be received upon a relatively small antenna (such, for example, as a single wire not more than thirty or forty feet long), it is usually best to use the shunt-condenser connection shown in Figure 1.

This simple circuit may equally well be used with single control for tuning both primary and secondary, by following the principles explained in the preceding article of this series. Noting that the capacity of the antenna wire with respect to ground acts to increase the effective capacity connected across the terminals of the primary coil L_1, it is clear that if the secondary coil L_2 is made identical in size one should connect an additional condenser across the secondary terminals in order to make the condensers C_1 and C_2 tune alike.

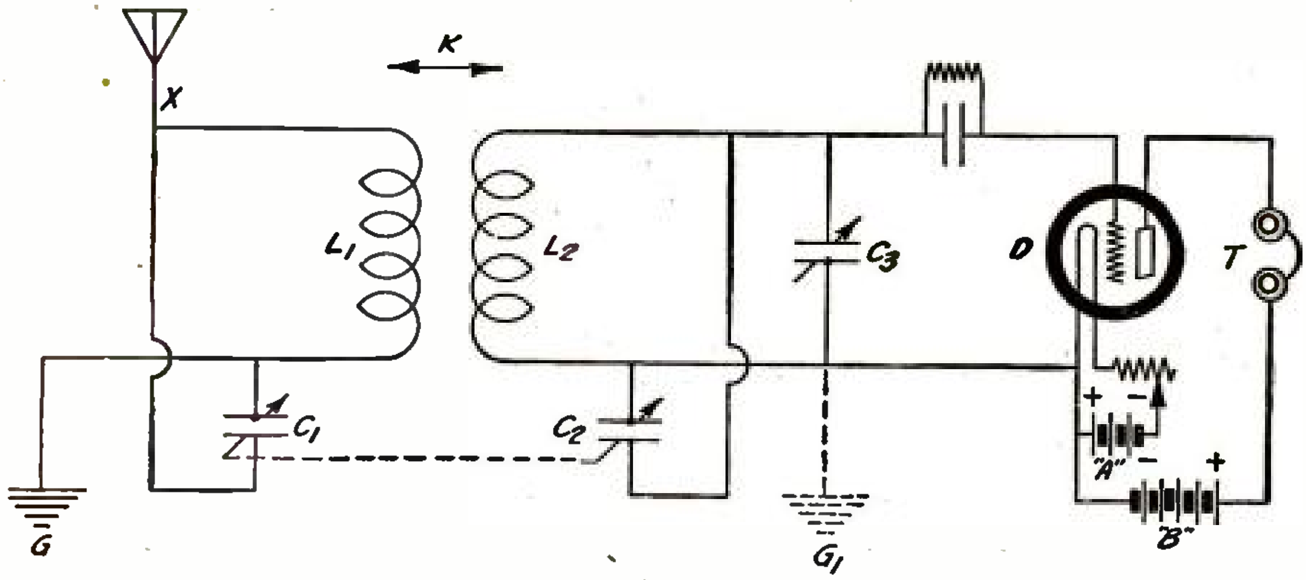
Figure 2 shows an arrangement in which C_3 is added for this purpose, the two tuning condensers being C_1 and C_2 as before.

If the supplemental or compensating condenser C_3 is made to equal the effective capacity of the antenna (less whatever small effect is produced by the detector), and if the coils, L_1 and L_2 as well as the tuning condensers C_1 and C_2 are alike, the settings of C_1 and C_2 will have the same scale-reading for best reception of any wave within their range. Thus it is feasible to use a double condenser that has a common shaft to turn both rotary sections, in place of C_1 and C_2, and so to tune both circuits by a single control. Changes in the coupling between L_1 and L_2 will affect the tuning of the two circuits and so may change by a scale division or two the resonance point for any particular



THE "SHUNT CONDENSER" TUNED ANTENNA CIRCUIT FOR SMALL AERIALS

FIGURE 1: *The connections at the right may be taken to a detector tube, through the usual grid condenser and leak, or to the first tube of a radio frequency amplifier.*



HOW TO USE "SINGLE CONTROL" OF TUNING IN THE SHUNT-CONDENSER CIRCUIT

FIGURE 2: *A small series condenser may be added at X. A simple detector tube is shown, but the first tube of a tuned or "untuned" radio frequency amplifier may be substituted.*

station. However, the tuning of the two circuits will remain "in step" because the inductions are equal and, therefore, their reactive effects upon each other are the same.

Should you find it difficult to balance the two circuits exactly, the compensating condenser C_3 may always be used as a supplementary adjustment to bring the tuning to exactly the best point.

The vacuum tube detector of Figure 2 is the simple non-regenerating type. In order to gain selectivity, and thereby increase operating distance at times when interference is severe, the separately tuned antenna circuit is shown. There is another very useful way of getting greater freedom from interference and at the same time increasing the responses to desired signals, and that is by adding regeneration or feed-back to the receiver.

Fortunately for our present purposes the desirable regenerative selectivity is obtained in a way that may be used to supplement rather than to replace the selective power gained by the separately tuned antenna circuit. Thus we may utilize both of these methods to reduce the harmful effects of interference and so get better results from the two in combination than could be had from either used alone. Not only will the reception of signals from distant stations be improved because of the reduction of interference, but the characteristic amplification that comes with regeneration will make the desired signals louder.

The reasons for these results may easily be understood if we find out a little more about regenerative or feed-back effects.

Let us look for a moment at a simple vacuum tube circuit such as that of Figure 3.

Here, at the left are a coil, L_1, and a variable condenser, C_1, connected to the grid G and filament F of the vacuum tube. The circuit containing these elements is the grid-filament or input circuit (often called simply the "grid circuit") and is variably tuned as shown. The usual "A" battery is used for heating the filament, and may be supplemented by a filament rheostat for temperature control. The plate P of the vacuum tube is connected through a variable inductance coil, L_2, the indicating meter M and the battery "B" to the filament; these elements are in the plate-filament or output circuit.

If radio frequency currents are set up in the input circuit, as (for instance) by coupling coil L_1 to an antenna-ground circuit, they may be resonated up to a maximum value by tuning the circuit with the aid of the variable condenser C_1. Then the rapidly alternating and relatively intense potentials applied between the grid and filament will, because of the "controlling" action of the grid and the normal amplifying characteristic of the vacuum tube, cause corresponding pulsations or radio-frequency currents in the plate or output circuit. If the meter M is of the sort that responds to radio-frequency currents, their presence and amount will be indicated by the scale reading of the meter.

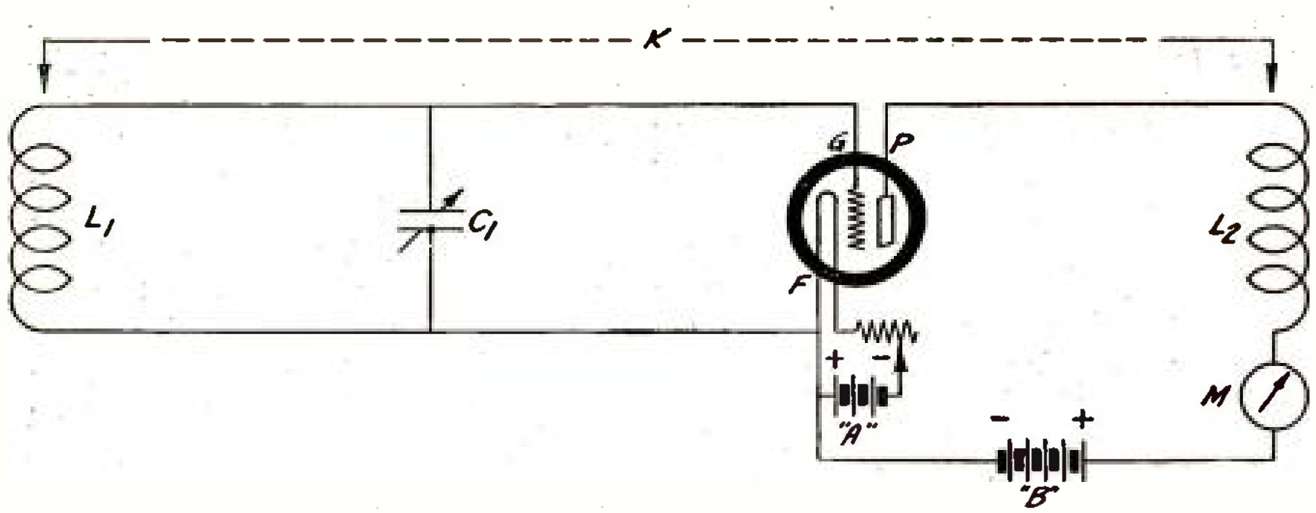
Now suppose that the coil L_2 is moved over toward the coil L_1, thus making of the pair a transformer. We may look on the coil L_2 as a primary winding and L_1 as a secondary. Part of the energy of the radio currents in the output circuit, passing through L_2, may thus be fed back into the input circuit containing the coil L_1, and (by correctly selecting the relative position of the coils) used to build up the amount of radio-frequency current of the frequency to which the grid circuit is tuned.

The augmented current in the input circuit, acting through the tube, will naturally cause larger radio-frequency currents in the plate circuit, and part of the energy of these will in turn be fed back to amplify further the oscillations in the input circuit.

This process of radio-frequency amplification, involving the amplifying power of the tube itself and the feeding back of plate-circuit energy, is repeated over and over again, and produces a very large increase in the strength of the radio-frequency impulses applied to the circuit. The power used to produce the magnification of signal strength comes from the B battery of the tube system, and the final effect is much as though the resistance of the entire circuit had been artificially reduced.

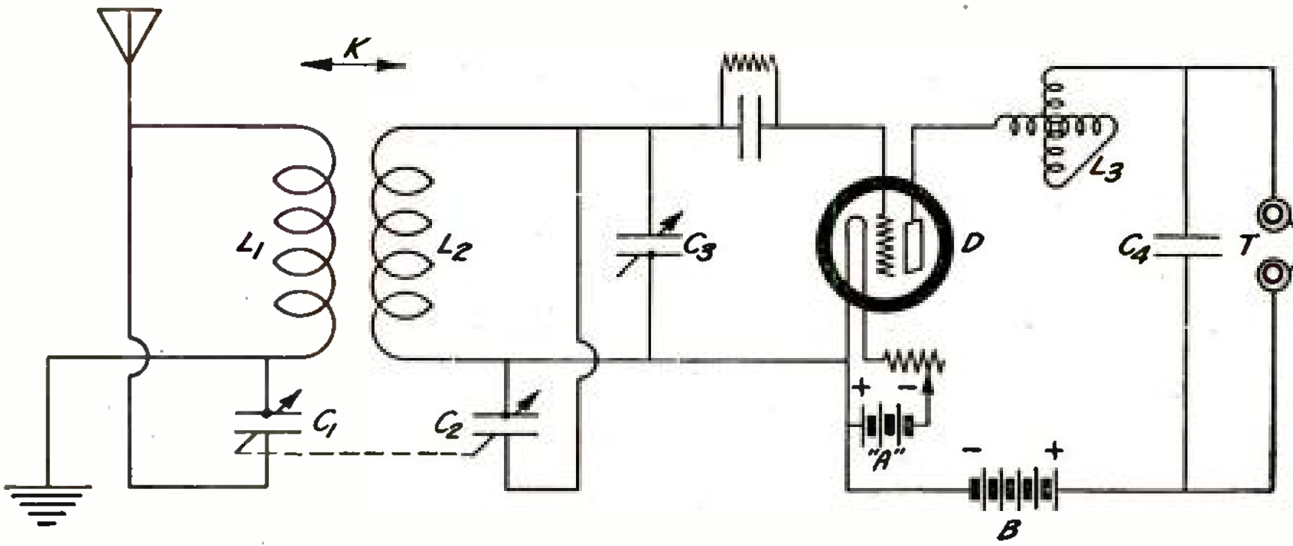
One of the most interesting things about this regenerative system is that its useful property of reducing the apparent resistance of a circuit occurs at the frequency to which it is tuned. That is, such a system will oppose relatively little of the absorbing or power-wasting property (that characterizes electrical resistance) to currents of the frequency to which it is tuned. On the other hand, it will not permit the flow of such relatively large currents of other frequencies.

Thus you can see at once that the useful amplifying power of the regenerative circuit is particularly valuable because it occurs at the tuned frequency, and, unlike some other forms of amplification, does not magnify impressed currents of other frequencies. In that way regeneration contributes to sharpness of tuning and is a powerful aid in reducing interference effects. Its multiplication of signal strength is also very helpful in-



HOW REGENERATION MAY BE USED TO INCREASE SIGNAL STRENGTH

FIGURE 3: *A simple vacuum tube circuit in which regeneration may be used to increase signal strength and sharpness of tuning.*



A GOOD CIRCUIT FOR LONG DISTANCE RECEPTION

FIGURE 4: *The regenerative detector applied, with variometer L_3 in the plate circuit, to the single-control arrangement of Figure 2. This easily-handled circuit, with one stage of audio amplification added, is very effective for long distance reception.*

directly for solving interference problems, for the increased sensitiveness that it provides makes it possible to use quite loose coupling between resonant circuits and thus to minimize the breaking-in of strong spark signals or of cross-talk from nearby broadcasting transmitters.

The arrangement described in connection with Figure 3 called for inductive coupling between coils L_1 and L_2 in order to facilitate the transfer of energy back from the plate circuit to the grid circuit. It is not necessary to have such inductive coupling for this purpose. One of the most useful arrangements of the regenerative circuit utilizes the capacity of the tube electrodes as a coupling for feedback.

Bearing in mind that a condenser is essentially a pair of conductors insulated from each other, you can see at once that the grid and the plate of the tube (being relatively close together in the evacuated space) are in effect the two plates or electrodes of a small condenser. Consequently, if we may use the language of the old art for a moment, a positive charge impressed upon one will induce a negative charge on the other. This is equivalent to saying that the condenser-effect or capacity between the grid and plate may provide an electrical coupling between the grid circuit and the plate circuit. Given such a coupling, we now know that it may be used to feed back energy for regeneration.

One of the simplest ways to get sufficient energy across this grid-plate capacity is to put a variable coil such as a variometer in the plate-filament circuit (as at L_2 in Figure 3) and with it adjust the natural frequency or tuning of that circuit. As the inductance is increased, the plate circuit will approach more and more closely to resonance with the tuned frequency of the input circuit and more and more radio-frequency energy will be developed in the output. As the energy thus increases the potentials applied to the grid-plate capacity will increase, and more and more energy will be fed back right up to the point where oscillations begin and (in ordinary broadcast receiving) heterodyne squeals or whistles are consequently heard.

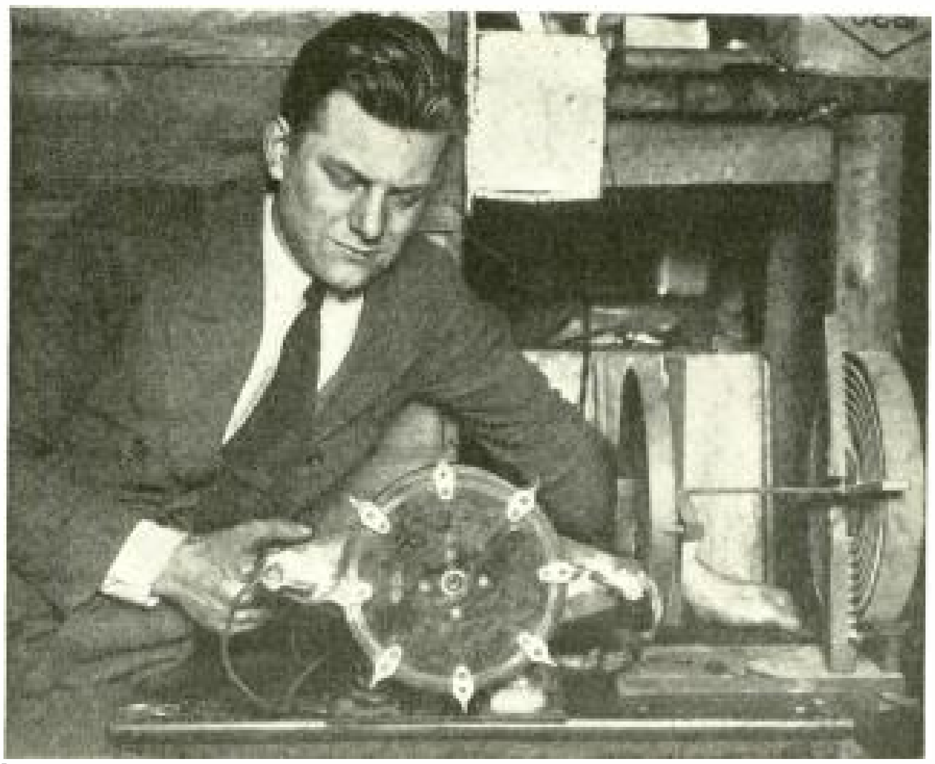
Figure 4 shows how this "tuned plate circuit" method of producing and controlling regeneration may be applied to a single control circuit like that of Figure 2. The variometer is indicated at L_3, and another additional element, a condenser of say .002 microfarad, is shown connected across the telephones at C_4.

Such an arrangement is particularly desirable because the plate circuit variometer is very efficient at the high wave frequencies (short waves) used in broadcasting and because its adjustment produces little if any effect upon the tuning settings of the circuits including C_1 and C_2. Yet the amplification and sharpness of tuning obtained are extremely helpful.

Audio-frequency amplification may, of course, be added to the receiver of Figure 4 by substituting the primary of the audio coupling transformer for the head telephones illustrated. It is fair to say that such an arrangement, having only one audio stage (two tubes in all) and used with head telephones and a moderately good antenna system, will give surprisingly loud signals from distant stations, together with relatively great freedom from interference of all kinds. For loudspeaker operation additional amplification may be added, but this should be of both the radio and audio-frequency types in order to get the best overall results.

The same principles of loose coupling and multiple tuned circuits, with or without unified tuning control, and of regenerative amplification and tuning-sharpness improvement, may be applied to a great many variations of circuit arrangement.

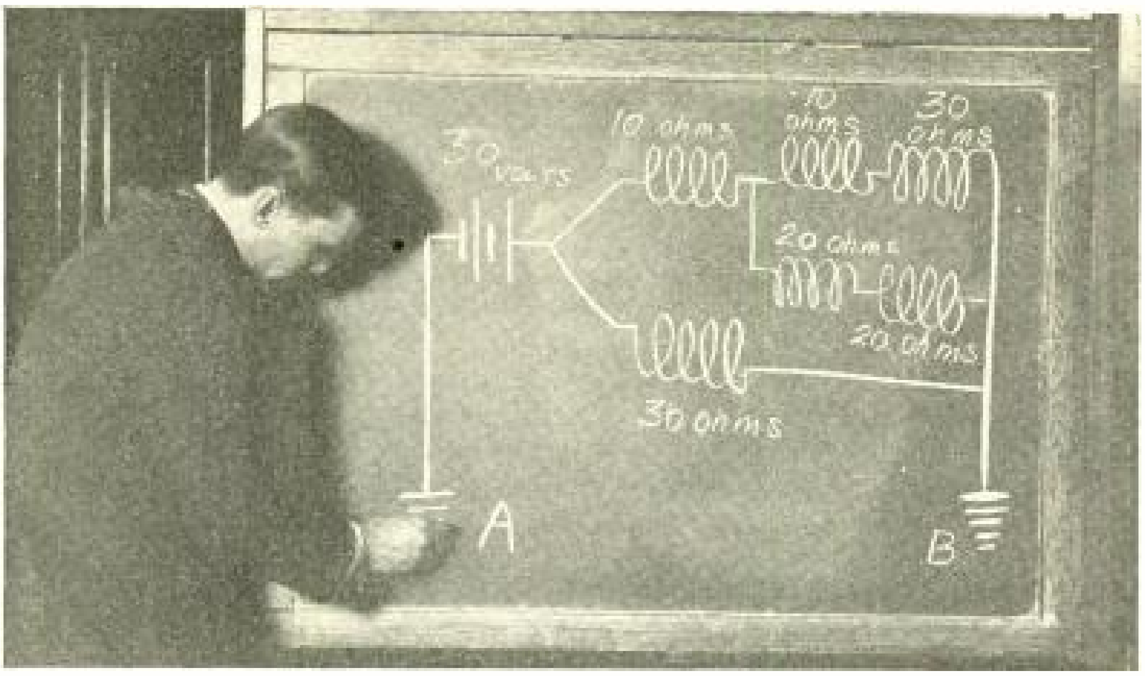
It would be outside the scope of this series of articles to go into the details of the sharply and broadly tuned radio-frequency amplifier combinations, and the various other cicuit modifications, that can be worked out along the lines suggested. In closing the series, then, I hope that I have succeeded in pointing out some of the specific paths that can be followed in our persistent and progressive march towards the goal of perfect broadcast reception.



Kadel & Herbert

AN OLD ROTARY SPARK THAT BROKE ALL RADIO RECORDS IN ITS DAY

This peculiar outfit is an old type rotary spark gap which was used when radio was in its infancy. This type was very popular in 1907, and this particular example was used and still is owned by Kenneth Hewitt, known to brass pounders as 2RK, a world's record holder both for transmission and reception. A huge spark coil delivering 36,000 volts was used to operate it and it has over one kilowatt of power.



From a photograph made for POPULAR RADIO

SERIES-PARALLEL COMBINATION

FIGURE 1: *It is more difficult to calculate the total resistance of a combination circuit as shown above than the simple one shown in the preceding article. The solution to this problem appears in the text.*

WHAT "CURRENT" MEANS IN RADIO

Chalk Talks in Radio—No. 3

The short, informative articles in this series are written for the radio novice. They embrace the electrical background of radio work. Keep them for reference

By J. W. GOOSTREE

BEFORE we take up the next electrical subject, I will tell you how I solved the circuit problem in our last chalk talk.

I twisted and turned the diagram about until I divided it into four arms and redrew it as shown in Figure 1.

This is what I made of it:

10 ohms on the top arm at the right plus 30 ohms beside it equals 40 ohms.

20 ohms plus 20 ohms on the center arm equals 40 ohms.

Multiply these two results together and you get 1,600.

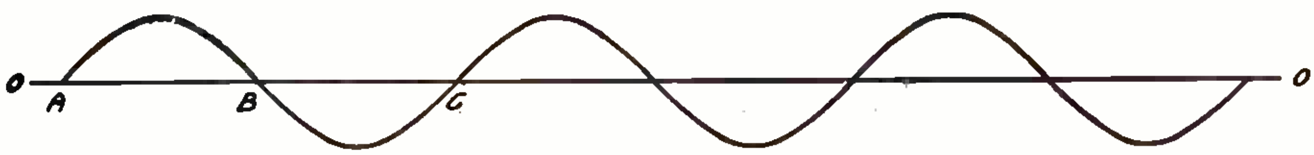
Divide this result by 80 (the sum of the resistance of the two arms) and you get 20 ohms.

Add to this result, which is the resistance of the two upper arms at the right, 10 ohms, which is the value of the top arm at the left. This equals 30 ohms.

This resistance is multiplied by the resistance of the lowest arm—30 times 30 equals 900.

900 divided by 60, which is the combined resistances of the upper arms added to the resistance of the lowest arm, equals 15 ohms.

The combined resistances, therefore,



A GRAPHIC ILLUSTRATION OF ALTERNATING CURRENT

FIGURE 2: *Alternating current flows through a circuit in pulses of continuously reversing polarity. In the diagram above it is shown starting at A at zero and increasing and falling again to zero at B, with one polarity. Then it reverses in polarity and the same process is repeated from B to C, and so on continuously.*

from A to B are equal to 15 ohms.

30 volts divided by 15 ohms equals 2 amperes.

30 volts times 2 amperes equals 60 watts.

Now you have the answer to the problem in CHALK TALK No. 2.

Perhaps you have wondered about symbols to represent current.

Direct current may be likened to the flow of a river that runs from the North Pole (+) to the South Pole (—).

A simple symbol for direct current is a straight line with the poles at either end, like this:

+ ——— —

Direct current flows from the positive (+) terminal of a battery or generator, through the external circuit to the negative (—) terminal and from the negative (—) to the positive terminal (+) within the battery or generator.

Alternating current is different. It is waving or varying in intensity and must be represented in a way that indicates its regular changing character.

In Figure 2 the line A, B, C gives you a picture of an alternating current.

Starting at zero in the figure the line rises to its maximum in one direction, and returns through zero to its maximum in the opposite direction. In this figure A to B is a alternation, and A to C one complete cycle.

Pulsating current travels along the circuit, like a frog down a path, in jerky jumps, but always in the same direction. Lop off all the alternations below the zero line in Figure 2 and you have a fair picture of "pulsating" current.

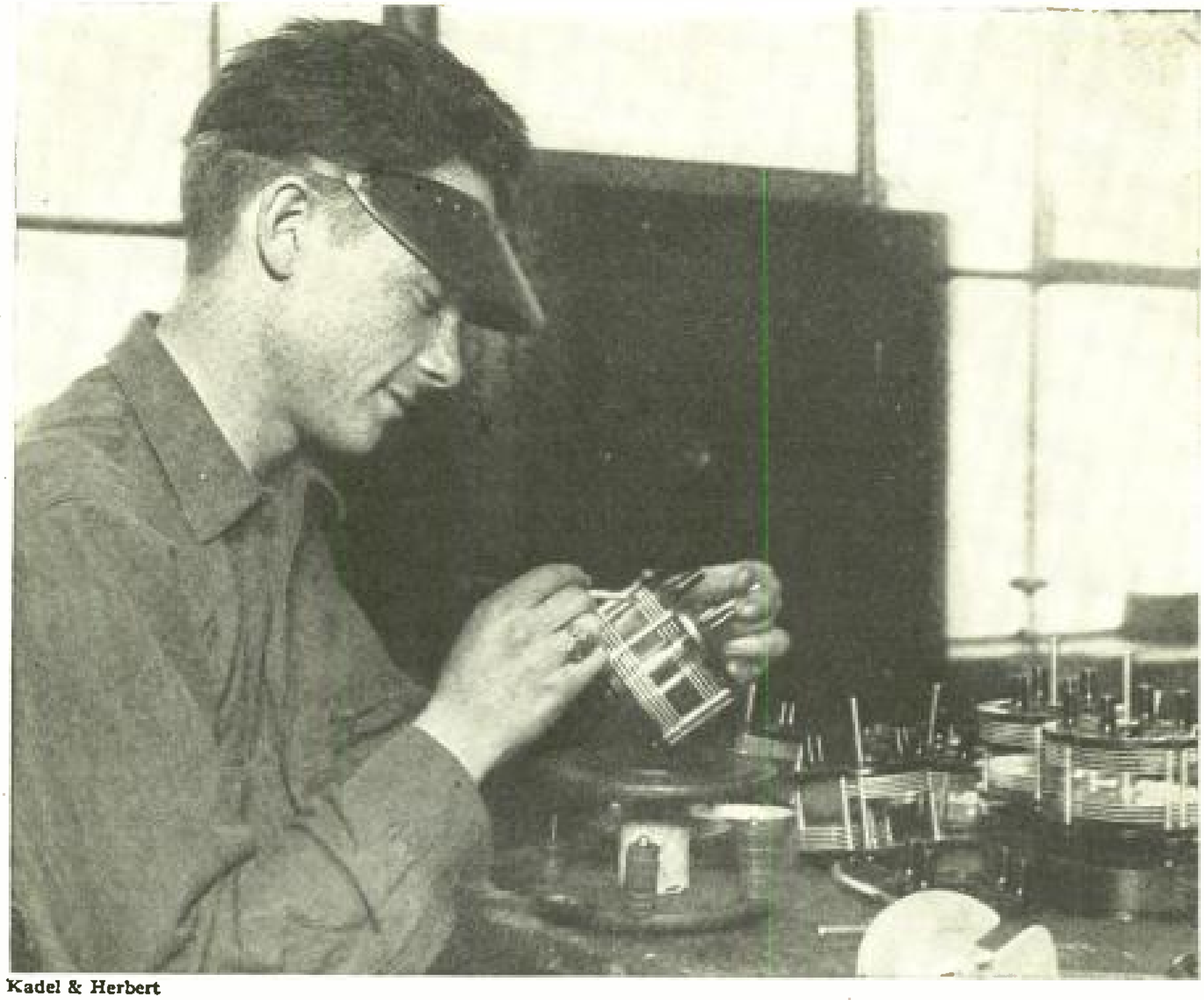
Variable, high-tension, high-frequency and other kinds of current will be explained in a later talk.

The next problem is how would you connect five 20-ohm resistances in a 50-volt circuit to get 100 watts?

The answer will appear in CHALK TALK No. 4, in which I tell about more symbols.

What Helpful Hints Can *You* Give to Your Fellow Radio Fans?

ALL owners of receiving sets—sets either built at home from plans and specifications published in POPULAR RADIO or ready-made sets—are invited to tell their fellow readers of this magazine about their successful experiments in getting broadcast reception. Have you discovered some little kink that will be of service to your neighbor? Tell him about it—in a letter addressed to the Listening-In Editor of POPULAR RADIO, 627 West 43rd Street, New York City.



Kadel & Herbert

ASSEMBLING CONDENSERS

Great care must be taken in assembling the condenser units so that the spacings of the rotor and stator plates are kept uniform. This is a tedious job that must be done by an experienced operator.

WHAT EVERY RADIO EXPERIMENTER SHOULD KNOW ABOUT

CONDENSERS

PART II

Little known data about variable condensers and about the "low-loss" fallacies as applied to this type of instrument

By SYLVAN HARRIS

WHATEVER "low-loss" and "dielectric losses" in regard to varible condensers may mean to you, recent check ups of methods for measuring condenser resistances (some of which are explained in this article) will upset many of your ideas about condenser efficiency.

The simplest method that is used in attempting to measure the resistance is illustrated in Figure 1.

The condenser to be measured is placed in series with a coil, a current meter and a variable resistance. This circuit is excited by the oscillator at the desired wavelength. If the meter used is a current-squared meter, the resistance R, which has to be inserted to make the current in the circuit drop to one-fourth its original value, is equal to the resistance of the whole circuit, including condenser and coil.

For the next step in the method, a special condenser is built, which consists as nearly as possible, of plates only. That is, all the insulating material is omitted which it is possible to omit. In some cases the condenser consists of two plates hung on silk threads. The resistance of this condenser is assumed to be zero. It is inserted in the circuit at C, and a second determination of the resistance is made. The difference between the two measurements is said to be the resistance of the first condenser, since the second was assumed to have zero resistance.

Now let us consider the faults.

In the first place, it is absurd to suppose that any piece of apparatus has zero resistance. The argument may be raised that it is small enough to neglect. But it is not. As has been shown before* there are other losses in condensers besides dielectric losses, and the special "standard" condenser surely has some of these.

Furthermore, on account of the fragile construction of the "standard," it generally has to be small. Figure 4 shows what this means. Four condensers of the same make and design, and all with the same amount of insulating material, were measured for resistances and the results were plotted in this curve. The condensers differed only in the number of plates and length of shaft. It is seen that the smaller condensers have inherently the higher resistance. Hence the resistance of our "standard" is likely to be much higher than we imagine.

Another cause of error in this method is the high resistance of the coil and meter, as compared with the resistance of the condenser. Suppose the resistance of the coil, meter, and unknown condenser is 10 ohms, and the resistance of the coil and meter (assuming the "standard" to have no loss) is 9.5 ohms. The resistance of the unknown will then be

$$10 - 9.5 = .5 \text{ ohm}$$

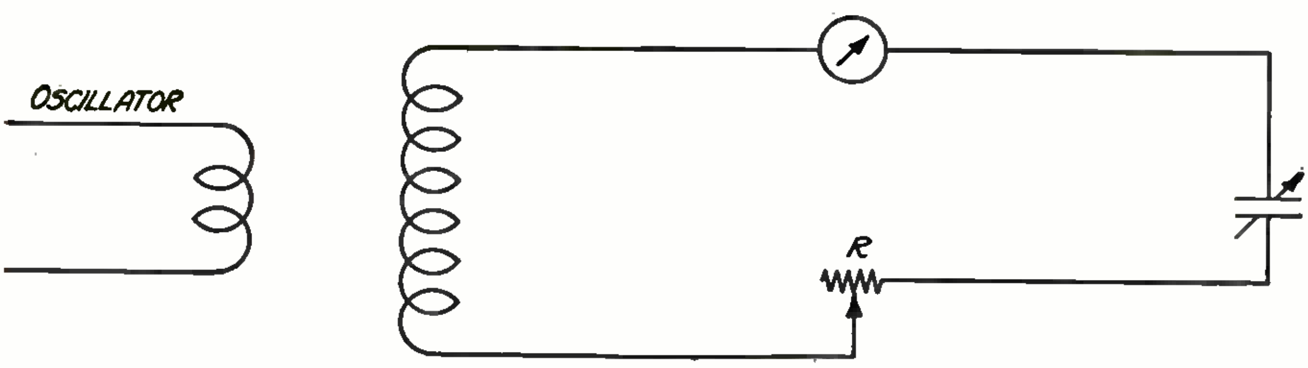
Now a small error in the measurement with the standard, such as .1 ohm, will represent an error of only one percent in the actual measurement, but this error will increase to 20 percent when the subtraction is made to find the condenser resistance. Thus,

$$\frac{0.1}{9.5} \times 100 = 1\% \quad \text{(roughly)}$$

$$\frac{0.1}{0.5} \times 100 = 20\%$$

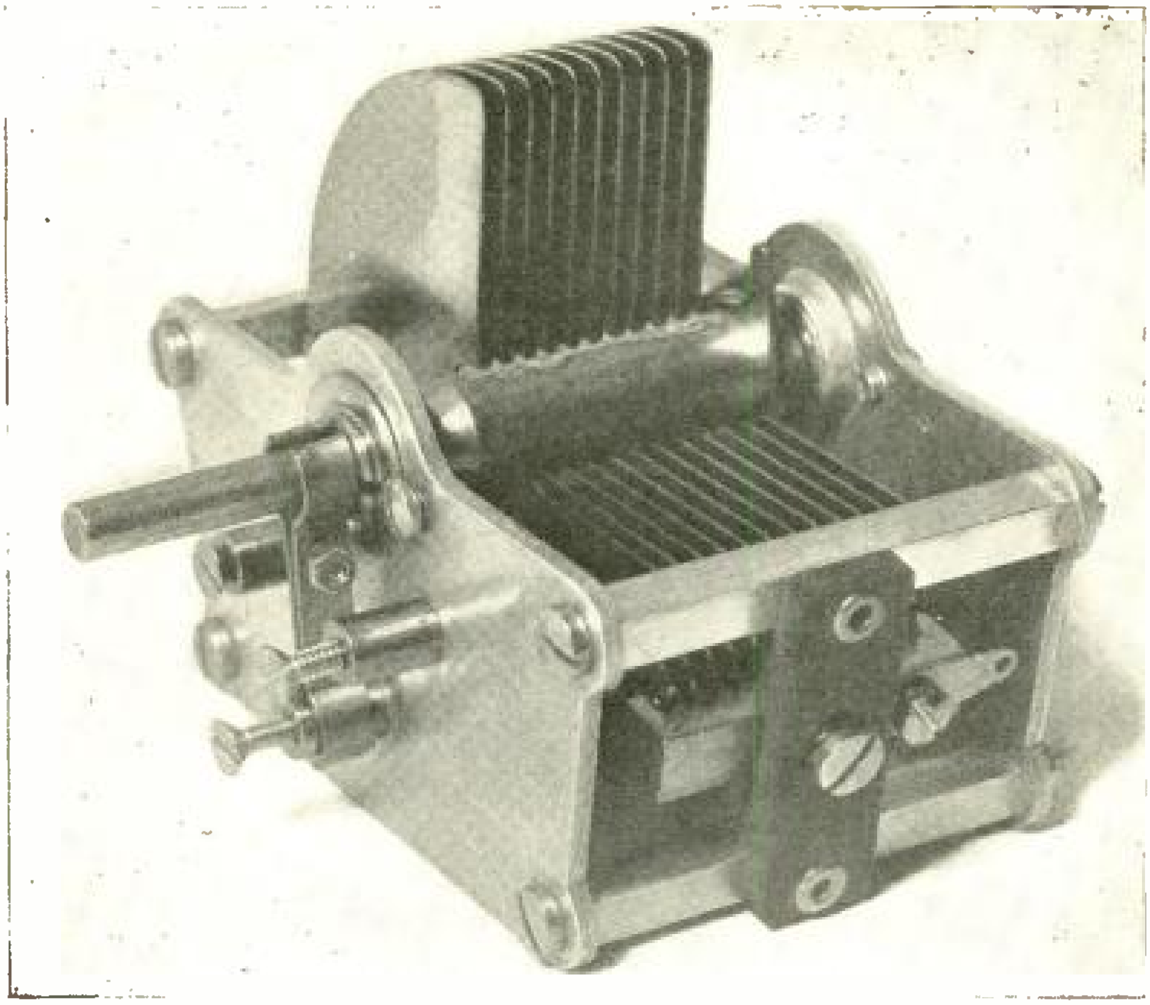
This is one of the difficulties that had to be overcome in making the measurements described in this and the preceding articles and anyone wishing to learn the details of the method may consult

*See Popular Radio for February, page 130, Figure 3.



THE AUTHOR'S METHOD OF MEASURING CONDENSER RESISTANCES

Figure 1: *This diagram shows the general arrangement of the testing circuit for obtaining the efficiency of the variable condenser at high frequencies of the order used in radio receiving sets for broadcast reception.*



AN EFFICIENT METAL END-PLATE CONDENSER

FIGURE 2: *This condenser (which is a well-known make) shows the construction of a variable type that employs metal end plates with two small slabs of insulating material. This condenser really is an efficient piece of apparatus from both the electrical and mechanical standpoint.*

the more technical paper in the I. R. E. Proceedings.†

To overcome this difficulty the resistance of the measuring circuit must be as low as possible. At any rate it must not be greater than the resistance that is being measured. This also means that the resistance of the current measuring instrument, which is generally 4 ohms or greater, must not remain in the circuit. It must be shunted by a relatively low-resistance conductor, or wire. Many may fear that shunting the meter may cause difficulty because the distribution of the current between the meter and shunt will vary with the frequency. That is, the current through the meter will not bear the same relation to the current in the shunt at all frequencies. This would make it impossible to determine the current in the circuit.

But, where the actual values of the current are not needed, as in comparisons, and in the method referred to here, it will be found that the relation between the currents in the meter and shunt will remain the same, at the same frequency no matter what the total current in the circuit may be. In comparison measurements, therefore, no harm will come from shunting the meter if the comparison is made at a constant frequency.

