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RADIO DESIGN

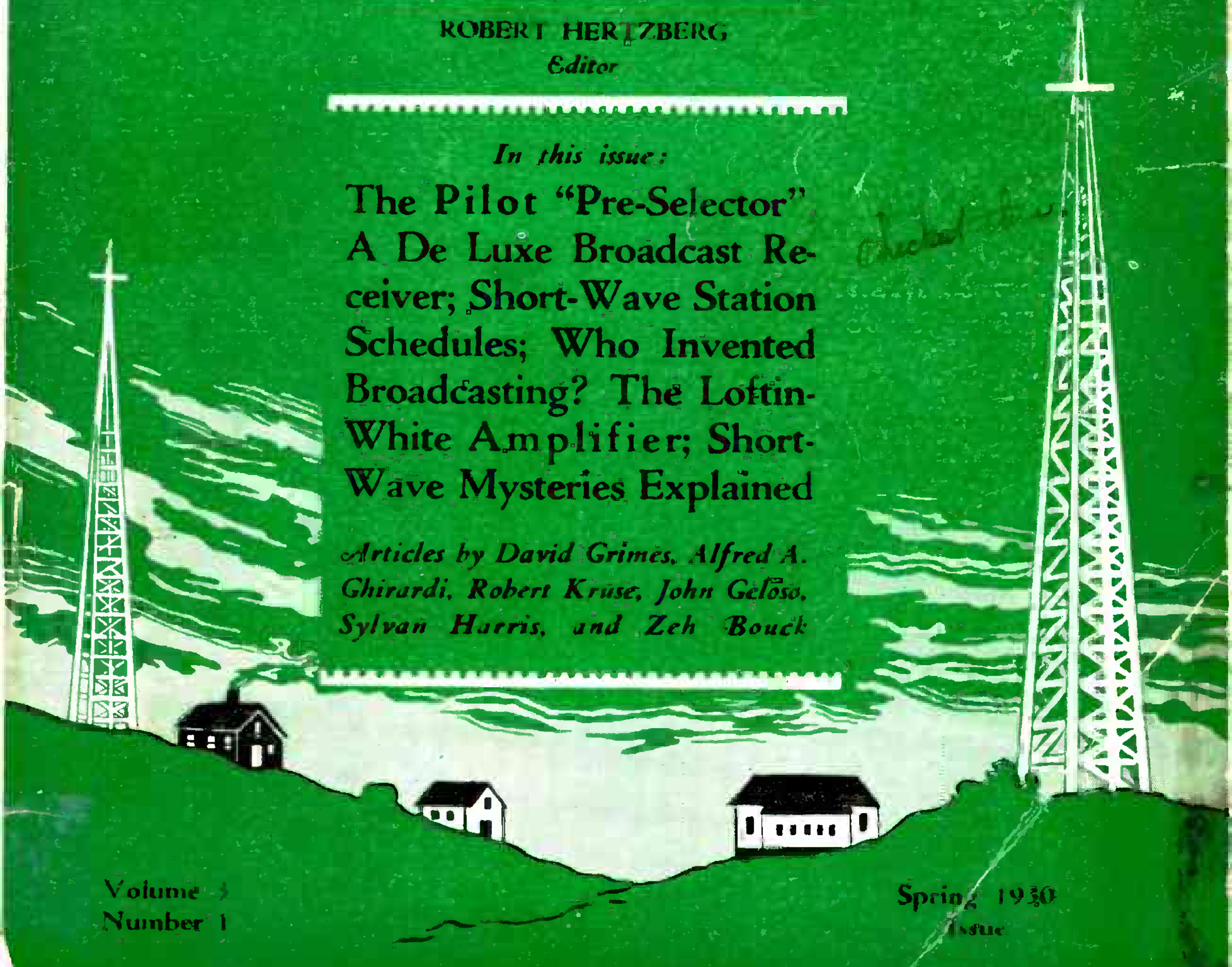
OFFICIAL ORGAN OF THE RADIO INTERNATIONAL GUILD

ROBERT HERTZBERG
Editor

In this issue:

The Pilot "Pre-Selector" A De Luxe Broadcast Receiver; Short-Wave Station Schedules; Who Invented Broadcasting? The Loftin-White Amplifier; Short-Wave Mysteries Explained

Articles by David Grimes, Alfred A. Ghirardi, Robert Kruse, John Geloso, Sylvan Harris, and Zeh Bouck



Volume 3
Number 1

Spring 1930
Issue

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ROBERT S. KRUSE..........*Contributing Editors*..........DAVID GRIMES

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RADIO DESIGN

OFFICIAL ORGAN OF THE RADIO INTERNATIONAL GUILD

A Quarterly Magazine

FOR THE CUSTOM SET BUILDER, EXPERIMENTER,
STUDENT, AMATEUR AND RADIO FAN

Edited by

ROBERT HERTZBERG

Former Editor of Radio News

RADIO DESIGN is the only magazine to which all of these experts are regular contributors:

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The Pilot "Pre-Selector"—A De Luxe Broadcast Set

Band-Pass Tuning, Screen-Grid Amplification and Detection, 245 Push-Pull Audio and Built-Up Foundation Unit Make This The Best Broadcast Receiver Ever Presented by Radio Design

by DAVID GRIMES

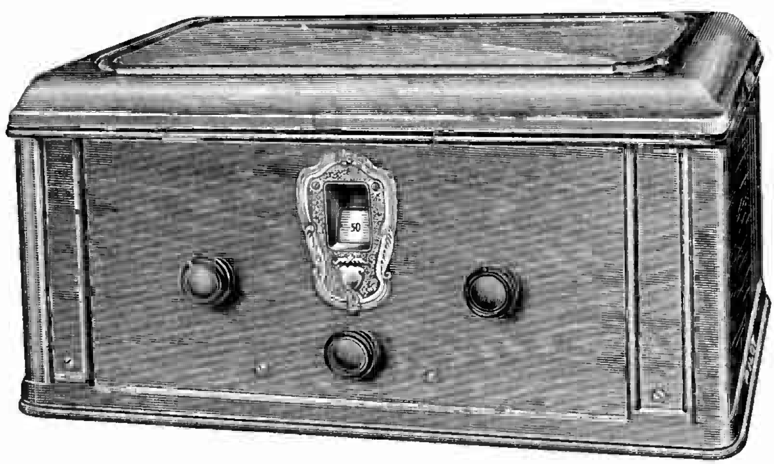
IN THE last issue of RADIO DESIGN, I went to some literary lengths to describe the engineering specifications of an ideal screen-grid broadcast receiver. This set employs screen-grid tubes for not only the radio-frequency amplifiers but also for the detector. And the latter is really a screen-grid connection and not merely a make-shift so commonly seen in so-called space-charge detectors which attempt to employ the screen-grid tube for rectification purposes.

In this issue, a continuation of the design will be presented, and its application to the new Pilot "Pre-Selector" also given. In order to coördinate these two articles, as well as enlighten those who did not see the original article, I feel that a little recapitulation is in order. So please stand by for the recapitulating!

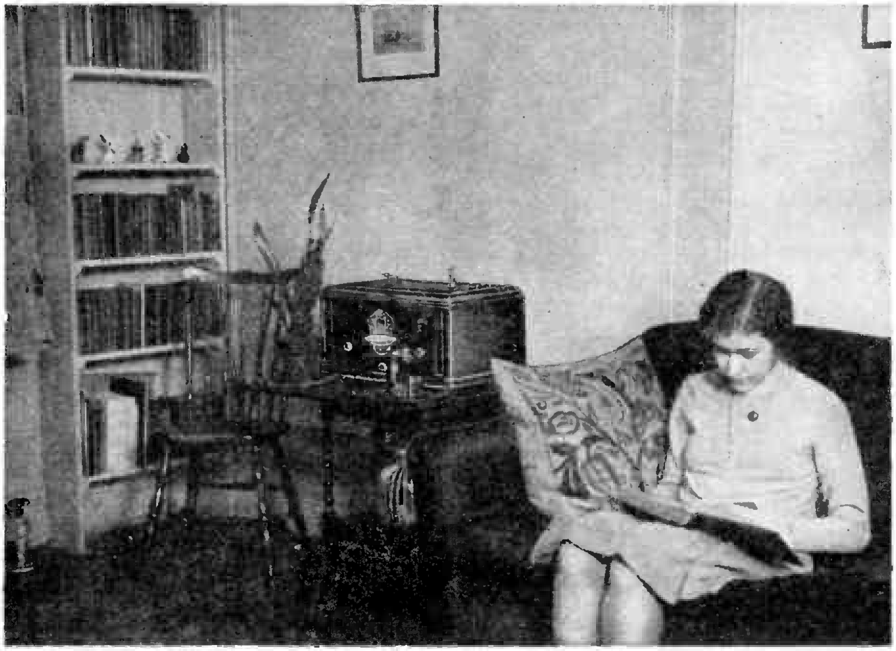
AMPLIFICATION WITHOUT OSCILLATION

In the first place, it has become generally appreciated that the screen-grid tube is an excellent radio-frequency amplifier. It not only gives enormous gain, but does so with little or no tendency toward oscillation. In the old days with the 227 type of tube, a good radio amplifier did well if the average voltage amplification per stage ran around seven, and only the best sets were able to employ more than two stages effectively. This gave a radio-frequency gain of forty-nine. Regeneration usually boosted this considerably, but the best of them certainly didn't go much above 500 even with neutrodyning and three stages. Now just place against this fact that it is rather a simple matter for a screen-grid amplifier to register a gain of four or five thousand, and some of the best of them run up as high as twenty-five thousand. Laugh that off! When it comes to figures like that, there just isn't any argument.

But with all that benefit you would naturally expect some drawback—otherwise the radio industry would have reached perfection and radio engineers could all pick up their marbles and go home. No, the very increase in R. F. amplification has created other troubles which require some attention or disaster will appear in the offing. The main difficulty comes from the



The "Pre-Selector" in the handsome walnut-finished metal cabinet supplied with the K-128 kit.



The "Pre-Selector," being small and compact, lends itself admirably for use in the home. It is shown above in a convenient yet unobtrusive position on an end-table next to a sofa.

fact that the new screen-grid tube uses a relatively small negative grid bias. You will recall that the standard 227 tube takes about 14 volts of negative "C" bias when 180 volts is employed on the plate. The screen-grid tube uses only about 2 volts negative bias with 180 volts on the circuit.

This unusually low grid bias results in several peculiarities. There was a time not so long ago when nearly every commercial receiver employed a stage of fixed radio-frequency amplification between the antenna and the first tube. This was to dispense with the necessity of a tuned stage on the antenna which would naturally be affected by the different antennas to which it would be connected, causing the tuning to run off and thus preventing the proper synchronizing of the entire gang of tuning condensers. Such a stage did not compromise the operation of the receiver much when the 227-tube was inserted in the first socket. The high negative bias prevented most of the many troubles which immediately arose upon the adoption of the 224-tube.

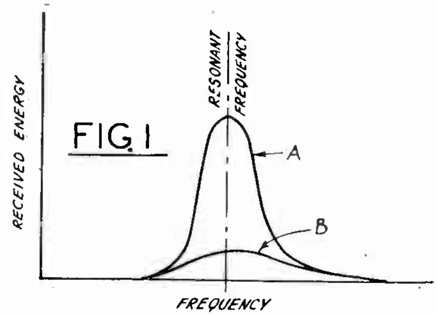
Now you will find that modern radio receivers do not employ the fixed input stage, that a tuned stage has been reverted to, and that very small couplings are employed to the aerial so as to overcome antenna variation. The reduced pick-up is offset by the increased amplification of the 224-tube. Before going into the "Pre-Selector" circuit, which we are herewith submitting, it is desirable to outline the difficulties presented by the 224 which

The Pilot "Pre-Selector" is without doubt the best broadcast receiver RADIO DESIGN *has ever described. It has the following outstanding features:* (1) *High gain screen-grid R.F. amplification and also screen-grid detection;* (2) *High-quality audio amplifier, using two P-245's in push-pull;* (3) *Single dial tuning;* (4) *Great sensitivity and selectivity—will work perfectly on short indoor aerial;* (5) *Smooth volume control;* (6) *Formed and completely drilled foundation unit has fully assembled and wired power pack welded permanently in place;* (7) *All-metal construction;* (8) *Uses new "Vaultype" shielded condensers;* (9) *Easily assembled and wired;* (10) *All wiring concealed under chassis;* (11) *Full A.C. operation;* (12) *Completed set has factory built appearance.*

Build a Pre-Selector and enjoy REAL broadcast reception!

caused the abandonment of the fixed input stage, because these same troubles still lurk in the 224 amplifier even with the installation of the first tuned stage. There is such a wide difference between 14 volts grid bias and 2 volts that it requires more than the simple addition of one tuned stage to offset the drawbacks. Hence the band-pass pre-selector circuit. But we are not quite ready for that.

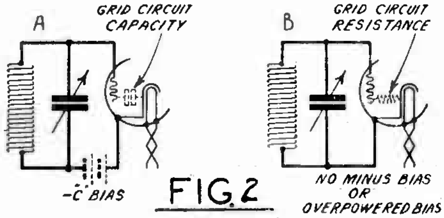
Please refer at this point to Figure 1.



Resonance curves of circuits with and without appreciable resistance.

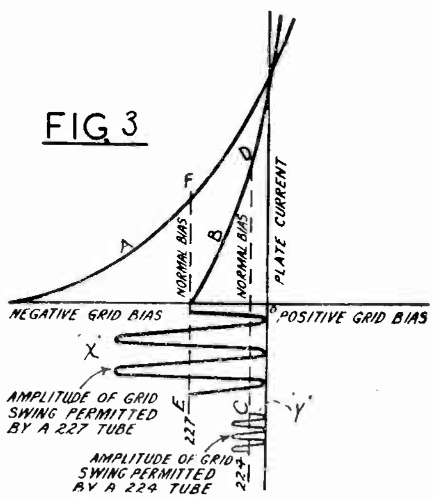
This shows two resonance curves, one fairly sharp and the other quite broad. The sharp one, curve A, is that of a standard low loss tuning circuit such as is found in the regular tuned receiver of today. Curve B represents the resonance when a little resistance is added—only a very little by the way! It is this critical resistance condition in the tuning circuits which led to all the hue and cry a few years ago concerning low loss condensers and low loss coils. All modern receivers now employ such condensers and coils. But what is the use when this loss is inserted in another way and the tuning efficiency once more sacrificed? Fortunately we have control over this other source of loss as well, after we realize that it is there.

This source of loss is caused by the low negative grid bias. Figure 2 is now pertinent and should be consulted. Sketch "A" in this figure shows the condition of the grid circuit when a sufficient grid bias is incorporated to prevent the grid running plus when the radio signal comes onto it. The grid-filament circuit remains a small condenser and as such has no loss effect on the connected tuning circuit. But let this grid become plus, due to excessive radio signal, and this whole grid-filament circuit becomes a resistance, as shown in "B" in the same figure. This resistance is located directly across the tuning circuit and changes the tuning characteristic to that shown in curve "B" in Figure 1. Unfortunately this broadening effect takes place on strong local stations right where the greatest amount of selectivity is desired.



Without suitable bias, the grid-filament acts as a resistance across the tuning circuit.

The overloading of the grid so that it runs plus is illustrated in Figure 3. Curve "A" shows the standard characteristic of the 227 tube, while curve "B" gives the signature of the 224. The slope of the curves is an indication of the amplification efficiency of the tube. Obviously the 224 is a much better amplifier. But by reason of this very fact, it requires much less change in grid voltage to operate the tube and much less normal grid bias. Too much grid bias will actually cut the plate current entirely off. The grid bias of 14 volts which would be normal for the 227 would open up the plate circuit of the 224. This is plainly shown in Figure 3. The dotted line C-D represents the normal bias for the 224 and the dotted line E-F shows this normal bias for the 227.



Comparison of characteristics of the 227 and 224 types of tubes.

A further study of this same figure will readily show that curve "A" will handle a much bigger carrier wave than curve "B" before the R. F. voltage at any instant is sufficient to overcome the normal bias, thus running the grid plus. Curve "X" and curve "Y" show the maximum carrier waves possible on the two types of tubes before the negative biases are overcome. So much for that.

This broadness in tuning, or lack of selectivity, is not the only peculiarity that arises from this small "C" bias, otherwise there would be no objection to using such a tube in the untuned first stage of the old-time sets where selectivity as such is not an item. Another one of the stepchildren is the harmonic generation so noticeable at the lower wavelength setting on your receiver dial. Oftentimes you have heard, no doubt, a nearby local station operating on its normal high wavelength coming in at some setting on the very bottom of the dial in addition to its appearance at its proper place on the tuner. "Harmonic," you say and proceed to curse the station for its low grade transmitting equipment. You will be pleasantly enlightened to know that the fault is probably yours and that the harmonic is being generated in your own set, and not at the broadcasting station. Fig. 4 attempts to make this clear.

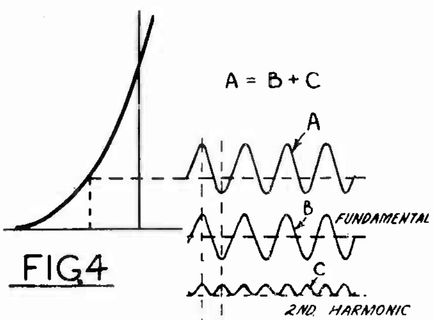


FIG4

How harmonics are generated in an improperly operating circuit.

It is well known that any tube characteristic that departs from a straight line always amplifies the positive half of the carrier wave more than the negative half. Curve "A" shows this condition. It is equally well known that there is no such thing as a straight line tube characteristic—they are all curved as generally shown in all the "curves" presented wherever tube information is given. Hence the word "curve." Such a curve as shown at "A" may be resolved into two other curves which are perfect and are not distorted by having one half amplified more than the other half. Tuning circuits automatically make this discrimination, so that curve "B" would be the one selected by a tuning circuit set for this wavelength. Then, what happens to the carrier shown in curve "C"?

This new wave in curve "C" is exactly twice the frequency of the standard wave and exists by virtue of the fact that the original wave has been distorted. Twice the frequency means one-half the wavelength and the tuning condensers set at one half the wavelength will pick out this new wave and bring in the program at this false setting. Now the next point is important in connection with this harmonic generation. Fig. 5 should here be consulted. Sketch 5A shows the operation of the 227 on a carrier wave of given strength. It will be noted that the curve of such a tube is fairly straight even though it is not absolutely a straight line. Harmonic generation under these conditions would be at a minimum.

Next consult sketch 5B. This shows the characteristic of the 224 tube. It is much steeper and much more curved for a given change in grid voltage. In other words, for the same strength incoming signal there is much more distortion and much more second harmonic generation. There is obviously a greater tendency for stations to come in at their half-wave setting on the 224 tube than on the 227. This means that we must be very sure that there is no high wavelength station forcing its way into the first tube while we are tuning the gang condensers down at the lower end of the tuning scale.

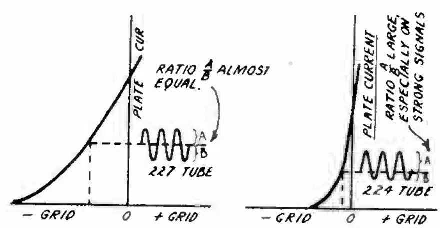


FIG. 5A FIG. 5B

Why the 224 is a more prolific producer of harmonics than the 227.

And we are not through yet with trouble arising from the low grid bias on the 224. The next big snag is called "cross modulation." This is a difficulty not generally understood and is sometimes confused with harmonics as it caused a strong station to come on other points on the tuning dial than the proper one. A sure indication that you are suffering from cross-modulation and not harmonics may be obtained from the fundamental difference in symptoms. A true harmonic trouble can occur only at exactly one-half the proper wavelength, while a cross-modulation will cause a strong station to come in on the carrier waves of all the other stations which you wish to receive. The two troubles are caused by one and the same fact: too small a grid bias for the amount of selectivity just ahead of the first tube. No additional diagrams are needed to explain this point, because unequal amplification, as shown in Fig. 5, means not only harmonic generation but also rectification. And rectification in the plate of the first tube means audio currents in the plate of the first tube. These audio currents, representing the program from the strong station, impress themselves on any other carrier wave coming through the tube by affecting the amount of gain in the tube. So, no matter what station is tuned in, the audio currents created by the strong local breaking through to the first tube appear superimposed on the program desired. The answer to this problem is the same as for harmonics: more selectivity before the first tube. And the cause is the same in each case—low grid bias on the first tube, which we are bound to accept due to the otherwise high efficiency of the 224 screen-grid tube.

By now you should be able to read between the lines and judge for yourself that the only answer is some sort of tandem tuner or band-pass filter ahead of the first tube. When we first dared to suggest such a device some months ago, we were not taken seriously. Now, every modern radio set manufacturer is coming gradually to this same conclusion. Practically every commercial, complete receiver this coming season will incorporate such a preselector. There is no other answer for a screen-grid set operating on an aerial.

And what is this mysterious pre-selector? Nothing particularly new, I can assure you. In fact, the irony of this new development is that it goes back way before the days of vacuum tubes. Selectivity is a very old trouble, and John Stone conceived the idea of increasing the selectivity of a tuned circuit by coupling the antenna input through several tuned circuits in series in which each was coupled to the preceding one. This was back in about 1904! Well, anyway, it's the only thing to do. Fig. 6 shows the circuit arrangement in which we are utilizing two such coupled circuits.

A three-turn and six-turn primary is very loosely coupled to the second secondary. The windings are placed about one-eighth inch apart and are wound on the same piece of tubing. The details of construction were given in the last issue of RADIO DESIGN. When extra sharp tuning is desired, even at the sacrifice of some signal strength, the three turn primary is connected. Increased signal strength with reduced selectivity results from the use of the six-turn primary. But even this is better than just one single tuning circuit before the first tube. All of the difficulties outlined in connection with cross-modulation, harmonics, etc., are overcome by this added selectivity, which permits us to use the new, high amplification 224 tubes with their resulting drawbacks.

The screen-grid detector arrangement was another radical departure which we advocated with this receiver. When the 224 tube was first suggested for use as a detector, no one thought that it could be made to function as a "C" bias device with the input connected to the inside, or control, grid. Rather mediocre results were obtained by employing grid leak circuits in which the leak was placed in the screen circuit. Figure 7 outlines the arrangement used in this Pre-Selector receiver. It is quite necessary to connect such detector to a resistance coupling stage. It will not work satisfactorily with any other combination and its performance with a resistance coupled outfit is excellent. It is one of the few cases in which a cheaper equipment outlay actually gives improved reception.

The detector really acts like a grid-

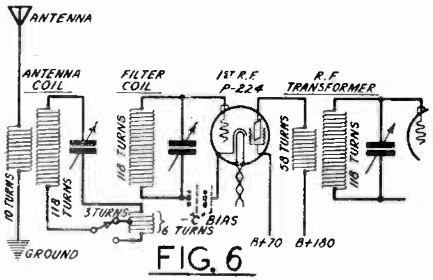


FIG. 6

Double coupling arrangement used in the new "Pre-Selector" receiver

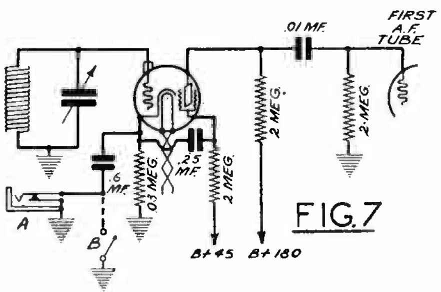
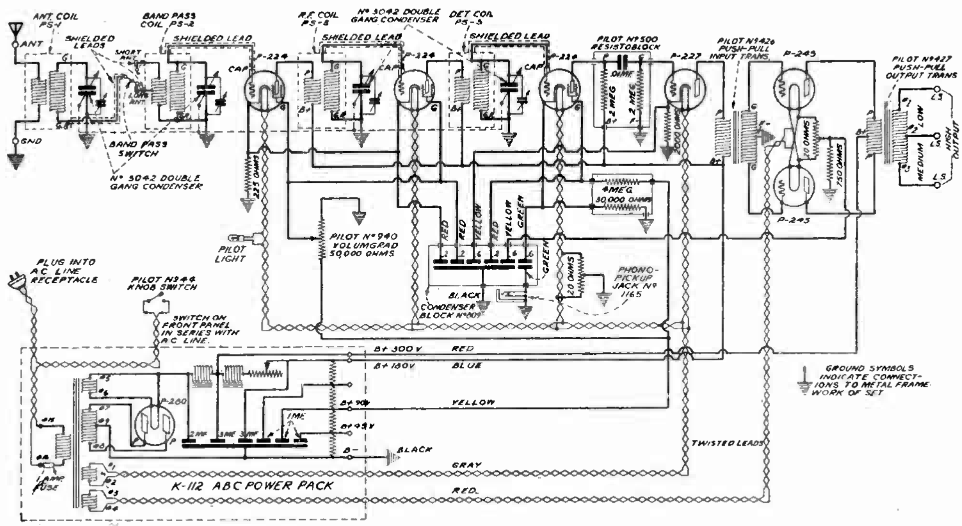


FIG.7

How the phonograph jack A is connected in the cathode circuit of the detector.



Complete schematic diagram of the "Pre-Selector." The K-112 power pack, enclosed within the dotted lines in the lower left corner, is supplied already assembled and wired.

leak and "C" bias system combined. The excessive grid bias on the control grid is supplied by the voltage drop across the 30,000 ohms in the cathode return in a manner similar to the method for obtaining the proper grid biases on the amplifying tubes. This high bias causes rectification to take place in the screen-grid circuit, and this is transferred into audio tones by the ¼ mf. by-pass condenser and the 2 megohm leak. The potential on the screen is thus varied according to the program coming in on the carrier.

This varying potential on the screen then affects the plate current in the same way as a standard three-element tube. A two-fold amplification is secured which makes this tube, operating as outlined, an extremely efficient device. No plate by-pass condenser is required, an unusual departure which will appear rather startling until you realize that no rectification actually takes place in the plate. The usual by-pass is now located in the screen-grid circuit, where all the detection occurs.

The detector circuit has been provided with a phonograph pick-up jack. This is a three-contact affair shown at "A" in Fig. 7.