As a result of this new information about losses in condensers, it should follow that a great part of the myriad radio fans will have to revise their ideas about "low-loss." The low-loss idea is a very good one, for it is upon the re-

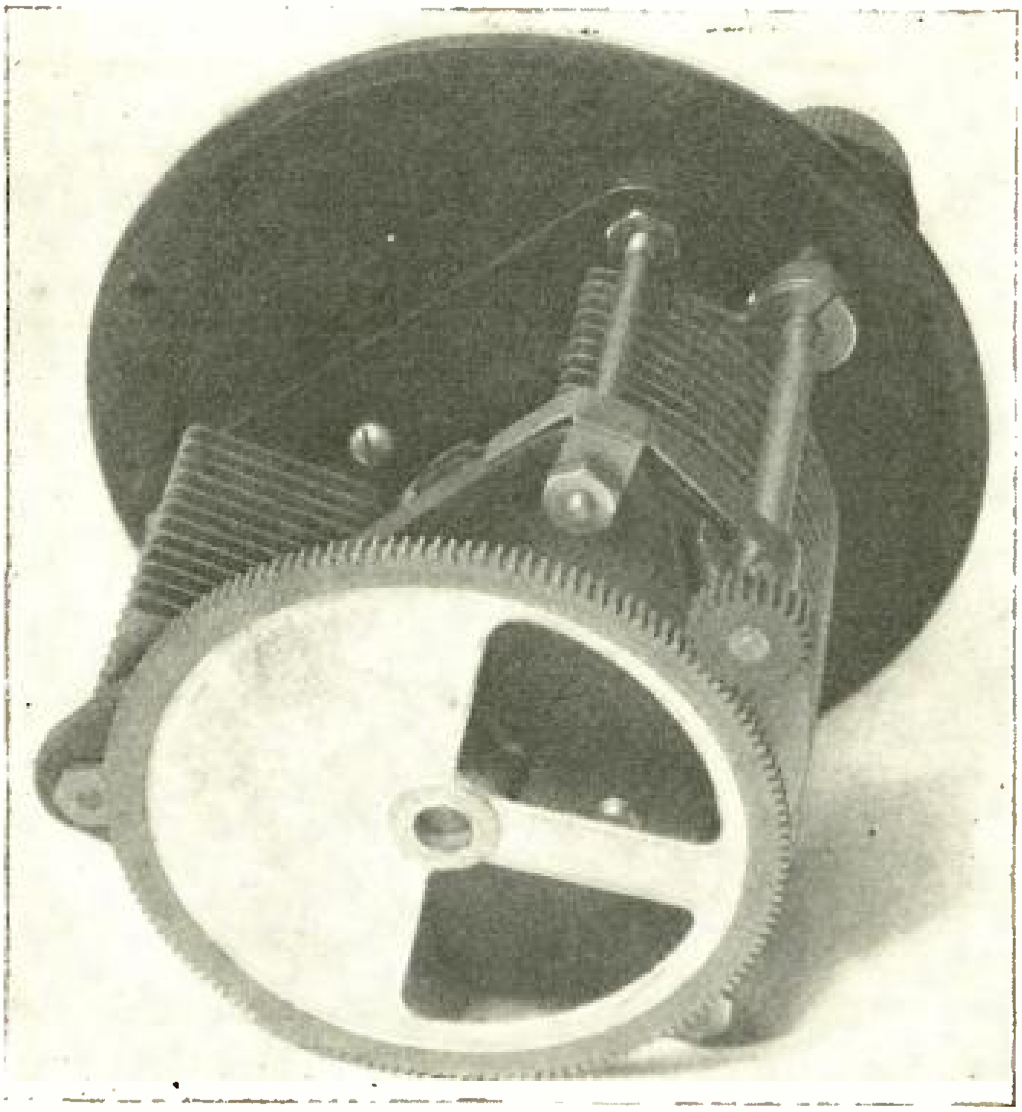
† Proceedings of the Institute of Radio Engineers, February, 1925.

duction of losses in radio circuits that efficient operation depends. It is about time, however, that the radio experimenter should learn that low-loss in a condenser does not necessarily mean metal end-plates. There are other factors to be considered, and it will be found that many of the metal end-plate condensers have higher resistances than some condensers with molded end-plates. It must not be forgotten that, if we assume other things to be equal, dielectric losses in molded end-plates decrease as the frequency increases (or as the wavelength decreases) while eddy-currents in metal end-plates increase. The effect of the end plates in either case is very small, so that it will be far better to concentrate our attention on the plates themselves, and forget the end-plates, except as a last refinement.

Then too, the amateur should be cautioned against attempts to make comparisons of condensers when they are connected in actual tuning circuits.

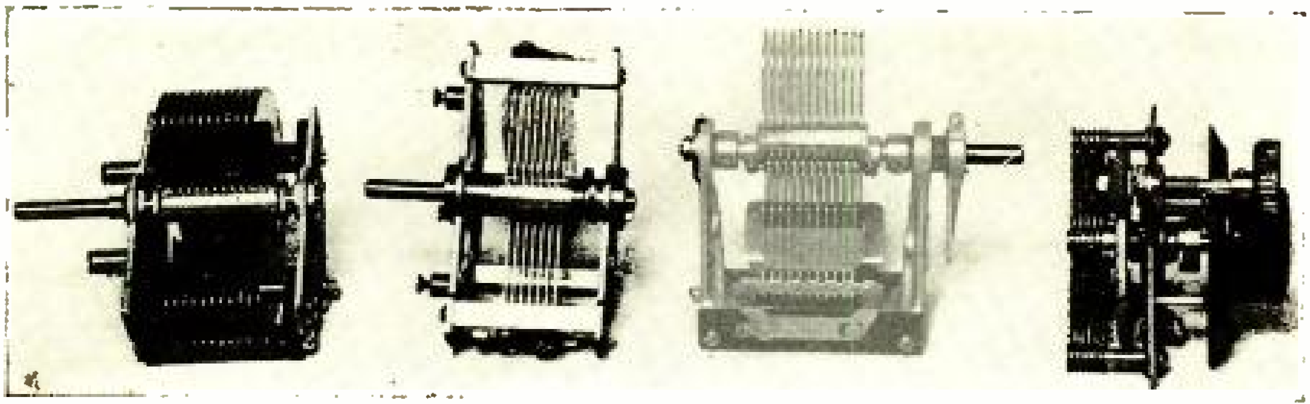
If one were to replace a relatively good condenser in his tuning circuit with one that is relatively poor, it is doubtful whether he could notice any difference in operation without exercising his imagination considerably.

The differences in the resistances of nearly all the condensers on the market are very slight. Furthermore, a change of say, a tenth of an ohm, more or less, in the resistance of the condenser means



AN EFFICIENT CONDENSER WITH DIELECTRIC END PLATES

FIGURE 3: *This type differs in general construction from the one shown in Figure 2; it is, nevertheless, a remarkably efficient piece of apparatus. It employs two end plates of triangular pieces of dielectric material.*



FOUR STANDARD MAKES OF VARIABLE CONDENSERS

FIGURE 4: *Here are some efficient makes of variable condensers—all of them, however, of different capacities. It is almost impossible to devise a means for testing and comparing condensers of different size capacities, as the physical dimensions as well as the capacity have a direct effect on the resistance at various frequencies.*

a change of only two percent in the total resistance of the tuning circuit, if we assume that the resistance of the coil is 5 ohms. The comparison generally shows up worse than this, for coil resistances often run up as high as 30 or 40 ohms. Another convincing argument has been found in the fact that the power output of the headphones has to increase ten times before the human ear can detect the increase. It becomes clear from this fact that the human ear can not be relied upon for such discriminations.

This recent study of condensers has brought to attention the following seven considerations, among others:

1: It is a fallacy to believe that all the losses in condensers are those in the dielectric material. Other causes of resistance are skin-effect in the plates, and eddy-current losses in metal end-plates and metallic structures.

2: Metal end-plates may introduce losses in condensers by reason of eddy-currents which may be in excess of dielectric losses in end-plates of insulating material.

3: In any event, the losses in the end-plates are only a small proportion of the total losses in the condenser. The greatest part of the loss lies in the plates themselves. This, of course, applies only at radio frequencies.

4: The argument is often advanced that a metal framework and metal end-plates reduce body capacity. This is true, but they do it by reducing efficiency and increasing losses. Body capacity in a well-designed, low-resistance receiver should not be troublesome.

5: The thinner the plates the less will be the skin-effect. Condenser plates should therefore be as thin as is consistent with mechanical strength.

6: The resistance of nearly all the condensers on the market is small compared with the resistances of the coils generally used with them in tuning circuits. As a rule the condenser losses represent less than ten percent of the total losses in the circuits.

7: Do not be misled by advertisements which represent the resistance of condensers to be zero or even as low as .1 or .01 ohm at radio frequencies. The lowest resistance in a commercial condenser now on the market is in the neighborhood of a half an ohm at 200 meters.

¶ *During the ensuing few months* POPULAR RADIO *will feature a series of articles on condensers—beginning with an article on straight-line-frequency condensers by Herbert J. Harries.*

From a photograph made for POPULAR RADIO

A MODERN AND SCIENTIFIC GROUPING OF THE INSTRUMENTS

The orchestra is placed at the opposite end of the studio from the microphone, and each instrument is located in the square (note how the squares are indicated by the letters and numerals on the walls) that tests have shown insure the best transmission in ensemble concerts.

"The Oboe in 4-D"

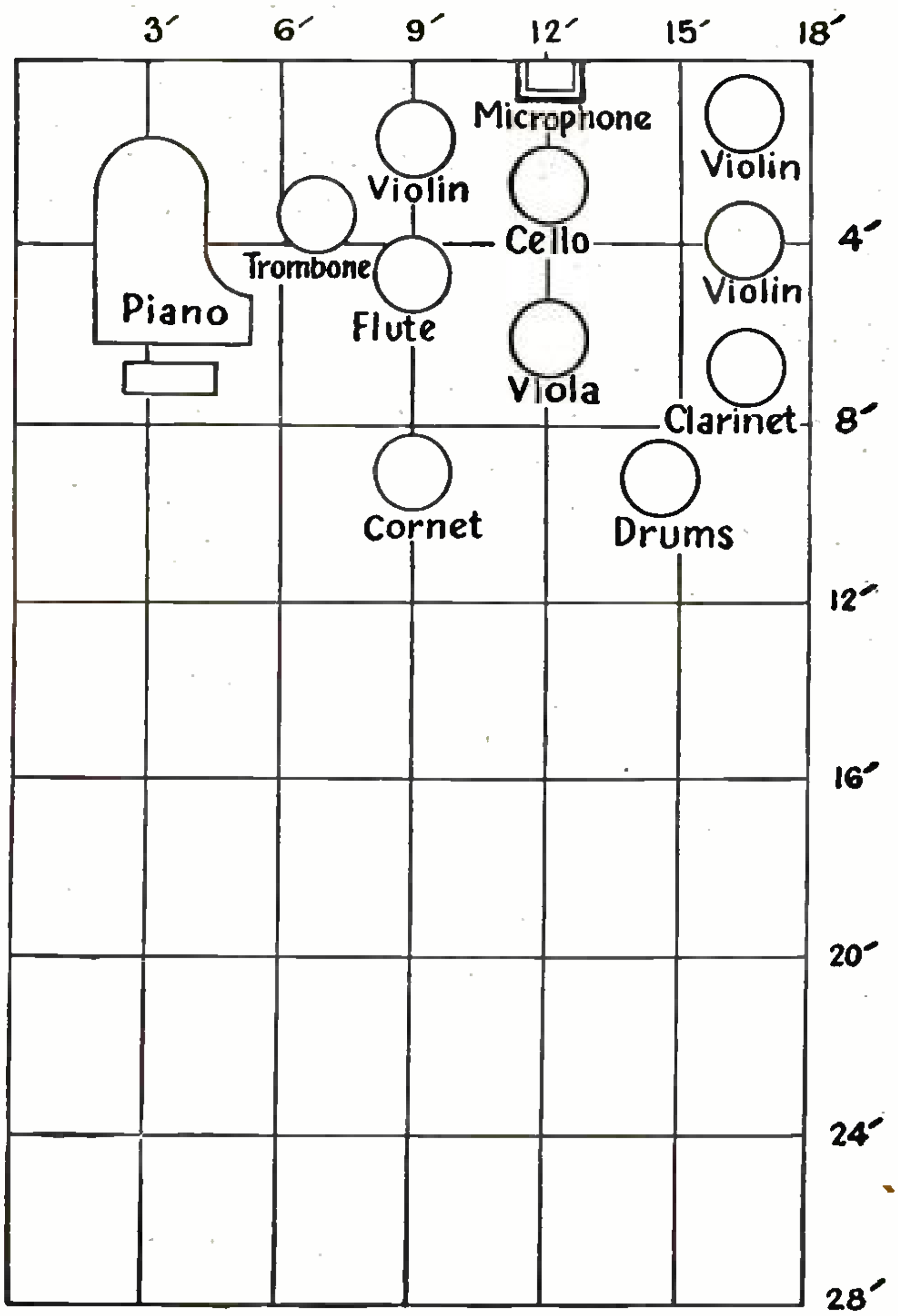
How science, which has vastly improved the transmitting circuit, is using the systems and charts of business for determining the exact locations before the microphone of each musician

By THOMAS L. BAYARD

WHILE the child is growing from a tiny baby of a few pounds to a strapping big boy of more than a hundred pounds, the mother, who sees him every day, is scarcely conscious of his increase in size from month to month, and realizes that he is growing rather by observing his change in moods and expressions than by making particular note of his increase in size. But the grandmother or the aunt who sees him only at intervals of three or four months, is quick to observe the change in size, and the increased dexterity with which he uses his body and powers of expression.

Most of the radio listeners are like the mother who lives with her child every day and who fails to note the weekly growth and improvement. After one acquires a radio set and gets a taste of the fascination of listening to the radio programs, he usually hears them more or less regularly; it is seldom that a confirmed fan will forsake his set for a time and turn a deaf ear to all radio programs for a long period of months. As a consequence he cannot readily compare today's program with the one three or six months ago, and he seldom realizes to the full the extent of improvement in radio transmission that is made in a year's time.

This improvement is strikingly revealed by two charts made by A. G. Popcke, an engineer attached to the staff of station KDKA, showing the proper position of orchestra instruments in a broadcasting studio now and two years



THE OLD "HUDDLE" METHOD OF GROUPING MUSICIANS

Because of imperfections in the transmitting circuit, which prevented much amplification of sound between the microphone and the transmitting set, the orchestra used to be crowded together—a system which gave improper tonal values to the various instruments. Compare this group with the one illustrated on page 530 ago. Mr. Popcke is a musician in addition to being an electrical engineer, and he checks the program daily to learn how different groupings of instruments affect the blending and tonal quality of the orchestra and band selections.

Two years ago the imperfections of the best transmission sets then in use made it necessary to group the orchestra instruments as close to the microphone as possible. The nearest instruments were two feet away, and the farthest often of necessity would be eight and ten feet away—four and five times the distance from the microphone to the nearest of the instruments. This made the nearest instruments sound much louder proportionately than the instruments farther away, as the strength with which a voice or musical instrument is recorded by a microphone diminishes very rapidly as the music moves away from the microphone. This wide difference in the strength registered by the various instruments threw out of balance the orchestral unity which had been developed by a long line of musicians through decades of study and practice in writing music scores for the orchestra.

It was realized that it would help some by placing nearest the microphone the instruments the tones of which possessed the least strength and carrying power, and Mr. Popcke set about to determine which these should be. He had been interested in this world's pioneer broadcasting station from its early days, when he had asked to pass on the talking machine records that were broadcast on some of the first programs and determine which ones would transmit well. Musical ensembles of which he was a member also had furnished music for some of the early programs.

As the result of his tests, the string instruments of the orchestra were placed nearest the microphone, the wood winds next, and the brass wind and percussion instruments farthest away. This order is still employed generally in the studios.

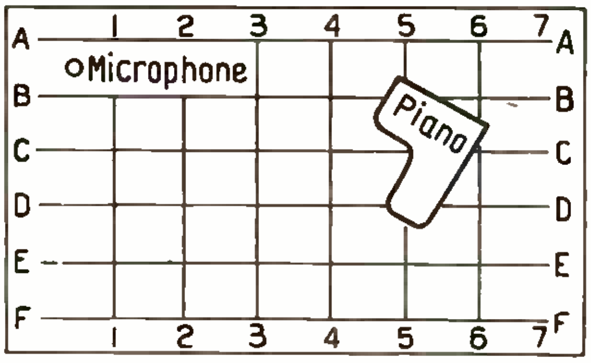
While proper arrangement helped some in regaining the desired balance for a band or orchestra, the results still were not entirely pleasing to the radio audience, which was constantly growing more and more critical of the radio program as the novelty of it began to wear off; people had begun to demand of the radio the degree of perfection asked in the other things they used every day.

The studio directors were prevented, by limitations of the early transmitting circuits, from moving the orchestra players back from the microphone and thus narrowing the difference between the nearest and the farthest instruments. The microphone of today gives off practically no noise, even when maximum practical amplification is applied, but those of the early broadcasting day, due to imperfections of the transmitting circuit, gave off a sputtering or "frying" noise. This noise was increased in volume as the tones were passed along the transmitting wires and through the vacuum tubes that amplified them before they were broadcast on the ether waves.

In order to keep down this "ground tone," as the engineers call it, and to prevent it from being broadcast with the music, the music was amplified as little as possible between the microphone and the antenna. To accomplish this, the radio people endeavored to have the musical tones strike the microphone with as much strength as possible, so that the volume of these tones would be considerably above that of the sputtering noise, and so that great amplification would not be necessary. This meant that the instruments were placed as close to the microphone as the players could conveniently sit.

As the transmitting circuit was refined, the sputtering noises were eliminated from the microphone and it became possible to increase greatly the amplification of the tones picked up by the microphone. This refinement has made such progress that today it is possible to group an orchestra from fifteen to thirty feet from a microphone, so that no in-

Distance From Microphone Desired	Location
4 Ft.	1½ B
5 "	1½ C
6 "	2 B
7 "	2 C
8 "	2½ B
9 "	2½ C
10 "	3 B
12 "	3½ B
15 "	4½ A,B,C



Plan View of Studio

Distance of Various Positions From Microphone

	Position						
Position	1	2	3	4	5	6	7
A	2½	6	10	14	18	22	26
B	2½	6	10	13	18	22	26
C	5	7	11	15	19	23	27
D	7½	9	13	16	20	23	27
E	–	12	15	19	21	25	28
F	–	15	17	21	23	26	29
	Distance from Microphone (Feet)						

Example: 2A = 6 Ft.
5D = 20 "
7C = 27 "

Vocal Selections		
Soprano	Distance	Location
Soft	5 Ft.	1½ C
Moderate	8 "	2½ B
Strong	12 "	3½ B
Contralto		
Soft	4 "	1½ B
Moderate	6 "	2 B
Strong	10 "	3 B
Tenor		
Soft	4 "	1½ B
Moderate	6 "	2 B
Strong	10 "	3 B
Baritone		
Soft	4 "	1½ B
Moderate	6 "	2 B
Strong	10 "	3 B
Bass		
Soft	2 "	1 B
Moderate	5 "	1½ C
Strong	8 "	2½ B
Male Quartet	10 "	Between 3A & 3C
Mixed "	10 "	Between 3A & 3C

Instrumental Selections		
Instrument	Distance	Location
Violin		
Soft	5 Ft.	1½ C
Loud	10 "	3 B
Cello		
Flute	6 "	2 B
Soft	7 "	2 C
Loud	10 "	3 B
Clarinet	10 "	3 B
Saxaphone	12 "	3½ B
Oboe	10 "	3 B
Bassoon	10 "	3 B
Cornet, Trombone, Horn	15 "	4½ B
String Quartet		
1st. Violin	8 "	2½ B
2nd. "	9 "	2½ C
Viola	12 "	3½ B
Cello	13 "	3½ C

Orchestra		
Instrument	Distance	Location
First Violin	14 Ft	4 A
" "	" "	4 B
Second "	15 "	4½ B
Viola	15 "	4½ C
Cello	11 "	3 C
Bass Viol	8 "	2½ A
Oboe	15 "	4 D
Clarinet	19 "	4½ E
Bassoon	19 "	5 D
Flute	20 "	4 F
Cornet	24 "	6 E
Traps	22 "	6 C
Piano	20 "	5½ A

Small Band		
Clarinet	18 "	4 E
"	20 "	5 E
"	22 "	5 F
"	24 "	6 E
Oboe	20 "	5 D
Bassoon	18 "	5 C
Flute	20 "	4 F
Cornet	28 "	7 F
"	25 "	6 F
French Horn	22 "	6 C
" "	25 "	6½ C
Baritone	26 "	7 B
Tuba	23 "	6 D
Traps	22 "	6 B

Note: For above Piano at 5½ A as in Plan View of Studio.

Guide for Placing Soloists & Ensemble Combinations In Studio

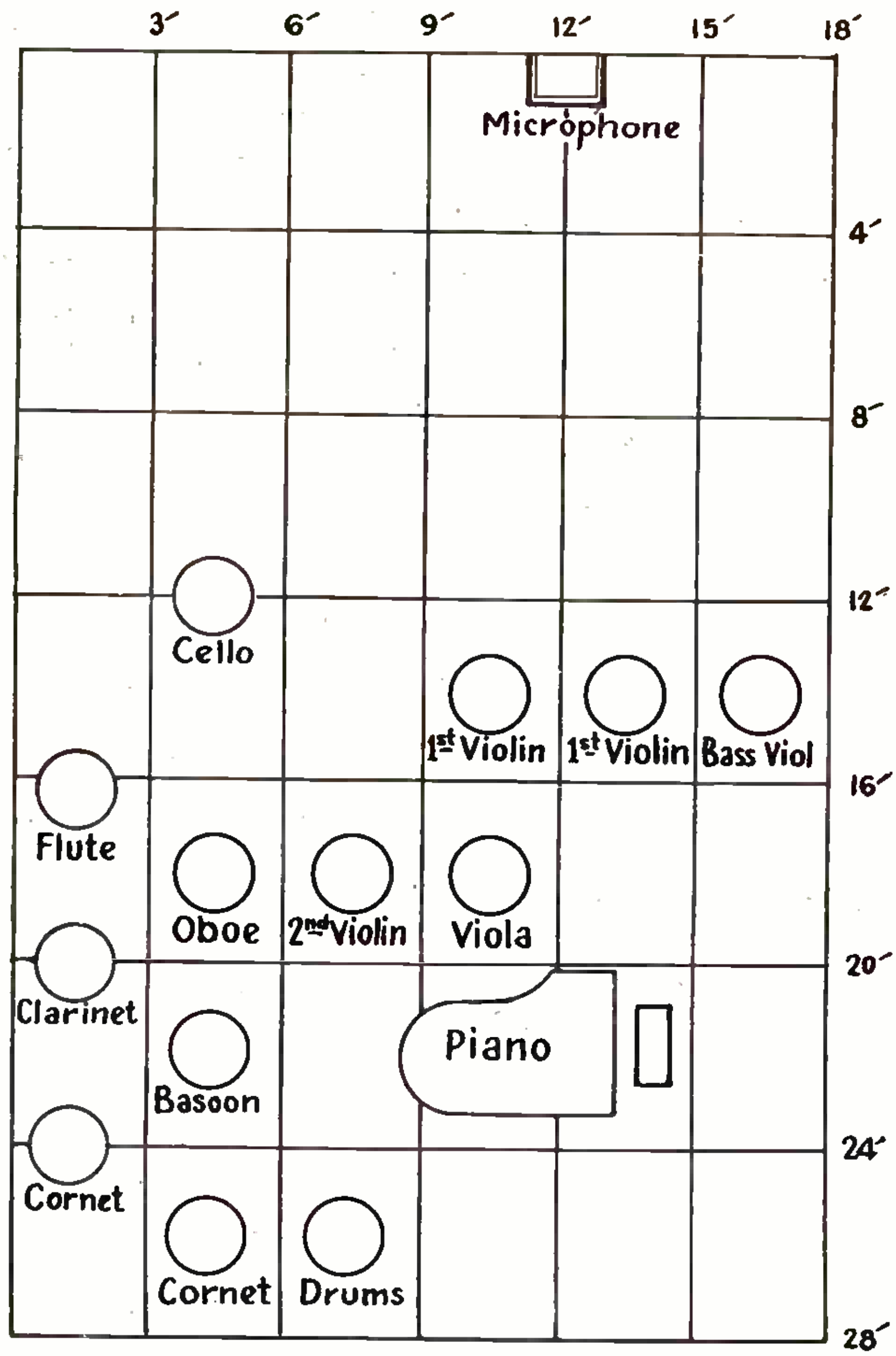
HOW THE ARRANGEMENT OF THE PLAYERS HAS BEEN REDUCED TO A SYSTEM

Just where each soloist or each musician in an ensemble combination should be located in relation to the microphone has been reduced to the formula expressed in this chart, which has been designed for the practical guidance of the studio manager. The exact position of the oboe player in an orchestra, for example, is shown to be 4-D; of the cornet, 6-E. The distance figures show the tendency to move all artists away from the microphone.

strument is more than twice as far from the microphone as another.

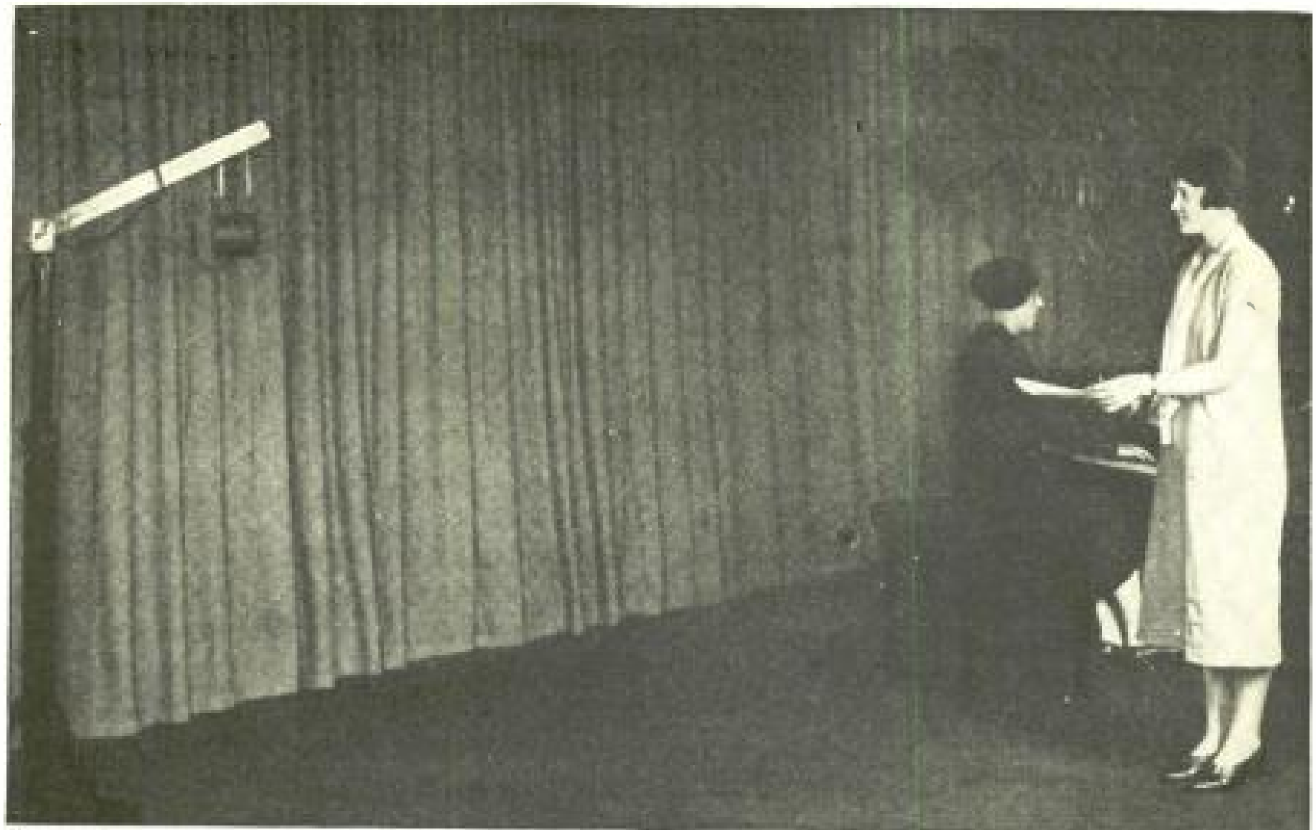
In the charts shown on page 527 and below on this page, made by Mr. Popcke, the one used two years ago to indicate the proper positions of the orchestra instruments shows all the instruments huddled together in a third of the studio nearest the microphone, while the chart that shows present positions shows the instruments grouped in the half of the studio farthest from the microphone.

The floor at the KDKA studio from which most of the musical programs are broadcast is divided into imaginary squares three feet wide and four feet deep, this being the usual amount of space required for each musician. The squares are indicated by letters placed during certain programs on two opposite walls and numbers placed on the other two walls of the studio. The instru-



THE MODERN SYSTEM OF GROUPING THE MUSICIANS

Note that the microphone is at one end of the studio and the orchestra is scattered about the far end. This arrangement is now possible because of the improvements made in the transmitting circuit, which permits the sound to be greatly amplified without loss of quality.



From a photograph made for POPULAR RADIO

THE DISTANCE FROM THE MICROPHONE DETERMINES THE QUALITY OF TRANSMISSION OF SINGING

The position of the singer before the microphone varies with the power and quality of the voice; a soprano with a strong voice may stand ten or twelve feet away, and the piano may be as much farther away as necessary to attain a proper balance.

ments are moved from one square to another between programs, and sometimes between selections of the same program, to see just which locations are giving the best tone effects.

In one of the Westinghouse Saturday night band programs (which are relayed in London by the station's international short wave relay system), it was found that on the first selection the tuba was too loud for the rest of the instruments. The tuba was about seventeen feet from the microphone, while the instruments nearest the microphone, the first clarinets, oboe and bassoon, were fifteen or sixteen feet distant. In playing later selections the tuba was moved back to the twenty-four foot position, and as it still was somewhat too loud for proper blending of the band instruments, the bell of the instrument finally was turned away from the microphone before the desired results were obtained.

During this program, the cornets and baritone were in the square twenty-four feet from the microphone, while the second clarinets, flute, drums and horns were situated between the nearest instruments and the brasses in the rear. The drums were placed well up towards the front row, because much of the band music is rhythmic and requires that the sounds of the drums be prominent to give it proper effect. This in general is the arrangement used in the KDKA studios.

When orchestra music is broadcast, the violins and cellos are placed nearest the microphone, with the oboe, clarinets, flute and the bass next, and the cornets and drums in the rear.

The arrangement is varied, however, as some selections will require that the cornets or drums be as close to the microphone as are the string instruments. When a string or wood wind instrument has a solo part, the player moves to a point between the microphone and the front row of players, when possible to do so without causing too much confusion in the studio. The brass instruments with their greater penetration are usually heard well in solo parts when they remain in place. Sometimes, however, the brass instruments must be moved closer to the microphone, as when "The Lost Chord" is played as a cornet solo. In this selection, there is a full harmony swelling to a climax at the end which sometimes buries the cornet part unless the cornetist takes advantage of position and moves between band and microphone. "The Rosary" is another selection of the same kind. In a selection like Schubert's "Serenade," however, the accompaniment is less prominent and no change in the cornet soloist's position is necessary.

The distance a singer should stand from the microphone depends upon the strength and pitch of the voice. In general a bass or baritone should stand nearer the microphone than other singers, as the lower vibrations of the bass voice do not make the same impressions on the microphone as are made by the higher vibrations of the other types of voices. The contralto voice may usually be placed farther from the microphone than the bass, the tenor next and the soprano farthest away. Actual strength of voice must also be considered.

Not all sopranos, however, should stand exactly the same distance from the microphone, nor at the same position in relation to the piano. In general, the piano for solo work should be placed fifteen to twenty feet, with the piano opened. For vocal solos the orchestra, when orchestra accompaniment is used, is placed at its usual position, with the singer ten to fifteen feet, depending on the type and strength of voice. When piano accompaniment is used, the piano is usually placed at a distance of fifteen feet.

Mr. Popcke has worked out a guide for the studio directors to use in placing soloists and ensemble combinations during the broadcasting. This guide shows the floor plan of the studio, and also a chart that gives the exact distance of the various positions, 4-B, 6-C, and so on, from the microphone. Tables that give the approximate location for the various type of voices and instruments, both in solo work and orchestra or band selections, are included.

Kadel & Herbert

A SET THAT OPERATES ON 110 VOLTS AC

A five-tube set that uses no batteries is the accomplishment of Rutledge Mayo of New York, in this receiver equipped with McCullough AC vacuum tubes. A small step-down transformer supplies current to the heaters which replace the ordinary filaments, while a two-tube rectifier supplies the plate voltage.

From a photograph made for POPULAR RADIO

A STRAIGHTLINE-FREQUENCY AUDIO AMPLIFIER

The resistance-coupled amplifier (such as pictured above in a laboratory set-up) should amplify all frequencies alike without choice—if it is properly designed. This type of amplifier is one of the popular types now in use by fans and experimenters for obtaining musical quality.

"Truthful Reproduction"

How to Get It from Your Set

Practical pointers for radio fans who want to know what causes the faults in radio reception and how to get rid of them

By PAUL GODLEY

THE equipment in all of the major broadcasting stations of the country and in most of the minor stations, has been designed and installed by large manufacturing organizations who have a considerable staff of carefully selected engineers. These men are constantly busy in an effort to improve the quality of transmission. In the case of the major stations—those stations about which we read the most and to which we listen the most—new developments are being continually put to work, with the result that a tremendous improvement in quality, shading and expression has been brought about in a comparatively short period of time. As compared to the state of affairs a year ago, practice in these stations is rapidly approaching perfection.

It must be apparent to anyone that to make this improvement at the broadcasting station fully effective it is also necessary to insure that the detecting, amplifying and reproducing equipment of the receiving set, in the home, is capable of delivering sounds which have not been slighted, distorted or which have lost their original studio values.

It is a regrettable fact that practically none of the equipment offered to the American public during the season of 1924-5 fulfills these requirements. As a matter of fact, of the one hundred and thirty or more nationally known manufacturers of radio receiving equipment over one hundred may be tabulated as offering equipment wherein the amplifying units at least were patterned after designs developed during the World War period for the reception of radio dot and dash signals. On this account at least, it is unfortunate that the method of reproducing radio-telegraphic and radio-telephonic signals is so nearly identical.

The marvel of taking vocal and musical sounds right out of the air has, of course, been the big thing in the minds of the public—has been the thing which has created tremendous markets for radio equipment. These markets in turn have tempted the manufacturer to put off just a little while longer the refinements with which his receiving equipment must eventually be supplied. To become permanent, radio must become *truly* musical.

In reviewing the development of the last four years the most surprising thing encountered is that up until the past summer only four or five manufacturers seem to have grasped the importance of this fact.

In order that the high-class modulation of the present day may be reproduced at the receiving end with complete success the receiving equipment must properly perform three functions:

(1) *Detection;* wherein the radio "carrier wave" is rectified so as to leave in the "out-put" circuit of the detector pulsating currents capable of transformation into sound.

(2) *Amplification;* wherein the sound currents are enlarged to the point where sufficient power is available for the operation of a loudspeaker.

(3) *Reproduction;* wherein the electrical energy in the form of sound currents is transformed in the speaker into mechanical energy thus producing sound waves in the air.

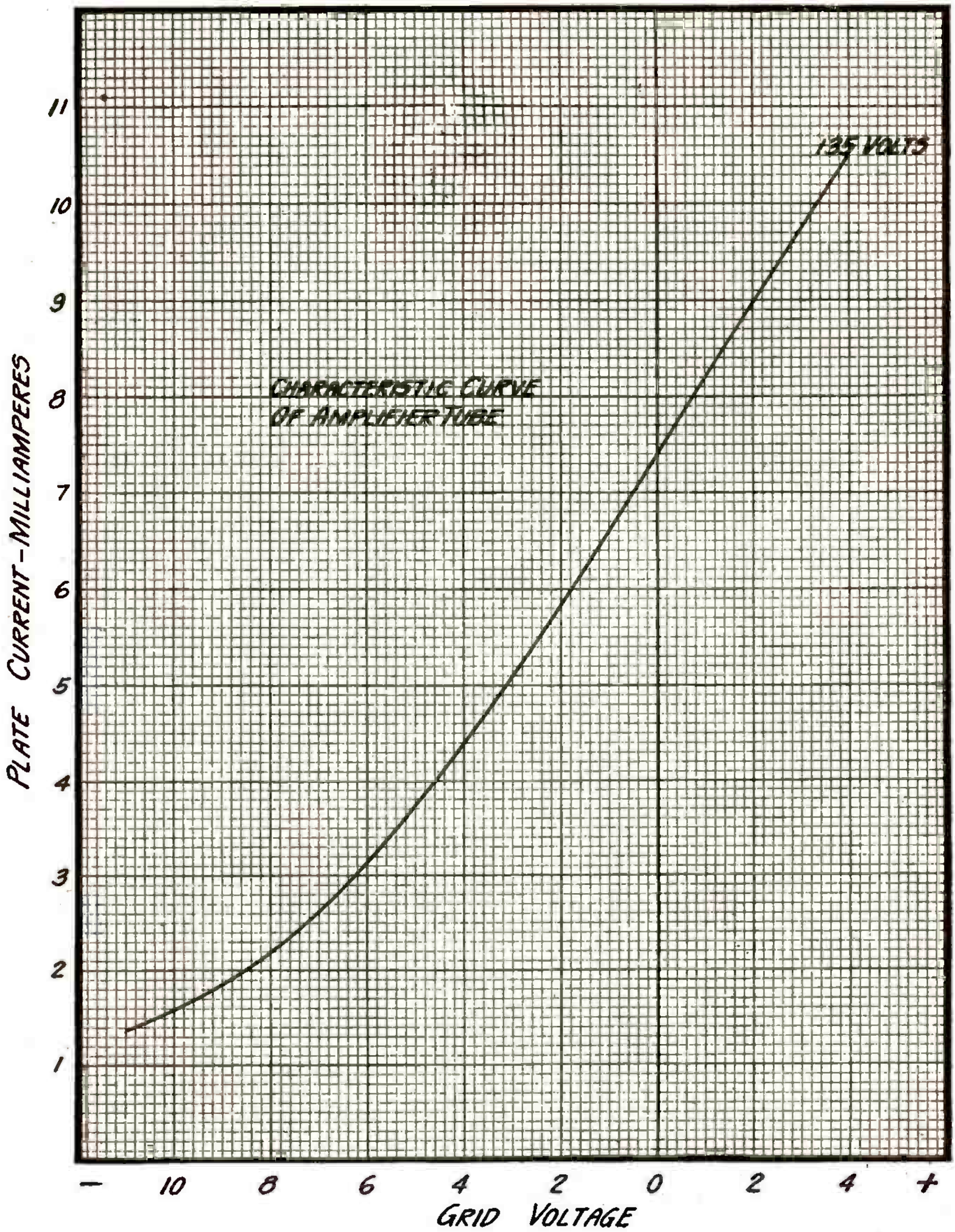
The requirements of detection are not difficult to supply. Perhaps the most common cause of fault in the detector circuit is that of a noisy grid-leak.

The grid-leak is used by manufacturers universally. It consists of a very small unit of high resistance—two to five million ohms. Generally, it is constructed by coating a tiny piece of hot-pressed card with a delicate layer of carbon or graphite in liquid form. The delicacy of the device is such that, too often, changes in temperature and humidity subject it to abuse. Eventually the carbon film upon the card is partially ruptured, whereupon the resistance of the unit is continually changing. The result is a continual change of current flow in the input circuit of the detector and certain scratching or hissing sounds not unlike the scratch of a phonograph needle. The ready cure is the substitution of another grid-leak which may or may not continue to function indefinitely.

The proper cure for trouble of this character is the use of a grid-leak that is now coming into the market, and which has a very finely drawn filament of carbon and which should remain constant once and for all.

In regenerative receivers detector action is frequently distorted by the operation of the receiver circuits too near to the unstable condition. Proper adjustment is, of course, possible, but an unsatisfactory adjustment is so easily secured by the novice that receivers wherein a control over the regeneration is provided have come into disfavor.

Various types of receivers utilizing what may be called "controlled" regeneration together with amplification of the signal prior to detection have replaced the



THE STATIC CHARACTERISTICS OF AN AMPLIFIER TUBE

This chart shows the change in plate current, in a vacuum tube when used as an amplifier, corresponding to varying grid voltages, for a given plate voltage of 135 volts. Amplifier tubes work best along the straight portion of the curve, but the free grid potential must be kept slightly negative so that the incoming impulses will not swing too far in a positive direction and cause overloading and distortion.