When the pick-up unit is inserted in the jack, it is merely connected in series with the 0.6 mf. condenser across the 30,000 ohm resistance. This loading of the resistance reduces any reasonance effects of the pick-up. Pulling the pick-up out of the jack restores the condenser directly across the resistance. It may strike you that this condenser is a little large for a by-pass, but it must be remembered that audio frequency currents are present in this part of the circuit, arising from the audio plate currents set up by the rectification in the screen-grid circuit.

The switch "B" is optional and is accordingly shown in dotted lines. In case you care to leave the phonograph unit permanently connected in the jack, the pick-up may be shorted out of use by closing the switch "B." The set is then ready for radio reception.

TWO PRE-SELECTOR KITS

The new Pilot "Pre-Selector" is available to the set builder in the form of two kits. The first, known as the K-126, is a chassis model, without cabinet or front panel, and is intended for mounting in consoles or other pieces of furniture of the builder's own choice. It includes a fully drilled and formed steel base-panel, with a completely assembled and wired K-112 power pack welded permanently in place to form the left side of the foundation unit. In the kit are all the parts necessary for the construction of the receiver: variable and fixed condensers, sockets, transformers, resistors, R. F. coils and their shield cans, binding posts, wire and all required hardware down to lock washers and soldering lugs. A template showing the exact location of the holes which must be cut in the front of the console is also supplied.

The second kit, the K-128, is simply the K-126 with a handsome table-model steel cabinet, the front of which is already drilled for the dial, the power switch and the volume control. The assembly operations with the two kits are the same, the two chassis merely being handled differently after they are finished.

The finished Pre-Selector has that fine factory-built appearance that is so hard to achieve with most home-assembled radio receivers. When you lift the top of the cabinet and look into the set, you are struck by its clean and business-like appearance, and you are truly proud of the outfit.

ASSEMBLING AND WIRING DIRECTIONS

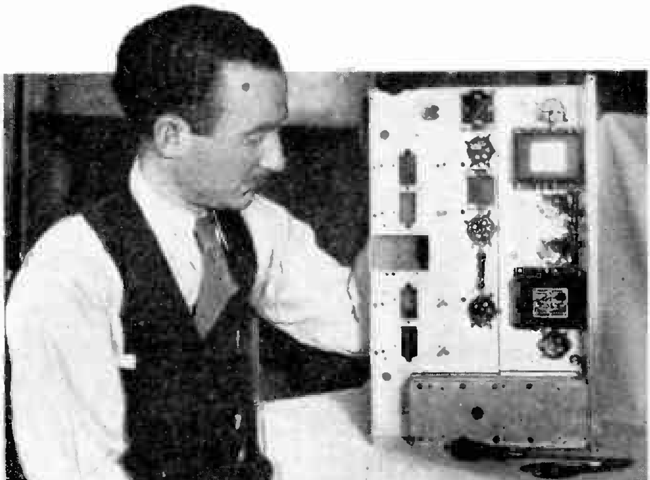
For the benefit of those who buy Pre-Selector kits, we are presenting herewith a detailed description of the assembly and wiring operations. If these are followed carefully, the set will go together with gratifying smoothness, and will work with a bang the first time the switch is turned on. The Pre-Selector as it is now marketed is the result of any months of experiment with more than a dozen different models, and all the annoying little wrinkles have been ironed out of it completely.

The following parts are included in the Pre-Selector kits:

Cata. No.	DESCRIPTION
1—690	Chromium Plated Chassis (with Bracket Supports).
1—K-112	Power Pack.
2—3042	Vaultype Variable Condensers.
1—1285L	Drum Dial.
1—236	Set of Four Coils, consisting of 2 R.F. (PS-3), 1 Ant. (PS-1), 1 Band Pass (PS-2)
1—426	Push-Pull Input Transformer.
1—427	Push-Pull Output Transformer.
1—500	Resistoblock.
3—216	4-Prong Sockets.
4—217	5-Prong Sockets.
1—965	750 Ohm Resistor.
1—958	2,000 Ohm Resistor.
2—756	2 Meghom Grid Leaks.
1—759	4 Meghom Grid Leak.
1—768	.03 Meghom Grid Leak.
1—1165	Jack.
2—354	20 Ohm Center Trapped Resistance.
1—940	50,000 Ohm Volumgrad.
1—44	Knob Switch.
1—45	Single Pole double Throw Switch.
5—	Binding Posts.
1—967	225 Ohm Resistor.
4—605	Coil Shields.
3—606	Grid Wire Shield Tubing.
1—809	Filter Condenser block.
1—689	Hardware Combination, including all necessary nuts, bolts, washers, lugs, special fixtures, wire, binding post, insulators, etc.
1—2502	Walnut Finished Cabinet (with K-128 kit.)

In the way of tools you need only a screwdriver, cutting pliers, long-nosed pliers, Spintite wrench, knife and soldering iron. The foundation unit is accurately drilled and all the parts will fit in place without trouble.

The first thing to do with any kit is to unpack all the parts and to identify them according to the accompanying illustrations and drawings and the full-size blueprint supplied with the kit. Too many set builders rush right into the assembly work without sufficient preliminary study of the layout, and as a result they usually find themselves hopelssly confused before they are half finished. Look carefully into all the individual little boxes and save the various hardware envelopes that you find in them. Spill all the screws in one little saucer or other flat dish, all the nuts in another, and all the washers and soldering lugs in a third; you will then be able to reach for them quickly. Put aside the cover of the K-112 power pack, the whole cabinet (in the case of the K-128) and the coil shield cans, as you will not need them until later. Clear away all the loose paper and debris and line the parts up in front of you.



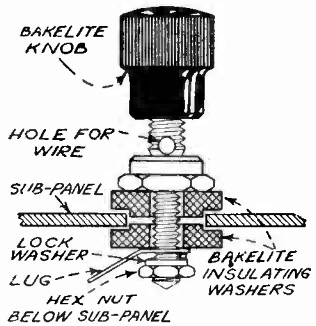
The "Pre-Selector" foundation unit with the sockets, resistors and transformers mounted in place on the under side.

REMOVE POWER PACK

As the power pack is rather heavy and will make thehandling of the foundation unit awkward, it is best to remove it before working on the set. The can is welded in place, but the unit itself is held by four screws. You can spot these easily on the bottom. Loosen them and let the pack slide out. Be careful to note how the fiber protecting strips fit.

Start the assembly by screwing down all the binding posts, the tube sockets, the 750 and the 2,000 ohm resistors on the back edge of the base-panel, the Resistoblock, the grid-leak clips on the bakelite strip already eyeletted to the base-panel, the 225 ohm resistor, the audio transformers, the little single pole baby knife switch, the coils, and the phonograph jack. Handle the coils carefully and note from the drawings how they fit. Do not mount the two Vaultype variable condensers or the No. 809 condenser block yet. Push the soft-rubber bushings in the three holes in the back of the base-panel and in the two near the front edge. Note that soldering lugs must be placed over some of the screws; lock washers should be put over all of them.

Now begin the wiring by making the antenna connections. Proceed to the rectifier tube, the power tube filaments, and the other tube filaments. Use the heavy No. 16 flexible wire for the 227 and 224 tubes, and the thinner No. 18 for the others. Twist the pairs of filament wires and bring them through one of the bushed holes in the back of the base-panel. Cut the wires about 18 inches long from the hole, for the connection later to the power pack.



How the binding posts and the S. P. D. T. switch posts are insulated from the metal sub-panel by the double bakelite washers.

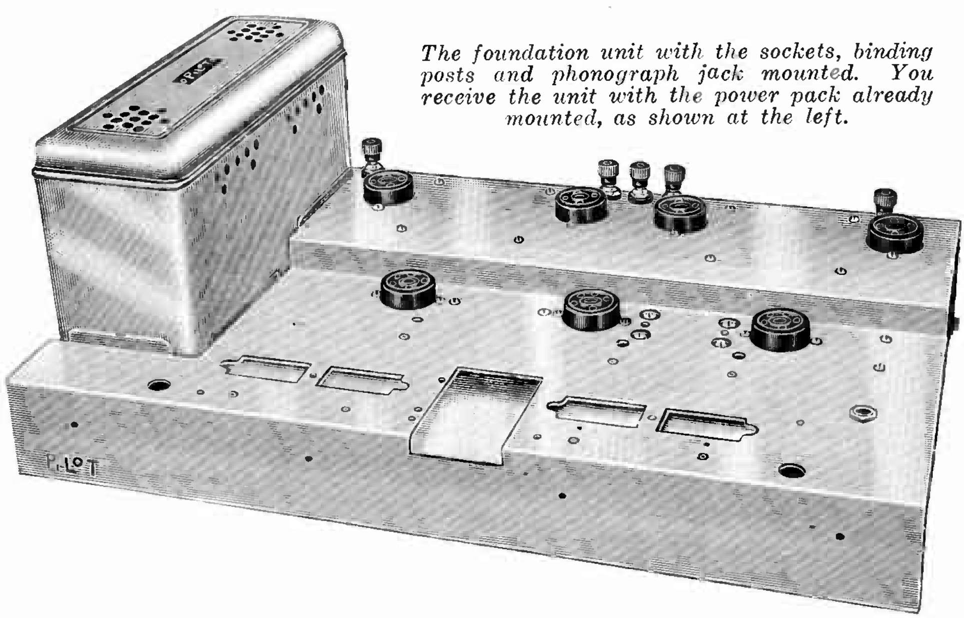
Wire the three loud speaker binding posts, put in the center-tapped resistors, and finish the audio wiring. Go to the R.F .end of the set and wire up the four coils, making connection to the various soldering lugs. Make all connections except the ones to the grid lugs of the coils. These will be made later.

As with the filament wires, cut the various "B" leads 18 inches long at the bushed holes.

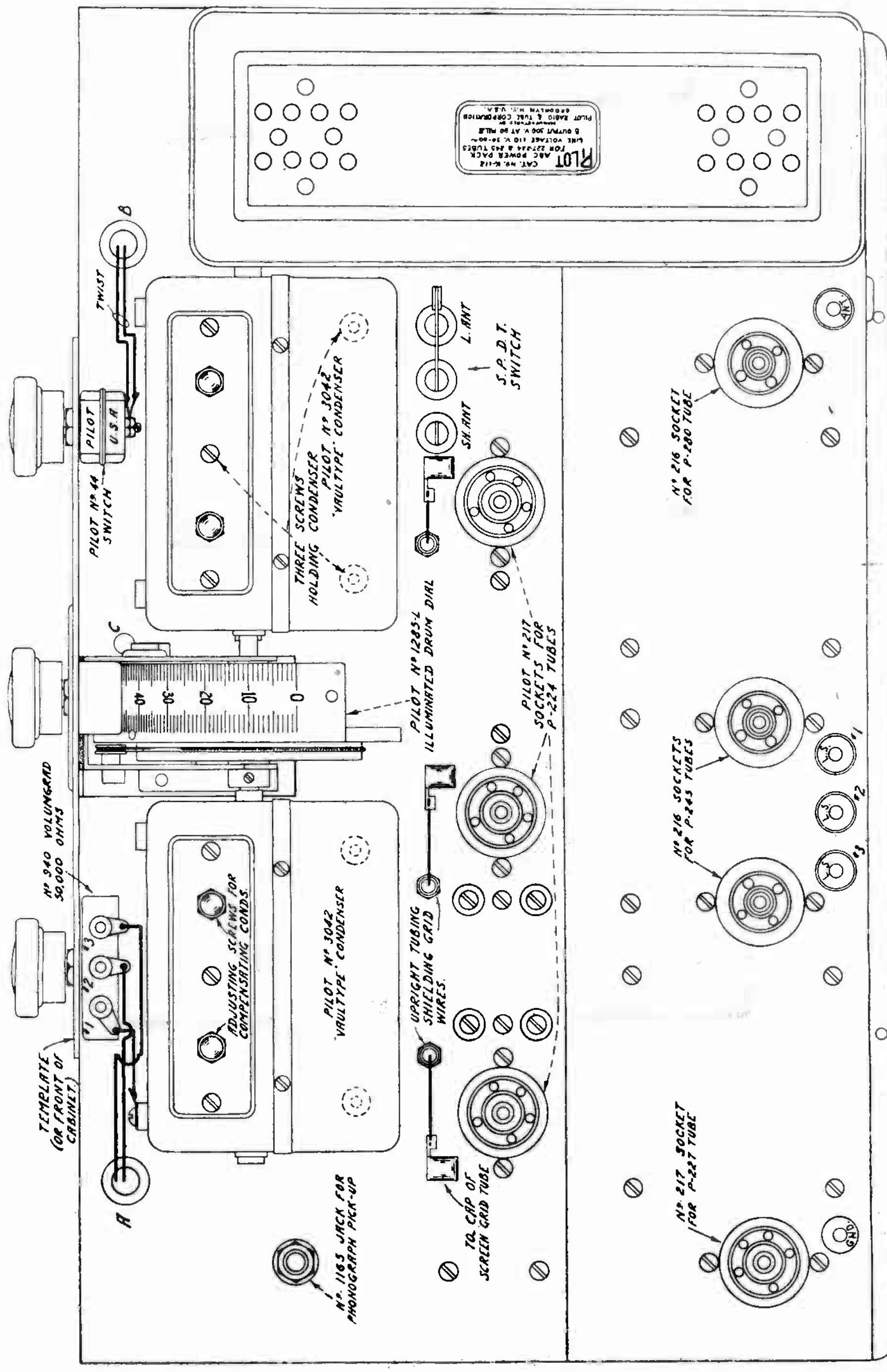
Now mount the No. 809 condenser block between the audio transformers by means of the special strap provided in one of the hardware packages, and bridge the various wires as shown in the picture wiring diagram.