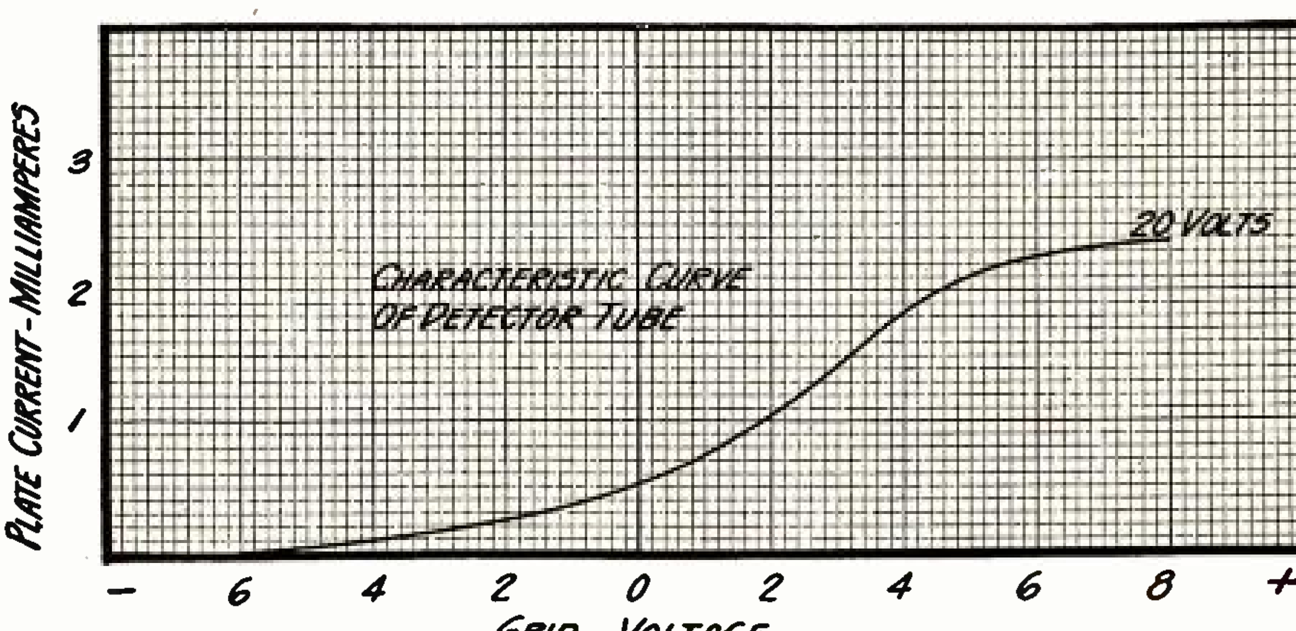
regenerative receiver. If the automatic control of regeneration has been carefully worked out, distortion due to regenerative action prior to and during detection is usually negligible. However, another difficulty which mainly concerns the reception of good music from nearby stations creeps in, i.e: the overloading of the detector with its consequent distortion.

A moment's study of the characteristic curve of a three-element vacuum tube detector will serve to illuminate this point.

The wide variation in voltages which may be supplied to the grid of a detector tube by the radio amplifier tubes runs operation over into the flat portions of the curve. A uniform variation of plate current for variation of grid voltage cannot take place under these circumstances, and a muddled flatness of all tones results. Here, some sort of control over signal volume prior to amplification and detection is the obvious requirement. In antenna types of receivers a variable coupling transformer inserted between the antenna and radio amplifier tubes serves the purpose. In loop type receivers, the position of the loop may be varied to determine the required amount of energy pick-up. Lacking either of these arrangements, the only recourse is to utilize a very small antenna for local reception in order that the detector tube may not be overloaded.

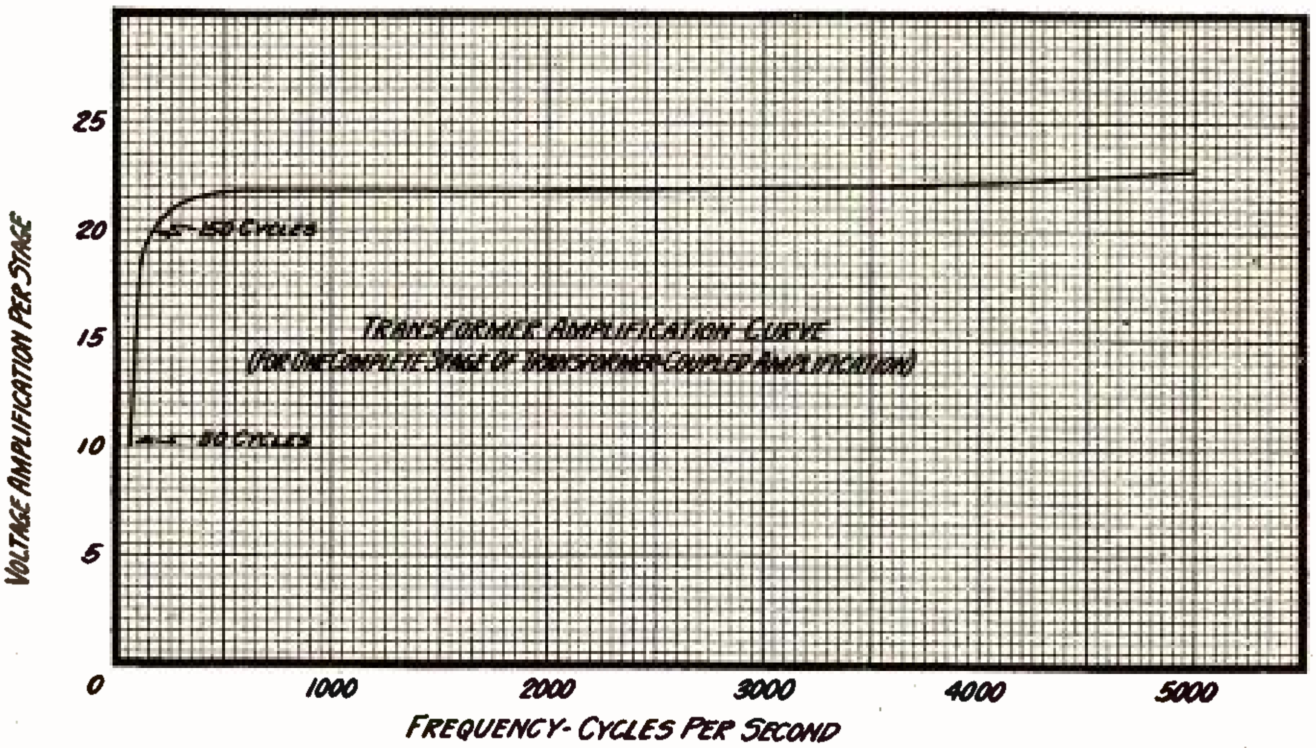
That portion of a radio receiver known as the audio amplifier is made up of (1) the amplifier tubes and (2) the intertube voltage-step-up transformers together with appropriate circuits.

In present practice the amplifier tubes differ in no essential particular from the detector tubes. The tubes now supplied perform one function as well as the other in properly arranged circuits. If the tube is that type that has the thoriated filament, it is subject to a failing which has at once puzzled and annoyed thousands of radio fans. These tubes usually have a filament of tungsten which has been impregnated with thorium. Thorium is a metal which gives up its electrons freely. When the filaments are burned at too great brilliancy, or when the plate battery voltages are carried too high, the supply of electrons inherent to the thorium is rapidly ex-



THE STATIC CURVE FOR A DETECTOR TUBE

This chart gives the change in plate current for variations in grid voltage of a detector tube, when used with 20 volts of plate battery. The detector operates efficiently when the lower bend of the curve is utilized for rectification because the positive voltages produce larger changes in current than the negative swing. In fact, this is the method used for obtaining rectification.



THE CURVE FOR VOLTAGE AMPLIFICATION AT VARIOUS FREQUENCIES

This chart shows the steep cut-off in amplification at low frequencies. Notice that the curve is practically a straight line from 500 cycles to 5,000 cycles per second, but at 150 cycles the amplification has decreased by roughly 10 percent. At 50 cycles the amplification has decreased to less than 50 percent of the amplification at 1,000 cycles. This means that tones below 150 cycles are not amplified to the same strength as those of 500 cycles or more. In this way, the low tones are missed in the music that is produced. The curve shown is for a transformer that is slightly below the average of those produced today. A few transformers now on the market have a much better low-frequency curve than that shown here.

hausted and the tube becomes a "dud."

It is the rule to find one or more "duds" in a receiving set which has been in operation a few weeks. A lowering of the emission of the filament results in tone souring.

Radio receivers wherein grid biasing batteries (known as C batteries) are connected are found to give the least trouble on this account. The loss of emission on the part of the tube is more often than not caused by the burning of the tube filament at too great brilliancy. If no filament voltage meter is built into the set it is best to operate the tubes somewhat below that point where maximum response is had than on or above that point.

"Dud" tubes may be reactified by the proper treatment. However, so many novices have destroyed tubes in an attempt at reactivation that no account of the method will be given. Nearly every dealer in radio supplies has, or should have, equipment designed especially for this work, and is generally glad to perform the service at a trifling cost.

By far the greatest shortcoming of the radio receiver with respect to true tone reproduction is apt to lie in its lack of inter-tube transformers having what is known as straight-line frequency characteristics—a transformer which is capable of handling in exactly the same manner tone currents of every frequency within the musical scale. If quality of tone is desired particular attention should be given to this point, either in the selection of the complete receiver or in the selection of the audio transformers for a receiver under construction.

Nearly all the transformers offered up until the past summer have been so designed as to seriously slight tones that begin at an octave below middle C on the musical scale, while in many cases no sign of operation on tones two octaves below middle C is apparent. This re-

A TRANSFORMER THAT AMPLIFIES LOW TONES AS WELL AS HIGH TONES

A receiver should incorporate in it one of the more modern makes of transformers, of rather large size, so that more amplification will be obtained at the lower frequencies. This will result in more "life-like" reproduction.

sults in the tin-pan music so closely identified with radio in the minds of many people. A musical rendition is seldom properly rounded out when it is lacking in the base tones, and certain it is that lacking them, the reproduction of America's most famous organ sounds for all the world like an accordion.

It is the habit of manufacturers of amplifier transformers to publish curves showing the amplification characteristics of their transformers. With perhaps one exception these determinations have not given any information with respect to tones more than ten full notes below middle C. The assumption is that suitable equipment for measurements at the lower frequencies has not been available to them. In any case, reliable information has heretofore been lacking, and unscrupulous manufacturers have been known to "fake" transformer curves for the lower tones. Transformer designs to accommodate the low tones as readily as the higher ones call for large values of inductance in the primary windings—thirty-five henrys and upwards. The average of the past is less than one third this figure. Large primary inductance values mean a larger number of primary turns, or a larger amount of the proper grade of core iron, or both. This may mean a larger transformer throughout, the developments of some of the larger electrical companies in the way of special steels show promise of securing transformers with the required characteristics of a size even smaller than those used at present. The practice of "doctoring" an audio amplifier circuit with condensers and resistances across primary and secondary of the transformers in order to secure a sweetening of the tone is a poor subterfuge to be guarded against in selecting or constructing the receiver.

Set builders in the past have been much puzzled concerning the proper ratio of primary turns to secondary turns in the transformer. Carefully designed transformers seem to indicate that a ratio of 3.5 to 1 insures the most satisfactory all-around results, and manufacturers have come to accept this as standard. This does not mean that all transformers having this ratio possess good characteristics. The safe procedure lies in the careful scrutiny of transformer specifications. If they are in the least hazy concerning tones below one hundred cycles, look elsewhere.

Because of a rapidly growing demand for full-toned reproduction, what is commonly known as the resistance-coupled amplifier circuit has become very popular with set builders during the past season. Regardless of tone frequency the resistance-coupled amplifier shows uniform action. It possesses true straight-line frequency characteristics. It has not been adopted by set manufacturers because of certain inherent disadvantages. The amplification per tube is not as great, as it is usually necessary to use three tubes to secure the same tone volume as may be secured with two where transformer-coupled circuits are used. Also, higher values of plate voltage are required. On the other hand the quality of tone which it provides leaves little to be desired and on this account it can be highly recommended.

With radio listeners it is the all too common practice to try for the greatest possible volume of tone from the radio set, and receivers as manufactured show a marked decrease in the quality of tone when put through such exercises. Perhaps this is due mainly to the unsatisfactory characteristics of the average inter-tube transformer, but it has been observed that in a great number of cases the difficulty arises through another cause. Reference to the characteristic curve of a tube such as used in the amplifiers at the transmitter will show that changes in the current of the plate circuit are approximately directly proportional to the changes in grid voltage. On the other hand, the curve of the detector tube shows that variation in plate current is approximately as the square of grid voltage variation.

Thus, when the volume of tone is double in the transmitter studio the modulation of the transmitter and the voltages at the receiver are doubled. With a doubling of the voltages on the grid of the detector tube there comes, however, a quadrupling of current change in the plate circuit of the detector. This brings about a great increase in the loads thrown upon the amplifier circuits.

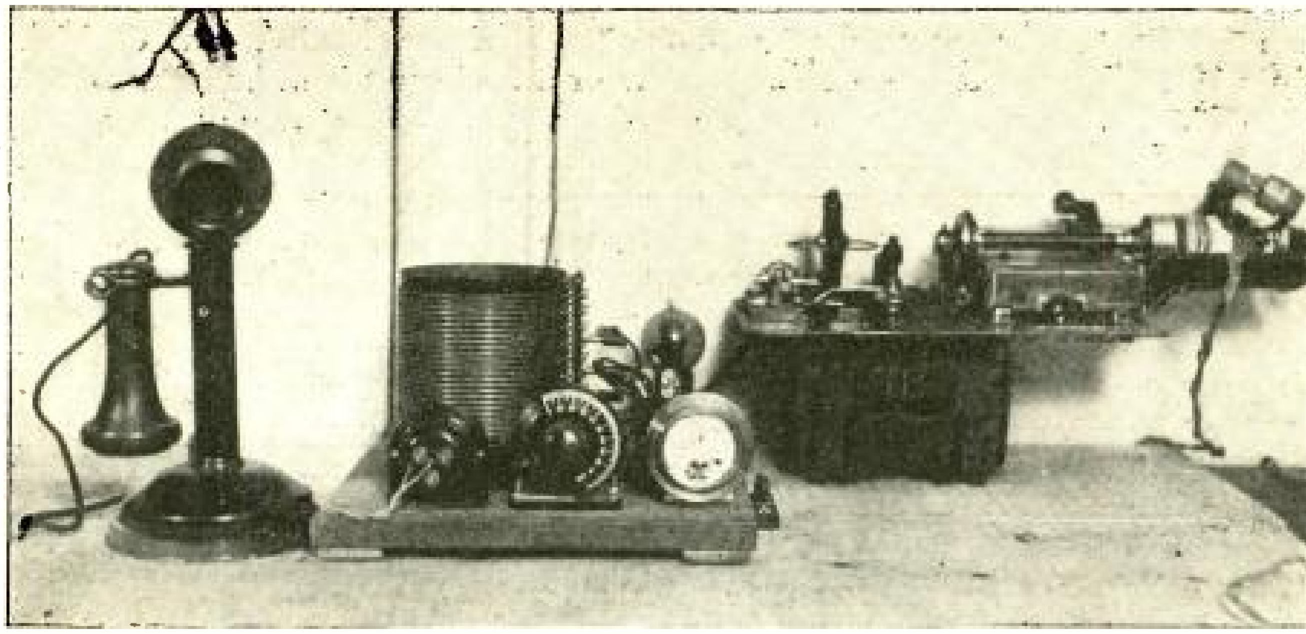
Upon attempting to produce great volume with the ordinary receiver considerable overloading with its consequent flattening of tone results. This is an experience which owners of dry-cell tube sets may expect to encounter frequently. With such sets tubes of larger capacity are required in the second stage of the amplifier. Regardless of the type of set or tube, where greater than moderate volume of tone is required tubes of larger capacity will have to be used if tonal quality is to be preserved. Accommodation for such may either be built into the set, or a special amplifier may be annexed to the receiver.

(To insure that one's receiver is capable of producing real music requires precaution. Thought given to the matter cannot but prove of lasting satisfaction. Of course, having seen to the capabilities of the receiver, one could scarce afford to make an unsatisfactory choice of the loudspeaker. It may be selected by actual comparison when connected to the favorite receiver, but even in this way many have been led astray. For these reasons a discussion of the characteristics of various types of reproducers by Mr. Godley will appear in a forthcoming issue.)

—EDITOR

Pacific & Atlantic

Bartholomew Molinairi of San Francisco (6AWT), is the first radio amateur in this country to communicate with French Indo-China. His signals have been heard in nearly every quarter of the globe.



This method sends photographs over an ordinary, commercial telephone line, without physical attachments to the instrument. The complete receiver is shown above; the cylinder with the received photograph is visible at the right.

A NEW METHOD OF TRANSMITTING

Pictures by Telephone—or Radio

One of the most important uses of the new instrument, the photo-electric cell—described in POPULAR RADIO last month—is in the transmission of photographs or other pictures by radio or by land wire. The new Phono-Photo method for accomplishing this involves several new principles. It is described in this article.

BY EDMUND H. HANSEN

DURING the past two or three years the newspapers as well as the magazines have called attention to the different methods of photo transmission and the great strides that have been made in the development of "pictures by radio." While to a large extent the developments of even such early experimenters as Korn and Belin are antedated by others, the fact remains that, like Marconi, the commercial application has followed their efforts. Until such a time as development warrants common usage, the transmission of both photographs and television will be of but momentary concern to the general public.

To be commercially practical the transmitting and receiving apparatus requires a ruggedness in construction and a simplicity in operation. This is best exemplified by the telephone, which is a machine capable of handling the most minute electrical currents and constructed to stand the rough handling and abuse of everyone. It was with these virtues in view that the phono-photo method of transmitting pictures was developed over two years ago. The fact that one of the best known methods has adapted certain of its features for its own is the biggest recommendation of its merit.

In all the methods that are being applied commercially today there are three major operations performed.

First, the conversion of the light values of the photograph into electricity; second, the transmission of these impulses, and third, the conversion of the electrical impulses back into light so that a record may be properly made.

The first and second operations are practically distortionless in all methods, and it is mainly in the third that sufficient distortion occurs to prevent accurate reproduction.

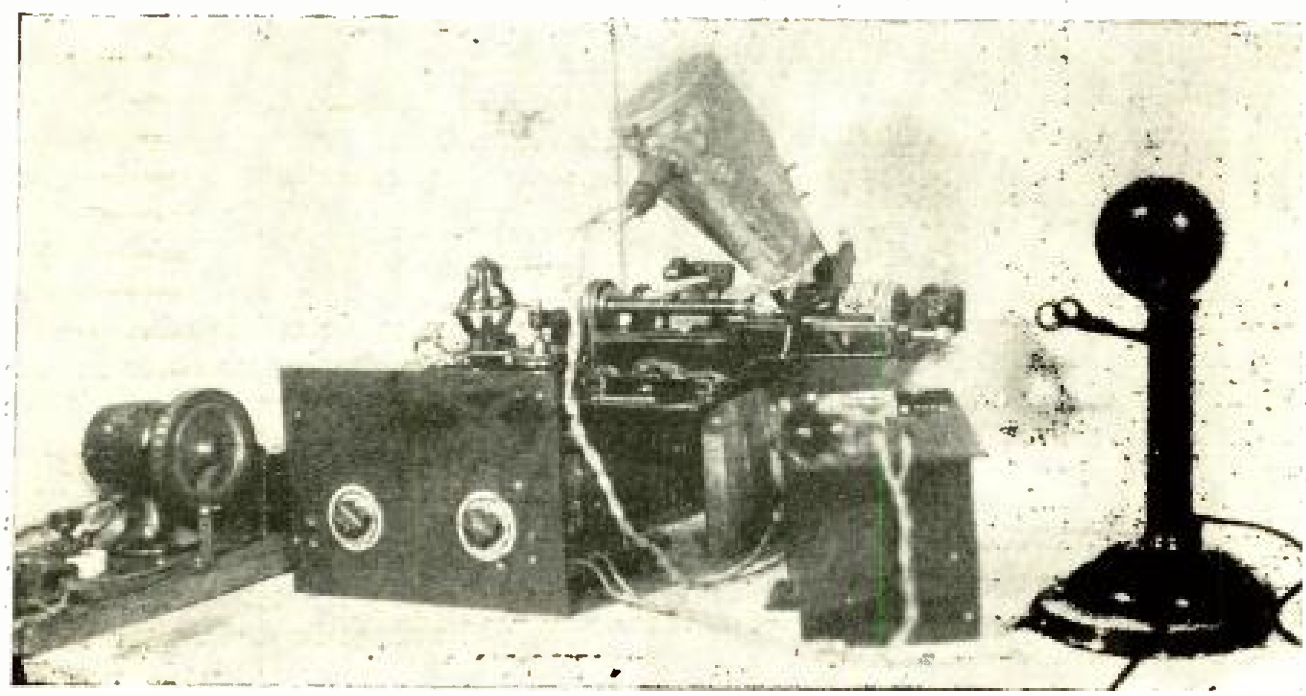
Unlike audible reproduction the eye demands one hundred percent efficiency and is not satisfied with less. In radio broadcasting slight static and extraneous noises are passed unnoticed, but in the transmission of photographs all flaws and blemishes form a permanent record. In converting electricity back into light either electro-mechanical or electro-chemical means are employed.

In the electro-mechanical methods, the Blondell oscillograph of the Belin method, the light valve of the American Telephone and Telegraph Company and the pneumatic oscillograph of C. Francis Jenkins are the better known. The Telepix method is the only one that uses electro-chemical means of conversion in commercial use today. It is a well known law of physics that in the operation of conversion certain losses take place, and the simplifying of any function by eliminating these losses will tend to a more perfect machine.

In the phono-photo method of telophotography there are only two operations; the conversion of light into electricity, and the transmission thereof.

For recording, special, gas-filled tubes are utilized. The received current flows in these tubes, which give varying actinic values for reproduction. Two types are used; in one there is an actual change in the quantity of the light, and in the second a light of varying spectrum value is obtained. In short, the wavelength of the light varies as the frequency of the incoming picture signal. As recording film is made for its greatest sensitivity at the white a change from white to red would be the same as varying a quantity of white light.

In the circuit used for wire work it will be seen that a constant frequency is ordinarily employed, although both varying and constant-frequency methods can be used for radio and wire trans-



THE COMPLETE TRANSMITTING APPARATUS

A moving light-pencil passes over the picture to be transmitted and is reflected into a photo-electric cell. The current from this varies with the intensity of the light reflected, thus corresponding to the lights and shades of the picture.

TRANSMITTED BY THE PHONO-PHOTO METHOD

The intensity of the light-ray emitted by the receiver is varied by the electric signals sent over the wire, thus producing varied light and shade on the sensitive photographic film. A photograph of this size can be sent and received in less than two minutes, less than the time of a long-distance call.

mission. This constant frequency is modulated in accordance with the varying density of the film by means of a photoelectric cell. There are two different methods of exploring; both film and flat plates may be analyzed. The flexible film is wrapped around a glass cylinder which is rotated and a spiral forward movement results. In working from a flat surface a special mirror mounting is used for the lateral movement and the plate is moved up or down at a synchronous interval a small fraction of an inch.

The photoelectric cell is of a special type and is capable of a frequency change of ten thousand per second. This permits transmission of a 5 by 7 inch photograph in two minutes or less. This is approximately four times as fast as any other known method. Working directly from the negative is of great advantage in newspaper work. In two of the other methods now in use, from two to four hours are required for the preparation of special transmitting cylinders.

In transmitting the picture, consideration is given to the type of communication available. In the case of radio, the varying frequency has been found most desirable as this permits the same efficiency of the transmitter as when emitting straight C. W. telegraphic signals. In this case a special transformer circuit varies the frequency of a master oscillator which in turn controls and varies in a similar manner the output of the power amplifier tubes. The transmitter is therefore varying its frequency in accordance with the different light values of the negative. As the mode of transmission is merely one dependent upon frequency alone the usual fading or swinging of signal strength does not mar the picture received.

As already stated, the usual wire method employs a single frequency which is modulated by the photo-electric cell. It has been found desirable to utilize standard telephone circuits without a physical attachment to either instruments or lines and placing upon

AN ORDINARY TELEPHONE LINE MAY BE USED

A special diaphragm conveys the picture-message to the telephone instrument. The message is transmitted just as a sound would be.

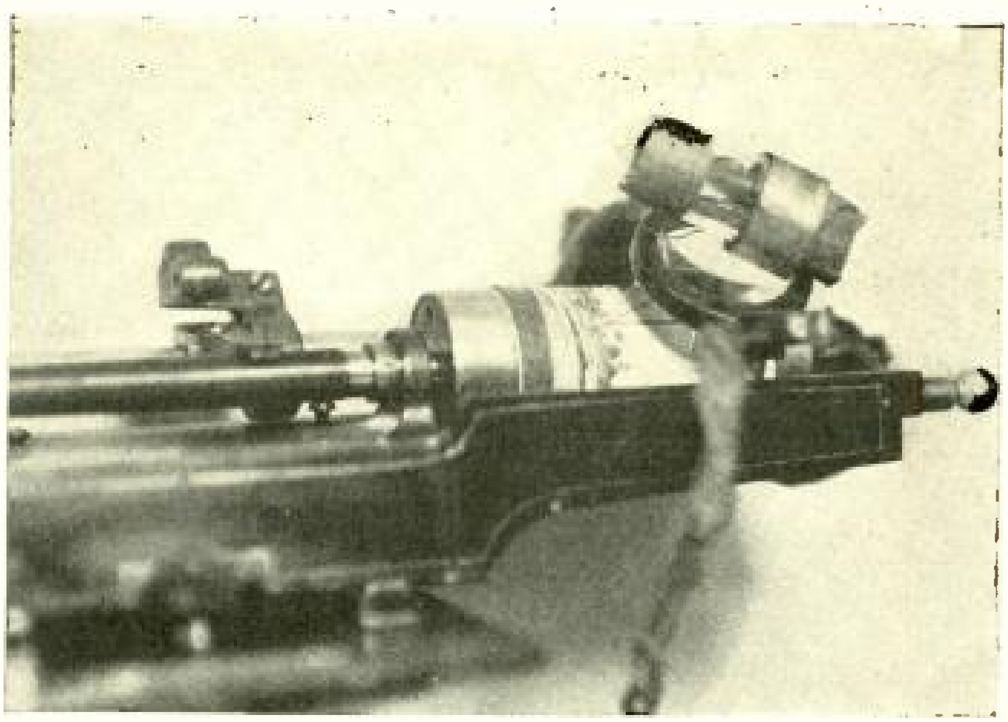
those lines merely sounds of usual intensity and pitch as of that of the human voice. This is accomplished by means of a special loudspeaker which talks a picture talk instead of the usual audible languages into the telephone microphone. This passes over the lines in a regular manner and as in radio the results being dependent upon frequency alone, the varying signal strength of the line does not change the reproduction of the picture.

In receiving, a special microphone is actuated by the air waves from the telephone receiver, and this is passed on to the glow tube circuit which performs two functions; that of modulation and that of amplification.

The amplification is accomplished without cascade tubes. In the use of varying frequency a glow tube is used that changes the frequency of the light with the impressed electrical frequency. As there are no moving mechanical parts or chemical reaction, this method is without distortion and is capable of unlimited speed in producing light changes. The constant frequency method merely varies the quantity of light emitted by the glow tube. This takes place over one of two buttons placed inside the tube. In both cases the light is condensed by lenses to a pin point and is photographed upon flat plates or film negatives.

The synchronizing or timing of the transmitter and receiver is accomplished by independent "time beaters" at each station which control, through a local circuit, their respective machines by means of magnetic clutches. This insures much smoother operation than that accomplished by the usual slip clutch, and gives a steady motion. This independent method is equally applicable to radio and wire and requires no special channel or impulse for correction purpose.

The necessity for simplicity and ruggedness is apparent from inventions in every day use, and the accomplishment of this in this method will undoubtedly



THE GLOW LAMP AT THE RECEIVING END

The frequency of the light emitted by this lamp varies in accordance with the electric signal being received. The light-spot from the lamp is focussed on the sensitive photographic film by a lens. The film-covered cylinder rotates in exact time with the cylinder at the sending station, thus reproducing the picture.

go a long way to popularize the transmission of visual messages. Heretofore, great difficulty has been met in obtaining transmission service. With this system your desk telephone in New York, when connected to one in San Francisco, will transmit a five by seven photograph within the minimum toll-time limit of three minutes. This use of the telephone wires does not violate the contract clause against attaching additional instruments to your telephone. The sound waves of this system are the same as the human voice except for the language. This is further proven by the fact that similar to our conversation which remains intelligible even though the strength varies a picture will be received even though similarily interfered with. Both are based upon frequency combinations rather than change in amplitude of vibration.

With the increased efficiency of short waves and the fact that this method employs a standard type of telegraphic transmitter, business and private interests can control their own communication medium. Machines for this system can be made for $500, and quantity production should lower this price still further. This would permit all business firms to own and operate their own machines.

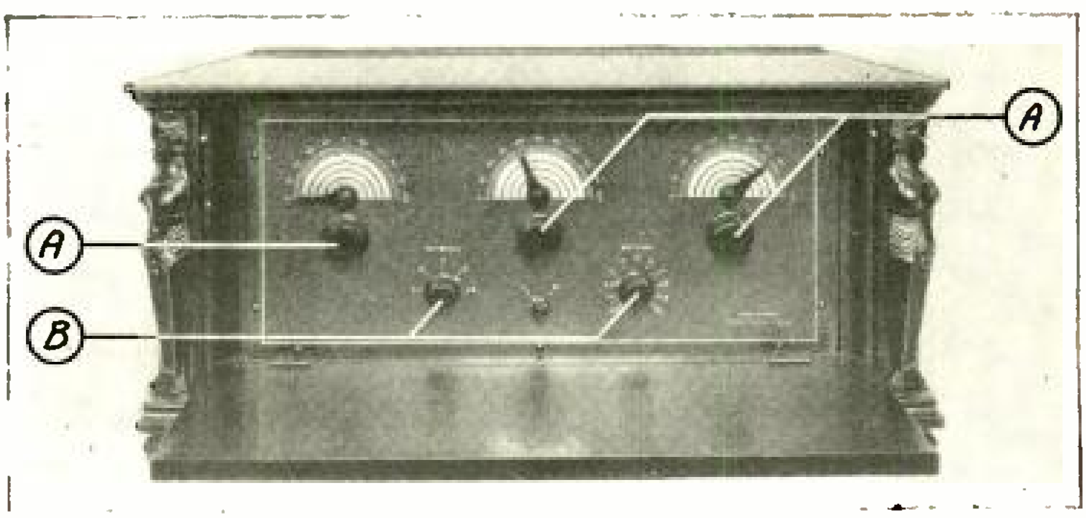
When using standard plates and film for transmission and reception no special preparations are necessary before transmitting. In fact, the corner drug store can do the photographic work for you while the local radio store would be sufficient to maintain the electrical equipment in good order. This will remove the transmission of pictures from the hands of research engineers and place it in the keeping of those to whom all inventions belong—everybody.

When Your Set Won't Work

WHERE *to start looking for the trouble; how to check up on the connections; how to locate and determine the nature of the disturbance—will be told. for the particular benefit of non-technical broadcast listeners. in* POPULAR RADIO *for January.*

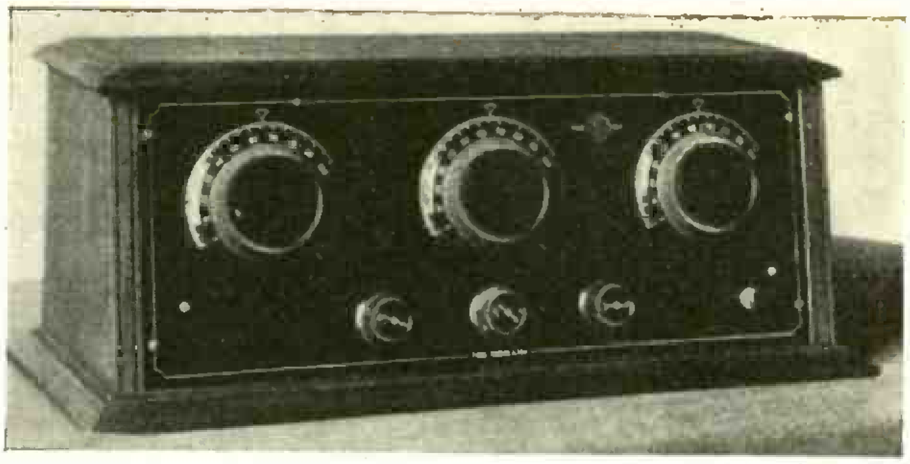
“What Set Shall I Buy?”

LESS then a year ago there were only a very few ready-made sets on the market; today there are about 140, ranging from small and inexpensive crystal receivers, which sell for as low as four or five dollars, to elaborate superheterodynes that run into the hundreds. Those that have been approved by the POPULAR RADIO LABORATORY will be pictured each month until the series is completed. They will be accompanied by brief but specific data concerning them—as a helpful guide to the broadcast listener and to the prospective listener who is thinking of selecting the receiver that will best meet his special needs as well as the limitations imposed by his purse. The data following each of the sets pictured in this series are the manufacturers own specifications and claims; they were obtained through a form of questionnaire sent to all manufacturers of receiving sets approved by POPULAR RADIO.



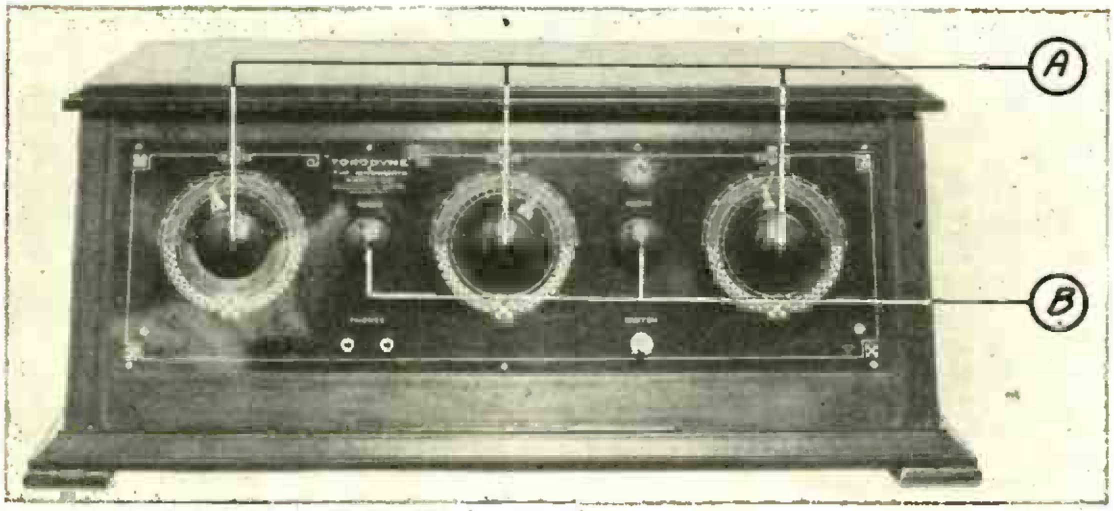
The 4D Inverse Duplex

MANUFACTURER'S NAME; David Grimes, Inc.
MODEL NAME; 4D Inverse Duplex
NUMBER OF TUBES; four
TYPE OF TUNING; tuned-radio-frequency
TYPE OF DETECTOR; vacuum tube
RANGE ON PHONES; limit of atmospheric disturbance
RANGE ON LOUDSPEAKER; same
COST COMPLETE; $160.00
ANTENNA RECOMMENDED; 80 feet
KIND OF TUBES FOR R. F.; UV-199 or C-299
DETECTOR TUBE: UV-199 or C-299
AUDIO TUBES; UV-199 or C-299
TYPE OF “A” BATTERY; dry cells, 4½ volts
TYPE OF “B” BATTERY; dry cells, 90 volts
DETECTOR “B” VOLTAGE; 22½ volts
WAVELENGTH RANGE; 165 to 600 meters
NUMBER OF TUNING CONTROLS; three
“A” BATTERY CURRENT USED; ¼ ampere
“B” BATTERY CURRENT USED; 5 milliamperes



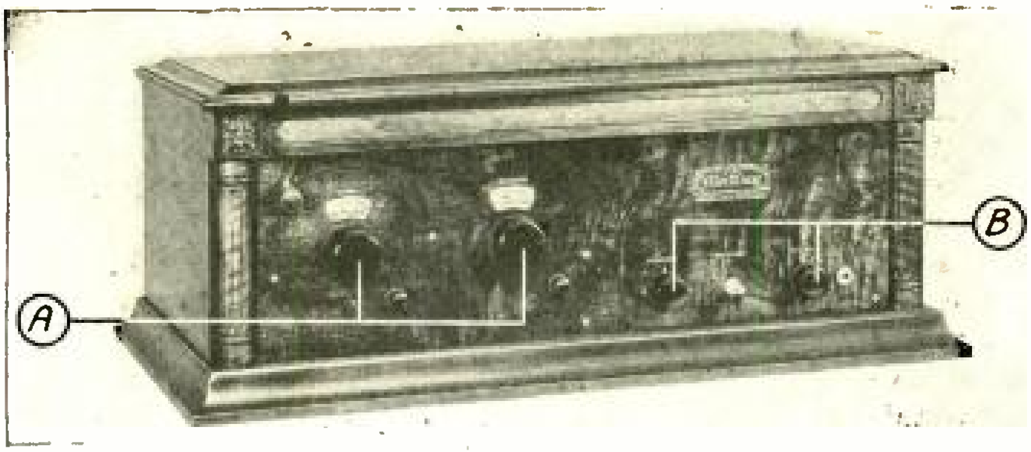
The Simplex SR-8

MANUFACTURER'S NAME; Simplex Radio Co.
MODEL; Type SR-8
NUMBER OF TUBES; five
TYPE OF TUNING; tuned-radio-frequency
TYPE OF DETECTOR; vacuum tube
RANGE ON PHONES; coast to coast
RANGE ON LOUDSPEAKER; coast to coast
COST; $65.00 without accessories
ANTENNA RECOMMENDED; 75 to 125 feet outdoor
KIND OF TUBES FOR R. F.; UV-201-a or similar type
DETECTOR TUBE; UV-201-a or similar type
AUDIO TUBES; UV-201-a or similar type
TYPE OF "A" BATTERY; storage, 6 volts
TYPE OF "B" BATTERY; storage or dry cells, 90 volts
DETECTOR "B" VOLTAGE; 22 to 45 volts
WAVELENGTH RANGE; 225 to 550 meters
NUMBER OF TUNING CONTROLS; three
"A" BATTERY CURRENT USED; 1.25 amperes
"B" BATTERY CURRENT USED; 18 to 20 milliamperes



The Torodyne

MANUFACTURER'S NAME; Ainsworth Radio Co.
MODEL NAME; Torodyne
NUMBER OF TUBES; five
TYPE OF TUNING; tuned-radio-frequency
TYPE OF DETECTOR; vacuum tube
RANGE ON PHONES; (not stated)
RANGE ON LOUDSPEAKER; (not stated)
COST; $100.00 without accessories
ANTENNA RECOMMENDED; outdoor
KIND OF TUBES FOR R. F.; UV-201-a or C-301-a
DETECTOR TUBE; UV-201-a or C-301-a
AUDIO TUBES; UV-201-a or C-301-a
TYPE OF "A" BATTERY; storage, 6 volts
TYPE OF "B" BATTEBY; 90 volts
DETECTOR "B" VOLTAGE; 22½ volts
WAVELENGTH RANGE; 220 to 550 meters
NUMBER OF TUNING CONTROLS; three
"A" BATTERY CURRENT USED; 1¼ amperes
"B" BATTERY CURRENT USED; 15 to 30 milliamperes

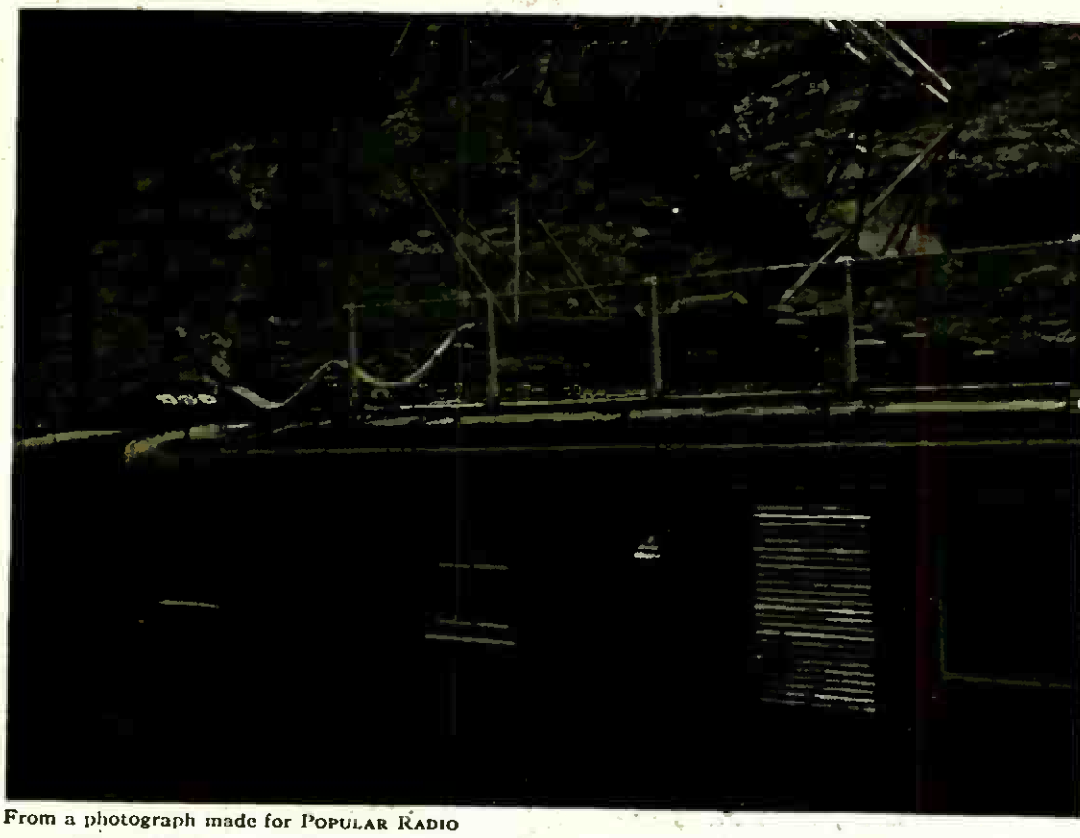


The Airway No. 61

MANUFACTURER'S NAME; Air Way Electrical Appliance Corp.
MODEL NUMBER; No. 61
NUMBER OF TUBES; six
TYPE OF TUNING; inductance
TYPE OF DETECTOR; vacuum tube
RANGE ON LOUDSPEAKER; 3,000 miles
COST COMPLETE; $98.50
ANTENNA RECOMMENDED; single wire, 75 to 100 feet
KIND OF TUBES FOR R. F.; UV-201-a, C-301-a
DETECTOR TUBE; UV-201-a, C-301-a or soft detector
AUDIO TUBES; ¼ ampere
TYPE OF "A" BATTERY; storage cell
TYPE OF "B" BATTERY; any type
DETECTOR "B" VOLTAGE; 45 volts for 201-a tubes
WAVELENGTH RANGE; 185 to 550 meters
NUMBER OF TUNING CONTROLS; two
"A" BATTERY CURRENT USED; 1½ amperes
"B" BATTERY CURRENT USED; 17 milliamperes

The Paragon

MANUFACTURER'S NAME; Adams-Morgan Co., Inc.
MODEL; Type three
NUMBER OF TUBES; three
TYPE OF TUNING; capacity
TYPE OF DETECTOR; vacuum tube
RANGE ON PHONES; (not stated)
RANGE ON LOUDSPEAKER; (not stated)
COST; $48.50 (without accessories)
ANTENNA RECOMMENDED; 100 feet, single wire
KIND OF TUBES FOR R. F.; standard makes
DETECTOR TUBE; standard makes
AUDIO TUBES; standard makes
TYPE OF "A" BATTERY; standard makes
TYPE OF "B" BATTERY; standard makes
DETECTOR "B" VOLTAGE; 20 to 45 volts
WAVELENGTH RANGE; 200 to 580 meters
NUMBER OF TUNING CONTROLS; one
"A" BATTERY CURRENT USED; ¾ ampere
"B" BATTERY CURRENT USED; 10 milliamperes



From a photograph made for POPULAR RADIO

THE ANTENNA ON THE ROOF OF THE MIDDLE CAB OF THE LOCOMOTIVE

It consists of a half-inch brass tubing, twenty-four feet long, supported by insulators mounted on upright posts. The antenna serves for transmission and reception alike.

A NOVEL AND PRACTICAL USE OF

Radio on Freight Engines

How radiotelegraph and telephone equipment makes team-work possible between locomotives at the front and rear of a mile-long train.

By AUSTIN C. LESCARBOURA

WERE it not for radiotelegraph and telephone equipment, it would not be practical to operate electric locomotives for hauling the mile-long coal trains up the steep mountain grades of West Virginia.

When steam locomotives are employed in the haulage of a long coal train, the practice is to place one Mallet compound steam locomotive at the head of the train and two at the rear for pushing. Thus the train is pulled and pushed at the same time, so that no undue strain is placed on the couplings of the train. When the train is about to start, the engineers of the two rear locomotives open their throttles, ever so slightly, so as to place a pressure on the train from the rear. This serves to take up some of the slack between cars. The front locomotive pushes back to take up the remaining slack, and then starts forward. Hence the front locomotive has the aid of the two rear locomotives, which have been pushing all the while and start moving the instant the front locomotive begins pulling. In this manner the motive power is synchronized. Signals for stopping, as well as starting, are given by means of steam whistle blasts, which carry over the mountains and valleys and numerous tunnels of this picturesque road.

When it came to operating the huge electric locomotives which replaced the steam giants, however, a serious problem arose in co-ordinating the tractive efforts of the units at the front and rear of the mile-long trains. First of all, the compressed-air whistles of electric locomotives do not carry as well as steam whistles. Secondly, it is poor practice and costly practice to apply forward pressure to the rear of the train before the train is ready to move. It cannot well be done with electricity; that feature, truth to tell, is one of the few advantages of steam.

The engineers who developed the electric locomotives hit upon the idea of short-wave radiotelegraph and telephone equipment in the cabs of the front and rear locomotives. And so well has the radio equipment functioned that the electric locomotives enjoy a marked superiority over the steam locomotives which they are replacing.

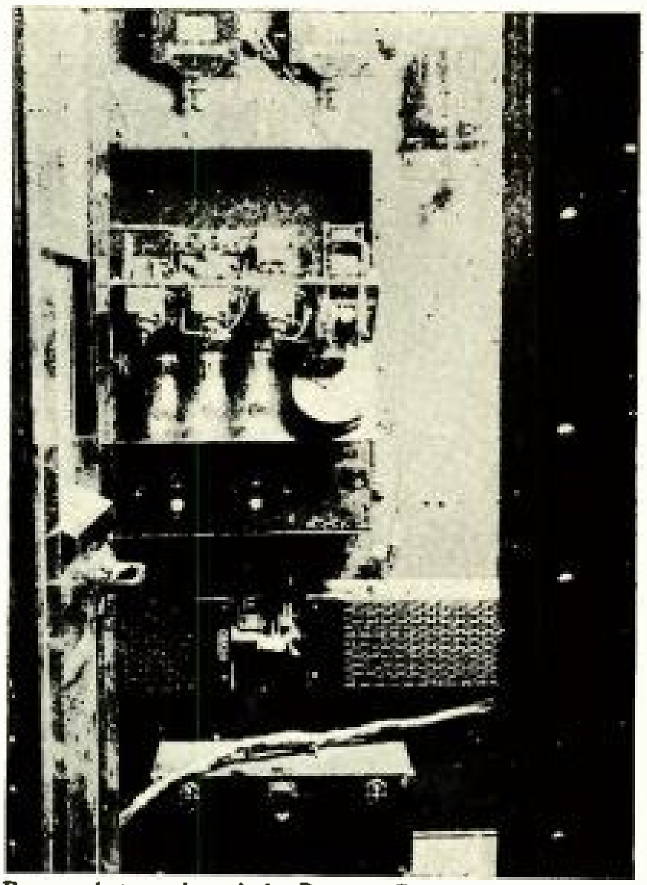
The radio equipment of the world's largest electric locomotives makes use of the guiding effect of the neighboring power lines, overhead trolley and the rails.

The transmitter and receiver are mounted in individual cabinets, placed one above the other, and mounted on the steel wall of the middle of the three sections comprising a complete electric locomotive. On the roof of the section that contains the radio equipment, along one side, is the antenna; it consists of a straight, twenty-four-foot length of one-half inch brass pipe, supported by porcelain insulators. The ground side is simply the frame of the locomotive.

The transmitter consists of a short-wave oscillator modulated by a 500-cycle tube oscillator. The circuit employed is a straight Hartley, with the antenna circuit coupled to the radio oscillator by means of a choke coil. There are two dials on the front panel of the transmitter, one controlling the antenna circuit and the other handling the oscillating circuit wavelength. The antenna circuit is brought into resonance with the oscillating circuit by obtaining the highest reading on the hot-wire meter. The transmitter operates over a wavelength of 110 to 140 meters, while its continuous-wave train is modulated at audio-frequencies ranging from 200 to 1,000 cycles, according to conditions.

The transmitter is rated as a 50-watt set. It employs three 50-watt tubes, one as the radio-frequency oscillator and two as modulators. Filament and plate currents are supplied by storage battery and a motor-generator set. The three transmitter tubes are arranged in series, so far as their filaments are concerned, in order to operate on the 32-volt storage battery of the locomotive which is employed for illumination purposes. The same 32-volt supply operates the motor-generator unit, which supplies the plate potential of 1,000 volts.

The receiving set, contained in a cabi-



From a photograph made for POPULAR RADIO

THE RADIO STATION IN THE CAB

The radio telephone and telegraph transmitter and receiver, with the cabinet of the former opened up and the working parts pulled out for inspection. The three 50-watt transmitting tubes are very much in evidence.

net directly below the transmitter, is of the three-tube, regenerative type. It makes use of three 201-a tubes, with two controls for tuning. The controls, when once set for the desired wavelength, are locked firmly in position. The same applies for the transmitter, since there is no object in constantly changing wavelengths. The receiving set has audio-frequency transformers tuned for a 500-cycle audio-frequency note, so as to produce the maximum signal strength on the normal 500-cycle modulation used in transmitting.

The control equipment is placed in the front locomotive cab, within ready reach and hearing of engineer and so-called fireman. This control equipment consists of a box which contains the ingenious switching and contact-making devices, with a pull cord and handle within reach of the locomotive crew, and a loudspeaker.

To use the radio equipment as a radio telegraph transmitter, the fireman or the engineer steps over to the control equipment and pulls the pull cord ever so slightly, which starts the motor-generator set, as well as lights the filaments of the transmitter tubes. Further pulling on the pull cord operates the modulator, which modulates the continuous-wave train and therefore sends a signal to the other electric locomotive. Ordinarily, the radiotelegraph is used for simple signals rather than for intricate telegraph signalling. Obviously, just so long as the electric locomotive is in operation, the tubes of the receiving set are turned on, ready for signals at any time.

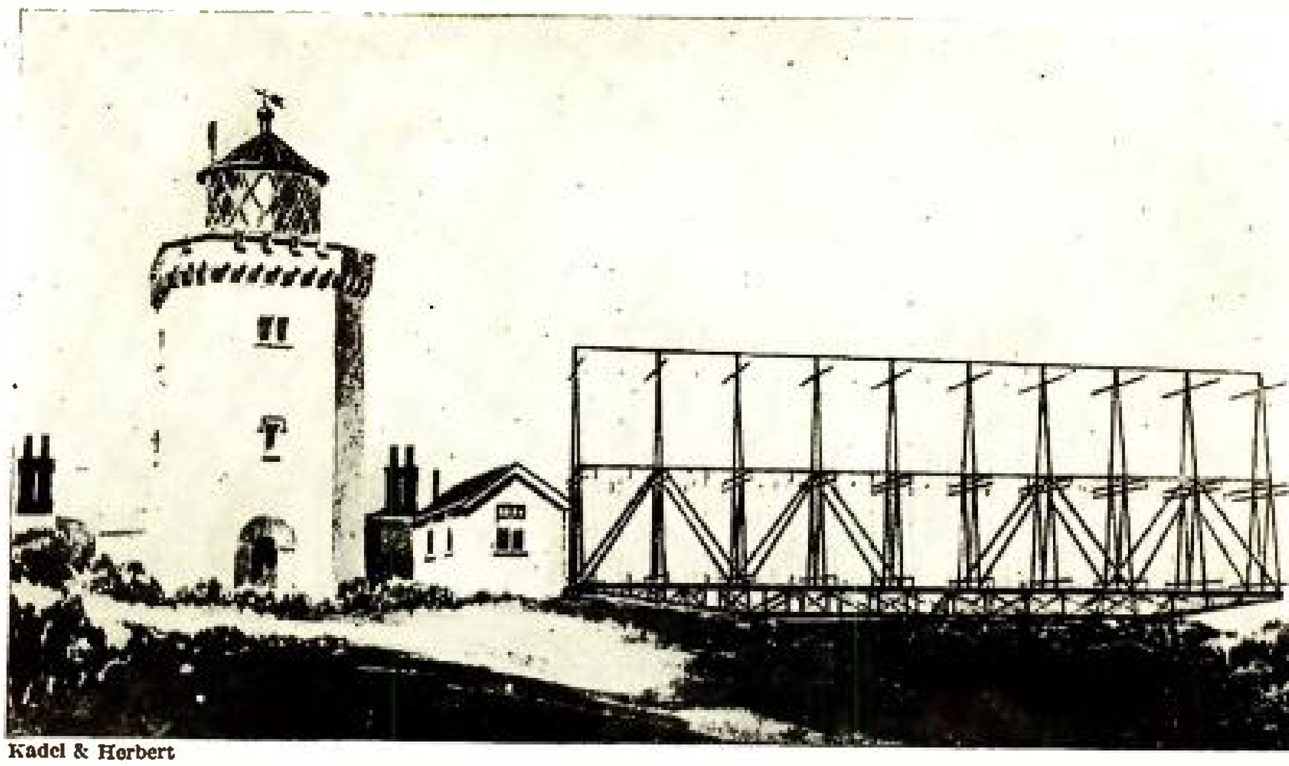
When it comes to radiotelephoning, it is necessary for the member of the locomotive crew to go to the transmitter set, which is provided with a microphone on the front panel. Also, a pair of earphones is plugged into the receiving set. A flip of a switch connects the radiotelephone arrangement, ready for talking.

The radio equipment on the world's largest electric locomotives is a forerunner of a new day in railroad operation, when the train crews may keep in constant touch with other locomotives and with the train dispatchers.

Kadel & Herbert

HOW TO DISTINGUISH POSITIVE FROM NEGATIVE WIRES

Dissolve some common table salt in a glass of water, and dip in the ends of the battery wires. Tiny bubbles will form about the negative tip.



Kadel & Herbert

THE ANTENNA OF THE RADIO LIGHTHOUSE AT DOVER, ENGLAND

The old tower and revolving light can be seen together with the new beam aerial, which is of the grid type. The energy radiated to any one spot is between thirty and forty times as much as can be obtained from a simple broadcasting antenna, using the same energy in the transmitter.

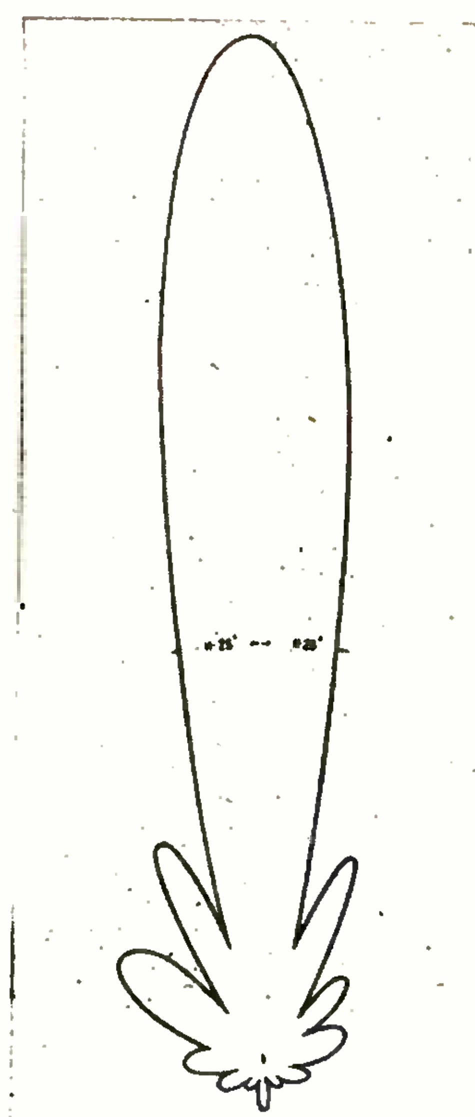
A Radio Transmitter That Pierces Fog and Storm

TO guide ships safely through the dense fogs that settle down on the English Channel and that make useless the ordinary type of lighthouse, a radio lighthouse that uses an application of the beam radio principle has been installed at South Foreland.

A six-meter transmitter is used with an antenna so designed that practically all of the energy is radiated in a beam fifteen to twenty degrees wide. This antenna is slowly revolved and a different Morse letter is sent out for each point of the compass.

On board the ship the navigator may hear as many as five letters. He chooses the loudest letter as giving the direction of the ship from the lighthouse; a chart gives the direction corresponding to the letter received. By taking various letters as the ship moves on, each giving him his new position in regard to the transmitter, he may calculate the correct course for the ship to follow.

The receiving apparatus is so inexpensive and easy to operate that it is within reach of even the smallest boats. And in addition the Morse letters are sent out at a speed of only ten words a minute, so that only an elementary knowledge of the code is necessary to understand them.



The radiation curve; note how the beam narrows and becomes sharply directional.

IN THE EXPERIMENTER'S LABORATORY

CONDUCTED BY LAURENCE M. COCKADAY

A Vacuum Tube as a Voltmeter

LIST OF PARTS:

VT—Federal vacuum tube socket and UV-201-a or C-301-a tube;
R1—Amperite filament resistance No. 1A, with mounting;
R2—Amsco potentiometer, 400 ohms;
MA—Hoyt milliammeter, range 0 to 15 milliamperes;
Baseboard, 7 inches by 9 inches; 11 Eby binding posts; 6 brass angles; 2 composition strips, 1 inch by 7 inches, and 1 inch by 5 inches respectively; bus wire; solder; etc.

THE peculiar characteristics of a vacuum tube make it adaptable to many more uses than is generally realized. One of the important ones is its use as a voltmeter for measuring all ordinary voltages, either direct or alternating current, from a fraction of one volt up to several hundred volts.

Thus with an inexpensive voltmeter, preferably one with a double range of say 0 to 10 and 0 to 100, it is possible, by the use of a vacuum tube, connected as shown here, to use this meter for measuring voltages far above the range of the meter. Not only this, but alternating-current voltages may be measured even though the voltmeter available is a direct-current meter.

The circuit described here also has other uses. For instance, it enables the experimenter to determine the characteristic curves of his vacuum tubes and it serves as a reliable tube tester. Still further uses will suggest themselves to the experimenter after he has the circuit in operation a short time and becomes familiar with its operation.

The action of the tube as a voltmeter is based on what is known as the "mu" of the vacuum tube. Any voltage properly connected in the grid circuit of the tube will prevent a much higher voltage in the plate circuit from being effective. If the tube used is a UV-201-a, with standard characteristics, a plate voltage of over 80 will be required to cause a current flow in the plate circuit, if the grid voltages (negative) are as much as 10 volts. The "mu" of the UV-201-a tube is 8, therefore the plate voltage must be more than eight times the grid voltage if there is to be any plate current flow.

Hence it is evident that we may measure an unknown voltage in the plate circuit if we have means available for measuring the grid voltage and for knowing when the plate current is O. For instance, if the battery "B" in Figure 1 is of unknown voltage we can alter the voltage of battery "C" in the grid circuit until there is zero current flow in the plate circuit. At this point the two circuits are said to be balanced and their voltage ratio is equal to "mu" of the tube, which is approximately 8, in the case of a UV-201-a tube. Therefore, the unknown plate voltage is figured by multiplying the grid voltage by the "mu" of the tube, 8.

This is the theory of the measurements. However, in actual practice conditions are slightly different. It is impracticable to obtain an accurate zero plate-current reading, to determine when the voltages of the two circuits balance each other out. Moreover, "mu" varies with different tubes, even of the same type, and it also varies with changes in filament temperature. It is therefore necessary to first of all calculate the "mu" of the tube to be used; to use some definite unit of current in the plate circuit, rather than zero; and to keep the filament voltage constant.

The method used is to set up the circuit with a known plate voltage and a known grid voltage, which are always left in the circuit. The plate voltage may be 90, for instance, and the grid voltage 3. If a milliammeter is connected in the plate circuit it will indicate a plate-current flow under these conditions of approximately 4 milliamperes. We care nothing about the exact amount of current flow, however, so it is not necessary to have an accurate reading milliammeter: in fact, a cheap voltmeter such as may be purchased for a few dollars will serve the purpose if connected in place of the meter MA in Figure 1. This latter will, of course, not give readings in milliamperes, but if the point on the dial to which the hand goes with the above voltages in the circuit is noted, that will be all that is necessary.

Assuming that the circuit is connected up as shown in Figure 1 and the voltages mentioned above are connected into the circuit at "B" and "C," we are ready to start measurements. The first step is to measure the "mu" of the tube used. For this purpose a known voltage, X1, is connected in series with the voltage already connected in the plate circuit. This will cause the needle of the meter, MA, to go up the scale.

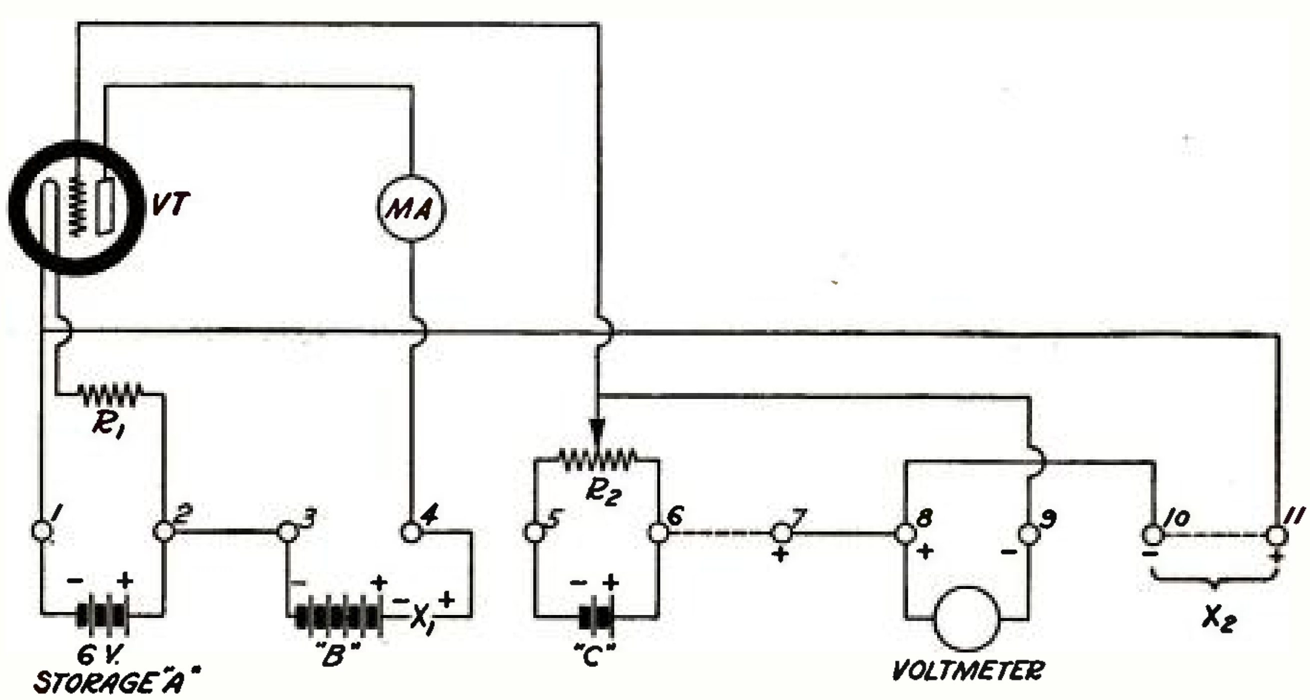
Now adjust the potentiometer until the indicator of the meter, MA, comes down again to the original setting. If adjustment of the potentiometer will not bring this about, take off connector between terminals 6 and 7 and connect additional voltage to these two terminals, negative side to No. 6 and positive to No. 7. Again readjust the potentiometer. When the MA needle finally comes to rest at the same point as when only 90 volts were used at "B" and 3 volts at "C," the exact voltage at "C" and "B" are read with a regular voltmeter. These voltages will include not only the original 90 volts at "B" and 3 volts at "C," but also the voltages that were added to both.

Next, subtract the original voltage of 90 from the new reading at "B" and the original grid voltage of 3 from the new reading at "C." This will give the voltage that was added. Say the added voltage at "B" is 45, and an added voltage at "C" of 5.25 was needed to balance out this added plate voltage, it is evident that 45 divided by 5.25 will give the "mu" of the tube which in this case would be 8.57.

Having found "mu," suppose we want to measure an unknown direct-current voltage. We simply connect it in series with the 90-volt battery at "B." Next we add more battery at "C" until the plate current reading is at the same setting as in the two previous measurements. With the voltmeter we measure the new voltage of "C" and subtract the original voltage of 3. Let us assume the difference is 10 volts. We have just found that for every 8.57 volts added at "B" it is necessary to balance with 1 volt at "C" (that is what "mu" really means), therefore, if 10 volts were added to "C" to balance the voltage added at "B," the latter must have been 85.7 volts.

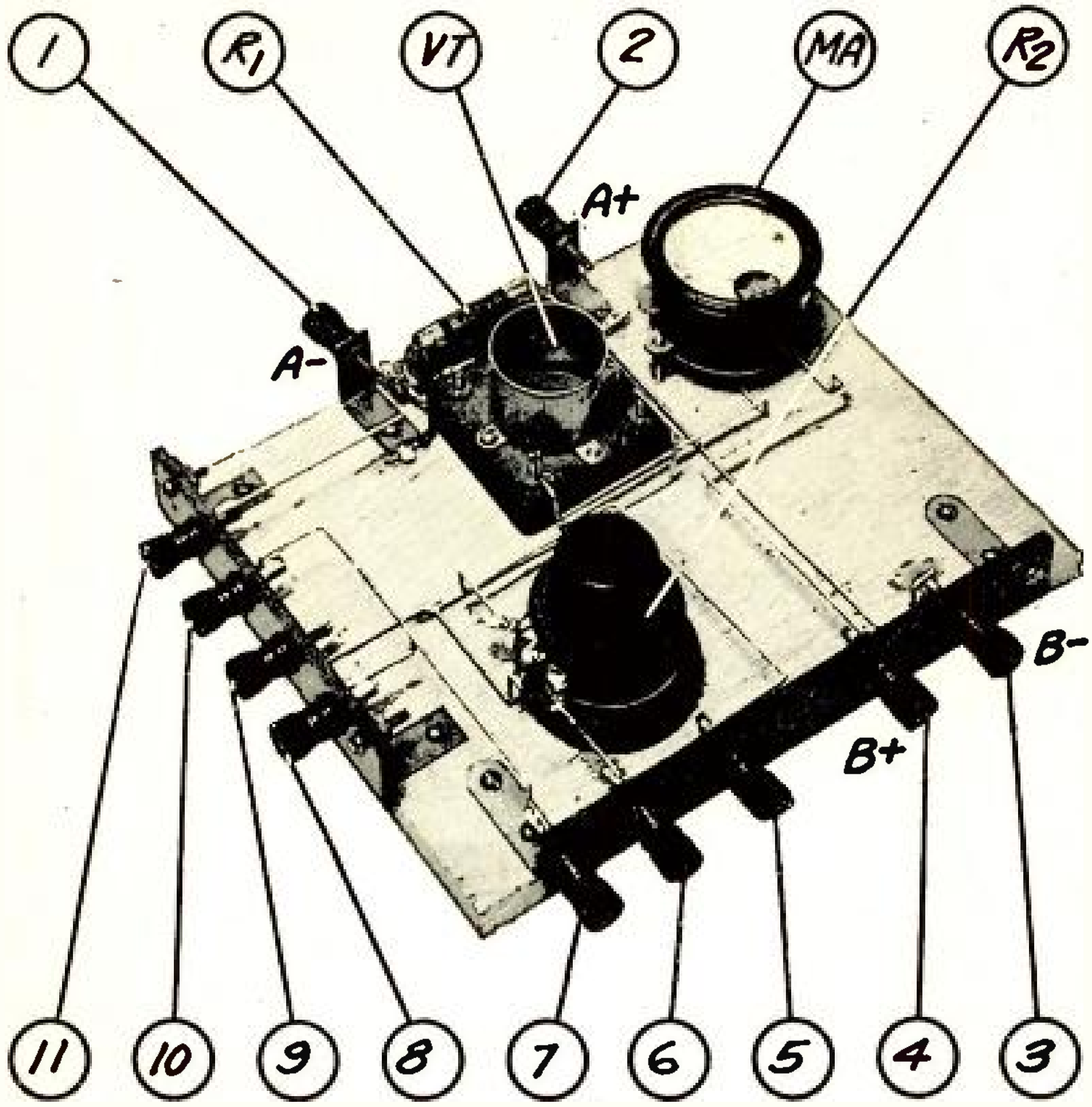
If this method is carefully used the accuracy of the vacuum tube voltmeter is greater than the average voltmeter used in radio work. Measurements taken in the laboratory proved the equipment shown in Figure 2 to be accurate within one-half of one percent up to several hundred volts. Where the voltage to be measured is low it may be placed in the grid circuit. and balanced out by adding voltage in the plate circuit. The unknown voltage added in the grid circuit will then be the added plate voltage divided by "mu."

Or, to measure small unknown voltages, up to 10, the substitution method may be used in the grid circuit. The circuit is set up with say 10 volts at "C" and perhaps 135 volts at "B." The MA reading is then noted. Next the small unknown voltage is connected across terminals 10 and 11 and the voltage at "C" is reduced by adjustment of the potentiometer until the same MA reading as before is obtained, leaving the voltage at "B" the same throughout. The difference in the readings of the voltmeter across "C" before and after the unknown voltage was added at "C1" will be the unknown voltage.



THE WIRING DIAGRAM OF THE VACUUM TUBE VOLTMETER

FIGURE 1: *It will be noted that terminals 6 and 7, also terminals 10 and 11, are shown short circuited. In certain measurements it is necessary to connect additional voltage in the grid circuit, and it is for this purpose that these terminals are used. Their use is explained in the text.*



THE VOLTMETER READY FOR USE

FIGURE 2: *All terminals are clearly marked. The designating symbols are the same as those used in the text, and in Figure 1.*

This method of measuring low voltages is only practical in the case of alternating current, of course, as low direct current voltages can be read directly on the regular voltmeter.

Direct-current voltmeters will not measure alternating-current voltages but with the systems described here the peak voltage of any alternating current may be measured accurately in exactly the same way as the direct-current voltages were measured, making use only of a direct current voltmeter and a direct current milliammeter (or another voltmeter as explained above), in addition to the vacuum tube circuit shown in Figure 1.

This system has advantages that even alternating-current meters do not have. For instance, measurements of alternating current of any frequency may be accurately measured. Moreover, this vacuum-tube voltmeter has almost infinite resistance and can therefore be shunted across any circuit without having any effect on the functioning of that circuit, therefore the readings show true voltage. In the case of the ordinary voltmeter if the resistance across the voltage terminals is higher than that of the meter the constants will change when the meter is connected and the voltage reading will vary greatly from the actual voltage of the circuit.

In using this voltmeter arrangement the following suggestions will be helpful.

Be sure that the "A" battery voltage is constant. In the hook-up shown an "amperite" fixed filament resistance is used to maintain constant voltage across the filament. However, when the "A" battery is nearly discharged the filament voltage will drop below this constant point, or when the battery is freshly charged the voltage will be higher for a short time. It is therefore advisable to measure the "mu" of the tube before starting a series of readings with this device. Or if an accurate low-voltage voltmeter is available, measure the voltage across the filament occasionally to make sure it does not vary.

In making measurements of unknown voltages in the plate circuit, short circuit terminals 10 and 11 with a piece of bus wire, and if the unknown voltage is less than 45, terminals 6 and 7 may also be short circuited. In all cases the voltage across the potentiometer (terminals 5 and 6) should be 6. If it is higher than this the drain on this portion of the battery, through the potentiometer winding, will be unnecessarily high. This permits a voltage regulation from zero to 6 volts simply by varying the potentiometer knob. If higher than 6 volts is needed in the grid circuit to balance the plate voltage, it is added across terminals 6 and 7. There is no drain on the portion of the battery thus connected. If preferred, where voltages over 10 are to be used in the grid circuit, terminal 6 may be left unconnected, in which case the potentiometer serves as a variable series resistance (rheostat) with only a slight current drain on the battery, connected across terminals 5 and 7.

The same tube should always be used in the meter because of the difference in "mu" in different tubes of the same type.

When making measurements, leave the voltmeter connected to terminals 8 and 9, because if the two circuits are first balanced and then 10 and 11, it will be found that the circuits are no longer balanced. The best plan is to leave the voltmeter in the grid circuit until the circuits are balanced, then note the voltmeter reading. After this the meter may be removed and connected across the plate battery (if the same voltmeter is to be used for measuring the plate voltage) as when measuring "mu" of the tube for instance. A separate meter is necessary for use in measuring the plate current. This may be either a milliammeter or another voltmeter. It is understood, of course, that to measure the voltage of a circuit the voltmeter is connected in parallel with the circuit. To measure current the meter is connected in series with the circuit.

The batteries used with the vacuum-tube voltmeter may be the regular type of "B" batteries for the plate circuit. For the grid circuit the usual type of "C" batteries may be used, or a "B" battery if this is more convenient. The "C" batteries are tapped every 1½ and 3-volts, however, and thus provide more gradual voltage changes than the "B" type of battery.

—S. Gordon Taylor

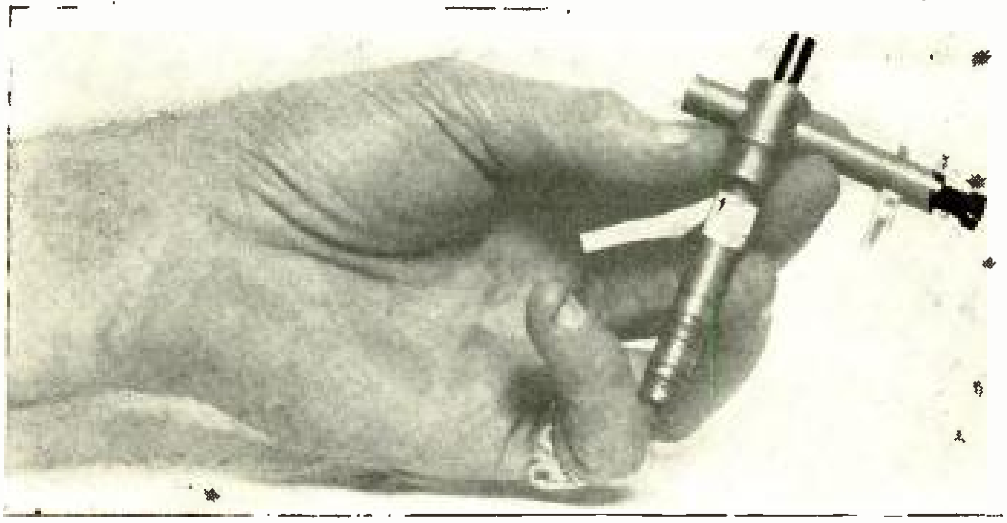
How to Drill Large Holes in Panels

The reduction in the price of panel-mounting meters by the various manufacturers, together with the introduction of the two-inch size, has made the meter more popular than ever with the home constructor.

Certain difficulties, however, present themselves in mounting on the panel. Perhaps that of drilling the large holes in the panel for the flush mounting type gives the greatest amount of trouble.

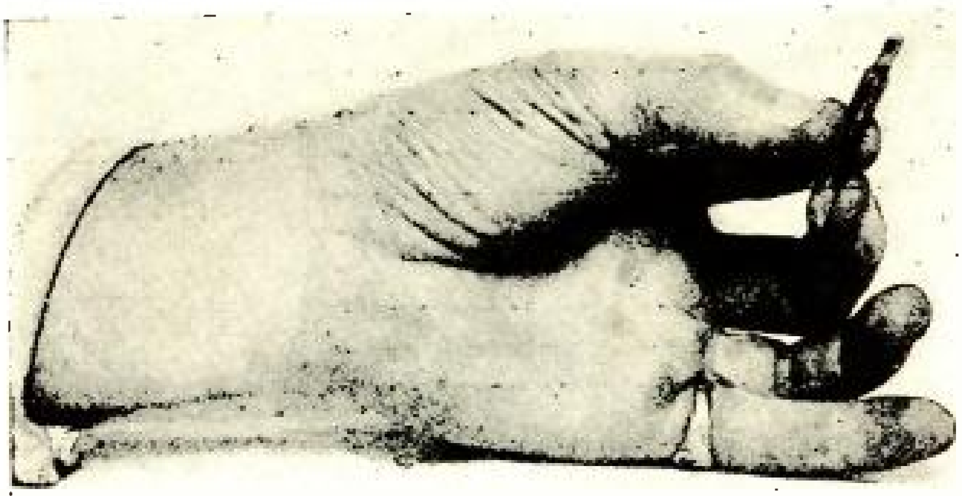
There are several fly cutters on the market, but not all of them are adaptable to this class of work, due to the fact that in some of them the steel cutting tool is not held rigid enough to cut properly. Extreme rigidity throughout is necessary in this tool. Figure 3 gives a good conception of a tool of this type; note its sturdiness of construction and simplicity. Observe in Figure 4 the shape of the cutter. If a fly cutter of this type is used, drilling takes but a few minutes. It is best to place a piece of cardboard, slightly larger than the panel, on the bench or table, to avoid scratching the face of the panel. The center hole for your meters should then be punch-marked and a hole drilled corresponding in size to the size of the centering guide of the fly cutter. (Some fly cutters are equipped with a drill instead of a centering guide, but the experience of the writer has been that this type has lacked the necessary rigidity.)

Now adjust the fly cutter for the proper diameter, and prove this by trying it out on a piece of wood to assure yourself that the finished hole will be the proper diameter for the meter. This proving method is important in



THE TOOL USED FOR BORING LARGE HOLES

Figure 3: *In mounting voltmeters or milliammeters on a panel the large hole necessary can easily be drilled if a cutter of the type shown is used.*



THE SHAPE FOR THE CUTTING EDGE

FIGURE 4: *This should be ground down to a sharp triangle for best results in making a clean, round hole in the panel.*

view of the fact that if a mistake is made in the diameter it will entail considerable labor to rectify it. Drilling may now be started.

Be careful to hold the brace in which the fly cutter has been tightened in an upright position as is possible so as to cut evenly. Proceed to cut a little over half way through panel, when the brace should be removed, the panel turned over and drilling resumed. The steel cutter will probably drop through the remaining uncut bakelite at the point that is thinnest. Make sure that your panel is resting on a flat surface and with a sharp blow from a hammer the "cutting" may now be broken loose.

A narrow fin may now be removed from the cut edge by means of a bastard file and the meter slipped into position for spotting the holes for the screws that go through the rim of the meter. These are usually three in number. These holes may be readily marked by holding the meter in proper position and marking the panel with a scratch point. Remove meter and drill the panel at the three marked places with a No. 31 drill, then tap with a 6-32 tap. Nickel round-head 6-32 screws may be used or brass round-head, which may be blacked afterward with a suitable enamel or paint scantily applied with a small brush.

Some manufacturers have devised a meter which does not necessitate the drilling of these three holes, and the meter is held to the panel from the rear by means of two jam screws. This facilitates quick mounting.

—ROBERT W. TAIT

A Shunt Plate Feed for Loudspeakers

MANY loudspeakers that use the ordinary telephone type of diaphragm and electromagnet contain an adjustment for varying the distance between the diaphragm and the magnet poles so that volume can be controlled. This is because the direct current that flows through the magnet coils in this type of unit produces a stress in the diaphragm that either attracts or repels the diaphragm in accordance with the polarity with which the loudspeaker is attached.

For this reason, some loudspeakers also require that the connections be made in a certain direction so that the diaphragm will be permanently attracted toward the magnet when the tubes are in operation and the plate current flows through the loudspeaker. This gives the diaphragm a certain inertia or drag which produces some distortion.

In the case of the type of loudspeaker in which the diaphragm is under no magnetic stress such as when a balanced armature is used, the moving coils are usually of fairly low impedance, and this places a considerable load on the output of the tube with which they are connected in series.