SWITCH CONNECTIONS

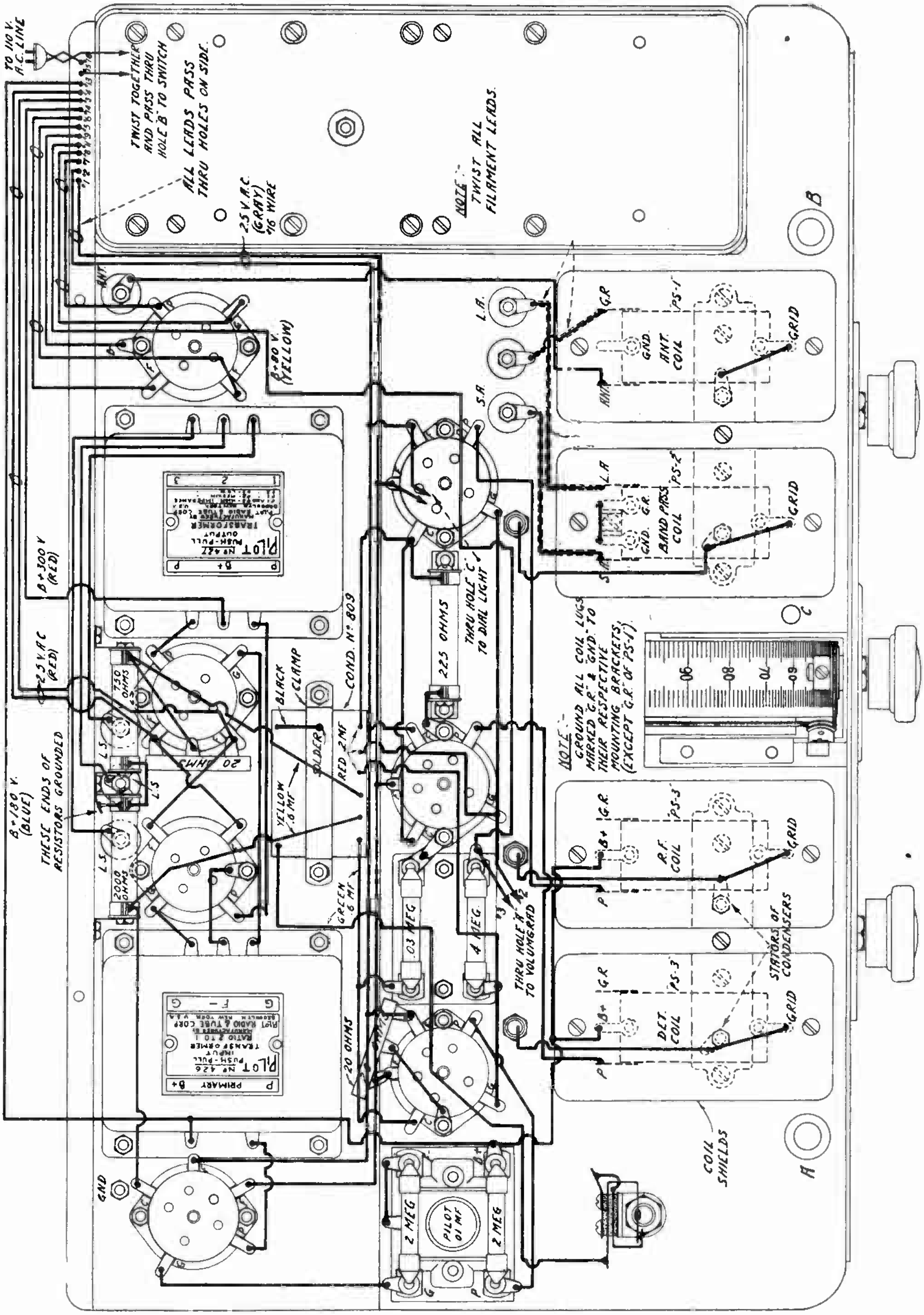
Slip the power pack back into its can, being careful not to bruise any of the connections, and tighten the screws at the bottom. Pull the loose 18-inch wires through the opening in the end of the can and connect them to the numbered posts on the bakelite terminal plate as indicated in the upper right hand corner of the under view of the set. To make the switch connections, cut a length of



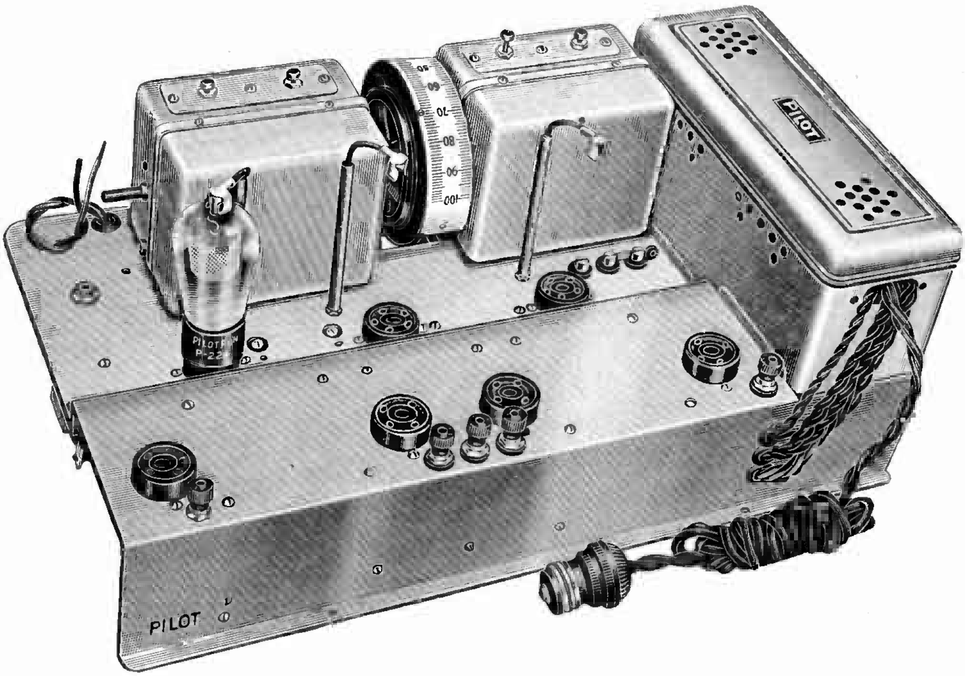
The foundation unit with the sockets, binding posts and phonograph jack mounted. You receive the unit with the power pack already mounted, as shown at the left.



Top view of a completed Pilot "Pre-Selector," showing particularly the connections to the switch and the Volumgrad and the short grid wires leading out of the upright lengths of tubing behind the variable condensers. Notice that post 1 of the Volumgrad is grounded to the frame of the left condenser.



Under view of a completed "Pre-Selector," showing the placement of the parts and the wiring. The connections look rather complicated, but when you actually make them one by one you will find them quite easy. Note carefully that soldering lugs must be put on many of the binding posts and fastening screws.



Back view of a completed "Pre-Selector" chassis, with the detector screen-grid tube in its socket. The set has a clean, business-like appearance of which you will be very proud.

twisted flexible pair about two feet long, splice one end into the 110-volt cord inside the K-112 can, pull the other end through the opening in the latter, through one of the bushed holes, along the side of the can, and up through hole "B." You will connect it to the switch in a little while. Cut another length of wire for the Volumgrad connections, which go through hole "A" from the 4 megohm leak and the adjacent tube sockets. Now fasten the long bracing arm across the bottom of the base-panel, next to the No. 426 input transformer.

PLACING IN CABINET

With all this done you are ready to mount the chassis in the cabinet. If you have the K-128 kit, unscrew the bottom of the cabinet and put it aside with the top. Take the chassis and lower it carefully into the cabinet. Push it against the back of the front, and screw the front edge in place with four ¼" brown oval head screws. Mount the Volumgrad and the switch and solder the loose wires from holes "A" and "B" to them. Also solder a 1½" length of wire to post 1 of the Volumgrad, for connection later to the frame of the nearby variable condenser.

Now take the two variable condensers, and mount them loosely in the No. 1285 dial. Screw a soldering lug to one of the studs in the condenser that will face the Volumgrad and also put lugs on the stator binding posts. One of the Vaultype condensers furnished with the Pre-Selector is specially constructed for the set. You will notice that the shaft is cut short on one end, so the condeser will fit the dial only one way. Remove the screw in the center of each conderser's bakelite strip. Place, but do not screw, the condensers on the base-panel. Before pushing the stud of the dial through the front of the cabinet, place the special fiber spacer between the cabinet and the dial; this will prevent the scale from scraping. Put the dial panel plate in place on the front, pass one screw through the bottom, turn the large nut on the threaded stud, and put two more screws through the top part of the panel plate. Fasten these screws in loosely.

GRID WIRES IN TUBING

You will now find the bakelite insulating strips of the condensers fitting nicely in the cut-outs in the base-panel. Put screws through the latter up into the condenser mounting studs, and tighten them. Replace the screws in the bakelite strips. Now tighten up all the dial screws. Mount the three threaded lengths of tubing on the top side of the base-panel, behind the condensers. Complete the grid wiring by making connections to the stator posts of the condensers and the grid lugs on the coils. Pull lengths of flexible wire through the metal "chimneys," leave their ends about two inches long, and solder the little snap clips to them. These clips go over the caps of the screen-grid tubes. Screw the coil shields over the coils, fasten the little L-shaped brackets that support the rear edge of the base-panel to the back of the cabinet, and you are ready to try the set. Do not screw on the bottom yet, so that you may make changes or corrections in the wiring if necessary.

If you are mounting the Pre-Selector in a console or other cabinet, you can mount the controls on a false front panel or directly on the front of the cabinet itself. The construction of the particular cabinet will determine the course to be taken. A drilling template for the dial, the switch and the volume control is included with the kit.

SEVEN TUBES NEEDED

You need three P-224 A.C. screen-grid tubes, one P-227, two P-245's and one P-280 rectifier. Test the "B" voltages of the K-112 pack with a high-resistance voltmeter, and make any necessary adjustments on the variable resistor in it.

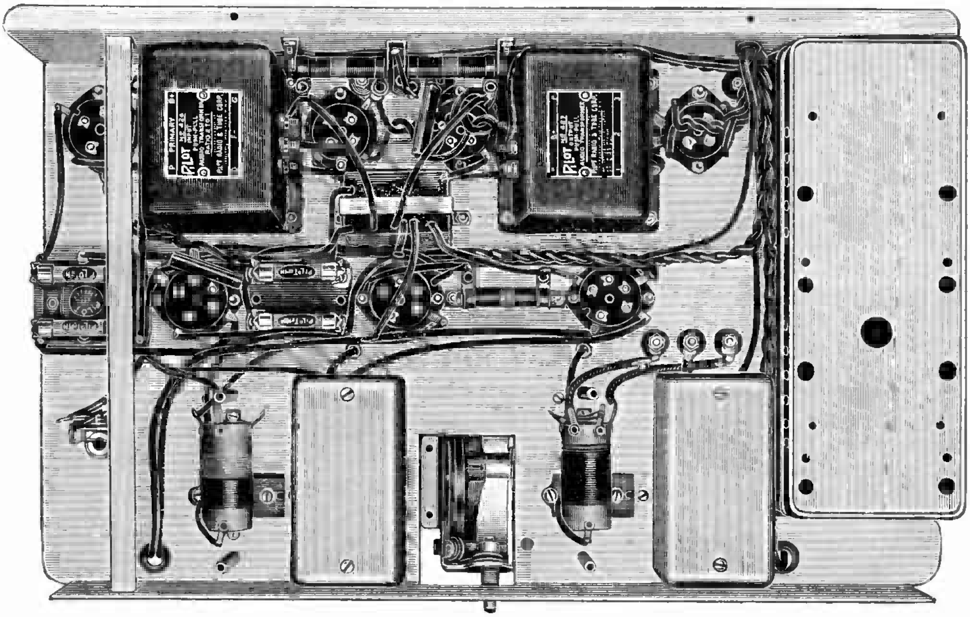
The Pre-Selector is so sensitive that it will work perfectly on an indoor aerial as short as ten feet. An outside aerial of the usual 60 or 70 foot length may also be used. With the set working, try throwing the little knife switch to both positions, and see which works better in regard to selectivity. Also try adjusting the compensator screws on the tops of the variable condensers if the signals seem weak.

The Pre-Selector is a "sure-fire" set. That is, it will work without fussy adjustments and without being at all critical.

The phonograph pick-up may be left connected permanently in the jack on the base-panel, or it may be shorted out with a simple single throw switch. It does not interfere with the operation of the set itself. In fact, both the phonograph and the radio set may be operated at the same time, if you want to hear some queer sounds.