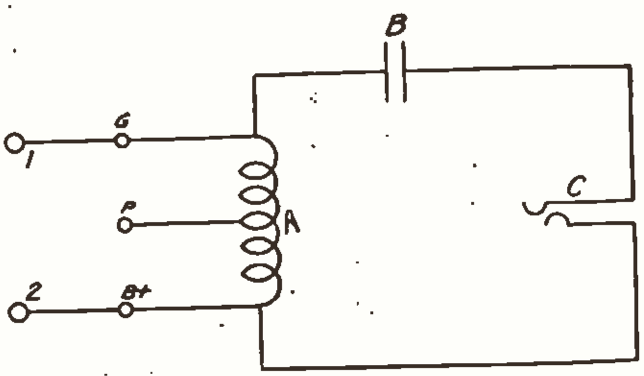
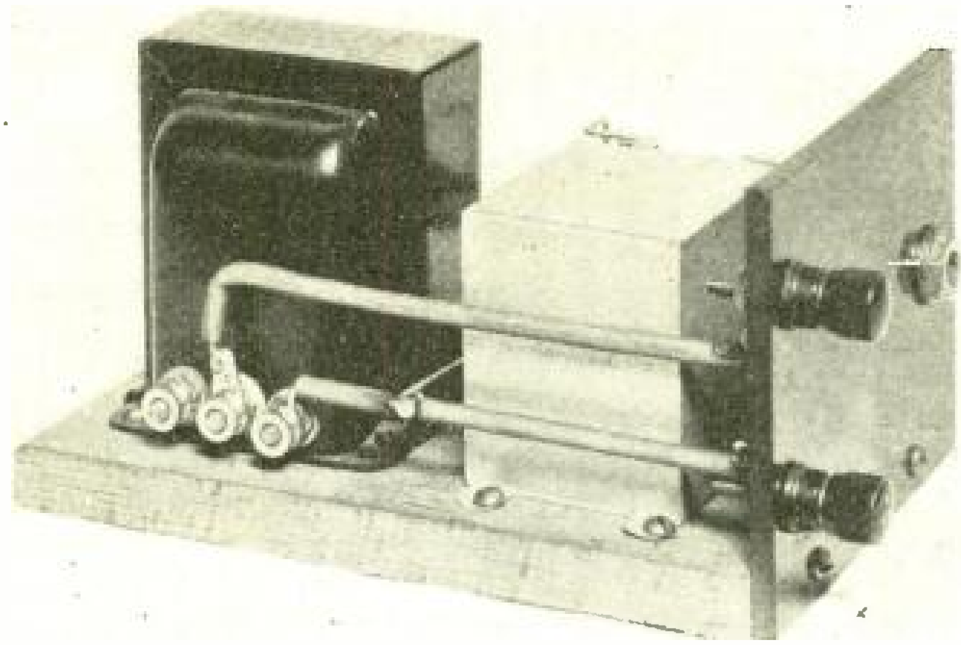


FIGURE 5: *This is the electrical circuit diagram for the choke, the condenser and the jack.*

A simple small unit that will improve considerably the operation of most loudspeakers is explained and information regarding construction given in this article.

In referring to Figure 1, the reader will notice that the unit consists of a high impedance

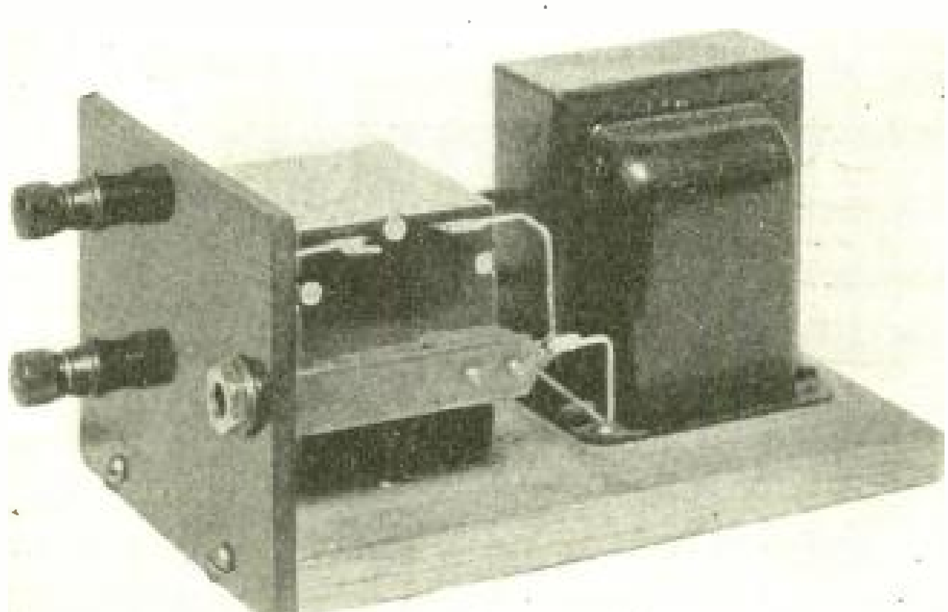


VIEW OF THE UNIT FROM THE LEFT

FIGURE 6: *This picture shows how the Thordarson autoformer is mounted on the wooden baseboard and wired to the two binding posts. Notice that the top binding post is connected to the middle terminal of the autoformer. This connection may be tried either here or on the left end terminal which in some cases gives a little better result.*

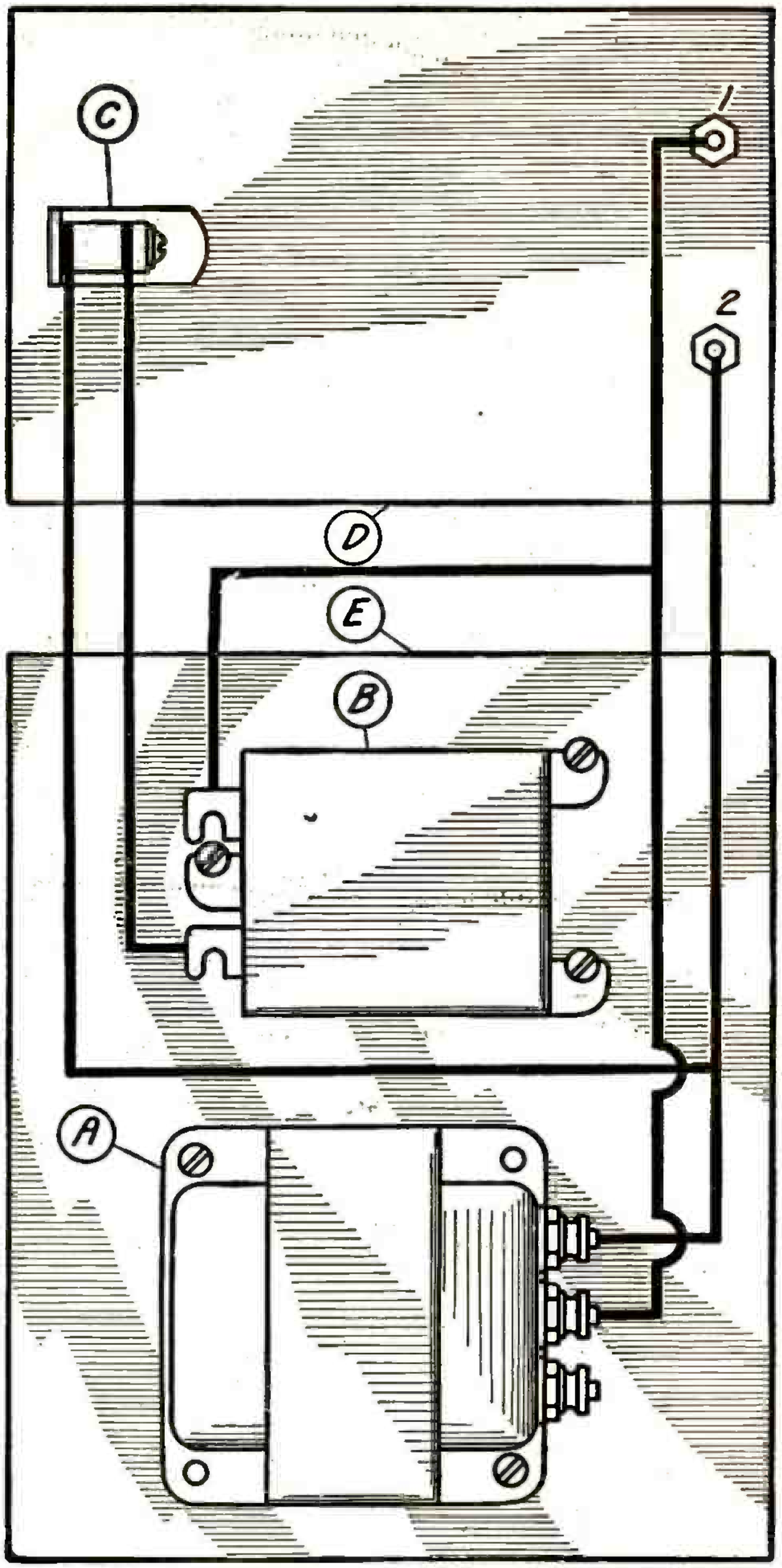
coil which may be connected across the plate and "B" battery output terminals of a receiver. Shunted across this are a large fixed condenser and a jack for accommodating the plug attached to a loudspeaker.

The impedance coil which is designated in the diagram as A serves to furnish the plate of the tube with the necessary direct-current potential. The loudspeaker is connected in circuit, however, through the fixed condenser B, which is in series with the loudspeaker by means of the jack C. This allows the alternating current output from the receiver to flow from the plate of the tube through condenser B and the loudspeaker and jack to the filament circuit through the "B" battery, but at the same time it prevents any direct current from flowing through the loudspeaker itself.



VIEW OF THE UNIT FROM THE RIGHT END

FIGURE 7: *This illustration shows how the Tobe 4 microfarad condenser is mounted and connected to the jack. This small unit is easy to make and simple to wire up.*



THE PICTURE WIRING DIAGRAM FOR WIRING UP

FIGURE 8: *This drawing gives the exact connections for the parts that go into the shunt feed unit. The wiring is shown in a heavy black line.*

This simple little unit will help the experimenter in obtaining better quality of reproduction from almost any loudspeaker now on the market and will in some cases also *increase the volume* to a considerable extent.

In making up a unit of this type, it will be necessary to obtain a small bakelite panel 3½ by 4 inches in size and a small block of wood to be used as a base 4 by 6 inches by ½ inch. These should be fastened together at right angles by means of two screws as shown in the two accompanying photographs.

Then mount on the baseboard a Thordarson Autoformer A and a Tobe fixed condenser B of 4 mfd. Then mount on the panel the two Eby binding posts and the Pacent single-circuit jack C as shown and wire up as indicated in the picture wiring diagram which is given in Figure 2.

The two binding posts of the unit then should be connected to a plug which is inserted in the jack of the set which has at previous times been used for general loudspeaker operation. The loudspeaker plug should then be inserted in the jack C and the unit is ready for operation.

There will now be no direct current flowing through your loudspeaker but only the alternating current of the plate circuit in your last tube will have passed through the loudspeaker coil windings.

As stated before, this unit will improve reception on almost any type of loudspeaker, it will increase the life of some loudspeakers and it will prove to be interesting and helpful to any experimenter who is looking for the utmost in quality of reproduction.

—Laurence M. Cockaday

The Relative Merit of Some Types of Inductance

The average radio experimenter is deeply interested in the subject of losses in radio apparatus; and as the greatest variation in loss is present in coils, here are some comparative data on the subject.

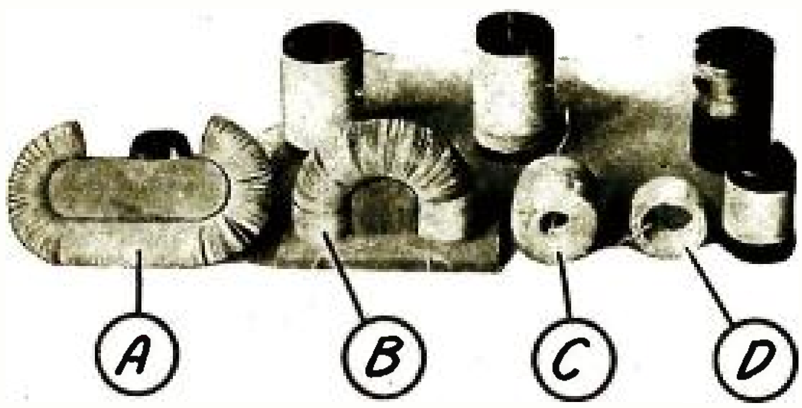
The difference in resistance at broadcast frequencies between the poorest variable condenser and the best obtainable is perhaps only one or two ohms, while coils of equal inductance may vary as widely as thirty ohms or more. It is obvious, therefore, that the coil is by far the more important of the two.

Mr. W. W. Harper has proposed a method of expressing the relative merit of coils as follows: The resistance is measured (at enough points to insure accuracy) over the wavelength band in which the coil is to be used (say from 200 to 550 meters). The pure inductance of the coil is also determined. The pure inductance is then divided by the *average* resistance of the coil over the entire wavelength range. [This average resistance is obtained either by taking the single integral of the function—providing the equation for the curve has been obtained—existing between wavelength or frequency and resistance; or by the use of a planimeter; or by any other method used in finding the average height of a curve above its X axis.] The result is in terms of microhenries per ohm. Thus if we have two coils each of 500 mh. inductance and if the average resistance of one is 10 ohms and of the other 15 ohms, their figures of merit are respectively 50 mh/ohm and 33.3 mh/ohm.

In the present discussion, however, it was thought best to show $\frac{L}{R}$ (inductance divided by resistance) for each of the wavelengths at which measurements were made. These results have been plotted as curves in Figure 1.

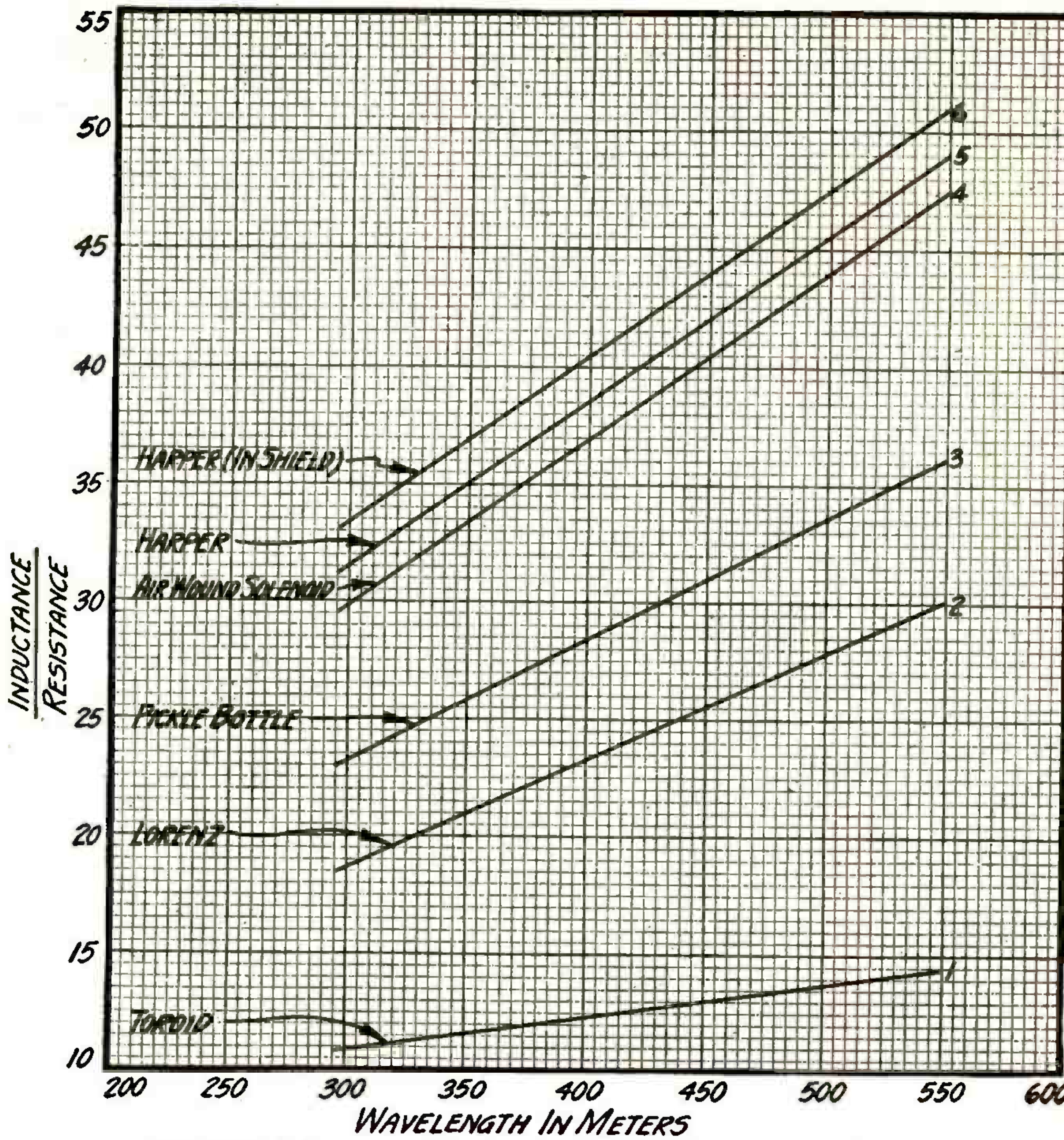
It will be noticed that these curves go only as low as 300 meters. This was the lowest wavelength to which the condenser used would tune the largest coil. In actual practice the resistance below 300 meters is not very serious because tuning is usually sharpened by the regeneration ordinarily present. Therefore, it was thought that stopping at 300 meters was not a serious omission.

The present trend seems to be toward coils that have confined fields, and in considering the



SOME OF THE COILS THAT WERE TESTED

Figure 9: *The inductances that were used in finding the relative merit of different kinds of coils at various frequencies. The results that were determined indicate that the solenoid type of coil still remains the best of any of the coil shapes that have been brought out. The coils A, B, C and D are those which the author refers to specifically in the text.*



THE RELATIVE MERITS OF VARIOUS TYPES OF COILS

FIGURE 10: *This series of curves shows the values of inductance divided by resistance for six different types of winding. Notice that the three upper curves which in this case happen to be practically straightline have a much greater inductance-resistance ratio than the other types of winding. These three curves are for solenoid types of winding.*

curves this should, of course, be taken into account. The problem of preventing interaction between coils has several apparent solutions: First, we may turn them at the angle of least coupling; second, we may confine the magnetic field by shaping the coil in the form of a torus or through some other scheme of winding; third; we may use a coil having only a semi-confined magnetic field and shield against the unconfined portion of the field; and fourth, we may obtain field confinement through shielding alone. In investigating this problem, all of these methods were tried.

The first method has the disadvantage that the angle is rather critical and varies with coil shape. (It also varies slightly with frequency.) Scheme two solves the problem of magnetic interaction but it gives an extremely poor coil from the standpoint of selectivity and losses.

Note that both methods one and two allow electrostatic coupling between coils.

Method three is successful in that a fairly good coil can be built (with no coupling either magnetic or static) as the coil is almost unaffected by the presence of the shield.

Solution four gives by far the best results in that it is possible to completely shield a coil and still maintain its electrical properties practically as good as those obtainable from the same coil in free space, as its constants are altered in about the same proportion.

There are two classes of shielding materials available: Magnetic substances function chiefly by deflecting the magnetic flux from its normal path to a path of lower magnetic reluctance, thus confining it to the space within the shield; non-magnetic materials prevent field escape by setting up a secondary field which is 180 degrees out of phase with the main field striking the shield, and practically equal to it. This presupposes the setting up of eddy currents within the shielding material. The effect upon the enclosed coil is similar to taking turns off it: i.e., both the inductance and resistance are decreased. Of the available classes of materials for shielding, certain non-magnetic substances are therefore best in that they produce the lesser losses.

A few of the coils having semi-confined fields are shown in the illustration, Figure 9. Coil A is an oval shaped coil similar in some respects to the torus but having superior electrical characteristics. The ideas involved in this coil are: First, to have a fairly long straight section (solenoid) so as to obtain efficient operation as a radio-frequency transformer; second, to have the two opposite ends (whose instantaneous magnetic polarity is opposite) pointing directly at each other so as to obtain fairly close field confinement; and third, to have the two opposite ends (whose instantaneous electrical polarity is opposite and greatest in magnitude of any two points on the coil) widely separated, so as to reduce distributed capacity.

Coil B is a semi-torus, or horseshoe-shaped coil which is inferior to coil A, both as to radio-frequency resistance and action as a transformer. It might be well to mention here that, from the standpoint of energy transfer between two windings, the torus is much inferior to a plain solenoid. That is, the voltage step up between primary and secondary falls off much more rapidly as the wavelength is increased, than is the case with solenoids. This action is the reverse of what we require because at higher wavelengths the tendency toward feed-back is reduced and; as a result, a set built with coils having such a drooping characteristic will give widely varying results over the tuning range. See Table 1.

TABLE 1

VOLTAGE AMPLIFICATION WITH 201-A TUBE

WAVE-LENGTH	SO-CALLED LOW-LOSS TORUS	STANDARD NEUTROFORMER
250	8.6	10.0
500	4.5	9.6

The impression seems to exist also (or, at least, we are led to believe that it exists) that there is nothing, after all, to this matter of feed-back through grid-to-plate capacity. Another curious belief is that, while it is desirable to prevent magnetic feed-back through the use of coils with confined fields, for some carefully-passed-over reason, it is undesirable or unnecessary to prevent this same feed-back through tube elements by oscillation-preventing devices. As an example of what is meant, much of the literature now appearing on toroidal coils stresses the desirability of eliminating interstage magnetic coupling and at the same time makes the rather inconsistent statement that anti-regenerative devices are successful only in so far as they cause a sacrifice in efficiency. A third superstition is that the use of anti-regenerative control causes poor quality. Only a little superficial thought is necessary to show the fallacy of these three ideas.

Coil C is of unusual shape in that, instead of having its opposite ends turned toward each other externally as in A, they are tucked inside the main coil. Coil D is a Lorenz type winding whose characteristics are given by curve "2" in Figure 1. The other coils in the illustration are solenoids of different designs. Several other types of coils were investigated but are not considered worth discussing.

As to shielding, this has heretofore been accompanied by losses too great to be tolerated. The solution was, to the best of the writer's knowledge, first successfully accomplished by Harper in the design of his "Metalloid" coil. Magnetic substances were found too sluggish in the accommodation of their molecular arrangement to magneto-motive forces at radio frequencies. Harper's coil involves the correct co-ordination of coil size and shape with shield spacing and material. This type of coil, modified to suit the circuit conditions, is being used in the Penetrola and Isofarad receivers.

Incidentally, coil pick-up is not a serious factor in selectivity. In fact, the amount of energy picked up in a 3-inch coil is negligible compared to that collected by the average antenna.

In Figure 10, curve 1 is for a so-called low-loss torus coil; 2 is for the Lorenz winding shown in the illustration: 3 gives the characteristics of a self-supporting solenoid of octagonal cross section; 4 is for a 3-inch solenoid of No. 22 DCC wire wound on a skeleton frame; 5 is for a coil designed on the principles determined by Harper (its bulk, for the same inductance is less than half that of coil 4); and 6 is for the same coil (5) shielded.

In conclusion: first, magnetic field confinement is not sufficient to prevent coupling between stages in a radio-frequency amplifier (even neglecting grid-to-plate capacity); second, magnetic field confinement does not prevent signal pick-up within the set; third, from the standpoint of selectivity, the best torus coil is by far the poorest coil investigated; fourth, torus coils are inefficient as radio-frequency interstage coupling transformers; fifth, it is possible to completely shield a coil and obtain at least as good electrical qualities as are present in the best types of coils in free space; and lastly, interstage coupling transformers whose losses are low and whose voltage step-up is at all near the maximum obtainable value cannot be used without some means for preventing self-oscillation. Therefore some losses are necessary in coils used in circuits employing no anti-regenerative device.

—BYRON B. MINNIUM

CONDUCTED BY HUGH S. KNOWLES

In justice to our regular subscribers a nominal fee of fifty cents per question is charged to non-subscribers to cover the cost of this service, and this sum must be inclosed with the letter of inquiry. Subscribers' inquiries should be limited to one question or one subject.

Automatic Voltage Control on a Resistance-coupled Amplifier

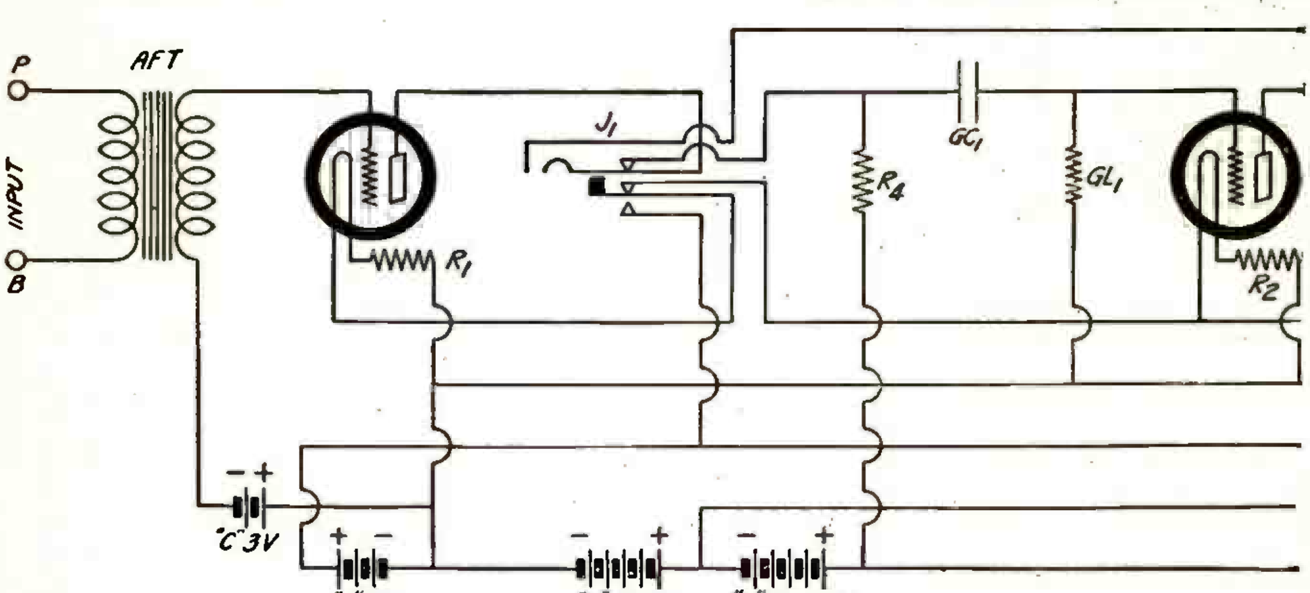
QUESTION: I have a single tube receiver which gives me very good headphone operation on even distant stations. I bought it with the intention of adding more tubes, to secure loudspeaker operation, at a later date. A friend of mine has an amplifier which he built according to the instructions you gave in the "Simple How-to-Build" article No. 7 which appeared in the March, 1925, issue of POPULAR RADIO. It gives excellent volume and quality when used with my receiver, but I would like to build one using filament control jacks so the unused tubes will be automatically turned off. If possible I would like to further simplify its control by using some sort of automatic filament control.

WILLIAM HULL

ANSWER: In Figure 1 you will find a diagram of the type of amplifier you want to use. It uses a stage of transformer and two stages of resistance-coupled amplification. The jacks control the number of stages of amplification used, turn off the unused filaments and connect the 90-volts "B" plus (+) to the plate of the last tube in any combination. Due to the low resistance of the phones or speaker as compared with the coupling resistances a much higher plate voltage is usually secured on the last tube resulting in a higher "B" battery drain and poorer reproduction.

You will need the following parts:

AFT—Type 285 (6 to 1 ratio) General Radio



audio-frequency transformer;
R1. R2 and R3—Code B Brach-stats;
J1 and J2—No. 66 Pacent filament-control jacks;
J3—No. 65 Pacent filament-control jack;
GC1 and GC2—fixed condensers .1 mfd.;
R4 and R5—coupling resistances .25 megohm;
GL1 and GL2—grid-leaks .5 megohm.

The constants given are for tubes of the 201-a type. For these tubes the second "B" battery marked 45-90-volts can be a 45-volt battery. This gives a total of 135 volts on the stages in which there is a coupling resistance in the output circuit.

If you want to get the maximum possible voltage amplification, two *high-mu* tubes should be used as the first tubes and a power tube in the last socket.

R1, R2 and R3 should be of the proper type to furnish the correct filament current to the respective tubes. Where the signals are quite loud it may be advisable to connect GL1 to one of the "C" batteries so that more bias is obtained. If the last tube is one of the new Radio Corporation power-type tubes the high negative bias recommended by them should be used.

Although operation on the first two jacks will not be quite as satisfactory when the phones are used it will be considerably better on the last jack when using the loudspeaker.

To get full advantage of the *high-mu* tubes R4 and R5 should be increased to about .5 megohm and the second "B" battery should be two 45-volt blocks. This voltage seems rather high but when it is remembered that the fraction of *mu* which is obtained per stage is proportional to the ratio of the external resistance to the sum of the tube and external resistances and that the plate resistance rises rapidly with decrease in plate voltage, it is clear that the "B" voltage has to be high to compensate for the drop in the higher coupling resistance needed.

What Is an Aperiodic Antenna?

QUESTION: I see the term "aperiodic" antenna coupling used frequently in radio articles, but I can find nothing about it in the radio books that I have. Will you explain what is meant?

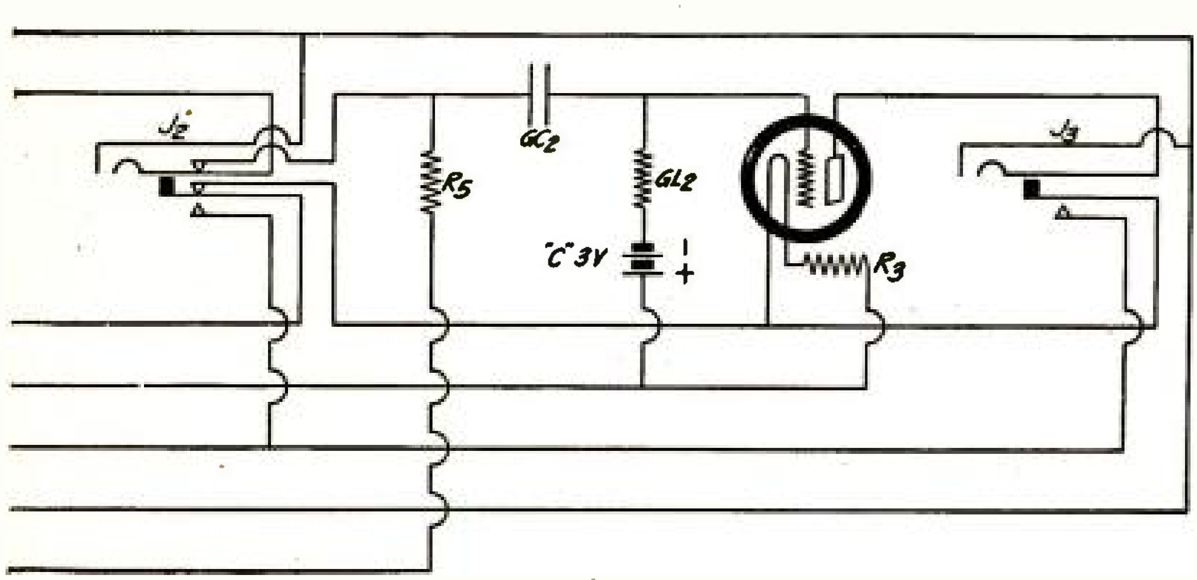
HOWARD THOMAS

ANSWER: The term aperiodic means "without period" or "dead beat." As applied to an electrical circuit this signifies that it has no resonant frequency. In a circuit containing capacity and inductance such as an antenna circuit this can only be secured by introducing a very high resistance in series. For absolute aperiodicity this resistance should be *infinite.* In practice this can be approached by using a few thousand ohms resistance.

The resistance of the average receiving antenna lies between about 25 and 100 ohms. This is obviously not enough to make the circuit aperiodic.

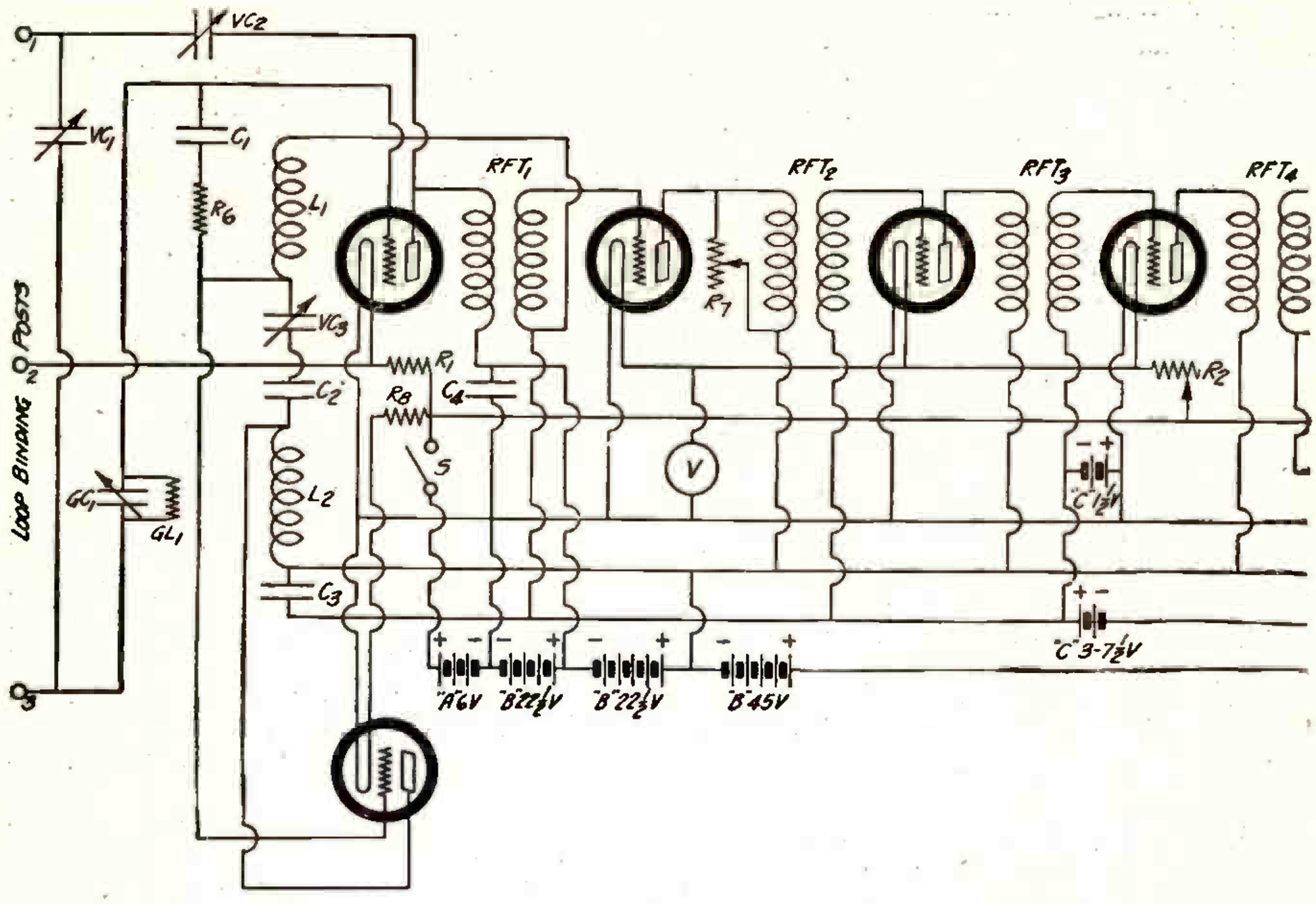
Actually in receivers using so-called aperiodic primaries the set is operated at frequencies well off the resonant frequency of the antenna circuit. This minimizes interaction between the antenna and secondary circuits and operation is somewhat analogous to that obtained with an aperiodic antenna.

When receivers that are designed to operate at the higher frequencies (shorter wavelengths, such as the amateur uses) are used on the usual antenna, the lack of aperiodicity is evident. At some setting of the receiver it will be difficult to make the circuits oscillate. Generally the coupling has to be loosened, the plate voltage increased, or feed back increased to maintain oscillations. This occurs at the resonant frequency of the antenna circuit and is due to the absorption of power by it, or what is equivalent to the introduction of resistance into the oscillating circuit. If the antenna cir-



AUTOMATIC VOLTAGE CONTROL ON A RESISTANCE-COUPLED AMPLIFIER

FIGURE 1: *This circuit diagram, using filament control jacks, shows a scheme for applying high plate voltage on all the resistance-coupled stages and a lower voltage on whichever stage the loudspeaker is operating.*



cuit were really aperiodic this would not occur.

A more accurate term to apply to this type of coupling would be "untuned." The term "semi-aperiodic" used by some authors also is more nearly the proper term.

The Circuit for Best's Superheterodyne

QUESTION: I would like to build Best's superheterodyne receiver for operation on a loop which will cover both the broadcasting and amateur wavelengths. Do you think a radio-frequency receiver would be as satisfactory? Can you give me the diagram for a receiver of either type?

HARRY HUNTER

ANSWER: To get satisfactory operation with a loop antenna the equivalent of three stages of radio-frequency amplification must be used. To get satisfactory selectivity the input to the first tube (the loop circuit) and one other stage of radio-frequency should be tuned. To cover the frequency band you wish to, a set of plug-in coils would have to be used which would unnecessarily complicate the construction and operation. We suggest you build the "Best's Modified Superheterodyne" which is designed to operate from 500 to 6,000 kilocycles (600 to 50 meters).

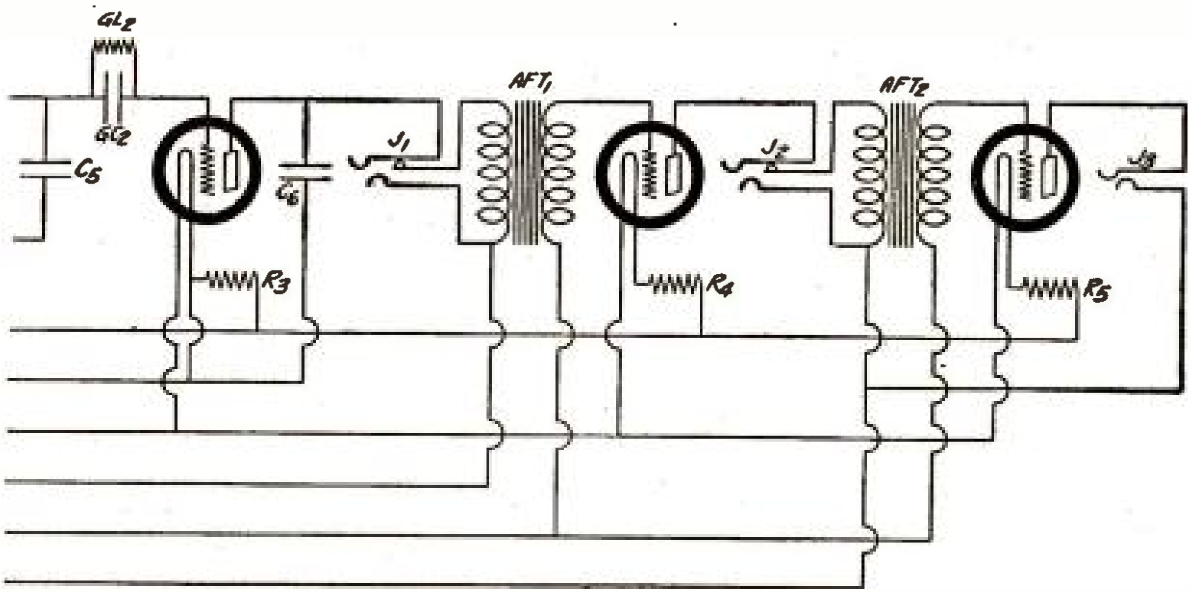
The complete diagram is given in Figure ?. You will need the following parts:

RFT1, RFT2 and RFT3—Intermediate frequency transformers, Remler No. 611, General Radio No. 271, or Silver untuned;
RFT4—Intermediate frequency transformer, Remler No. 610, General Radio No. 331, or Silver tuned;
AFT1 and AFT2—Audio-frequency transformers, General Radio, Karas, Pacent Superformer or Rauland Lyric;
R1, R3, R4 and R8—Automatic filament control cartridges, Amperite No. 1A;
R5—Automatic filament control cartridges, Amperite No. 112;
R2—Rheostat, 30 ohms;
R6—Grid-leak, .1 megohm;
R7—Potentiometer, 2,000 ohms, Federal or Centralab;
L1 and L2—Two windings of oscillator coils, General Radio No. 277-A, B and C;
VC1 and VC3—Variable condensers, .0005 mfd., any reliable make;
VC2—Variable condenser, .00005 mfd., XL Model G, Chelten or Continental;
C1 and C2—Fixed condensers, .006 mfd.;
C3—Fixed condenser, 2 mfd.;
C4—Fixed condenser, 1 mfd.;
C5—Fixed condenser, type recommended by manufacturer for RFT4;
C6—Fixed condenser, .002 mfd.;
GC1—Variable grid condenser, .00005 mfd., same as VC2;
GC2—Fixed grid condenser, with grid-leak mounting, .00025 mfd.;
GL1 and GL2—Grid-leaks, 3 megohm;
S—Filament switch.

In addition to this you will need 5 cushioned sockets for standard base tubes, 3 sockets for 199 tubes, an oscillator coil mounting, Gen-

THE CIRCUIT FOR BEST'S MODIFIED SUPERHETERODYNE

FIGURE 2: *The circuit is designed to tune from 500 to 6,000 kilocycles (600 to 50 meters). Plug-in coils are used to cover this wide frequency band.*



eral Radio No. 274-B and a panel type 0-6 V voltmeter.

UV-199 tubes are used in the three intermediate-frequency stages and standard base tubes in all of the others. The voltmeter permits regulation of the voltage applied to the UV-199 tubes. This voltage is controlled by R2.

When the manufacturers of the audio-frequency transformers specified manufacture transformers of two ratios, the higher ratio should be used in the first stage.

A loop with a mid tap should be used. Condenser VC2 controls regeneration in the loop circuit and should preferably be a small variable condenser which can be adjusted from the panel. If the regeneration control is not wanted the set should be tuned to a high frequency (short wavelength) and VC2 set just below the oscillating point.

Resistance R7 is a volume control. Only two of the connections on this potentiometer should be used. One of those used should correspond to the slider arm on the usual type. At the maximum resistance end it should be disconnected.

The capacity of C5 will depend on the type of intermediate frequency transformers used. This transformer should be a type designed to operate at the same frequency that the untuned ones are. Some manufacturers incorporate C5 in the transformer so no external condenser is needed. Others supply one of the proper value.

Condenser C2 is a fixed condenser which will prevent the full "B" battery voltage being applied to the tube filaments if the plates of VC3 are short-circuited. Its capacity is high enough so it has little effect on the tuning of VC3.

The values of GL1 and GL2 will vary slightly with different tubes and several values should be tried.

The Amperite specified for the last tube is designed to supply .5 ampere. This is the filament consumption of the UX-112 tube which should be used in this stage for best results. If a UV-201-a tube is used the standard .25 ampere Amperite should be used.

The four leads going to L1 and L2 should be connected to the plugs of the oscillator coil mounting. By plugging in the different coils the different frequency ranges can be covered. If no signals are received the connections to either L1 or L2 should be reversed (not both).

If the oscillator dial tunes broadly the value of R6 should be increased to .25 or .5 megohm.

Although one loop can be used for the whole frequency range this is not very satisfactory as two sets of taps on each side of the mid tap have to be used. For the range from 50 to 150 meters a special loop should be used. Use four turns on a 30-inch square frame with a mid tap.

The Proper Size of Coupling Condenser

QUESTION: I have a resistance-coupled audio-frequency amplifier made up with the ordinary resisto-coupler which holds the condenser and two grid-leaks. Could the quality of the music received be improved in any way? Some of the lower musical notes seem to be faint.

A. M. CLAYTON

ANSWER: If your set is made up as usual the coupling condenser in your resisto-coupler is no doubt of the .006 mfd. size. Try adding an external condenser (either one of the small .02 mfd. mica condensers or .1 to .5 mfd. paper condensers) in parallel to the original coupling condenser. This should increase the volume of the lower notes.

THIS *department is conducted by* POPULAR RADIO LABORATORY *for the purpose of keeping the radio experimenter and the broadcast listener informed concerning the newest inventions and the approved developments in radio equipment. Only such apparatus as has been tested and endorsed by the Laboratory is noted in these columns.*

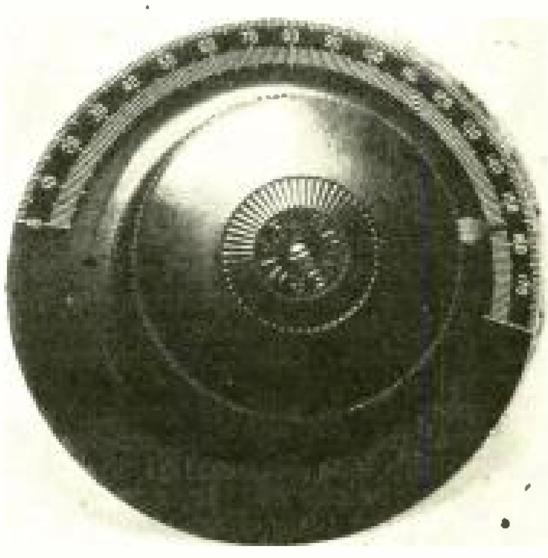
A metallized filament resistor that gives a permanent and uniform resistance for use in receiving sets.

A NEW TYPE OF RESISTANCE

Name of instrument: Resistance unit.
Description: This is a new type of resistance that can be used in resistance-coupled amplifiers or in any other place in the receiving set where a fixed non-varying resistance is necessary. It is made by a new process that embraces coating a glass filament with a metallic covering of the prescribed resistance. The unit fits in any of the standard resistance mountings or grid-leak mountings.
Usage: In any part of an electric circuit where a fixed resistance carrying only a small load is required.
Outstanding features: Small size. Neat appearance. Accurate values. Small variation with voltage.
Maker: Durham & Company.

AN EXCELLENT VERNIER DIAL

Name of instrument: Vernier dial.
Description: This instrument, which goes by the trade name of Univernier, consists of a fixed scale which is graduated in 180 degrees and contains a finer mark adjustment than those now prevalent on the market. It is equipped with a gear train that gives a high ratio of instrument revolution to dial revolution. It is equipped with a pointer and a large knob, which makes it possible for the eperator to see at a glance the setting for tuning in given stations. There is also furnished with this dial a small semicircular slip that fastens in the edge along the graduated circumference of the dial for marking down the station wavelengths as they are desired. This slip of good quality cardboard is large enough to accommodate the call letters of all the stations a set is capable of picking up. The stations are marked down and connected with a pencil mark on the dial setting where they tune in.
Usage: In any receiver for controlling the revolution of the instruments that produce tuning.
Outstanding features: Neat in appearance. Accurate adjustment. Capable of logging.
Maker: Walbert Mfg. Co.



Fine tuning may be accomplished with this dial. The graduations are closer than in any other type of tuning control.

Here is a charger that gives full-wave rectification.

AN EFFICIENT BATTERY CHARGER

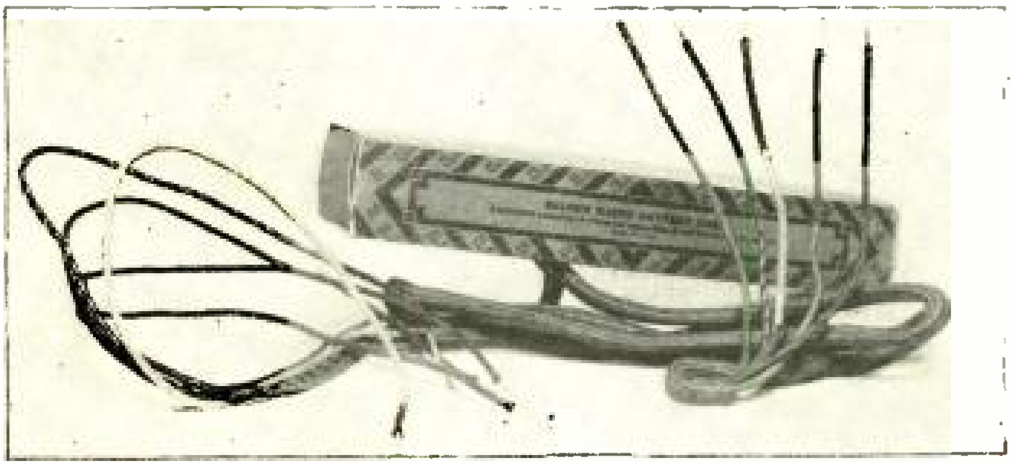
Name of instrument: Battery charger.

Description: This device is known by the trade name of Ful-Wave Battery Charger. It is unique in that it applies a more continuous current to the battery than the ordinary type of half-wave rectifier. It contains the necessary transformer and tube rectifying apparatus to apply both halves of the cycle in the form of a unilateral current to the battery that is to be charged. It is entirely enclosed in a metal case with suitable vent holes for cooling. It is equipped with a plug for screwing into a lamp socket and also with two battery terminals that are to be clipped on to the battery during charge.

Usage: In connection with a storage battery for recharging.

Outstanding features: Supplies a more continuous current to the battery. Quick in operation. Well made. Good appearance.

Maker: Liberty Electric Corp. of New York.



This cord will enable you to make neat connections to your receiver.

A MULTIPLE BATTERY CABLE

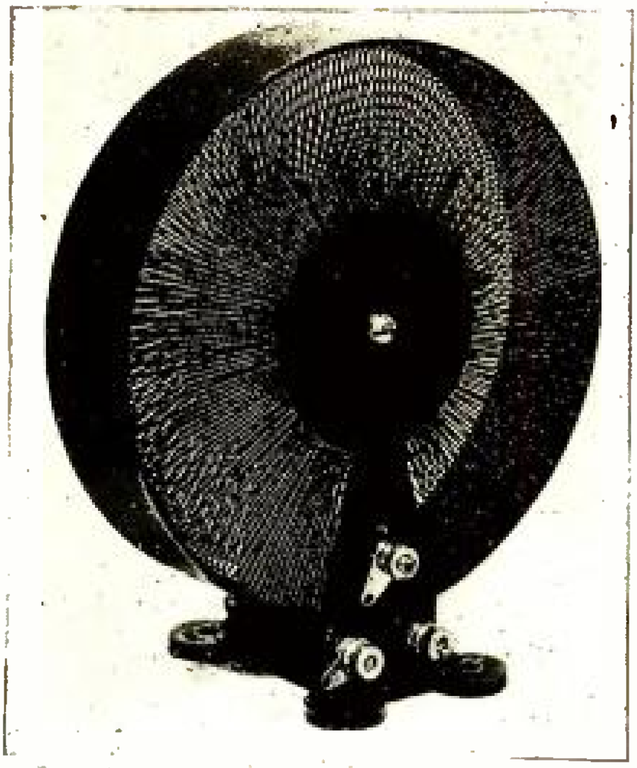
Name of instrument: Battery cable.

Description: This cable contains five different wires, each insulated with rubber and braided insulation of different colors for the "A" battery connection to the receiver and also for the "B" battery connection. It is covered with an "over-all" braid which assembles the five wires on one cable, thus making a very neat method for installation of a receiving set in the home. This article is packed in an attractive carton and is known in the trade as the Belden Radio Battery Cord.

Usage: In connection with the batteries for furnishing the "A" and "B" current to a receiver.

Outstanding features: Suitably insulated. Flexible. Neat in appearance. Easy to install.

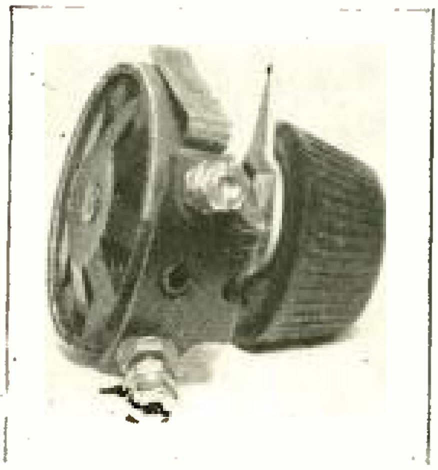
Maker: Belden Mfg. Co.



An air-spaced toroid.

A NEW TYPE OF COIL

Name of instrument: Radio-frequency coil.
Description: This coil is wound with a square cross section embracing the popular toroid shape. It is unique in that the windings are air spaced and only touch the insulating material at the outer periphery and at the inner support which contains the binding posts for connections as well as serving as a base for attaching to the baseboard of a set.
Usage: In a set as a radio-frequency coupler.
Outstanding features: Space winding. Air dielectric. Confined field. Neat.
Maker: All-American Radio Corp.



Compact and reliable.

A RELIABLE RHEOSTAT OF EXTREMELY SMALL SIZE

Name of instrument: Filament rheostat.
Description: This rheostat is made in very small form. It contains a resistance element that is wound on a flexible strip of insulating material which is held fast in a novel manner on the outside of a revolving disc. Contact is made in the same efficient manner as with previous rheostat controls manufactured by the same company. As the resistance element revolves its outer surface makes contact with a flexible arm which is attached to one of the binding posts. The other end of the resistance element is attached to the remaining binding posts. A neat knob and pointer is all that would be seen from the front of the panel when the rheostat is mounted in a receiving set.
Usage: In a set as a filament control.
Outstanding features: Extremely small size. Reliable operation. Good workmanship. Neat appearance.
Maker: Cutler-Hammer Mfg. Co.

No screws are required to mount this instrument.

A PLATE MILLIAMMETER OF SMALL DIAMETER FOR PANEL MOUNTING

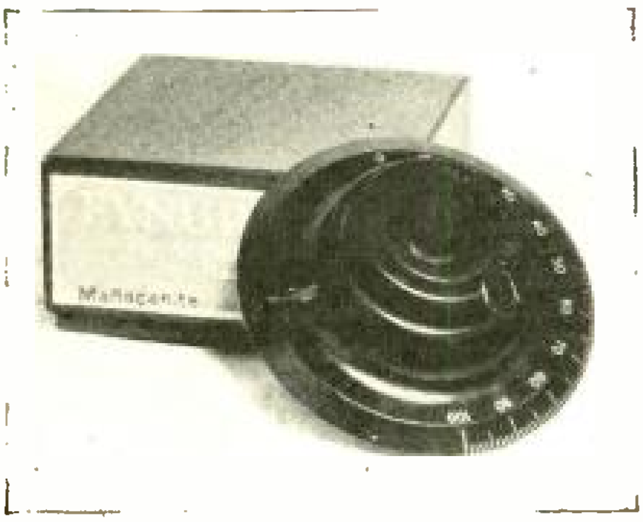
Name of instrument: Direct current milliammeter.
Description: This instrument, which contains a full size movement, is arranged in a small case for mounting on receiving panels. It has a scale reading of from zero to to 15 milliamperes, which makes it suitable for use with most receivers now on the market. It may be connected in the plate circuit in series with the "B" batteries to tell the total amount of current that the set is drawing. In mounting in the hole drilled for it on the panel there are two set screws that are furnished with the instrument which are used to draw the front flange up tight against the panel without drilling extra holes or without the use of external unsightly screws in the panel.
Usage: In a receiving set for measuring the total plate current.
Outstanding features: Small size. Neat appearance. Ease in mounting. Reliable.
Maker: Hoyt Electrical Instrument Works.

A CONDENSER WITH TWO SETS OF SQUARE MOVING PLATES

Name of instrument: Variable condenser.
Description: This condenser is mounted on a piece of bakelite which supports two shafts on which the movable elements pivot. The knob controls a cam which rotates in a grooved slot in the bakelite for obtaining the curve form desired for eliminating crowding of the lower wavelength stations in broadcasting. The trade name for the instrument is the Signal Spiral-cam Condenser.
Usage: In any radio-frequency circuit for tuning.
Outstanding features: High efficiency. Compactness. Low minimum capacity. Simple to mount on panel. Ease in tuning.
Maker: Signal Electric Mfg. Co.

A new type of condenser that contains two sets of movable plates and makes tuning easy at the lower frequencies.

A DIAL OPERATED BY PLANETARY ROLLERS



A vernier dial with no "back-lash."

Name of instrument: Vernier knob and dial.
Description: This knob is made in bakelite with either a black or a mahogany finish and consists of two tuning controls—one being the regular control and the other being a very smooth-action vernier. The dial itself is held on the shaft of the instrument which is used to control by means of a set screw. The action obtained with the vernier is exceptionally even and free from any kind of "back-lash." A suitable adjusting nut of bakelite is attached on the front of the dial, concentric with the shaft, which may be adjusted for applying the proper tension to the rollers for instruments that turn easily or with some friction. The trade name is "Fynur."
Usage: As a dial for tuning radio-frequency circuits.
Outstanding features: Neat appearance. Fine vernier action. No "back-lash." Clear vision of the numerals.
Maker: August Goertz & Co., Inc.

A NEW RESISTANCE ELEMENT

Name of instrument: Fixed resistance.
Description: This unit is built up of a bakelite base in which is mixed a graphitic solution material for the resistance element. It is molded in shape between two terminals that fit the ordinary resistance mounting or it may be soldered directly to the wires that connect it electrically in the circuit by inserting the wires in the hole at each end of the unit. It is known in the trade as a "Bradleyunit."
Usage: In any place in an electric circuit where a fixed high resistance of small carrying capacity is necessary.

A reliable type of resistance unit.

Outstanding features: Compact. Uniform. Not affected greatly by temperature. Accurate within reasonable limitations.
Maker: Allen-Bradley Co.

Apparatus Approved by Popular Radio

This list of apparatus approved by the POPULAR RADIO LABORATORY will be continued as a part of the WHAT'S NEW IN RADIO APPARATUS department until all instruments, parts and complete sets have been included. The listing is alphabetical by manufacturer's name and the installment in this issue includes only the letters S and T.

AERIALS

Balloon aerial (for amateur experimental purposes only); Everett Scanlon.
Springfield stranded braided antenna wire; Springfield Wire & Tinsel Co.
Super-antenna; Super-Antenna Co.

AUDIO-FREQUENCY TRANSFORMERS

Samson helical-wound transformer; Samson Electric Co.
Giblin audio-frequency transformer; Standard Radio & Electric Co.
"States" transformers; The States Co.
"Sterling" audio-frequency transformer; Sterling Mfg. Co.
"Superior" audio-frequency transformer; Superior Products Mfg. Corp.
Thordarson super audio-frequency transformer; Thordarson Elec. Mfg. Co.
Thordarson interstage power amplifying transformer; Thordarson Elec. Mfg. Co.
Thordarson autoformer; Thordarson Elec. Mfg. Co.

BATTERIES

Sidbenel "B" batteries (wet); Sidbenel Electric Co.
"Twin" dry batteries; Twin Dry Cell Battery Co.

BINDING POSTS

Snap-on binding post; Snap-On Electric Co.

CRYSTAL DETECTORS

Silvertone crystal detector; Silvertone Crystal Co.
Sensitive cartridge detector; Stafford Radio Co.
Radetec fixed detector; Towner Radio Mfg. Co.

DIALS

Visidials; Harold M. Schwab, Inc.
Dial; Trufix Radio Products Co.

FIXED CONDENSERS

"Sangamo" mica fixed condenser; Sangamo Electric Co.
"Schindler's" build-up mica condenser (can be taken down and varied); Chas. Schindler.
Fixed condenser; Stafford Radio Co.

GRID-LEAKS AND RESISTANCES

Resistron; Temple Instrument Co.
"Turn-it" adjustable grid-leak; Turn-it Radio Sales, Inc.

HEADPHONES

Deveau Gold Seal headset; Stanley & Patterson.
"Tower's" scientific headset; Tower Mfg. Co.
Ambassador phones; Tower Mfg. Co.
"Little Spitfire" headset; Tower Mfg. Co.
Berwick Supreme headphones; Triangle Electric Trading Co.
"Trimm" headset; Trimm Radio Mfg. Co.
Professional headset; Trimm Radio Mfg. Co.
Dependable headset; Trimm Radio Mfg. Co.

INSULATORS

"Stormproof" insulator; Stormproof Corp.

JACKS

"Saturn" jack; Saturn Mfg. & Sales Co., Inc.
Radio anti-capacity jacks; Sharpe Spark Plug Co.

KITS

Samson super-kit; Samson Electric Co.
De Luxe neutrodyne kit; Harold M. Schwab, Inc.
"Shamrock" kit (tuned radio-frequency); Shamrock Mfg. Co.
Silver superheterodyne kit; Silver-Marshall, Inc.
Sypher ultradyne kit; Sypher Mfg. Co.

LIGHTNING ARRESTERS

Simplex lightning arrester; Simplex Radio Co.

LOOPS

Volumax loop; Scott & Fetzer Co.
Hexloop; Scribner Co.
Silver collapsible center-tapped loop; Silver-Marshall, Inc.
"Key to the air" cage antenna; Stafford Radio Co.

LOUDSPEAKERS

"Sheltone" loudspeaker; Sheltone Co.
"Timbretone" loudspeaker; Timbretone Mfg. Co.
"Timbretone" loudspeaker (cabinet type); Timbretone Mfg. Co.
Timmons Talkers; J. S. Timmons.
"Little Spitfire" loudspeaker; Tower Mfg. Co.
Tower's Scientific loudspeaker; Tower Mfg. Co.
Berwick Supreme loudspeaker; Triangle Electric Trading Co.
Concert model speaker; Trimm Radio Mfg. Co.
Homespeaker; Trimm Radio Mfg. Co.
Trinity loudspeaker; Trinity Radio Corp.

MISCELLANEOUS ACCESSORIES

Safe-guard insulation; Safe-guard Insulation Co.
Battery connector; H. B. Sherman Co.
Extension connector; H. B. Sherman Co.
Somerville terminal tags; Somerville Radio Stores.
Universal coil winding machine; Specialty Automatic Machine Co.
Steinite interference eliminator; Steinite Laboratories.
Steinmetz amplifier for crystal sets; Steinmetz Wireless Mfg. Co.
Sterling home tube tester; Sterling Mfg. Co.
"Lastite" (soldering terminals); Wm. Stevens Co.
Insurtube; Terle Electric & Mfg. Co.
Wire nuts; Tork Co., Inc.

PANELS

Spaulding bakelite-duresto; Spaulding Fibre Co., Inc.
Celesto shadow black panels; Triangle Rubber & Supply Co.

PHONE PLUGS

"Saturn" automatic plug; Saturn Mfg. & Sales Co., Inc.

PHONOGRAPH ATTACHMENTS

Dulce-Tone; Teagle Co.
Trimm phonograph attachment; Trimm Radio Mfg. Co.

RADIO CABINETS

Salisbury radio tables; Salisbury Bros. Furniture Co.
Radio cabinets and furniture; Southern Toy Co.
Glass cabinets; Steffen Glass Cabinet Co.

RADIO-FREQUENCY TRANSFORMERS

Radio-frequency transformers; Sangamo Electric Co.
Silver radio-frequency transformer unit; Silver-Marshall, Inc.
Giblin radio-frequency transformer; Standard Radio & Electric Co.
Sterling radio-frequency transformer; Sterling Mfg. Co.
Sterling intermediate-frequency transformer; Sterling Mfg. Co.
Summit toroidal transformers; Summit Radio Mfg. Co., Inc.
Matched superheterodyne transformers; Sypher Mfg. Co.
Ultradyne transformer; Sypher Mfg. Co.

RECEIVING SETS

Brunswick De Luxe Ambassador receiver; Harold M. Schwab, Inc.

Service receivers; Service Radio Co.
Thermiodyne radio receiver; Shepard-Potter Co., Inc.
"Shepco" "All Purpose" receiver; Shepard-Potter Co.
Silver superheterodyne receivers; Silver-Marshall, Inc.
Silverset receiver; Silverset Radio Co.
Simplex SR-r receiver; Simplex Radio Co.
Giblin Radiocar receiver; Standard Radio & Electric Co.
Standardyne receiver; Standard Radio Corp.
7-tube superheterodyne receiver; Stanwood Electric Specialty Co., Inc.
Thermiodyne receiver; Thermiodyne Radio Corp.
Thompson neutrodyne receiver; R. E. Thompson Mfg. Co.
Thompson 5-tube neutrodyne knockdown set; R. E. Thompson Mfg. Co.
Sectional "Universal" radio outfits; Tresco Radio.
"Tuska" receivers; C. D. Tuska Co.

RHEOSTATS

Filament rheostat; Sterling Mfg. Co.

SOCKETS AND ADAPTERS

Silver 5-gang No. 199 socket; Silver-Marshall, Inc.
Dulce-Tone (phonograph adapter); The Teagle Co.

SWITCHES

"Saturn" battery switch; Saturn Mfg. & Sales Co., Inc.
Radjo anti-capacity switch; Sharpe Plug Co.

TESTING INSTRUMENTS

Filament meter; Sterling Mfg. Co.
Panel type meter; Sterling Mfg. Co.
Pocket type meter; Sterling Mfg. Co.

TOOLS AND EQUIPMENT

Samson electric soldering iron; Samson Cutlery Co.
"Bernard" hand-vise pliers; Wm. Schollhorn Co.
"Kant Stick" hydrometer; Scranton Glass Instrument Works, Inc.
Scranton hydrometer; Scranton Glass Instrument Works, Inc.
Ayanbee hydrometer; Scranton Glass Instrument Works, Inc.
Spintite wrenches; Stevens Co.
Stevens speed-up tools; Stevens Co.
Stevens panel cutter and bezel beader; Stevens & Co.
Stevens combined drill and countersunk; Stevens & Co.

TUBES

"Schickerling" tubes; Schickerling Products Mfg. Co.
Acrodyn tube type 201-a; Star Engineering Co.
"Comet" vacuum tube; Summit Radio Co.
Claritron tube, type 201-a; Superior Radio Co.
Supertron radio tubes; Supertron Mfg. Co.

TUNING INDUCTANCE UNITS

Samson oscillator coupler; Samson Electric Co.
Oscillator coil unit; Sangamo Electric Co.
"Ray" coils; R. C. Schoonhoven.
"Shamrock" variocoupler; Shamrock Mfg. Co.
"Radjo" low-loss tuner; Sharpe Spark Plug Co.
"Shepco" all-wave coupler; Shepard-Potter Co., Inc.
Sickles diamond weave inductance coils; F. W. Sickles Co.
Sickles variometer; F. W. Sickles Co.
Sickles variocoupler; F. W. Sickles Co.
Sickles tuned transformer coil; F. W. Sickles Co.
Sickles knockout coil; F. W. Sickles Co.
Sickles coils for Roberts' circuit; F. W. Sickles Co.
Sickles coils for Craig reflex; F. W. Sickles Co.
Silver oscillator coupler; Silver-Marshall, Inc.
Silver coupling unit; Silver-Marshall, Inc.
Simplex variocoupler; Simplex Radio Co.
Simplex DX tuner; Simplex Radio Co.
Kelcoil; Syco Radio Products Corp.
Oscillating coil; Sypher Mfg. Co.
Tuning coil; Sypher Mfg. Co.

VARIABLE CONDENSERS

Silver low-loss condenser; Silver-Marshall, Inc.
Microdenser; Sterling Mfg. Co.
Thordarson variable condenser; Thordarson Electric Mfg. Co.

Kadel & Herbert

A NOVEL VARIOMETER LOOP

A new variometer loop antenna which consists of two semi-elliptical coils, one of which may be rotated in a plane at right angles to its axis so that the inductive relation may be varied continuously, has been designed by Stewart C. Whitman, who is pictured above adjusting the knob that tunes the instrument. This loop may be used with a fixed shunt capacity instead of the usual variable capacity unit.

CONDUCTED BY DR. E. E. FREE

The Einstein Theory Confirmed Once More

OF the three tests originally proposed to determine the truth of the Einstein theory of relativity one was the alteration of the wavelength of light rays originating on the sun. According to Einstein light is affected by gravity. One of the other two tests, you remember, was the bending of the rays of starlight by the intense gravitational attraction of the sun. The wavelength alteration is another gravitational effect. The intense gravitational attraction at the surface of the sun affects the hot atoms of hydrogen and other gases there. The light waves which these atoms omit are slightly longer than similar waves omitted by the same kinds of atoms on earth, where gravity is less intense.

This wavelength test for the Einstein theory was applied to sunlight by Dr. St. John of Mount Wilson Observatory. His results confirmed the theory, although the proof turned out not to be absolute. Some necessary corrections were introduced and a few possible uncertainties came in with them. Now the same test has been applied to a much more striking instance, the light from the tremendously heavy companion star of Sirius. Again the work comes from the Mount Wilson Observatory and is reported in a paper by Dr. Walter S. Adams, the Director of that observatory!

This star called Sirius is the brightest fixed star in the sky. To the eye it seems a single star. Astronomers have discovered, however, that it really is two stars. They revolve about each other in some fifty years, much as the earth revolves about the sun. The fainter of the two stars is believed to have an astounding density. Professor Eddington, the great English astronomer, has estimated that the matter of this star may weigh more than 4,000 times as much as the same volume of lead.

Naturally the force of gravity on so dense a star will be far more intense than on the surface of our sun. The shift of the wavelengths of the light rays, as required by the Einstein theory, will be correspondingly greater. Calculations indicate, in fact, that this shift in the light from the Sirius companion ought to be about thirty times as great as the analogous shift in light rays from the sun.

The exact determination of the wavelength shift in the Sirius light was not easy. The light rays from the faint companion star are difficult to separate from those originating on the much brighter disk of Sirius itself.* But, using the great 100-inch telescope at Mount Wilson, Dr. Adams overcame these difficulties. The expected shift of the wavelengths was detected. It corresponds with the amount predicted from the Einstein equations. And so, the famous theory has passed successfully another test.

Electrons Leave Filament as They Should

MANY years ago the great British physicist, James Clerk Maxwell, worked out what has come to be known as Maxwell's Law for the formulation of events which happen by chance. For example, this law states the number of molecules of a gas which will have high speeds, the number which will have low speeds and the number which will have moderate speeds; all at any given instant and at a determined temperature and pressure. Electrons in a vacuum tube behave in many ways as do the flying molecules of a gas, and Maxwell's Law has been applied, also, to the calculation of many of the rules which control the behavior of the electron population in such a place as a radio vacuum tube.

The same law has been applied, furthermore, to the escape of the electrons from the filament. Many filament calculations are based, implicitly or explicitly, on this famous principle. Experiment has confirmed it, so far as the experiments were accurate, but it has been felt that they were not accurate enough. Re-

* "The Relativity Displacement of the Spectral Lines in the Companion of Sirius," by Walter S. Adams. *Proceedings of the National Academy of Sciences* (Easton, Pa.), vol. 11, pages 382–387 (July, 1925).

cently Mr. L. H. Germer, of the Bell Telephone Laboratories, has repeated the experimentation with extreme care and with every possible refinement.* The electrons are well-behaved. Maxwell's Law is obeyed; the respective percentages of speedy, slow and moderately fast electrons leaving the filament in any instant are just what the Maxwell calculations indicate that they ought to be.

To the radio expert the chief value of this result will be an increment of peace of mind. We have been assuming certain things about electrons; that they are tiny separate charges of electricity, that they can collide and rebound much as tennis balls would, that they escape from a hot filament in somewhat the same way in which water molecules evaporate from an exposed surface. Gradually we have grown to think of these assumptions as facts, although no one of us has ever seen an electron nor can make even the wildest guess as to what it would look like if we could see it. And so, it is consoling to discover that a piece of extremely careful measurement on electrons shows that they really do behave, in this instance at least, in the way which we have been assuming for them.

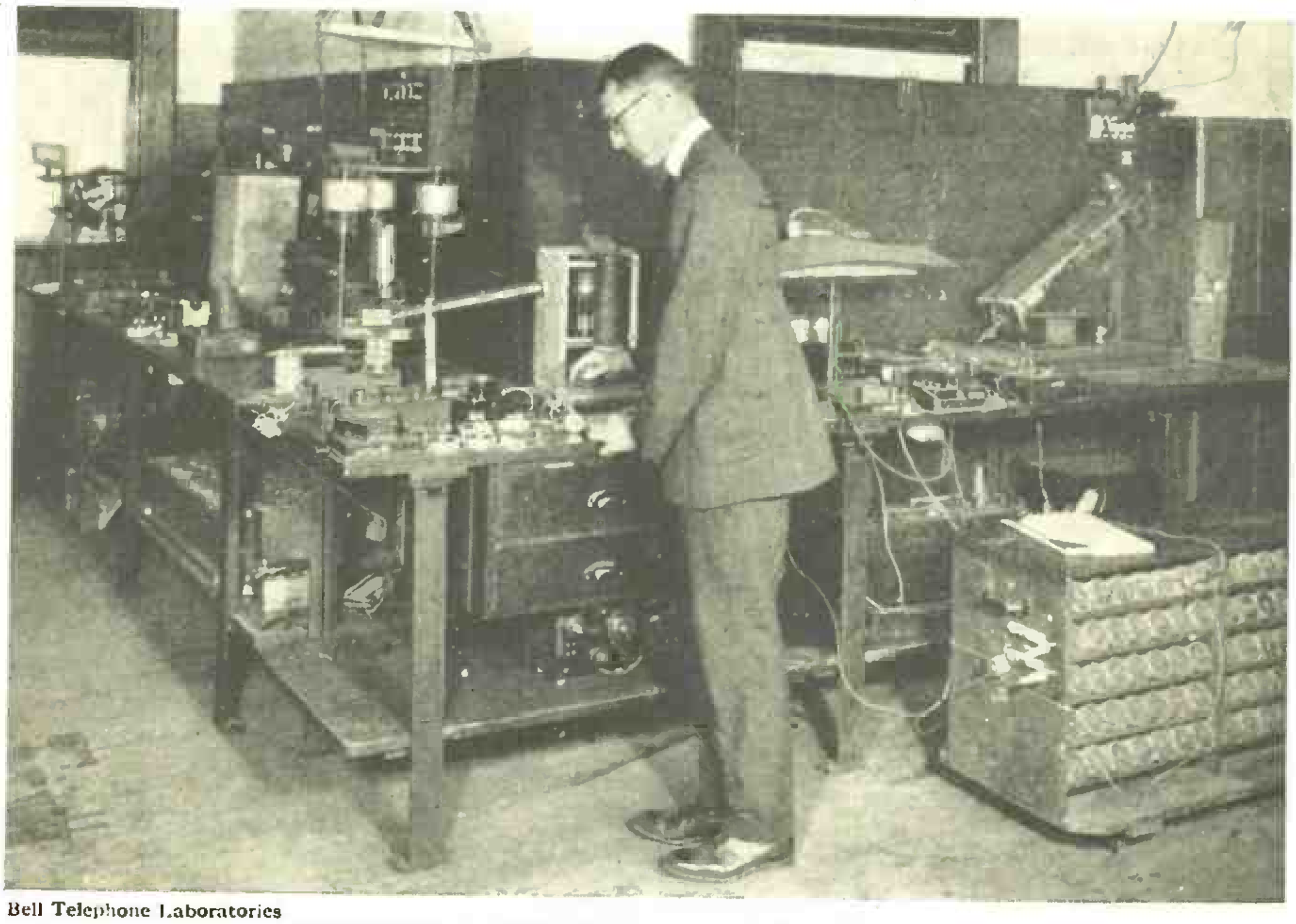
*"The Distribution of Initial Velocities Among Thermionic Electrons," by L. H. Germer. *The Physical Review* (Corning, N. Y.), vol. 25, pages 795-807 (June, 1925).

Inspecting Motors by Radio

EVERY radio listener knows that a radio set will pick up and make annoyingly audible the electromagnetic disturbances sent out by motors which have imperfect brushes or are otherwise not in good condition. Many a fan has complained about the elevator motors in his apartment house, often to the actual advantage of the landlord, who did not know that he was wasting costly current for want of a little adjustment of his motor brushes. Now this same tendency of bad motors to broadcast radio noise has been put to practical use by Mr. John O. Gerson of the street railway company of Charleston, S. C.*

By arranging an antenna wire parallel to the track along which the cars are run and connecting this antenna to a special listening set, Mr. Gerson was able to hear the noises produced by the motors and to determine, in many instances, incipient faults of adjustment before these faults became noticeable to the motorman. The inclusion of simple tuning devices permitted the listener to distinguish between the normal hum of the motor and the high-frequency hiss of an arcing brush.

*"Radio Used to Discover Electrical Defects in Cars," by John O. Gerson. *The Electrical Railway Journal* (New York), vol. 66, page 90 (July 18, 1925).



Bell Telephone Laboratories

HOLDING A STOP-WATCH ON ELECTRONS

Mr. L. H. Germer, of the Bell Telephone Laboratories, has studied with the maximum possible accuracy the speeds of the electrons given off from a hot filament, like the filaments of radio vacuum tubes. Some of these electrons are very fast, others are relatively slow. The percentages of slow ones and fast ones agree with the theories worked out in advance.

A RECORD OF THE ELECTRON GUN

This picture shows how the end of the electron pencil, where it strikes the glass end of the tube, vibrates under the influence of an alternating magnetic field.

It seems probable that a special, portable receiver, properly equipped to tune in, in turn, different frequency bands, would be a useful inspection instrument, not only in the street railway industry, but to all users of many electric motors. Here is a problem for radio amateurs, one which it might be well worth while financially for some one to solve by devising a dependable and convenient standard hook-up for motor-inspection purposes.

A New Electron Gun

ONE of the well-known instruments for studying the oscillations of radio circuits is the Braun tube or electron oscillograph.* In this device a narrow stream or "pencil" of flying electrons is deflected to one side or the other by the voltages of the oscillating circuit. This electron pencil strikes against a flattened end of the tube. This end being coated with a chemical which gives off light under electron bombardment. Where the electrons strike, a glowing spot appears on the tube. As the pencil swings back and forth in time with the oscillations of the circuit, this spot is spread out into a line or curve. Thus one obtains the oscillograph records which are used to determine the modulation of broadcasting stations and to study the multitudinous properties of radio circuits and instruments.

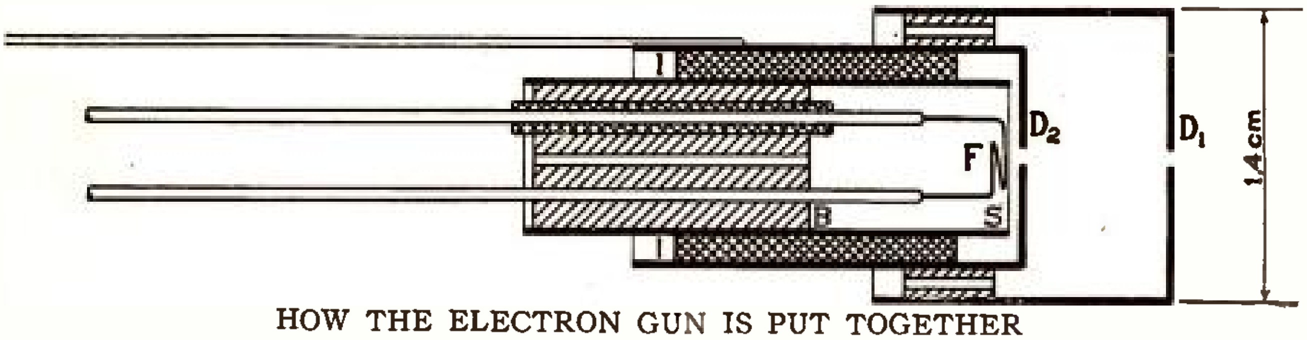
This instrument has now been so modified that not only the glowing spot at the end of the tube is visible, but also the beam of electrons itself. The electron pencil shines visibly as it passes along the tube, much as though it were a beam of light. A more exact analogy is the visible track produced by a stream of tracer bullets fired from a machine gun, each bullet leaving its trace of smoke and flame as it flies through the air. Just so the electrons shot from the new "electron gun" leave a glowing track in the gas inside the tube.

The new instrument is the invention of Professor J. W. Buchta, of the Department of Physics of the University of Minnesota.† It differs from the ordinary Braun tube mainly in containing a little mercury vapor. It is this vapor which renders the electron beam visible. Electrons are given off from a hot filament, just as in the ordinary radio tube. An applied voltage drives these electrons through holes in two metal diaphragms, thus producing the electron stream. This is the "gun" part of the apparatus. The electrons then encounter free atoms of mercury, flying around inside the tube. Some of these atoms are disrupted by the flying electrons. They then give off light. Thus the visible beam is produced.