In making any adjustments on the set, remember that the power pack delivers some 300 volts, which is quite enough to jolt you severely if you get your fingers mixed up in with the wiring. *Always shut the set off before touching anything on the underside of the base-panel,* and you will never have to nurse a shocked hand.

The seven tubes of the Pre-Selector will develop some heat, but this is entirely normal and no cause for alarm. The top of the cabinet may become a bit warm after a few hours, but don't worry about it.



Under view of a completely wired "Pre-Selector." Two of the R.F. coils are shown with their shield cans in place, and two without them.

Mr. Manuel, general export manager of the Pilot company, is shown at the right, shaking hands with Mr. Bouck, while Mr. Alexander looks on. Mr. Manuel sailed from New York for Rio de Janeiro early in February, so as to be in South America to greet the fliers on their arrival there.

Rolling Down to Rio---1930 Style

Pilot Radio Plane to Make First Commercial Good-Will Flight to South America, Covering 22,000 Miles

by E. MANUEL

ON THE twenty-fifth of March, the flying laboratory of the Pilot Radio and Tube Corporation will take off from Roosevelt Field, Mineola, Long Island, on the first commercial good-will flight to South America. Starting from New York City, this flying symbol of business amity will wing its way to Rio de Janeiro, eleven thousand miles distant.

Several records will be established by this flight. It will be the longest flight ever made by any business organization in its own plane in the furtherance of the interest of its customers. It will be the first commercial good-will flight of any length ever made. It will be the first commercial good-will flight from North to South America and it will be the first time that any standard type of plane has made the complete journey from New York to Rio over the contemplated and somewhat hazardous route.

The purposes of the trip are threefold. It is hoped primarily to promote commercial good-will between the two great continents of the Western Hemisphere—the vast manufacturing country of the north and the almost unlimited agricultural land of the south, countries ideally complementary.

COMPLETE EQUIPMENT CARRIED

The flying laboratory will carry complete radio transmitting and receiving equipment, and it is believed that the flight will demonstrate beyond argument the utility of such apparatus on long distance airplane flights.

By altering the route slightly, in passing down the west coast of South America, it is expected to establish a new airway particularly adapted to the requirements of land planes. The pilot of the plane has spent several months mapping out the course.

THE CREW

A crew of two will be carried in the plane. The pilot will be William H. (better known as Bill) Alexander, a veteran with 7,000 hours flying since his first 200 hours built up in the R.F.C. during the World War. In the course of his flying time, Alexander was a lieutenant commander with the U. S. Navy, in charge of flying instruction at Pensacola, Florida. He is one of the best known mail and transport pilots in the game. He holds F.A.I. license number 1, issued in 1911; a sporting license, and the Department of Commerce transport and mechanic's licenses.

Zeh Bouck will accompany Alexander as co-pilot navigator and radio operator. Mr. Bouck is well known to the readers of RADIO DESIGN, and needs little additional introduction to them. Mr. Bouck has been closely identified with radio broadcasting since its inception, as a writer, engineer, editor and radio operator. The special airplane transmitter and receiver carried on the flying laboratory has been designed by him. Aside from his radio activities, Bouck has been associated with aeronautics for some years. He is an experienced navigator, and the editor of *Aero News* magazine. As engineer in charge of aeronautics with the Pilot Radio Laboratories, the activities of the flying laboratory have been under his direction, and he has accompanied the Stinson J-6 monoplane on all of its long flights.

THE ROUTE

The air-lane covered in the complete journey to South America and return will be twenty-two thousands miles long, and with the contemplated stop-overs will take between two and three months.

Leaving New York with letters from Mayor Walker to the heads of South American municipalities, the first stop will be made in Washington, D. C., where messages will be picked up from President Hoover and the Pan-American Union, carrying further words of commercial and general good will to the southern continent. The plane will then proceed to Atlanta, Georgia, and Miami, Florida. A ninety mile over-water hop takes the goodwill flight to Havana. The next leg of the journey is another over water hop to Mexico, following the coast up to Vera Cruz, and then inland to Mexico City.

After a brief stay in the Mexican capitol, the nose of the plane will again be headed south for Guatemala City. Refueling here, the flight proceeds to Managua in Nicaragua and Panama in the Canal Zone.

The most hazardous leg of the journey now lies before the aviators—from Panama to Buena Venture in Colombia and Guayaquil in Ecuador — twelve hundred miles of cliff bordered coast, with impassable mountains on the left.

Crossing the next international border brings the fliers into Peru, with stops at Talara, Trujillo, Lima and Arica. Antifogasta, Chile, is not far away, and then the capital, Santiago. The next leg of the journey is the shortest hop in the flight, but necessitates crossing the Andes at an altitude of twenty thousand feet to Mendoza in the Argentine.

It is planned to arrive at Buenos Aires the first day of May, with a stop over of one week during the radio show there. The flight will continue to Montevideo and San Paola, and then to Rio de Janeiro in Brazil, and follow the coast north as far as Victoria and Natal.

The exact course of the return flight has not been decided upon at this writing, and its selection will be determined largely by the difficulties of the southern flight.

THE RADIO APPARATUS

The radio transmitter and receiver have been designed for airplane purposes. The transmitter consists of two 210 type tubes, especially evacuated by Eveready-Raytheon to withstand high plate voltages.

The compact radio equipment in the rear cabin of the plane. At the bottom is a "Super-Wasp" receiver; above it is the transmitter.

The size of the Pilot plane can be judged from this picture, which shows six-foot Mr. Alexander sitting on a wing strut.

The plate and filament potentials will be supplied by a dynamotor and a storage battery, respectively. The storage battery will also operate the dynamotor, and will be charged continuously in flight by a wind-driven generator. This arrangement permits emergency transmission from the ground. A trailing wire antenna will be used for general transmitting and receiving purposes.

The transmitter will operate on wavelengths in the neighborhood of forty meters for communication with amateurs and the Pan-American airway stations along the route. It is expected that the good will flight will maintain consistent communication with North America throughout the tour via amateur radio. A six hundred meter wavelength will also be available for distress purposes.

"SUPER-WASP" USED

The receiver is a redesigned A. C. "Super-Wasp" operated from batteries. A. C. tubes are used to reduce microphonics. The receiver will be supplied with plug-in coils covering the amateur and American broadcast bands, the 600 to 800 meter ship wavelengths and the 800 to 1,100 meter aircraft bands. A loop will be available for receiving where directional effects are desired.

The entire ignition system on the plane will be shielded to eliminate ignition noises, which otherwise would cause considerable interference on a high sensitivity receiver of the type employed.

Communication will be in International Morse code, in both English and Spanish. I. C. W. will be used on the plane.

FLYING EQUIPMENT

The plane will be completely fitted out for a long distance flight. With the co-operation of the South American governments, it is understood that special permission will be granted to carry photographic equipment, both still and movie cameras. Among other equipment will be Irwin airchutes, revolvers, pistols and rifles, ammunition, emergency food rations, medical supplies, plenty of quinine, water, extra oil, air mattresses, pajamas, chewing gum, tobacco, fruit, a wind drift indicator, two compasses, two chronometer watches and three wrist watches, and a Battenberg disk.

The plane ordinarily will carry a twelve hour supply of gas. However, on particularly long hops, additional gas will be carried in the cabin, and transferred to the main wing tank by means of a wobble pump. Oil can be replenished, while in the air, by an oil pipe leading to the crank-case.

The first commercial good-will flight to South America has been made possible by the hearty cooperation of many organizations interested in the vast possibilities of Pan-American commerce. The Richfield Oil Company of New York will ship Richfield gasoline and Richlube lubricating products to all stopping places along the route. The National Carbon Company, through its subsidiary, Eveready-Raytheon, is furnishing vacuum tubes and "B" batteries. Among the other cooperating organizations are *Aero News* magazine, the Irving Parachute Company and the Stinson Aircraft Corporation.

NOTICE

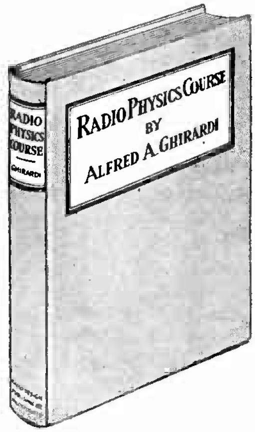
All our copies of the first six issues of Radio Design have been sold, and we have none left to fill the many orders we receive for them. The only back copies we have available now are of the Fall issue of 1929, Number 3 of Volume 2. These are going fast; if you want to complete your files, order your copies now. They cost fifteen cents apiece; coin or stamps accepted. Address your orders to

Circulation Department,
RADIO DESIGN,
103 Broadway,
Brooklyn, N. Y.

"Radio Physics Course" is Ideal Book for the Radio Fan

362-page Volume, by Alfred A. Ghirardi, Describes Modern Circuits and Apparatus and Latest Developments in Television and the "Talkies."

IN THE short time that it has been out, Alfred A. Ghirardi's book, "Radio Physics Course," has been hailed by school teachers, engineers, writers and editors as the finest text book ever brought out for the radio student, set builder and service man. Written in clear, understandable language by a man who has had many years of experience in both the radio and teaching fields, it covers present-day radio thoroughly and accurately, and gives the reader a clear conception of the various complicated phenomena and instruments he is likely to encounter in his experiments as a student or his work as a professional radio man.



The book as it is now sold by RADIO DESIGN contains 362 pages and more than 300 illustrations, and is handsomely bound. No radio student, experimenter, set builder or service man should be without a copy, as it is the one radio book that describes, in both theory and operation, all the modern radio circuits, receivers and accessories. It contains even the data on the A.C. "Super-Wasp," the latest advances in television, and the most recent developments in the talking movies.

Those who have been following the "Radio Physics Course" in installments in RADIO DESIGN need not be told of the value of Mr. Ghirardi's writings. To our new readers we earnestly recommend the book as a complete radio education.

The "Radio Physics Course" is divided into twenty-three chapters. Mr. Ghirardi gives only two short chapters to a review of the elementary principles of electricity, magnetism, sound, and vibrations, as these subjects are already familiar to most radio students and are covered in great detail in many other books devoted exclusively to them. With Chapter 3 he starts at the broadcasting station and from there continues to the many phases of radio operation. While most other radio textbooks barely mention the A.C. tube, the "Radio Physics Course" deals at great length with the latest sets and circuits using the screen-grid variety, and continues with a study of all the radio improvements known in the art today: push-pull audio, power detection, shielding, condenser speakers, etc.

The book is timely, particularly because it treats with the latest and most advanced instruments, and not with circuits and apparatus that have already outlived their usefulness.

The chapter on the talking movies describes all the systems being used at present in American theatres. The reader who has studied the preceding material on audio amplification and reproduction will find the "talkies" quite simple, as they involve the same principles as standard radio equipment.

The book is replete with many valuable charts and tables for which the experimenter, constructor and service man will find daily use.

We are honestly enthusiastic about the "Radio Physics Course" because it contains such a wealth of "dope" and is written in such fine style. Most of the other so-called "text books" for the radio student that we have seen are either hopelessly mathematical and technical or so simple as to be devoid of real information; the "Radio Physics Course" strikes just the happy medium, and fills a long-felt want on the part of radio experimenters. The best compliment to its contents is the fact that it has already been adopted as a standard text by several high schools.

If your local book shop has not yet received copies, order direct from RADIO DESIGN. The price is only $2.50 per copy, postpaid. It is the best two and a half dollars you ever invested in radio.

More About the Short-Wave Broadcasting Stations

Valuable and Hitherto Unpublished "Dope" on Wavelengths and Hours of American and Foreign Stations Supplied by Readers

by ROBERT HERTZBERG

THE LIST of the short-wave broadcasting stations of the world published in the last number of RADIO DESIGN was evidently something our readers have been wanting for a long time. We have been overwhelmed with letters from short-wave fans, thanking us for the accurate operating schedules and offering much additional information on stations we did not list.

We did not have room in the Winter issue to explain how difficult it is to obtain reliable short-wave "dope." The published list represents more than six months of work, and involved the writing of hundreds of letters and the scanning of all the radio magazines published in the entire world. We checked the lists in the American and British magazines against those in the German, French, Italian, South American, African, Australian, New Zealand and (believe it or not) Japanese magazines, and weeded out the stations that were actually reported by more than two listeners. After much weary cross-checking and classifying, we had a really good list.

There was not enough time between the last number of RADIO DESIGN and this one to reclassify the stations according to the letters sent to us and the new data accumulated from other sources. Instead, we are simply reproducing the contents of the best letters, with some comment and additional notes on the side. We wish to express our sincere thanks and appreciation to all who were kind enough to write and we invite them to continue sending in new "dope" whenever they can obtain it. This sportsmanlike exchange of information through the columns of RADIO DESIGN is helping to make short-wave reception more and more interesting to every owner of a short-wave set.

These letters are especially valuable because many stations are strangely unwilling to release information about their own activities. All broadcasting stations want big audiences (if they didn't why should they be broadcasting?), yet the owners of KDKA and WLW, two of the largest and most important stations on the air, absolutely ignore letters and even telegrams sent to them in request for wavelengths, operating hours, etc.