Any beam of electrons is easily deflected by electrostatic or magnetic forces, but the beam of Professor Buchta's device is especially readily moved in this way. A permanent magnet held near the tube will bend the beam through a considerable angle. Even the effect of the earth's magnetism is evident when the

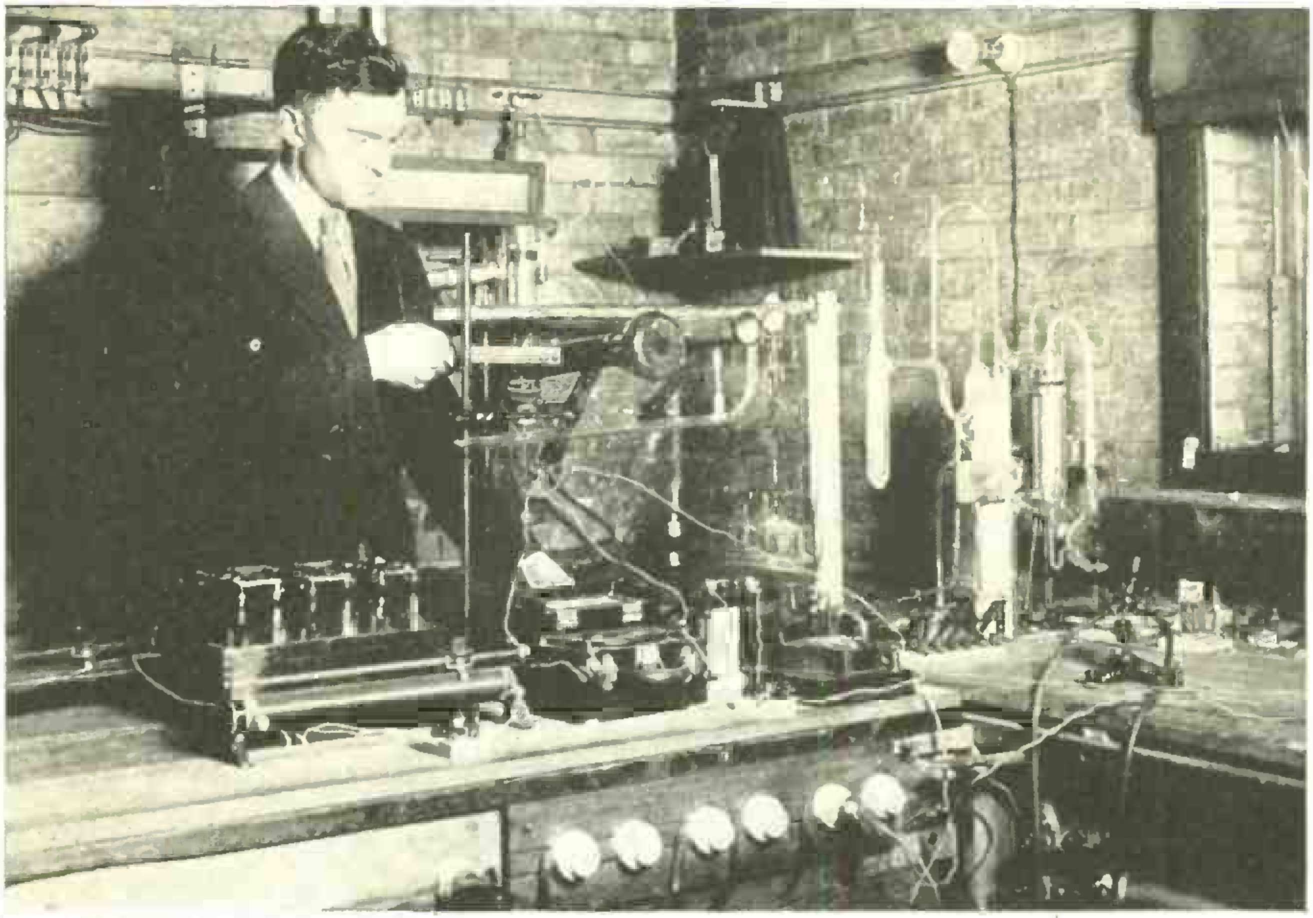
*For a description of this instrument see "The Electron Pencil for Studying Radio Circuits," by Paul Findley, POPULAR RADIO, for April, 1924, pages 328-334.

†"A Low-voltage Electron-beam Oscillograph," by J. W. Buchta. *Journal of the Optical Society of America* (Manesha, Wis.), vol. 10, pages 581-590 (May, 1925).



HOW THE ELECTRON GUN IS PUT TOGETHER

F is the hot filament from which the electrons escape. D_1 and D_2 are diaphragms, each with a small hole, these holes confining the escaping electrons to a single straight pencil. The first diaphragm is positively charged, to pull the electrons away from the filament. B is a metal block. The doubly crosshatched portions of the diagram represent glass tubes, used for insulation.



From a photograph made for POPULAR RADIO

PROFESSOR BUCHTA'S ELECTRON GUN IN ACTION

The oscillograph tube, into which the electrons are fired, projects toward the front, just at Professor Buchta's left. The gun itself is in the rear. Professor Buchta is holding a bar magnet, by which the visible stream of electrons inside the tubes may be deflected to one side or the other, depending on the pole of the magnet which one uses. At the right is the pump used to maintain the necessary vacuum in the tube.

tube is moved from a north-and-south position to an east-and-west position. Like other forms of electron-beam oscillograph, the instrument has practically no lag and almost no inertia. It responds instantly to alterations in the electric or magnetic forces affecting it.

Its greatest value will probably lie, however, in the visibility of the electron pencil through the tube. Professor Buchta states that the characteristics and utility of the instrument as a radio-frequency oscillograph are now being investigated. The possibility of actually seeing, instantly and directly, what is happening to the stream of bullets from the electron gun ought to give the device important value in many radio investigations, as well as in studies of magnetic and electric effects in other fields of science.

Do Impurities Improve Crystal Detectors?

AN important contribution to the much-discussed question of the theory of crystal detection was made a short time ago by Dr. Edgar T. Wherry, the distinguished mineralogist, now connected with the Bureau of Chemistry, in Washington.* Dr. Wherry examined a large number of mineral species of the most varied chemical composition. A number were found to have some value as detectors and some of these were found to vary from good to bad depending upon the amount of impurity in the crystal. Zincite, for example, is better the purer the crystal. But galena and pyrite reverse this behavior. Pure crystals do not detect well. Impure crystals, containing atoms of other elements built into the crystal structure, sometimes form the best detectors.

To explain his results, as well as the many other puzzling facts about crystal detection, Dr. Wherry suggests that the property of one-way conduction which characterizes good detector crystals may be related to an internal atomic structure such that the electrons are held in place by slightly unbalanced forces. They find it possible to move more freely in one direction (with relation to the crystal axis) than in the reverse direction. The effect of impurities may be, Dr. Wherry thinks, to distort slightly the atomic framework of the crystal, so that this one-sided holding of the electrons to their places comes into play.

What theory of crystal detectors will prove to be correct only time and more experiments will determine. Meanwhile, experimenters will find in Dr. Wherry's tables, reprinted on the next page, what is probably the most complete list of detector minerals compiled to date.

* "Radio-Detector Minerals," by Edgar T. Wherry. *The American Mineralogist* (Menasha, Wis.), vol. 10, pages 28-31 (February, 1925).

GOOD DETECTORS

Artificial Silicon .... Si
Impure pyrite, iron sulphide .... FeS_2
Tennantite, iron-copper arseno-sulphide .... $Fe_2Cu_{10}As_4S_{13}$
Enargite, copper arseno-sulphide .... Cu_3AsS_4
Artificial zinc oxide (zincite), pure .... ZnO
Impure galena, lead sulphide .... PbS

FAIR DETECTORS

Graphite, carbon C
Artificial carborundum, silicon carbide .... SiC
Octahedrite, titanium oxide .... TiO_2
Brookite, also titanium oxide .... TiO_2
Molybdenite, molybdenum sulphide .... MoS_2
Pyrolusite, manganese oxide .... MnO_2
Pyrrhotite, iron sulphide .... FeS (variable)
Loellingite, iron arsenide .... $FeAs_2$
Hematite, iron oxide .... Fe_2O_3
Taenite, iron and nickel .... Fe, Ni
Chalcopyrite, iron-copper sulphide .... $FeCuS_2$
Tetrahedrite, iron-copper-antimony sulphide .... $Fe_2Cu_{10}Sb_4S_{13}$
Linneite, cobalt sulphide .... Co_3S_4
Glaucodotite, cobalt arseno-sulphide .... $CoAsS$
Polydymite, nickel sulphide .... Ni_3S_4
Rammelsbergite, nickel arsenide .... $NiAs_2$
Chalcocite, copper sulphide .... Cu_2S
Berzelianite, copper selenide .... Cu_2Se
Famatinite, copper antimono-sulphide .... Cu_3SbS_4
Stromeyerite, copper-silver sulphide .... $CuAgS$
Aguilarite, silver seleno-sulphide .... Ag_2 (S, Se)
Naumannite, silver selenide .... Ag_2Se
Hessite, silver telluride .... Ag_2Te
Sylvanite, silver-gold telluride .... $AgAuTe_4$
Calaverite, gold telluride .... $AuTe_2$
Natural zincite (impure), zinc oxide with manganese .... (Zn, Mn) O
Tiemannite, mercury selenide .... $HgSe$
Coloradoite, mercury telluride .... $HgTe$
Clausthalite, lead selenide .... $PbSe$
Chiviatite, lead-bismuth sulphide .... $PbBi_4S_7$
Beegerite, another lead-bismuth sulphide .... $Pb_6Bi_2S_9$
Guitermanite, lead-arsenic sulphide .... $Pb_3As_2S_6$
Guanajuatite, bismuth seleno-sulphide .... Bi_2Se_2S

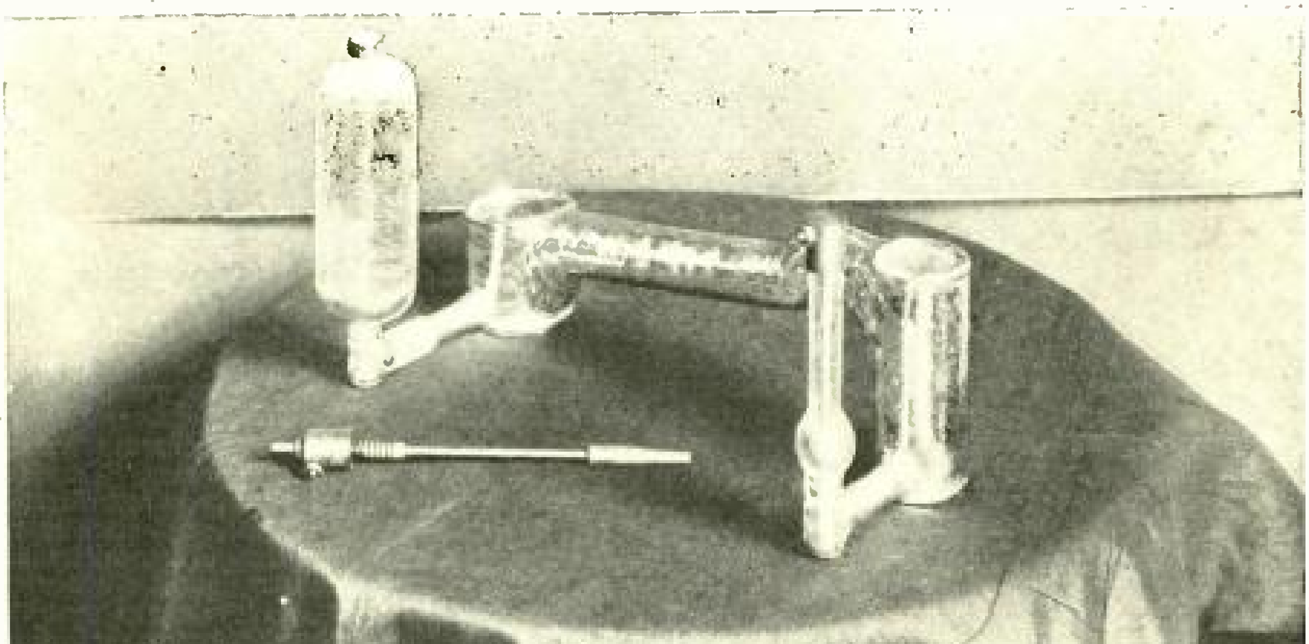
POOR DETECTORS

Anthracite (hard coal), carbon with impurities C
Artificial metallic titanium .... Ti
Ilmenite, iron-titanium oxide .... $FeTiO_3$
Psilomelane, hydrated manganese oxide .... $MnO \cdot OH$
Metallic iron (artificial) .... Fe
Arsenopyrite, iron arseno-sulphide .... $FeAsS$
Magnetite, magnetic iron oxide .... Fe_3O_4
Pentlandite, iron-nickel sulphide .... (Fe, Ni) S
Bornite, iron-copper sulphide .... $FeCu_5S_4$
Stannite, iron-copper-tin sulphide .... $FeCu_2SnS_4$
Smaltite (Safflorite), cobalt arsenide .... $CoAs_2$
Cobaltite, cobalt arseno-sulphide .... $CoAsS$
Metallic nickel (artificial) .... Ni
Ullmannite, nickel antimono-sulphide .... $NiSbS$
Domeykite, copper arsenide .... Cu_3As
Covellite, copper sulphide .... CuS
Rickardite, copper telluride .... Cu_4Te_3
Eucairite, copper-silver sellenide .... $CuAgSe$
Aikinite, copper-lead-bismuth sulphide .... $CuPbBiS_3$
Argentite, silver sulphide .... Ag_2S
Empressite, silver telluride .... $AgTe$
Argyrodite, silver-germanium sulphide .... Ag_8GeS_6
Petzite, silver-gold telluride .... Ag_3AuTe_2
Alaskaite, silver-lead-bismuth sulphide .... $Ag_2PbBi_4S_8$
Nagyagite, gold-lead antimono-telluro-sulphide .... $AuPb_6$ (Sb, Te)$_4S_9$
Metacinnabarite, mercury sulphide .... HgS
Onofrite, mercury seleno-sulphide .... Hg (S, Se)
Altaite, lead telluride .... $PbTe$
Bismutoplagionite, lead-bismuth sulphide .... $Pb_5Bi_8S_{17}$
Galenobismutite, lead-bismuth sulphide .... $PbBi_2S_4$
Lilianite, lead-bismuth sulphide .... $Pb_3Bi_2S_6$
Arsenic .... As
Antimony .... Sb
Bismuth .... Bi
Tetradymite, bismuth telluro-sulphide .... Bi_2Te_2S
Tellurium .... Te

NON-DETECTORS

(Although they might be expected to be detectors)

Rutile, titanium oxide .... TiO_2
Zircon, zirconium-silicon oxide .... $ZrSiO_4$
Columbite, iron-columbium oxide .... $FeCb_2O_6$
Tantalite, iron-tantalum oxide .... $FeTa_2O_6$
Chromite, iron-chromium oxide ("chrome iron ore") .... $FeCr_2O_4$
Ferberite, iron-tungsten oxide .... $FeWO_4$
Uraninite (impure), uranium oxide .... UO_2
Alabandite, manganese sulphide .... MnS
Troilite, iron sulphide .... FeS
Franklinite, iron-zinc oxide .... Fe_2ZnO_4
Millerite, nickel sulphide .... NiS
Cuprite, copper oxide .... Cu_2O
Marmatite, iron-zinc sulphide .... (Fe, Zn) S
Greenockite, cadmium sulphide .... CdS
Cinnabarite, mercury sulphide .... HgS
Cassiterite, tin oxide .... SnO_2
Stibnite, antimony sulphide .... Sb_2S_3
Bismuthinite, bismuth sulphide .... Bi_2S_3
Selenium (crystallized) .... Se



The Scientific American

PROFESSOR MIETHE'S GOLD-MAKING LAMP

This lamp, built of fused quartz and containing mercury vapor, is an exact replica of the lamp used by Professor Miethe in the experiments which were reported to have yielded gold from mercury. American investigators, repeating these experiments, have failed to confirm them. German reports also indicate doubt of Professor Miethe's results.

Courtesy of Dr. O. von Miller, Deutsches Museum, Munich

WHERE A REAL ALCHEMIST WORKED

In the famous German Museum, at Munich, Germany, there has been constructed this exact model of a laboratory used by the ancient alchemists in their chemical researches, one of the chief of which was the attempt to make gold out of baser metals. The curiously-shaped pieces of alchemical apparatus were the parents of many devices used in modern laboratories.

The New Alchemy Fails to Make Gold

OVER a year ago Professor Adolphe Miethe, a well-known chemist of Berlin, startled the scientific world by the announcement that he had succeeded in the century-long quest of the ancient alchemists. He had accomplished, he believed, the transmutation of a base metal—in this case mercury—into gold. The process was quite simple. Some mercury was put into a quartz tube and boiled. Through the mercury vapor thus produced a strong electric current was passed, exactly as it is passed in the familiar Cooper-Hewitt lamps and in other forms of mercury vapor arc. After some hours of the action of the current the mercury was found, Professor Miethe reported, to contain a minute amount of gold which had not been there before.

He assumed that a few of the atoms of mercury in the arc had been transmuted by electric forces into atoms of gold. A little later, a Japanese scientist, Dr. H. Nagaoka, of Tokyo, announced the probable transmutation of mercury into gold by a somewhat different method; the effective agent in this instance being bombardment of the mercury surface by a stream of high-speed electrons.*

Immediately following the first announcement by Professor Miethe, the *Scientific American* arranged for the repetition and critical examination of the experiments, the work being conducted by Mr. Roger S. Estey, working under the direction of Professor H. H. Sheldon in the physical laboratories of Washington Square College of New York University, New York City. The result of this test is now reported.†

The tests were entirely negative. Experiments with special apparatus, devised to test the theory of atomic transmutation supposed to underly Professor Miethe's results, showed no transmutation. Other tests conducted with the exact method and apparatus used by Professor Miethe himself, led to the same result. Although the *Scientific American* is properly cautious in claiming that Professor Miethe's results are definitely erroneous, the fact is clearly evident that these results have failed to be confirmed after a most careful and competent test.

Meanwhile a committee of German chemists has been scrutinizing Professor Miethe's results and materials in his own laboratory. These experts, too, are critical. It is reported that the method used by Professor Miethe to purify his mercury before use was incapable of removing

*Professor Nagaoka reports his results in *Nature* (London), vol. 116, pages 95-96 (July 18, 1925).

†"Tests Fail to Confirm Transmutation to Gold." *The Scientific American* (New York), vol. 133, pages 296-297 (November, 1925).

the last traces of gold which might have been present as an impurity. It is probable, says the German committee,§ that the gold which was found *after* exposure of the mercury to the electric forces had really been there all the time. The implication is that Professor Miethe neglected to purify his materials and that his work is entirely wrong. So far as now announced, no repetition of Professor Nagaoka's experiments has yet been undertaken, but the negative result in Professor Miethe's case will naturally cast some suspicion on the Japanese claims as well.

Transmutation stands, therefore, in just the situation in which it stood before the recent excitement. Atomic theory indicates that it is possible. The atom of mercury has only one more planetary electron than has the atom of gold. The atom of another element, thallium, has two more; the atom of lead three more; the atom of bismuth four more. On the other side, platinum has one less planetary electron than gold; our familiar tungsten has five less electrons. Any of these atoms might be converted, by simple enough changes, into gold atoms. Probably some of them will be so converted before long. But there is no evidence, as yet, that any of them actually has been converted. Cheap gold—so cheap, for example, that we could use gold wire for antennas and gold plates for condensers—would have many industrial and scientific utilities, but it is not now in sight.

§The report, by E. H. Riesenfeld, Wilhelm Haase, Erich Tiede, Arthur Schleede and Frieda Goldschmidt, is abstracted, in English, in a newspaper dispatch by Science Service, Washington, D. C., published in *Science* (Lancaster, Pa.), vol. 62, number 1601, page xiv (September 4, 1925).

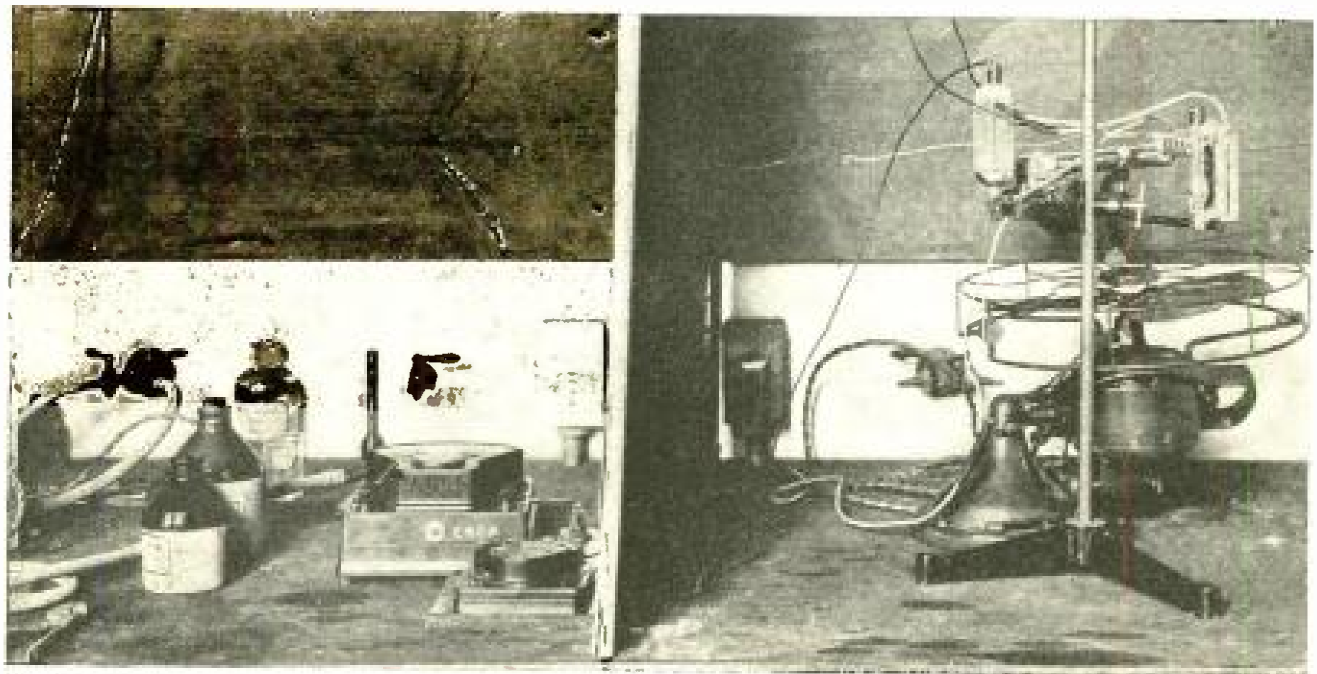
Compound Interest in Ether Waves

READERS of this Department are familiar with the many puzzling facts recently discovered about the radiation of light or of other ether waves by atoms; puzzles related to the so-called quantum theory of radiation.* Radiation seems to come out of atoms, you remember, in tiny separate pulses—in what Sir Oliver Lodge called so vividly "squirts" of energy. All rays, light and radio included, seem to consist of these small separate bundles or particles. On the other hand, there are facts which indicate that radiation consists of waves. How to reconcile these two conflicting ideas is probably the most pressing problem of modern physics.

Many physicists have suspected that this emission of radiation in tiny squirts might be accompanied by a less jerky process of some sort occurring inside the atoms, a process of which we are not yet aware. For example, energy might accumulate, somehow, in each atom until it reached the bursting point. Then some of it would escape as radiation. This would be not unlike the operation of the great geysers of Yellowstone Park or of New Zealand. In these curious volcanic springs steam accumulates deep in the earth until its pressure is too great. Then it suddenly blows up. A vast column of water is hurled high into the air. This relieves the pressure. The water falls back. Steam begins to accumulate again and the cycle is repeated. Possibly atomic radiation is something of this same sort.

There has recently been added to these sug-

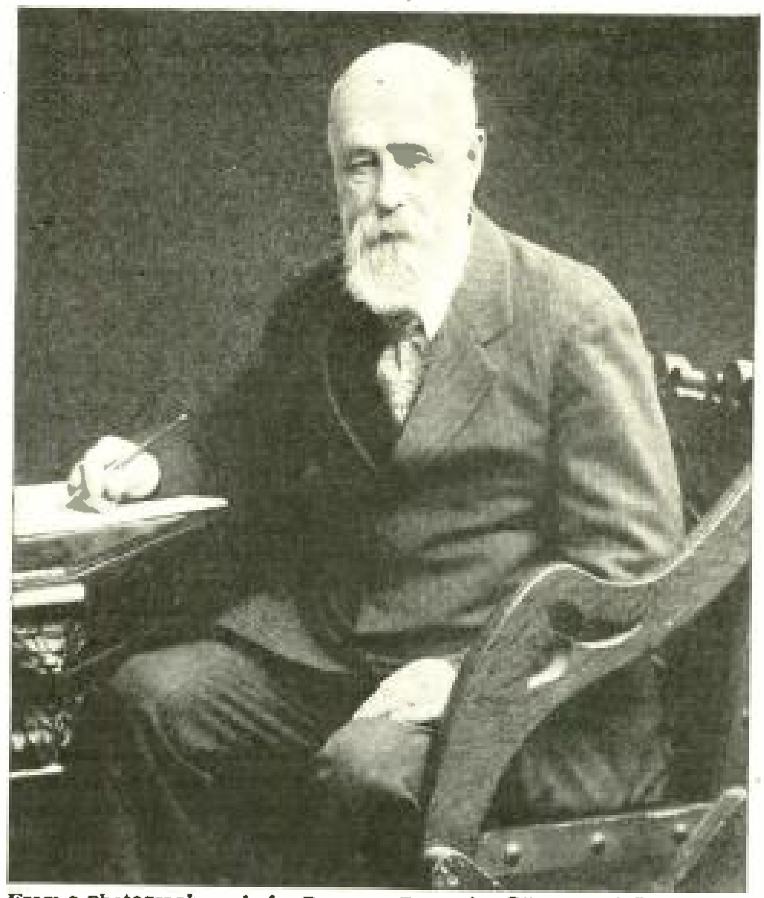
*See, for example, "New Theories of Ether Waves," POPULAR RADIO for August, 1925, pages 168-171.



The Scientific American

HOW THE MODERN GOLD-MAKING CLAIMS WERE TESTED

The replica of Professor Miethe's lamp, as set up in New York by Professor Sheldon and Mr. Estey, is at the right of the photograph. Underneath it is an electric fan used to keep it cool enough that the quartz will not melt. In operation, the lamp is surrounded by a wooden box, one side of which is shown in place. This prevents escape of the dangerous ultra-violet light rays which the lamp gives off while operating.



From a photograph made for POPULAR RADIO by Gilman and Co., Oxford

DISTINGUISHED MATHEMATICIAN POINTS OUT RADIATION LAW

Dr. Alfred Lodge, of Oxford, England, calls attention to the fact that the emission of pulses of radiant energy from atoms occur as though the atom accumulated energy from somewhere in accordance with the familiar law of compound interest, a pulse of energy being given off whenever the accumulated atomic "interest" reaches a sufficiently high value.

gestions the interesting observation that if energy does thus accumulate inside an atom between bursts of radiation, its accumulation appears to follow the familiar law of compound interest, the law according to which the sum increases at a rate proportional to itself. This suggestion comes from Dr. Alfred Lodge, brother of Sir Oliver Lodge and an investigator of distinction in the field of pure mathematics.†

"Interest is compound until it is paid, and then begins again." The energy of the atom grows until there occurs a "payment" of radiation; then it is left to grow again until it is time for another dividend. "Within the atom the energy grows continuously, but it is given out spasmodically." The energy which thus accumulates within the atom is presumably "internal electronic energy, the only kind of disturbance which can affect the ether and either radiate or absorb. It is doubtless associated with some particular frequency of revolution or internal vibration. Mere molecular or mechanical energy alone would not radiate. Matter alone has no link with the ether."§

Better knowledge of what ether radiation really is, is one of the great needs of radio theory. We talk glibly of "waves" and "vibrations" and what-not, but it is worth while to remember occasionally that these are merely words. In plain truth we do not know in the least what constitutes a ray of light or a beam of heat waves or the spreading radio waves which carry our signals around the earth. All these things are mysteries which science has still to solve.

There is undeniably something satisfying in the idea that the universe may be full of energy which we do not perceive, that this energy is accumulated, like compound interest, by the structure of an atom and is paid out, when it grows great enough, in the form of ether waves. This, one gathers, is not far from the idea held by Sir Oliver Lodge. Dr. Alfred Lodge, as becomes a mathematician, is cautious of speculation. He confines himself to pointing out the interesting fact that the mathematical formulation of the quantum theory of ether radiation and the mathematical formulation of compound interest are the same.

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†The suggestion of Dr. Alfred Lodge is quoted by Sir Oliver Lodge in a letter in *Nature* (London), vol. 115. page 798 (May 23, 1925). Further details are given by Dr. Alfred Lodge himself in letters in the same periodical, page 838 (May 30, 1925) and page 947 (June 20, 1925).

§The quotations are from the letter of Sir Oliver Lodge cited.

Radio During the Next Eclipse

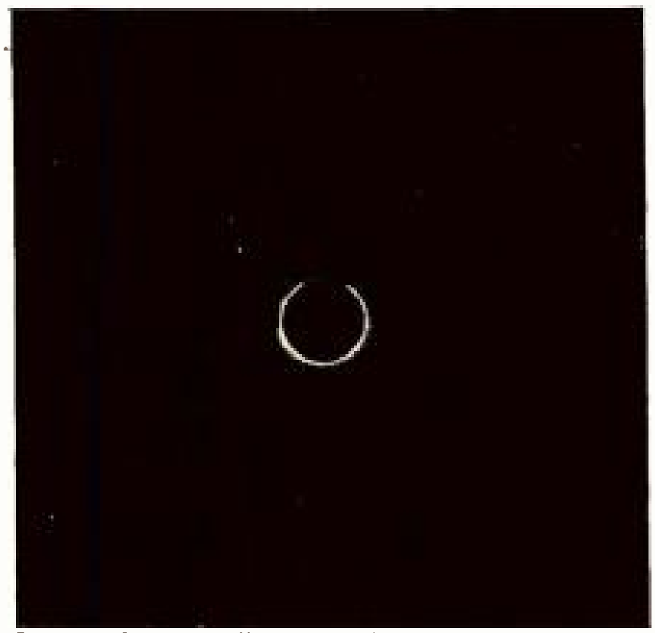
THE total eclipse of the sun, which occurred last January over the northeastern states, was one of the great events of radio as well as of astronomy. By the co-operation of thousands of radio engineers and broadcast listeners, as well as of the broadcasting stations, data were obtained which meant a great deal for our knowledge of the propagation of radio waves over the earth's surface. There will be another total eclipse of the sun next January, but it will be much less of a radio event and scarcely anything of a public spectacle.

This is because of a difference of location. Next year's eclipse will be visible (as a total eclipse) only in eastern Africa, the Indian Ocean and the islands of Sumatra, Borneo and Mindanao. It occurs on January 14, 1926, beginning at sunrise in the African mountains north of Lake Victoria and ending at sunset in the ocean southeast of the Philippine Islands. Totality will last from a fraction of a minute up to four minutes and ten seconds, about twice as long as the maximum totality during last year's eclipse in the United States.

Astronomic expeditions will be stationed at several points on the Island of Sumatra, which island the eclipse crosses during the mid-portion of the afternoon. It is possible that expeditions will be stationed, also, on the east coast of Africa and in Mindanao. The radio stations in Sumatra, Borneo and elsewhere near the path of totality will probably make observations. Scientists in Europe are planning other tests with around-the-world radio, in order to see whether the eclipse will have important effects on radio transmission over parts of the earth not close to the shadow. There is no probability, however, that the radio investigations will be organized with anything like the completeness and care exhibited last year. There are so few possible observers in the region of the eclipse that such effort would be wasted.

Any radio listener, on ship or ashore, who happens to be in or near the zone of totality on January 14, should be sure, however, to make what observations he can. The editor of this department will be glad to supply detailed suggestions for any specified locality on request. In the absence of advance plans, what the listener should do is to tune in some large transmitting station on the opposite side of the path of totality and listen to this station for about one hour before totality, through totality and for about one hour afterward, recording the exact second of any marked changes of intensity. POPULAR RADIO will be glad to receive reports of such observations. Exact times, preferably in Greenwich time, are essential; as is also an exact specification of the location, by latitude and longitude.

Persons not equipped with radio receivers, but who expect to be within or near the eclipse path, can make some useful observations also. If you plan to be in that part of the world on January 14, write this department and say so. We shall be glad to supply detailed data of the eclipse path, the time of totality, suggested observations and the like. Be sure to give us the exact location of the place where you expect to be.



Courtesy of Professor Edward S. King

THE SUN'S CORONA PHOTOGRAPHED BY INVISIBLE LIGHT

During the eclipse of the sun last January, Professor Edward S. King, of Harvard University, made this remarkable photograph at the Maria Mitchell Memorial Observatory, on Nantucket Island. The photograph was made by ultraviolet light, passing through a quartz lens covered with a film of silver, so that it was quite opaque to ordinary light.

A Photo-electric Grid-leak

THE problem of obtaining a variable high resistance for grid-leak purposes has been solved in a novel manner by a British experimenter, Mr. G. G. Blake. He uses a selenium cell.*

The metal selenium has the peculiar property, you remember, of altering its electric conductivity when light falls on it. This property is put to use in making the selenium photo-electric cells used in many kinds of apparatus in which light signals are converted into electric signals. It was a selenium cell, for example, which was used in the famous "electric dog" of Mr. John Hays Hammond, Jr., a small device mounted on wheels and which would follow a light from place to place, just as a dog follows a man.

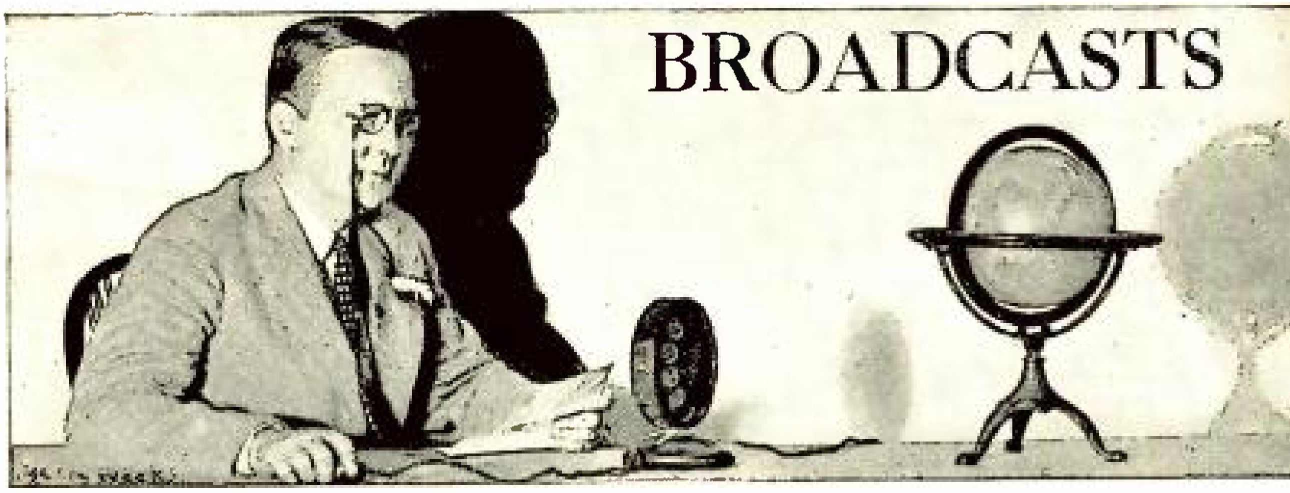
Normally, selenium has a rather high electric resistance. When light falls on it this resistance decreases. The amount of the decrease depends on the intensity of the light. Mr. Blake mounts a selenium cell, therefore, in place of the grid-leak. This cell can be illuminated by a light ray, the intensity of which can be increased or decreased by means of a shutter or in any other convenient way. Adjustment of the light increases or decreases the resistance until the proper value is attained.

*"A Grid-leak Controlled by Light," by G. G. Blake. *The Wireless World* (London), vol. 17, page 254 (August 26, 1925).

From a photograph made for POPULAR RADIO

An Amateur Station (2NM) that is Heard Around the World

A SHORT time ago the newspapers reported that Mr. Gerald Marcuse, a radio amateur in Surrey, England, talked by radio with the operator of the *U.S.S. Seattle*, 600 miles east of Australia. In response to a request from POPULAR RADIO, Mr. Marcuse reports: "I am sending you a picture of my gear which has been successful in sending telephony and music all over the world and in some cases in the remotest part of the world. Regular schedules are maintained with Mosul twice a week. My speech has also been successfully received in the following countries: U. S. A., Canada, Mexico (IK), Australia, New Zealand, India, Egypt, Iraq, Argentine (A8) and although I have received reports from South Africa of my CW QSA have not yet received any reports of my speech being received there. For the guidance of your readers I give you my regular times of transmission; every morning at 0600, Friday 2300, Sunday 1400 G.M.T."



CONDUCTED BY J. ANDREW WHITE

IN *this department the Dean of Broadcasters—whose voice is known to millions of broadcast listeners—records items of interest and value to all radio fans everywhere.*

"Radioville" Is in Alaska

IN Alaska there is a town called Radioville. Neither the atlas nor railroad and post office records confirm this, but Joseph P. Bauer signed his name to a telegram bearing this address which was received at KOA, the Rocky Mountain broadcasting station, and it is a fair assumption that the sender of the message knows where he lives.

* * *

Ireland Joins the Ethereal Chorus

WORD from Ireland carries the encouraging information that the plan for establishing broadcasting stations as a State concern has been approved by the Minister of Finance, and work will soon be begun on initial installations at Dublin and Cork.

* * *

Why 90 Percent of the World's Broadcasting Is Done in the United States

THERE has been some talk about the United States Government establishing a Commission on Communications, and the idea is not popularly received in quarters where the freedom from State restriction is known to have made possible America's amazing development of broadcasting. At the radio industries banquet Senator C. C. Dill of Washington sounded a warning that was heard by listeners to the chain of twelve stations hooked up for that occasion, an audience of probably 5,000,000 persons, who were told by the Senator: "The day you give to any board in Washington the power to regulate radio, that day will the liberty of radio and the radio industry end. In some other countries they have a radio censorship and the result is that 90 percent of all broadcasting is done in our own country."

The Ghost-seekers Adopt Radio

SPIRITISTS in convention at Paris made the strange admission that mediums are recognized as being generally unsatisfactory and untrustworthy, and it seems likely that they will abandon the long standing and seemingly only plausible means yet devised for communicating with the dead and substitute therefor some new adaptation of the radio. Certainly this is a naïve supposition, resting probably on the sweetly simple belief that there is something mysterious about the transmission and reception of radio messages that fits in with mediumistic phenomena, whereas radio is merely a utilization of scientific electrical laws fixed and inflexible and so simple that any person can grasp the subject with little study and an absolute novice manipulate a set and get results without the slightest surprise at the successful accomplishment at the first trial. But the spiritists declared that a new means for reaching those in the other world "must" be devised—so, radio.

* * *

A Belgian Amateur Makes a Record

A BELGIAN amateur has accomplished the trick of communication half-way around the world to New Zealand, and that's a new and distinctive achievement to be written down in the records of the Radio Club Belge, for it was the vice-president of that organization, A. Courtois, who put over the distance test from his station 4YZ, at Verviers. Using sixty-four watts on a forty-five-meter wavelength, he communicated for several minutes with Ivan O'Meara of Gisbourne, New Zealand, who answered and was heard, although the transmission was effected in broad daylight at his end. English stations have reached New Zealand before, but this is the first time for Belgium.