Before plunging into the mass of station data, we would like to introduce to our readers Mr. Arthur J. Green, of Klondyke, Ohio, and to nominate him for the position of champion short-wave listener of the world. He has heard sixty-five foreign short-wave broadcasting stations (not counting the Americans), has letters of verification from forty-four of them and photographs from fourteen. Blessed with a marvelous location, a large amount of patience and a hankering to tinker, he has established an international reputation by his exploits in the short-wave field, and is regarded by many of the stations of the world as the best source of reports on their transmissions.

Arthur J. Green, short-wave listener extraordinary.

As a result of the world-wide publicity he has received through stations KDKA, PCJ, NRH and VRY, Mr. Green's correspondence has reached staggering proportions. More as a matter of self-defense than anything else, he has formed the "International Short-Wave Club" and started the publication of a little monthly bulletin containing his latest data on the short-wave broadcasters. He charges ten cents an issue or a dollar a year, a price that barely covers postage. We recommend this little sheet highly for its last minute dope. Mr. Green can be addressed at Box 713, Klondyke, Ohio.

Because Mr. Green is interested only in furthering the short-wave game as a hobby and not in making money out of it as a business, he has given RADIO DESIGN permission to reprint the information from his latest bulletin of February 10, 1930. We are presenting this as authentic and reliable. The following paragraphs are excerpts from the bulletin and not a complete copy, as much of the data in it was published in the last issue of RADIO DESIGN or is being published in the latter section of this article. The editors' notes are ours.

SPECIAL PROGRAM IN ENGLISH

"This month's prize happening was when the new station at Tegucigalpa, Honduras, call letters HRB, put on two special English programs for club members. We sent them their first report on reception in the U. S. A., and in return they gave us the two programs on January 18 and 25. (Ed. Note: These programs have been reported by hundreds of 'Super-Wasp' owners.)

"This station is owned by the Tropical Radio Telegraph Company, and broadcasts on Monday, Wednesday and Friday, 9:15 to 12:00 p. m. E. S. T. The present wave is 49.95 meters and the power 25 watts. (Ed. Note: Is that all? This station comes through like the proverbial ton of bricks). This will soon be replaced by a new 350-watt crystal-controlled affair that will work on the present wave except in static seasons, when the wave will be 25 meters. This station is very easy to get.

"A new ship-to-shore telephone service started this month. The ship is the *S. S. Olympic*, call letters G2GN, and talks to F8BZ, France, G2AA, England and WOO, U. S. A. (Deal, N. J.) No definite dope on them yet, but they have been heard near the following waves: G2GN, 18.3, 24 and 35 meters; F8BZ, 19.5 and 38 meters, and G2AA, 36 meters. Almost everyone is hearing these stations day and night. (Ed. Note: See letter on page 28 in regard to *S. S. Leviathan* transmissions.)

"Reception conditions changed rapidly during the month of January and the last week was fairly good. In this week the editor logged 41 foreign stations. This gives promise of good reception again after a long, bad spell. (Ed. Note: When Mr. Green received only 21 foreign stations during the first week of January he thought conditions were terrible. What a man!) Here in Eastern U. S. the stations to the south were best. Some Europeans began to get in last week, while stations to the west faded some, except RA97 (Siberia), who seemed to improve. In the east stations NRH, VRY, HRB and PHI were leaders and in the west it was RA97, VK2ME (Sydney, Australia) and K1XR (Manila).

"All times given in following list are Eastern Standard. Each of these stations was heard during the past month here in Ohio:

30.8 meters—NRH, each night 10:00 to 11:00 p. m. Box 40, Heredia, Costa Rica, Central America.

31.4 meters — PCJ, Wednesday and Thursday, 1:00 to 3:00 p. m. Thursday and Friday, 7:00 to 10:00 p. m. N. V. Philips, Eindhoven, Holland.

16.88 meters: PHI, Irregular broadcasts. 7:00 to 10:00 a. m. N. V. Philips, 722 Keizersgracht, Amsterdam, Holland.

English phones GBU, GBS, GBK, GBX, GBW are heard at all hours on several waves. General Post Office, London, E. C. 1, England.

15.02 meters—LSG worked FW3 10:00 to 11:00 a. m. in French. San Martin, 329, Buenos Aires, Argentina.

15.42 meters—FW3 worked LAG. 79 Boulevard Hausseman, Paris, France.

15.02 meters—DIH worked XDA, Mexico City. Heard on Friday and Sunday near noon. 11-15 Schoneberger Strasse, Berlin Templehof, Germany.

14.0 meters—LSH worked DGW in German, irregular near 10:00 a. m. See LSG address.

WHERE IS "ART"?

"Station ARI broadcasts on several mornings a week on 29.5 and 49 meters. No definite wave is available as they change without notice. Heard on Tuesday, Wednesday, Friday, Saturday and Sunday, irregular after 8:00 a. m. No exact data available on this station as some say it is located at different places. Probably Hong Kong, China.

20.79 meters—VPD. Heard several times talking in English to VK2ME, near 3:00 a. m. Amalgamated Wireless A/Asia Suva, Fiji Island. (Ed. Note: Here's where that globe comes in so handy.)

28.5 meters—VK2ME. Tests and telephones to GBX, England, after 9:00 a. m. and also tests with KDKA and WGY occasionally near 7:00 a. m. Amalgamated Wireless A/Asia, 47 York Street, Sydney, Australia.

31.38 meters—Zeesen, broadcasting German chain programs. Heard on Friday and Sunday, 3:00 to 6:30 p. m. See DIH address.

43.86 meters—VRY. Heard regularly Wednesday and Sunday, 7:15 to 9:00 p. m. They moved up on their wave several times to avoid code trouble but are back on 43.86. McInroy Building, Georgetown, British Guiana.

25.65 meters — KIO. Heard several times talking to California, near 5:00 to 7:00 p. m. M. Kaukuku, Oahu, Hawaii.

"A new station replaces CJRX. It is VE9CL, on about 52.5 meters. Owned by J. Richardson and Sons, Winnipeg, Canada. Power now 200 watts, but will be one kilowatt soon.

"Give the editor credit for this station. HKT, Universal Broadcasting Company, Bogota, Colombia, South America, is on about 48.5 meters and heard here about every night from 8:00 till midnight. This one is very good here.

"Spanish speaking stations have been heard this month on the following waves: 37.9, 43, 45, 48.25, 48.5, 49.95, 50.5 and 50.8 meters. Out of these we located the 37.9 and 48.5 as HKT; the 49.95 as HRB; the 43 as EAR110, Madrid, Spain. (Ed. Note: See letter from Louis Hahn on page 99.) Incidentally, we advise every fan to comb the dials above 40 meters every night, as there is something there almost every minute after 8:00 p. m. E. S. T.

"Station VE9AP at Drummondville, Canada, is testing near 47.5 meters nearly every night.

"Station FZS, Saigon, Indo-China, was heard talking to FW, France, several Sundays near 2:00 p. m. on 16.4 meters. This is correct, as we have a letter from FW telling whom we heard."

This concludes the material taken from the bulletin of the International Short-Wave Club. Many thanks, Mr. Green, and may you hear Mars!

The following letters are from the readers and correspondents addressed to the editor of Radio Desin:

SOME GOOD RECEPTION

"Just a few lines to let you know of some of the short-wave stations I have received and their schedules. Station VRY, Georgetown, British Guiana, wavelength 43.86 meters, is on the air Wednesday and Sunday from 7:15 to 9:00 p. m., Eastern Standard Time. Station BZW at Zuzin, Germany, is on a wavelength of 31.3 meters, schedule 2:00 to 4:00 p. m. E. S. T., now and then; just a degree lower than PCJ, Eindhoven, Holland.

"Station ZL3CZ, of the Home Recreation Broadcasting Co., Christ Church, New Zealand, in on the air Wednesday, Friday and Saturday, from 9:30 to 11:30 p. m., E. S. T. They are on 50 meters, just a degree above WLW.

"Motola, Sweden, wavelength 49.46 meters, daily at 6:30 to 7:00 a. m., E. S. T., and 11:00 to 4:30 p. m. This station is on about the same wavelength as WLW, so the only chance of hearing it would be early in morning, as WLW is very powerful.

"Also heard LON, Buenos Aires. In on Wednesday, Thursday, Friday, 9:30 to 11:00 p. m., E. S. T. Judge their wavelength about 48.30, as it is one degree lower than W2XE. This station is operated by Transradio Internacional, San Martin 239, Buenos Aires, Argentine."—*Richard A. Laffin*, 45 16*th Street, Brooklyn, N. Y.*

ABOUT THAT SPANISH STATION

"The station EAM spoken of in Radio Design is at Madrid and is on 30.70 meters. This is one of the first stations I received two years ago, and it has come in very well several times since. I do not know if they are still on the air.

"The 67.75 meter station at Doberitz, Germany, call DOA, schedule, Monday, Wednesday, Friday, 5:00 to 6:00 a. m., and 1:00 to 2:00 p. m, E. S. T., other times irregular. Comes in on the loud speaker here. The 30.5 meter Madagascar station came in twice. They were working the Ste. Assise station. Ste. As-

We wish to express our sincere thanks to all the readers of Radio Design *who took the trouble to write us about the short-wave broadcasting stations they have heard. We received hundreds of reports ranging from ten to two thousand words in length, and are able to print only a few of them because of our limited space. Please do not feel offended if your own letter does not appear; continue to send in your "dope" on new stations, and we will publish as much of it as possible.—Editor.*

sise (France) is on 24.5 and 15.55 meters. The 15.5 transmitter carries on regular telephone service with Buenos Aires, and the 24.5 works Madagascar, Buenos Aires and Saigon (Indo-China). The station is connected by land line to London, Berne and Amsterdam.

"Have heard two New Zealand stations testing at 3:00 a. m., but cannot make them out."—*Clifford J. Daly, General Delivery, Jamaica Plain Station, Boston,* 30, *Mass.*

(EDITOR'S NOTE: DOA, Dobertiz, Germany, is easily recognized after one becomes accustomed to the German pronunciation. DOA is pronounced "Day-oh-ah." Incidentally, the word "radio" in Europe is invaribaly pronounced "rahdio," this usage giving further background to the same pronunciation used by former Governor Alfred E. Smith.)

PROGRAMS FROM BANANA LAND

"I want to congratulate you on your information on the short-wave broadcasting stations. That is what I call real information.

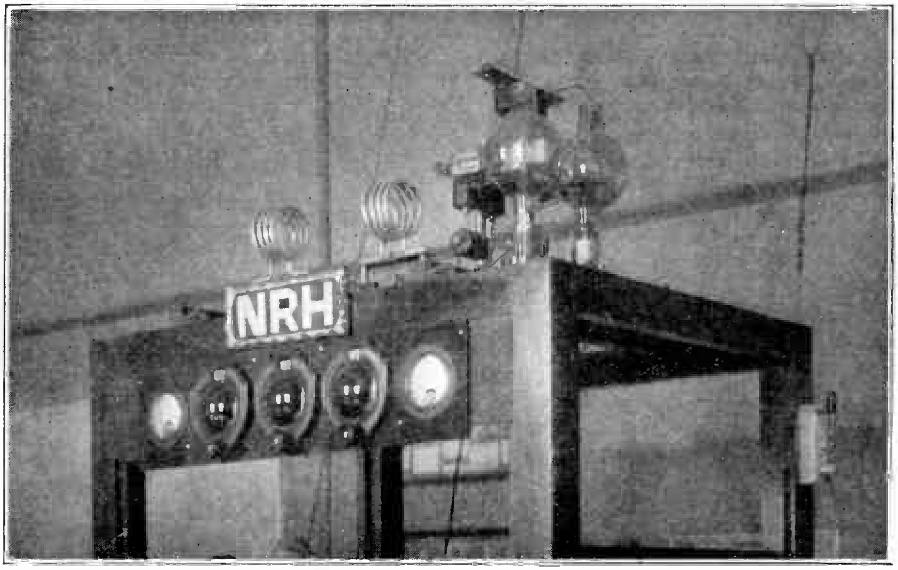
"Saturday evening, January 18, I had a station putting on test programs from 10:00 to 12:00 p. m. They came in just above WENR-W9XF. The Tropical Radio & Telegraph Company of Honduras, Central America. I could not get the name of the city as there was considerable static and a code station on either side of them. They announced in both English and Spanish.

"Here are a couple of good ones for fans to tune in: the S.S. *Leviathan* and S.S. *Olympic*. I have had them both on the phone, the *Olympic* just a night's run out of Southampton, and the *Leviathan* practically all the way across. Now as to my set: it is two years old, with home made coils and all Pilot parts. Just put in one of the new No. 1611 condensers, and it helps a lot. Thanks again for all the good dope in RADIO DESIGN."—*R. V. Perry,* 600 *W.* 141*st Street, New York, N. Y.*

EDITOR NOTE: This city is Tegucigalpa. No wonder Mr. Perry couldn't get it straight! The Jan. 18th program was a special one, arranged with Arthur Green of Ohio.)

BREAKFAST ENTERTAINMENT

"Referring to Winter edition of RADIO DESIGN, you ask for 'dope' on short wave stations received on the Super-Wasp. Here goes: picked up PHI, Huizen, Holland, on the red coils at about 22 on the dials. Wonderful loud speaker volume. Time about 8:00 a. m. A German station comes in at 18 on the orange coils. Call not known. Wave about 32 meters. Comes in around 4:00 p. m., E. S. T."—*C. M. Stevenson,* 135 *Washington Place, Hasbrouck Heights, N. J.*



Station NRH, in Costa Rica, Central America, has established some world records with only 7½ watts of power. Senor Amando Cespedes Marin, its owner, is now installing the 150-watt job shown above, and will be on the air with it by about the time this number of RADIO DESIGN *appears.*

MORE ABOUT EAM

"In reference to the station EAM, Madrid, Spain, mentioned in your Winter issue of RADIO DESIGN, I would like to inform you that I picked up a Spanish station last winter that I thought was EAM. I wrote to a man in Madrid, and he told me that there were no such station, but the only short-wave station was EAR110, operating with a power of 75 watts and on a wavelength of 29.7 meters." —*Sgt. Major Louis Hahn, 212th Coast Artillery, N. Y. N. G.,* 120 *West 62nd St., New York, N. Y.*

(EDITOR'S NOTE: Station EAM has been definitely reported by numerous listeners, so it must be on the air.)

NEWS FROM HOLLAND

"Pleased to report the following short-wave broadcasting news received today (January 6th) from station PCV, Kootwijk, Holland:

'The short-wave transmitters of Kootwijk are all constructed by our laboratory and belong to the Dutch State Post Telegraph Service. Quite recently we have finished a new transmitter, PCV, with a power of 80 kilowatts, which you should be able to hear in the United States every day except Sunday, for telegraph and telephone experimentation, on a wave of 16.82 meters, together with PCK on 16.3 meters. As PCV has not a beam aerial, I think it will be heard very well in the United States.

'The beams of PCK and PCL are directed toward the Dutch East Indies. PCK and PCV are on the air from 0800 to 1400 G. M. T. on the wavelengths mentioned; after that time they transmit on 38.8 and 38.3 meters. (3:00 to 11:00 a. m. E. S. T.)' "—*Richard H. Addison, 29 Armandine Street, Boston P. O. District 24, Mass.*

FROM THE DUTCH EAST INDIES

"I am in receipt of your letter dated October 8th, and can inform you that the call letters of our short-wave station ANE have been changed to PLE. The exact wavelength is 15.94 meters. Our broadcasting hours are every Tuesday between 1340 and 1540 G. M. T. (corresponds to Wednesday 8:40 to 10:40 a. m., E. S. T.) The call letters of ANH have been changed to PLF, wavelength 16.8 meters, but no broadcasting is given by PLF."—*F. F. Bruler, Chief of the International Telephone Office, Government Telegraph and Telephone Station, Bandoeng, Dutch East Indies.*

(EDITOR'S NOTE: Announcements from PLE are usually made in Dutch, French, German and English, and generally in this order.)

SCHEDULE OF THE PARIS STATION

According to the British magazine *Wireless World*, the Dutch government short-wave plant at Kootwijk will soon be augmented by the addition of three new transmitters equipped for C.W. and radio telephony. These will use the call letters PCO, PCS and PDM. Their wavelengths will be 15.68, 16.60 and 16.12 meters, respectively.

This same magazine gives some further data on the Paris experimental station mentioned in the last issue of RADIO DESIGN. The wavelength of 31.65 meters was correct as stated. A power of one kilowatt is used, and transmission of phonograph music and speech are made four days a week at the following times: Sunday, 5:00 to 6:30 a. m., E. S. T.; Tuesday, at 4:30 p. m.; Thursday, 1:00 to 2:30 p. m., and Friday, at 2:00 p. m. The interval signal between announcements is that of a metronome with 120 beats per minute. The station closes down with the playing of the French military march *Entre Sambre et Meuse.*

A LONG LETTER, WITH SOME GOOD DOPE

"Just a little over a week ago I got to brooding over the scarcity of reliable dope we short-wave fans really had. We could get hold of lists of several dozen stations with their wavelengths, if known, but outside of a few like PCJ and G5SW, and possibly PHI and a few American stations, all of which come in with utmost regularity, we hadn't the slightest idea at what time we might expect to hear them. Then, too, these stock lists were published month after month without any changes or additions even though the same magazines published letters from subscribers that gave accurate and reliable information concerning new stations and changes in the wavelengths of old ones. Much of this information, too, was often several months old before it was published. A condition like this is sure to be discouraging. But what to do? As I pondered on these dark thoughts I devised a little plan. Why not send letters to as many fans as I could get the addresses of and give them all the latest information I had? Then ask them to send their latest dope. All this information I could combine and send out to these same fans. With this scheme it would be possible to get information concerning stations, wavelengths and schedules that would be right up to date. I had planned to start this scheme that very week end. I changed my plans, however. I bought a copy of your Winter issue and there found the missing information nicely classified in Robert Hertzberg's list of short-wave stations.

"That is one reason why I am sending in a subscription for RADIO DESIGN. That is also the reason why I am sending in as much additional dope as I have at the present.

"I do not own a Super-Wasp. I might add I wish I did. At any rate I have gotten a great deal of enjoyment and some education besides out of my contact with short-wave radio. I am planning to write (mostly for my own amusement) a little article on my first year of short-wave radio. It will give some idea of the thrills I received listening to voices from eleven countries on four continents and code from twenty-two countries (in spite of my very poor knowledge of code). It may prove encouraging to those who became disgusted (and I personally know some) when the first small receiver which they threw together failed to function as it should, or when they failed to receive distance stations because they skipped over them, because I myself had no success for about five months.

"Just a few suggestions before the dope on short-wave stations:

"Why not publish a schedule of time signals? A large number of short-wave fans are interested in these transmissions. For instance, NAA (Arlington, Va.) sends time signals beginning at 11:55 a. m., and 9:55 p. m. on 74.72 meters, 37.36 meters and 24.9 meters. Signals are also sent at 2:55 a. m. on at least the 37.36 meter wave. WNBT at Elgin, Ill., sends signals at other times. Short-wave time signals are probably sent from the Eiffel Tower station, and possibly from Nauen. A time signal that is probably not recognized as such is sent from G5SW. This signal is sent at 8:00 a. m. and 4:00 p. m. on the days the transmitter is on the air. It is in the form of six dots at second intervals, the final dot marking the exact hour. I think a list of time signal transmissions would prove helpful."

(EDITOR NOTE: Good idea. That's our next job.)

"In regard to the short-wave dope I am sending, I want to say that in every instance in which I am not absolutely sure of the accuracy of my information, I have sufficiently implied my doubt.

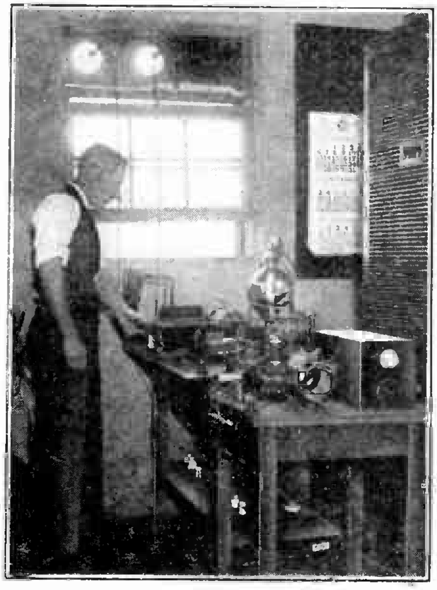
"Here is some short-wave dope. Much has been ascertained during the past two weeks. (Jan. 1st to 10th, 1930.) First, the American stations.

W8XAG, located on the Spring Valley Road, Dayton, Ohio, was heard Jan. 3, between 8:00 and 8:30 p. m., sending a musical program on 8,660 kc. Reception was good. Would welcome reports.

W3XAU, in Philadelphia. Heard several times during the last few days. On Jan. 4, at 8:00 a. m., announced that they would be on the air from that time until midnight. Uses a frequency of 6,060 kc. Will probably broadcast programs of WCAU, with which station it is affiliated.

W3XC (or D or E or?) Broadcasts programs of WFBR of Baltimore, Md. Heard several times from 12:00 to about 2:00 p. m. Did not get frequency or wave although both are announced at frequent intervals. Approximately 8,650 kc., or between 34.5 and 35 meters.

W2XV, Long Island City. 8,650 kc. or 34.69 meters. Radio Engineering Laboratories. Heard first in the latter part of September calling WFBN, the *Leviathan*. This led me to believe it was affiliated with WOO, the *Leviathan's* land station, which sometimes uses about the same wave. Since that time has been heard several times sending musical programs. These are heard at about 4:30 and 10:00 p. m."



This is the 500-watt transmitter of W2XE, in New York, that makes such a big noise in the ether on 49.02 meters

(EDITOR NOTE: See letter from W2XV.)

"Now, a few foreigners.

XDA, Mexico City, Mexico. 15.9 meters. During the early part of October, held daily schedules with Nauen. Heard them between (about) 12:15 and 12:45. Was always unable to listen after about 12:45, so don't know how long they were on the air. After the time changed from Daylight-saving to Standard, was unable to listen at this time. However, XDA still sends code on this wave and may still have voice schedules. Music was sent during these test periods.

The station in Nauen I at first thought was DGV, which DHC announced (in June), sent television on 14.87 meters. It is probably the station you have listed as DGW on 14.83.

G2GN, heard first sending code and thought was a British amateur. In the morning, Jan. 6, called London. The same afternoon, from 4:15 to 4:30, called some place in French. Wave is around 19 meters. I believe this is the station I heard speaking French on Christmas morning. This station was on the air for several hours but I didn't get the call letters.

VK2ME, Sydney, Australia, uses a power of 20 kw., according to my latest report.

DHC, when I first heard it, April 11, 1929, and a few days previous, was using a wave of 26.22 meters. This wave was used for several weeks. From May 25, however, each time I heard this station the wavelength was announced as 26.04 meters. I have not heard this station now for several months, and so am not sure which wave is used at this time.

The station in Königswusterhausen, which you report as sending on 31.88 meters, really operates on 31.38 meters. This is confirmed by the announcements as well as the fact that the wave used is lower than that used by W2XAF. These corrections may seem almost unnecessary but, as far as I am concerned, I think that if I had not heard this station it might prove embarrassing to look for it above W2XAF when it really is below.

"On Jan. 7, G2GN was heard at 4:15 p. m., talking with someone in English but with a French accent. At 4:20 he called, in French, the same station he called at about the same hour on Jan. 6. As nearly as I could make out, this French station is F8EZ or F6EZ. Nothing more definite. He called for about 20 minutes without success. On Jan. 8, at 8:20 a. m., a station called G2GN in French and was apparently answered right away. He was still talking at about 9:00, and again at 10:00. It was this French station, and not G2GN, that I heard on Christmas morning.

"In regard to RFM, I have a card that was sent from that station to Mr. Fred Grimm, of 1611 Tibbits Avenue, Troy, dated Nov. 29 1929, stating that this station is now RA97, using the wave 70.2 meters. The card also states that the station transmits every day from 9 to 1430 G. M. T. (4:00 to 9:30 a. m., E. S. T.).

I have also a letter sent to Mr. Grimm from Bandoeng on Oct. 24. This letter states that besides PLE, on 15.94 meters, and PLF, on 16.8 meters (which seems to be a new wave) there are the following other telephony transmitters: PMB on 14.5 meters; PLG on 16.88 meters; PLR on 28.8 meters, 'but mostly PLE and PLF are used.' The letter also says: 'Very occasionally we carry out tests with Manila, Sydney, Bangkok, Paris, Nauen, and San Francisco, but we are unable to send you any information regarding these tests in advance.'

"I hope that some of this information may assist you in helping other short-wave fans to get more enjoyment out of their Super-Wasps or other short-wave receivers. I would appreciate any assistance in gaining a little more information concerning G2GN or his French friend."—*Henry C. Ort, Jr.*, 2203 *Burdette Avenue, Troy, New York.*

(G2GN is the S.S. *Olympic.*)

In regard to that Siberian station, it has been definitely identified by a number of listeners and by the station officials themselves as RA97. This is located at Khabarovsk, Siberia, U. S. S. R., which is at the north end of the Sea of Japan. Mr. Green writes in regard to this station:

"From my own reception I would say that RA97 is on both 35 and 70 meters, beginning at the lower wave and changing over near 4:30 a. m. This is not authentic but checks with my reception."

The schedule of the Siberian station are somewhat in doubt, as its own cards seem to contain conflicting information. This is brought out in the following letter:

"For the benefit of the short-wave fans of RADIO DESIGN, I would like to make a correction relative to radiophone station RA97. Here's the correct dope, from the station itself: The old call letters of this station were RFM. (EDITOR'S NOTE: On this point everyone is agreed.)

"Khabarovsk, Far East, Union of Soviet Socialistic Republics, crystal controlled short-wave radio telegraph and broadcasting station. Wavelength 70.2 meters. Regular transmissions daily except Wednesday 2:00 to 7:00 a. m. Pacific time (5:00 to 10:00 a. m. Eastern time). Operator, B. Ageer. Heard out here as loud as WGY.

"Here's the dope of DHC, Nauen, Germany. Experimental commercial station, 15 kilowatts power, wavelength 26.22 meters, transmission not regular. Experimental telephone, commercial television and telegraphy. Dr. Bohn in charge.