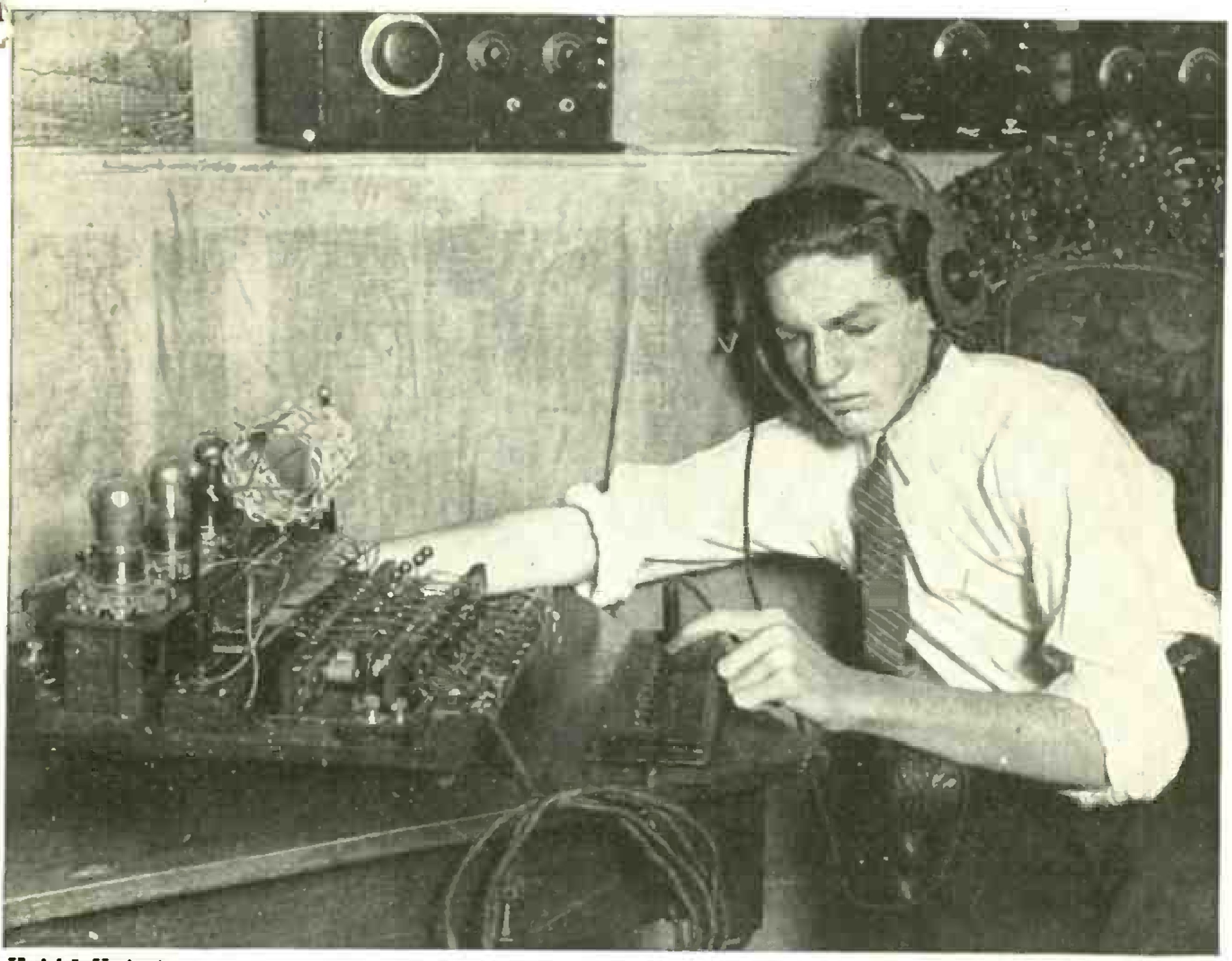
A Novel Radio Pilot for Flyers

AIRPLANE pilots will no longer be required to listen in continuously for the code signals which keep them on their course through darkness and fog if their craft is equipped with the newest type of receiver developed at McCook Field. When the receiver is properly tuned to the radio beacon it operates three tiny electric lights mounted on the dashboard, indicating whether the airman is on his proper course or veering to the left or right. The central light is white, and when lit it means that the proper course is being held to; a red light flashes on if the craft is off to the left and a green lamp on the right tells if the veering is in that direction. This is accomplished by an interlocking signal system which is simplicity itself. The transmitter at the flying field which sends out the radio beacon to guide the aviator transmits two distinct signals. If the flier is off the course to the left only one signal is received, the Morse letter A (dot, dash); if off to the right, the letter N (dash, dot); if fiying exactly on the prescribed course these two signals combine for a series of dashes. It is these code impulses picked up by the radio receiver which light the various lamps, through a relay. The unbroken series of dashes operates the white light, and since this means that both A and N signals are being received with equal intensity and have therefore combined, this is the proper course. Deviating to the left of the course brings in the letter A, which lights the red light; if off to the right, N alone comes through and the green lamp glows, so visual evidence of whether or not the aviator is holding to his course is always before him.

* * *

Less Interference from Ship Radio

SHIPS flying the American, British, Irish or Canadian flags are now required to keep off the broadcasting waves when within two hundred and fifty miles of the shores of these countries. The new order is, of course, designed to prevent needless interference between broadcast programs and ship messages, a workable and useful arrangement for both interests. The distress call wavelength, six hundred meters, is to



Kadel & Herbert

A RADIO SET WHICH TUNES ITSELF

One of the novel radio receivers entered in the contest for amateur set builders at the recent Radio World's Fair was made by John J. Muller in the shape of a typewriter. To tune a station on this set you merely press a button which actuates electric magnets, which in turn cut in portions of the tuning coil.

be used, and the channels above reserved to ship communication. The Great Lakes, too, are included in the agreement. Safety of life at sea has always been a matter of first consideration since the advent of radio, and vessels have in consequence been favored with the best channels of communication, but broadcasting has so markedly increased in importance that the old order is changing daily, and perhaps the most significant step yet taken is this one, prohibiting ships the use of the three hundred and four hundred and fifty meter waves when they are sufficiently close to shore to spoil the enjoyment of the broadcast fans.

* * *

Listening In on Japan

The Japanese high power system has gone over to private hands finally, a transfer that has been the subject of long discussion. Four fifty-kilowatt stations are planned, the material and equipment to be purchased from an American company. New stations are to be built at Isamimura and Kaizomura, the latter to communicate with the United States. The system for overseas message traffic will include the present stations at Harunomachi and Tomioka communicating with Germany, France and the Far East. Tomioka now handles messages for Europe *via* Hawaii and San Francisco, thence to the cross-Atlantic chain. Meanwhile, broadcasting has not been overlooked in Japan, the programs having started last July from Nagoya and since then Tokyo and Osaka have joined in.

Pacific & Atlantic

A HERO OF THE S-51 DISASTER

Over one hundred hours on the job, with never more than three hours sleep in each twenty-four was the record of James S. Herren, radio operator at the submarine base at New London, Conn., when the accidental sinking of submarine S-51 necessitated constant vigilance there.

Re-broadcasting Yankee Programs in Germany

The Germans are so much interested in receiving American broadcast programs that an agreement has been reached to provide special equipment for this purpose and attempt to re-broadcast features transmitted by the Radio Corporation's super-power station, using for the purpose the central station of Konigswusterhausen. And if this is successful it is proposed to increase the power of one of the German transmitters and at regular intervals send out an "American Program" for listeners in the States, to be re-broadcast, of course, by an RCA plant here. None other than Dr. Hans Bredow, State Secretary of the Reichspost, is authority for this statement, which opens up the interesting possibility that performances from the opera houses at Berlin, Munich and Frankfurt-Main may be transmitted overseas as they are now being heard throughout the German provinces.

* * *

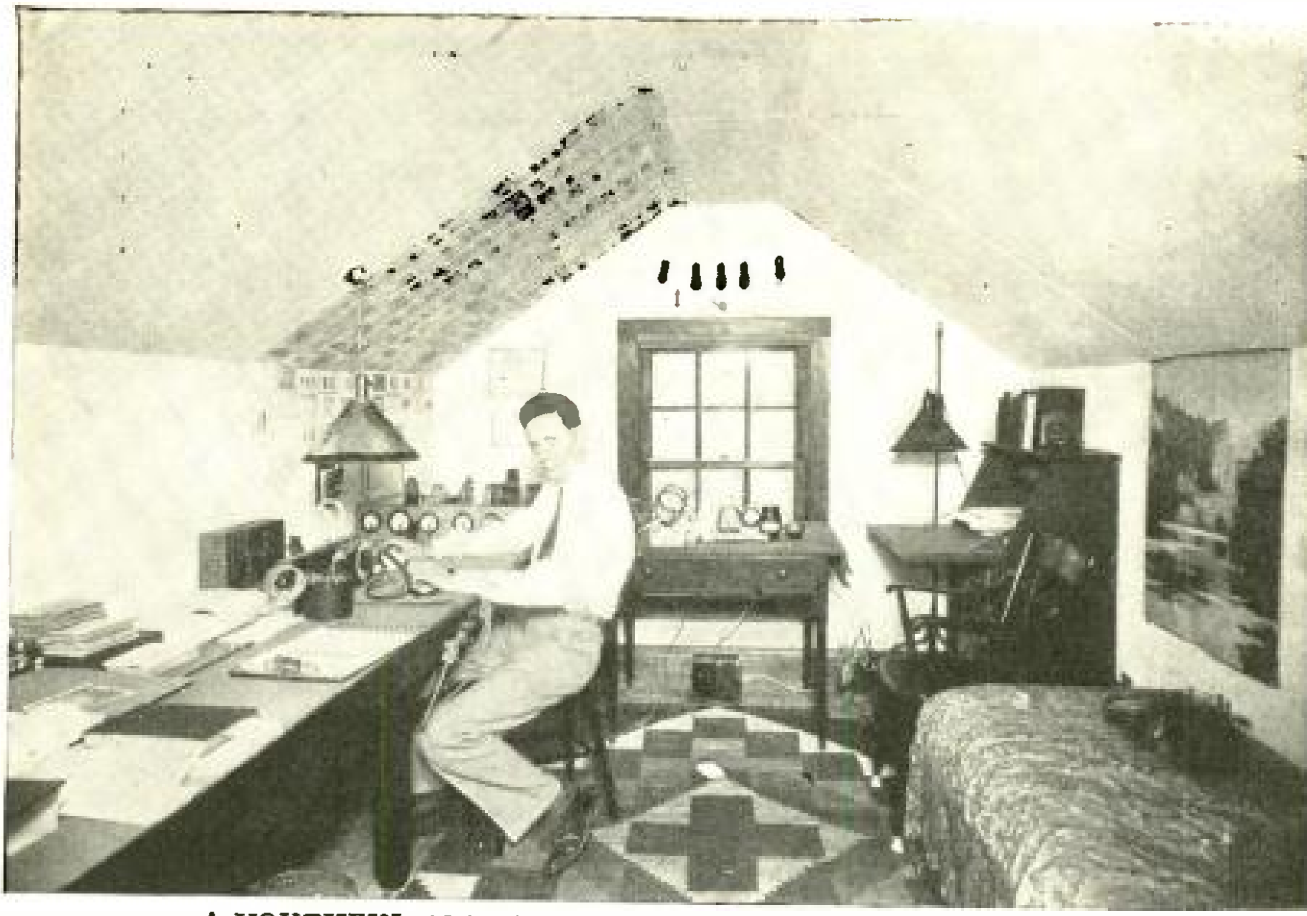
A New Station to Compete for Long-distance Honors

The Daventry station, England's new high power broadcaster located in Northamptonshire, should come across the ocean with good volume, for twenty-five kilowatts of power is being used on a wavelength of 1,600 meters. Chelmsford is now through and the famous call 5XX has been transferred to the latest candidate for distance honors erected by the British Broadcasting Company. There will be re-broadcasting from Daventry, so if you pick up this station on a low wavelength, before you begin bragging about receiving England direct, don't overlook the fact that its wave is the 1,600 one, above the span of the average receiver used in the United States.

* * *

The Difference Between "High-power" and "Super-power" Stations

Misuse of the designation "super-power" as a descriptive term for many of the broadcasters using high-power is not to the liking of officials of the Department of Commerce. Fifty kilowatts or more are required to climb into that classification, and there are only three stations proposed to operate with that electrical wallop. Fifty-two stations in the B classification are using power above a half kilowatt. KDKA is licensed to use ten kilowatts experimentally, and half that power is permitted to ten other broadcasters. Two are permitted use of 3,500 watts, two others 3,000, and an additional two employ 2,500 watts. Next in line are three stations with 1,500 watts, twenty-five which use 1.000, or one kilowatt, and there are seven broadcasting with 750 watts. But, says the Department of Commerce, these are high-power stations, not super-power.



A YOUTHFUL AMATEUR MAKES A RECORD ON A UNIQUE HOME-MADE SET

Arthur Collins, a fifteen-year old amateur of Cedar Rapids, Iowa, has the distinction of being the first to pick up the low-wave signals from station WNP, aboard the McMillan ship BOWDOIN *in the Arctic. Collins' home-made equipment includes pieces of coal and coke used as rectifiers, a coil taken from a Ford car and glass towel racks for insulators.*

A Convict Radio Student

CONVICT No. 13,377 is the most popular of the more than 500 men imprisoned at a Pennsylvania penitentiary, for he recently completed a five-tube radio receiving set and each night he entertains scores of his fellow-unfortunates with programs of the DX variety. It all started when No. 13,377 enrolled in a radio course that is conducted by a Pennsylvania college.

* * *

"Radio Insanity"

THE establishment of a regular service of radio concerts and entertainments by the Post Office Department of Vienna has resulted in what is called the first case of radio insanity on record in Austria. A forty-six-year-old lithographer complained to the police that the whole world was talking about him. He said he was connected with a radio receiver and could distinctly hear people in every part of the globe gossiping about him. He asked, pitifully, to be disconnected from the radio waves. He has been placed under observation in an insane asylum.

* * *

Licenses for Receiving Sets

ON January 1st Sweden put into effect new radio regulations and new licenses were required. Licenses for private receiving sets cost twelve kronen, but when loudspeakers are employed in public places or for advertising, special permits at increased fees are necessary. The regulations require that regular receiving sets must not be connected with automatic recording apparatus, and also that listeners must maintain secrecy as to all communications heard, except, of course, the broadcast programs. The copying of news items broadcast by a publisher is prohibited for commercial purposes. All licenses issued carry a provision that the sets covered may be inspected at any time by the authorities.

* * *

Broadcasting Hours for the Blind

DR. GUSTAV GAERTNER, a German professor, has conceived the idea that the early hours of the morning might be devoted exclusively to radio broadcasting for the blind. A single speaker could thus reach the blind and those with defective vision. He suggests finding out what such persons would like to hear through a "round-robin" addressed to the blind themselves; he himself suggests a program of important political and current events, that would be followed by an hour of reading from good literature, both fiction and more serious works, and an hour of simple scientific information.

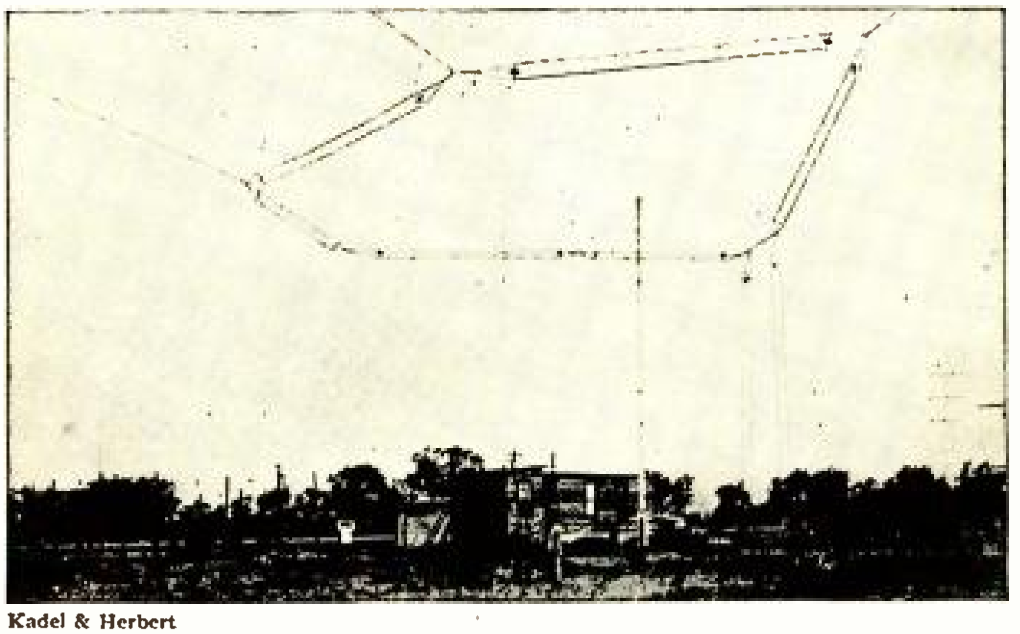
Stations That Broadcast Weather Forecasts for the States

Alabama........WSY, WEAP, WSB, WMC, NAA.
Arizona........KFAD, KOA, KOB.
Arkansas........KTHS, WDAF, WHB, KSD, WMC, WBAP.
California.......KGO, KLX, KFI, KHJ, KMJ.
Colorado........KOA, KLZ.
Connecticut.....WABL, WNAC, WGI, WGY, WHN, WJAR, WEAN, NAA, WAHG, WEAF, WJZ.
Delaware........WRC, WCBM, WCAO, WIP, NAA.
Florida.........WDAE, NAA.
Georgia.........WSB, NAA.
Hawaii.........KGU.
Idaho..........KGO, KFAU.
Illinois.........WAAF, WGN, WLS, KYW, WHAS, WJAN, WOC, KSD, WEW.
Indiana.........WAAF, WGN, WLS, KYW, WHAS, KDKA, WGBF, WBAA.
Iowa...........WAAF, WGN, WLS, WOC, WOI, WHO, KFNF, WEAU, WCCO, WHB, KSD, WEW, WJAG, WIAK, WOAW.
Kansas.........WGN, KFNF, KSAC, WEAH, WDAF, WHB, KSD, WOAW.
Kentucky.......WHAS, KSD, KDKA, WMC, NAA.
Louisiana.......KTHS, KSD, WBAP, WEAY.
Maine..........WNAC, WGI, WGY, WHN, NAA, WEAF, WJZ, WAHG.
Maryland.......WRC, WCBM, WCAO, WIP, KDKA, NAA.
Massachusetts...WNAC, WGI, WGY, WHN, WJAR, WEAN, NAA, WEAF, WJZ, WAHG.
Michigan.......WAAF, WGN, WLS, KYW, WWJ, WCX, WWAO, WKAR, WREO, WABM, KDKA, WBAA, WEBK, WBDC.
Minnesota......WAAF, WCCO, WGN, WLS, WOI, WEAU, WPAU, WOAW, WPAK, WDAY.
Mississippi......WEAP, WMC, NAA.
Missouri........WGN, WLS, KFNF, WOS, WDAF, WHB, KSD, WEW, WOAW.
Montana........WGN, WCCO, KFBB.
Nebraska.......WGN, WOI, KFNF, WEAU, WDAF, WHB, KSD, WCAJ, WFAV, WJAG, WIAK, WOAW.
Nevada.........KGO.
New Hampshire..WNAC, WGI, WGY, NAA, WEAF, WJZ, WAHG.
New Jersey......WOAX, WHN, WJZ, WIP, WOO, NAA.
New Mexico.....KOA, KLZ, KOB.
New York.......WGY, WGR, WCAD, WMAK, WHN, WJZ, WHAM, WEAF, WAHG, WNYC, NAA, KDKA.
North Carolina...WRC, WBT, WFBQ, KDKA, WTAR, NAA.
North Dakota...WAAF, WGN, WCCO, WPAU, WPAK, WDAY, KDLR.
Ohio...........WLW, WEAR, WBAV, WEAO, KDKA, NAA.
Oklahoma.......KTHS, WEAH, WDAF, WHB, KSD, WNAD, WBAP.
Oregon.........KGO, KFEC, KGW.
Pennsylvania....WRC, KDKA, WCAO, WHN, WDBC, WIP, WOO, WQAN, WFBG, WEAF, NAA, WAHG.
Porto Rico......WKAQ.
Rhode Island....WNAC, WGI, WGY, WHN, WJAR, WEAN, WEAF, WJZ, WAHG, NAA.
South Carolina...WSB, NAA.
South Dakota....WAAF, WGN, WOI, WEAU, WCCO, WJAG, WOAW, WCAT, WNAX.
Tennessee.......WHAS, KSD, WMC, NAA.
Texas..........WCM, KFLX, WOAI, KFGX, WRR, WFAA, WBAP, WEAY.
Utah...........KOA, KLZ, KDYL.
Vermont........WNAC, WGI, WGY, WHN, WEAF, WJZ, WAHG, NAA.
Virginia........WRC, WTAR, NAA.
Washington.....KGO, KFEC, KGW, KFQX, KFOA, KJR.
West Virginia....KDKA, WRC, NAA.
Wisconsin.......WAAF, WGN, WLS, KYW, WOI, WCCO, KFIZ, WABN, WHA, WCAY, WHAD, WLBL, WTAQ.
Wyoming.......KOA, WCCO, KLZ, WGN.

* * *

Schoolboys Make Own Receiver Cabinets

THOUSANDS of radio cabinets are being shipped from Latvia to this country. These cabinets are shipped unfinished in knock-down form and most of them are made by schoolboys in Riga.



Kadel & Herbert

THE NEW HORIZONTAL WAVE ANTENNA

This is the experimental antenna made up of a number of separately tuned sections for transmitting a horizontally polarized wave. This is the field laboratory of E. F. W. Alexanderson of The General Electric Company who is investigating the scientific aspects of this development as they apply to the future of broadcasting.

Pacific & Atlantic

A CONSTELLATION OF STARS SIGN CONTRACTS FOR RADIO CONCERTS

Twenty-five of the great operatic stars are included among the artists who recently contracted to perform before the microphone. Here Anna Case is signing up while Louise Homer, Reinald Werrenrath, Toscha Seidel and Hilda Lashenska wait their turns. Mr. Atwater Kent is presiding at the ceremony.

The BROADCAST LISTENER

Comments on radio programs, methods and technique —from the point of view of the average fan

By RAYMOND FRANCIS YATES

Baby Peggyizing the Ether

IT really requires a lot of nerve to write what we are going to write with all of the mothers and fathers that we have in this country. If you were as old as we are you would know that a mother or a father is a pretty weak thing when it comes to discovering "cuteness" in any of the human species under six years and three months. Just let anybody's baby gurgle at a mother, and she melts like a Bayberry candle. Fathers fall a little harder, but they are essentially weak when it comes to "little hands" and "li'l' fat legs." Our movie directors know their business when they work in the cradle with the pretty baby. "Aw, isn't it sweet," has held the record for movie soliloquizing since the first nickelodeon was installed in the opera house out in Oskosh back in 1907.

They can "Baby Peggy" the movies until the cows come home, but when the babypeggyization of the radio begins, we grab our walking stick and hobble right out to the voting booth to put in one big, fat vote against the practice. That shows what kind of a radio listener we are. Once in a great while (oh, say every seven years), we might have the patience to listen to somebody's three-year-old recite Mother Goose. When you hear a little tot recite a nursery rhyme from a studio, you at least know that there is a very happy mother and a very happy father somewhere in the United States, but the few years that we have left on this earth are a bit too precious to be devoting them to the comforts of mothers and fathers. We like our radio on the hoof. Besides there are too many ambitious parents anxious to start their children off on a stage career through any medium that offers the opportunity, and the average studio is as easily exploited in this connection as the church bazaar.

Queen Titania, somebody's baby out at station KHJ, is making a big hit, if we are to listen to the publicity man. The big editorial mind that directs the *Los Angeles Times* permits the publication of the standard picture showing Queen Titania in a fluffy white ballet dress seated in the center of thousands and thousands of letters from her appreciative fans. When you see a picture like that you will know that there is back of it a scheming and wise mother, ferociously intent on putting her offspring in the movies. Mothers like that are pretty hard to beat and so we might just as well fold up our little tent and move on, but this we shall not do without one parting word. *So is your old man.*

* * *

The Tweedledum and Tweedledee of Jazz

THE difference between Ben Bernie (WEAF and several others) and Vincent Lopez, is that Mr. Lopez announces like a voice from a Kelvinator and Mr. Bernie announces like a voice from a heating pad. Mr. Lopez is without doubt one of the most naïve announcers in the business, and that is a pretty nasty thing to say about a gentleman who is otherwise so artistic. It seems that Mr. Lopez has made up an announcing form on the style of an application blank for a chauffeur's license and that he simply inserts the names of the numbers in the proper spaces.

Pacific & Atlantic

THE BUFFALO NICKEL INDIAN BROADCASTS

When Two Guns White Calf, who posed for the head on the Buffalo Nickel, came to St. Paul, radio station WCCO persuaded him to broadcast in his native tongue. The only objection of the Blackfoot chief was that the radio was "no good for the sign language."

We have been in line with Mr. Bernie's customers for several months now, and while we may be dumb to the point of inflammation where syncopation is concerned, and while our opinion may not be worth one little pinch of grandpa's snuff, we hold that Mr. Bernie is one of the greatest artists on the air. He is original with his arrangements, and there is a charm to his orchestra which lies safely beyond our power of description. Mr. Bernie is also a suave announcer and when he takes it in his mind to be funny his humor does not strike you in the face like a dish of stewed tomatoes.

* * *

The Menace of Propaganda on the Air

SOME day we shall sit down at our L. C. Smith No. 9 and tattoo a thesis on radio propaganda that will cause quite a stir in this big country of ours. Radio is a bit more troubled with propaganda than most people think, and unless the big guns of this department are turned loose, heaven only knows what will happen to these United States. George Creel saved this country once and we can do it again.

The American Civil Liberties Union is planning to put a station up for propaganda purposes, which means, of course, that such an installation would immediately be followed by a station owned and operated by that big, broad-minded body called the National Securities League. Put a radical outfit on the air and you invite the conservatives. Put the conservatives on the air and you invite the radicals.

To be real serious, we believe that propaganda over the air is one of the great dangers in broadcasting, and we are opposed to it regardless of the motives displayed. It is bad enough that we have to contend with religious propaganda. Propaganda is a pretty sneaky thing, regardless of its source and how often it pans out that it is pure bunk.

* * *

A Small Improvement in Announcing Methods

IT has taken our Johnny-on-the-spot managers four years to discover that the identification of an announcer has no more public significance than the identification of the bus boys at Childs' or the Redcaps at Grand Central. That "this is Norman Brokenshire announcing" or that "this is AON speaking" is inconsequential so long as Mr. Brokenshire or Mr. AON does not attempt to inflict too many witticisms (God, forbid!) and personal opinions upon the wholly helpless audience.

This whole game of broadcasting, it seems to us, has been too largely and too ambitiously devoted to the popularization of bumptious neophytes recruited from the insurance offices, the soda fountains, the ribbon counters, and the boot shops. Broadcasting, except in cases as rare as pearls or charitable Scotchmen, has not been enriched one iota by the administration it receives from the gracious zealots in the studios.

The wonderful performance of these CROSLEY Radios will be duplicated this year—and with these New Prices they should be Radio's best values!

Crosley 2-Tube 51 Regular

This efficient little set uses any make of tubes. Nearby stations on loud speaker, long range on headphones.

Now 14^{75}, was 18^{50}

Crosley 3-Tube 52 Regular

For a less expensive 3-tube set the Crosley 52 Regular cannot be surpassed at the new low price.

Now $25 was $30

Crosley Super-Trirdyn Regular

In the Super-Trirdyn, 3 tubes do the work of 5.
cose tchless performance.
comes
again tifully finished solid
bedroom any cabinet.
man, if w
perhaps we
Big Names th **Now $45 was $50**
for themselves.
done this and time
turned away feeling
this you can easily imag
happy over the late tende
ward the elimination of the w
references to the whozis doing t
have decided to keep right on b
about this business, and we warn you
argue with us about it should you meet us
the street. Anybody who cannot agree with
us in this matter, gets a great big sock on the
nose.

Low Power Stations Heard Across the Country with the Crosley 3-Tube 52

"One big asset of Crosley '52' is its ability to pick up low powered broadcast. I have picked up KFON, Long Beach, California, and KFUM, Colorado Springs, Colorado, both stations using only 100 watts and EFEL a 50 watt station in Denver."
PHILLIP S. WILLIAMS, Bristol, Pa.

Lives in California—Lists 35 Stations East of Rockies Heard on Loud Speaker

J. F. McGinley living in Hallster, California, sends us a list of stations in the East including Ohio, Pennsylvania and New York, whose broadcasting he enjoys constantly on his loud speaker. He emphasizes the fact that he owns *no* ear phones.

"Coast to Coast" Reception With a Crosley 3-Tube 52

"I have a record of reception of practically all the large radio stations in this country and Canada from WBZ, New England to WMBF, Miami; from Fort Worth, Texas, to CURT, Toronto; and from CYL, Mexico City to KGW, Portland, Oregon and KFI, Los Angeles."
WALTER HAGERTY, Burlington, Iowa

Spruce, Michigan, Is Within Earshot of Europe with a Crosley 3-Tube 52

"During the International test last year I heard the following stations clearly and distinctly: 'Paris, Berlin, London, Honolulu, and Porto Rico.' 6 and 8 tube sets in my neighborhood don't begin to compare with my "Little Wonder.'"
ELLIS C. MARTIN, Spruce, Michigan

Vancouver to Torrington, Connecticut, Is a Short Distance for the Crosley 2-Tube 51

"Following are only a few of the stations I have received: WBAP, Fort Worth, Texas; 6 KW, Cuba; KOA, Denver, Colorado; WTG, Manhattan, Kansas; KPO, San Francisco; Manchester, England and Vancouver, for which I can furnish sworn statements if desired."
HARRIS C. RODSEFELLOW, Torrington, Conn.

The Famous MUSICONE

This marvelous loud speaker—well on the way to REPLACE HALF A MILLION HORN TYPE speakers by January 1st—is sub-
because of assembly
can be pr Crosley
faithful as
The resu nes—
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asked to review ng
convince you tha
and that, further,
business at the same old
way for many years to co

Now 14^{75} was 17^{50}

* * *

Revolutionary Novelties for the Winter Season

By the time these little paragraphs are immortalized in type, the robins and the hobos will have left for the South and radio broadcasting will have settled down into its fourth winter. Unless your hearing is very good, however, you probably missed the actual opening of the season. Of course, you no doubt noticed that the ice in the ice-box is lasting longer and that the bathing caps have been taken out of the

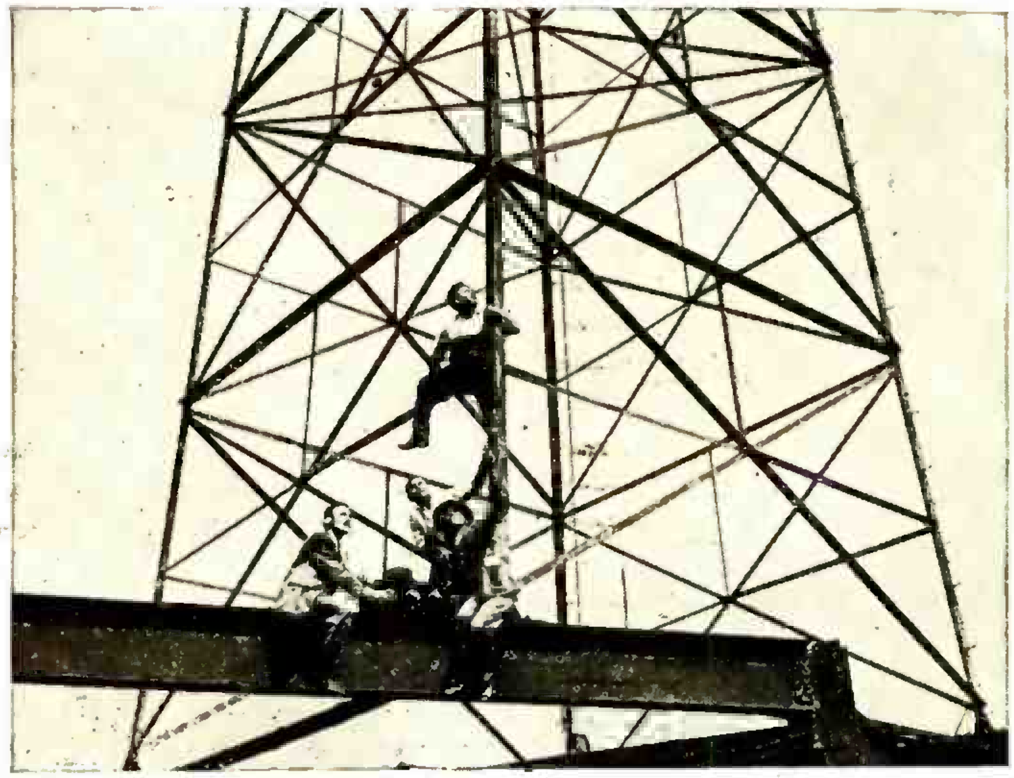
WAAM—"The evening en
sufficiently diversified to attrac
ing tastes."

That's a big improvement, isn't
WBBM—"No program will lack entertainment. Every twenty minute teners will be assured of orchestral mus
will be good and different."

DIO

innati

W YORK



Kadel & Herbert

PICKING UP A PROGRAM FROM A FLYING STUDIO

Popular songs broadcast on a 40-meter wave from a giant Sikorsky plane flying overhead were recently picked up on a receiving set on the roof of station WGBS in New York and rebroadcast. A few days later a small orchestra that included a piano was broadcast from a plane flying over London.

Perhaps we are a little bit touchy on this subject and perhaps we are a little hard and bellicose in our treatment of the matter, but it comes after long deliberation. Time and time again we have stood before the mirror on the bedroom door and asked ourselves, man to man, if we were not a little prejudiced or if perhaps we were not a trifle envious of the Big Names that our studio boys are making for themselves. Time and time again we have done this and time and time again we have turned away feeling pure and justified. From this you can easily imagine that we felt pretty happy over the late tendency of the studio toward the elimination of the wholly unimportant references to the whozis doing the talking. We have decided to keep right on being touchy about this business, and we warn you not to argue with us about it should you meet us on the street. Anybody who cannot agree with us in this matter, gets a great big sock on the nose.

* * *

Revolutionary Novelties for the Winter Season

By the time these little paragraphs are immortalized in type, the robins and the hobos will have left for the South and radio broadcasting will have settled down into its fourth winter. Unless your hearing is very good, however, you probably missed the actual opening of the season. Of course, you no doubt noticed that the ice in the ice-box is lasting longer and that the bathing caps have been taken out of the five-and-ten-cent store windows, but, to reiterate, we're pretty sure that our scheming impressarios slipped their new season stuff over on you without your being any the wiser. This simply goes to show that broadcasting is troubled as much by its anaemia in the winter season as in the summer season and that a radio impressario runs true to form summer or winter.

If we ran a studio, we'd put on a "grand opening night" in the middle of November if for no other reason than showing that broadcasting was not wandering about with a bad case of amnesia. The trouble with the business now is that it invariably forgets where it is going but usually remembers where it was last week and last year. We recently decided that it has settled down into a vicious habit and that it is practiced as assiduously as any bad habit can be practiced. It is as consistent and as faithful as grandma is with her knitting.

The results of a recent canvas of the studios wherein our dashing young managers were asked to reveal their winter plans, will help to convince you that our appraisal is a fair one and that, further, broadcasting will be doing business at the same old stand in the same old way for many years to come.

WAAM—"The evening entertainment will be sufficiently diversified to attract those of varying tastes."

That's a big improvement, isn't it?

WBBM—"No program will lack orchestral entertainment. Every twenty minutes the listeners will be assured of orchestral music that will be good and different."

Burgess Laboratories

A BABY TRANSMITTER THAT COVERS 1,800 MILES

Only five pounds in weight and using less power than a two-cell flashlight is this transmitter of Phil Zurian of (9EK-9XH) of Madison, Wis. But it has been big enough for two-way communication with Massachusetts, New York and Mexico City.

Well, that's something to look forward to.

WCAP—"During the winter WCAP will present a well-balanced series of programs consisting of the better grades of music both vocal and instrumental. Educational talks will be used in proper proportion."

You'd better get those new "B" batteries.

WCBD—"WCBD will pursue the same general policy followed during the two and more years it has been in the broadcast field."

We roast our peanuts in the good old-fashioned way.

WCCO—"With two cities with a combined population of approximately a million and the entire Northwest looking to the station as its own, WCCO has a large field from which to draw its talent."

Go West, young soprano, and grow up with WCCO.

WCTS—"We have our own WCTS orchestra and are glad to furnish the public with whatever music it desires, classical or jazz."

There's somebody that'll play "By the Waters of Minnetonka" for you.

WEMC—"Specializes in classical and semi-classical music, lectures and the old-time songs and hymns."

Ma and pa will like that, won't they?

WFI—"During the winter, WFI will continue with classical music and a reasonable amount of dance music."

As faithful as a new pair of garters.

WHAS—"For the ensuing twelve months, we shall have a greater diversity of programs including a wider news bulletin service and sports service."

Diversification, that's the thing.

WHN—"WHN will follow along its customary policy of 'The station of Human Interest,' serving the masses rather than the classes."

That's the kind of stuff that goes over big out here in the Bronx.

WHT—"Our educational and cultural programs are broadcast for our Woman's Clubs numbering many thousands. The classics are emphasized during the period from seven to eight. A straight varied program is broadcast from ten-thirty until midnight."

Culture for the ladies. That's a big idea.

WLIT—"WLIT aims to broadcast a comprehensive educational program this winter."

We'll eddycate this country or bust.

WMBB—"WMBB's hours of broadcasting at present are from 7 to 8 P.M., at which time a semi-classical program by the Trianon Ensemble of string instruments and vocal artists is broadcast, and from 9 to 11 P.M., when a popular program by the Trianon Orchestra and vocal artists is broadcast."

The great Trianon Ensemble in different moods.

PWX—"We propose during the coming season when the static has disappeared to continue our usual routine."

Cuba getting its bad habits from America.

KOA—"Dramatic productions will continue to have a large place on our programs. Debates on serious topics will be arranged and we are considering establishing an open forum."

KOA caught in the act of thinking.

WRNY—"WRNY is now in the process of being departmentalized. A repertoire company is in formation. The whole time that WRNY will be on the air will be made into a permanent though flexible schedule which will become as familiar to listeners as breakfast, dinner and supper. We desire to make it possible for listeners to know just what they are going to hear at any time this week, next week or a month in advance."

Well, what have we been telling you right along? Oh, dear.

WSAI—"WSAI will feature more symphonic music during the coming season. However, a mixture of jazz will be added to satisfy those who prefer a lighter type of entertainment."

There's a case of clear thinking for you.

KFWB—"KFWB program will have variety, no special form of entertainment being shown preference."

Another member of the "National Association for the Maintenance of Variety."

WTIC—"Connecticut's only class B station will continue to comb the state for instrumentalists, singers and ensemble organizations as it has in the past."

A whale of a chance for the music teachers in Connecticut.

No matter what set you buy, be sure the dealer puts in *genuine* Radiotrons:

UV-199	$2.50
UX-199	$2.50
UX-120	$2.50
UV-201-A	$2.50
UX-201-A	$2.50
UV-200	$2.50
UX-200	$2.50
WD-11	$2.50
WD-12	$2.50
WX-12	$2.50
UX-112	$6.50
UX-210	$9.00

Rectrons:

UX-213	$7.00
UX-216-B	$7.50

A "UX" or "WX" tube is the same as the corresponding "UV" or "WD" tube, except in the design of the base.

for every

Christmas Radio Set

use only genuine RCA Radiotrons

READ all the claims of all the makers of radio sets—and then remember this when you buy—that getting what is claimed for a set depends upon the quality of the *vacuum tube* put into it. You cannot get clearness—you cannot get distance—you cannot get volume—unless the *tubes* get it. That is why it is so important to look at the base of every tube, to be sure it is a *genuine* RCA Radiotron.

A great gift for any fan—at $2.50

A radio fan will appreciate a "spare" Radiotron, just as an autoist appreciates a spare tire. But the Radiotron—a genuine RCA Radiotron—costs only $2.50. If you note what make of set a man owns, any dealer can tell you which *type* of Radiotron he uses, and you can give him exactly what he would choose for himself.

for owners of Super-Heterodynes — the new power tube

Every owner of a Radiola Super-Heterodyne can bring his set right up-to-date with the latest improvement, if you give him the new dry battery power Radiotron UX-120, and the adapter. The adapter costs but $1.50. And this new tube means great volume with better tone than ever!

Radiotron UV-201-A, standard high-vacuum tube for storage battery sets.

RADIO CORPORATION OF AMERICA
CHICAGO NEW YORK SAN FRANCISCO

RCA-Radiotron

MADE BY THE MAKERS OF RADIOLAS