"Also, two new stations on 20, 25 and 30 meters testing. Call letters G2GN and WOO. They don't give their location; who are they? May the good work of RADIO DESIGN continue."—*Fred A. Deardorff*, 1416 *S. Harvard Boulevard, Los Angeles, Cal.*

(G2GN is the S.S. *Olympic;* WOO the Bell Telephone land station in New Jersey.)

THAT MANILA STATION

"Your letter of Dec. 31, 1929, has just been forwarded from San Diego and, in answer to your query, I am giving below all the information I know re Manila and VK2ME.

"The Philippine station was on 24.9 meters when I heard it, but soon after shifted to 48.8 meters, and the last I heard, this is the wave they were using. I do not know their correct call, for although I listened for several hours no call was given, but they relay the programs of KZRM, and that is the call given in my verification. Here are their schedules, as given in the letter from them:

Mr. Startz, the famous announcer of station PCJ, who announces in six languages

	Manila Time	*Pacific Time*
MONDAY	4.00 to 5.30 p. m.	12 m. to 1.30 a. m.
TUESDAY	4.00 to 11.00 p. m.	12 m. to 7.00 a. m.
WEDNESDAY ..	4.00 to 10.30 p. m.	12 m. to 6.30 a. m.
THURSDAY	4.00 to 10.30 p. m.	12 m. to 6.30 a. m.
FRIDAY	4.00 to 11.00 p. m.	12 m. to 7.00 a. m.
SATURDAY	4.00 to 12.00 p. m.	12 m. to 8.00 a. m.
SUNDAY	10.30 a. m	6.30 p. m.
	3.00 to 4.00 p. m.	11 p. m. to 12 m.
	6.00 to 10.00 p. m.	2.00 to 6.00 a. m.

"When it was 9:28 p. m. Saturday, Manila Time, by their clock, it was 5:28, Saturday morning, Pacific Time. That is the basis used for my conversion of their schedules above. I had them from 2:20 until shortly after 5:30 a. m., and reception grew constantly better and was loudest when I quit.

"VK2ME says 'We have no regular transmission schedule as 2ME is experimental only.' I usually heard them after 9 p. m., Pacific Time, with best reception around 1 a. m. PST. I never tried for them in the morning, but a friend writes that he gets them fine in the a. m. around seven o'clock, PST. I have picked up their carrier at 10 a. m., but could not tune it in.

"The verification says 'VK2ME is the largest broadcasting station in the Southern Hemisphere, having a power unit of 20 kw., and is located at A.W.A. Radio Centre, Pennant Hills, Sydney, N. S. W. Australia.'

"I hope that this information can be of use to you, and thank you for the copy of RADIO DESIGN, which you mention has been sent under separate cover.

"It might interest you to know that I use Pilot parts almost exclusively for short-wave work."—*Willis Werner*, 4423 *Fulton Street, San Francisco, California.*

SHORT WAVES FROM THE LION COUNTRY

From British sources of information, we learn that Kenya Colony (British East Africa), which has already won laurels with its station at Nairobi, has started a new station at Mombasa, which will operate 24 hours a day. Wavelengths of 36.74 and 21.59 meters will be used, as well as higher waves for ship telegraph traffic.

Kenya Colony, which is cut right in half by the Equator, borders on the Indian Ocean, and is probably the most famous big-game hunting country in the world. Mombasa is on the coast, while Nairobi is a few miles inland. Nairobi is noted as the jumping-off place of numerous hunting and exploring parties.

Since the publication of the Winter issue of RADIO DESIGN, we have received a letter directly from the director of the Nairobi station, 7LO, who writes as follows:

"We are in receipt of your letter and have pleasure in giving you the following information in connection with our broadcasting station. We transmit on a wavelength of 31.1 meters, with a power of approximately one-half kilowatt, and our times of transmissions are from 1600 to 1900 G. M. T. (11:00 a. m. to 2:00 p. m., E. S. T.). The usual type of program is broadcast, viz.: gramaphone records, music provided by local artists, news bulletins, church services, children's programs, etc. The programs are broadcast entirely in English." (EDITOR NOTE: "Gramaphone" means "phonograph" in American.)

Station 7LO is operated by the British East African Broadcasting Company, Ltd., Nairobi, Kenya Colony, British East Africa.

AMERICAN STATIONS

The number of American short-wave stations is increasing rapidly, and soon the short-wave channels will probably be as crowded as the 200-500 meter range. However, the more stations the more fun there is listening. Following is the latest "dope" on the U. S. transmitters:

W3XAU, PHILADELPHIA

A new station that has produced numerous letters from listeners is W3XAU, which is operated in conjunction with WCAU, Philadelphia, Pa. This is the Philadelphia key station of the Columbia Broadcasting System, and takes many of its programs from WABC in New York. Two waves are used: 9,590 kc. (31.28 meters) and 6,060 kc. (49.5 meters). The station is on the air from 8:00 a. m. to midnight.

STATION W2XV, LONG ISLAND CITY

"The present schedule for our experimental short-wave station W2XV calls for official broadcasting each Wednesday and Friday night, between 8:00 and 10:00 p. m., E. S. T., on a frequency of 8,650 kilocycles, which is equivalent to 34.68 meters. We also have other periods of transmission during the day time. Some of these are carried on a frequency of 17,300 kc. (17.34 meters) and 4,975 kc (60.3 meters). Day time transmission is experimental and done at indefinite times. Therefore, we cannot give you the exact periods. The transmitter employed is crystal controlled, using 100% modulation. The output power is 750 watts."—*Charles M. Srebroff, Radio Engineering Laboratories, Inc., 100 Wilbur Avenue, Long Island City, N. Y.*

W3XAL, BOUND BROOK, N. J.

Regarding W3XAL, which is associated with the regular transmitter of WJZ at Bound Brook, N. J., we have the following:

"I learn from Mr. C. W. Horn, our General Engineer, that W3XAL is operating on 6,100 kilocycles (49.18 meters), experimenting regularly from midnight to 1:00 a. m., as well as at other intermittent times. The station is owned by the Radio Corporation of America and operated by the National Broadcasting Company."—*G. W. Johnstone, Manager of Press Relations, National Broadcasting Company, 711 Fifth Avenue, New York, N. Y.*

SHIP-TO-SHORE TELEPHONE

The ship-to-shore radio telephone experiments being conducted by the Bell Telephone Laboratories and the S.S. *Leviathan* and between the S.S. *Olympic* and various British and French short stations, are providing short-wave set owners with some very interesting reception. Many people have been able to follow the progress of the two vessels right across the Atlantic, the signals coming in with fine strength and clarity.

We have little data on the activities of the British ship, other than that its call letters are G2GN and its wave around 18.5 meters. However, we have the following from Mr. Paul B. Findley, of the Bell Telephone Laboratories:

"The one pair of frequencies used between the *Leviathan* and the shore is 4,116 and 4,392 kilocycles (72.9 and 68.3 meters); another pair is 8,630 and 8,830 kilocycles (35.89 and 33.98 meters). Work is progressing on a third frequency in the vicinity of 13,000 kilocycles (23 meters)."

The American shore station through which the telephone traffic is handled is located at Deal Beach, N. J. This is connected by land line to the long-distance headquarters of the A. T. & T. Co., at 24 Walker Street, New York, from which the trans-Atlantic radio channels are also operated.

W9XF, CHICAGO, ILL.

Station W9XF, which has been putting such strong signals into short-wave receivers, is operated by the Great Lakes Broadcasting Company, 310 South Michigan Avenue, Chicago, Ill., in conjunction with WENR. According to a letter from E. H. Gager, chief engineer, the transmitter has an output of 5,000 watts and uses the frequency of 6,020 kilocycles (49.83 meters). It is located at the site of the WENR station, which is three and a half miles south of Downers Grove, Ill., or about twenty-three miles southwest of Chicago. W9XF broadcasts all the programs of WENR and all announcements include the call letters of both stations.

Station W9XF was constructed for the purpose of relaying the WENR programs to foreign countries, where they may be rebroadcast for local consumption. A successful relay to New Zealand was accomplished on January 26th, when station 3YA, at Christ Church, rebroadcast a special program. The management of the New Zealand station reported excellent transmission and quality.

Cashing-in on the Short Waves

IF you have had some slight experience in building radio receivers from standard kits, particularly the two models of the Pilot "Super-Wasp," you can make quite a little money on the side by assembling these short-wave kits for people who haven't either the time or the ability to do the work themselves. The general public is slowly but surely waking up to the fact that short-wave reception is a very thrilling and interesting hobby, and people in all walks of life are inquiring about suitable receivers. There are thousands of mechanically inclined Americans to whom the job of assembling a "Super-Wasp" is quite easy, but there are many others who would prefer to have the work done for them.

Now is the time to take advantage of this interest. Even if you have a regular day-time position you can easily assemble a set a week, working only an hour or so an evening; or you can do the whole job in two single evenings. You should charge a minimum of $5.00 a set, and up to $10.00 if you do a special job.

Your problem, as an individual, is to advertise your availability for work of this kind. The best thing to do is to make the acquaintance of the local radio dealers, if you don't already know them, and to offer to do assembling on "Super-Wasps." In many cases the dealer's regular service man or men are too busy to do work of this kind in the store's shop, or they are not very familiar with short-wave equipment. Present yourself as a specialist, and you undoubtedly will be able to pick up enough orders to keep you quite busy in your spare time. Leave your name, address and telephone number with the dealer, so that he will know where to get in touch with you.

Some dealers may prefer to pay you themselves, so that the whole sales transaction goes through their hands. Others may turn the customer over to you directly.

If you care to invest a few dollars in a small advertisement in your local newspaper, you will probably be able to build up a nice little business as a custom set builder. We might suggest that you place an ad something like this:

HEAR FOREIGN STATIONS ON THE SHORT-WAVES

There are dozens of foreign short-wave broadcasting stations that you can pick-up right in your own home with a simple and inexpensive receiver. Don't depend on occasional local rebroadcasting; hear stations in England, Holland, Australia and Asia every day.

I am a short-wave specialist, and will assemble the famous Pilot "Super-Wasp" for you. No batteries to fuss with; this set operates right off the lamp socket. Let me help you get into the interesting short-wave game!

JOHN T. SMITH

145 *Pine Street* *Phone* 117

You'll be surprised at the number of inquiries that you will receive. Once you sell one set, you will have a continuous string of customers, because one set always sells another. It really is not difficult to tune in the foreign stations, and your first customer will go around boasting about his trans-oceanic DX. He'll rave about hearing Europe and Australia to his associates in his office and to his friends in the train, and sooner or later one of his acquaintances will get bitten by the "bug," too.

The fact that the K-115 "Super-Wasp" works entirely in A.C. is a strong selling point. Of course, some people may have storage batteries that they would like to use, in which case you can recommend the K-110 battery model.

New Pilot Power Amplifier for Public Address Systems

Uses Two 250 Tubes, Works Six Dynamic Speakers at Full Volume, and Is Suitable for Radio, Phonograph and "Talkie" Operation

by JOHN GELOSO

Chief Engineer, Pilot Radio & Tube Corporation

TO MEET the increasing demand for a heavy-duty audio amplifier suitable for the operation of loud speakers in public places, the Pilot Radio and Tube Corporation has brought out a new public-address unit using two 250 tubes and having a maximum undistorted output of 15 watts. It will work six auditorium model dynamic speakers simultaneously at full volume, for the reproduction of programs from a radio receiver, music from a phonograph disc, announcements through a microphone, or sound from "talking" motion-picture apparatus. It is suitable for use in dance halls and dancing pavilions, amusement parks, race tracks, swimming pools, gymnasiums, armories, exhibition halls, hotels, skating rinks, churches, restaurants, railroad stations, airports, and theatres seating not more than about 2,000.

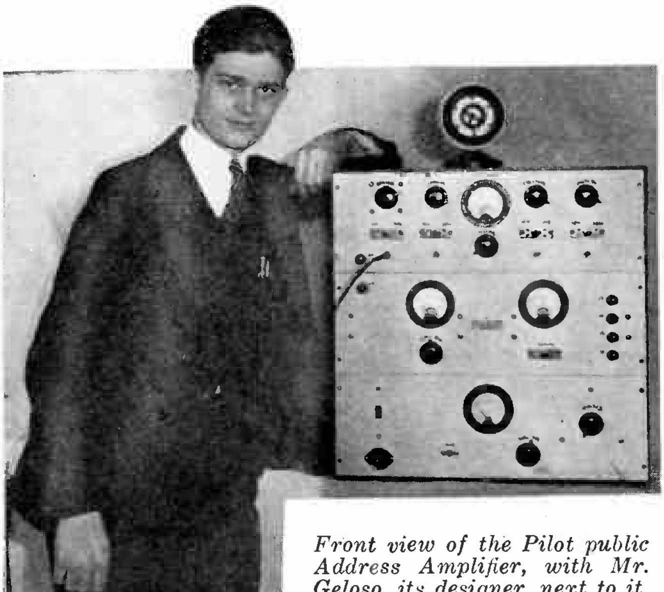
The wide-awake custom set builder or technically-trained radio dealer who is familiar with the various public places of his city should try to sell their owners on the desirability of such an amplifier as a publicity medium and business-getter. There is real profit in public-address systems, for both the seller and the buyer.

AVAILABLE IN TWO FORMS

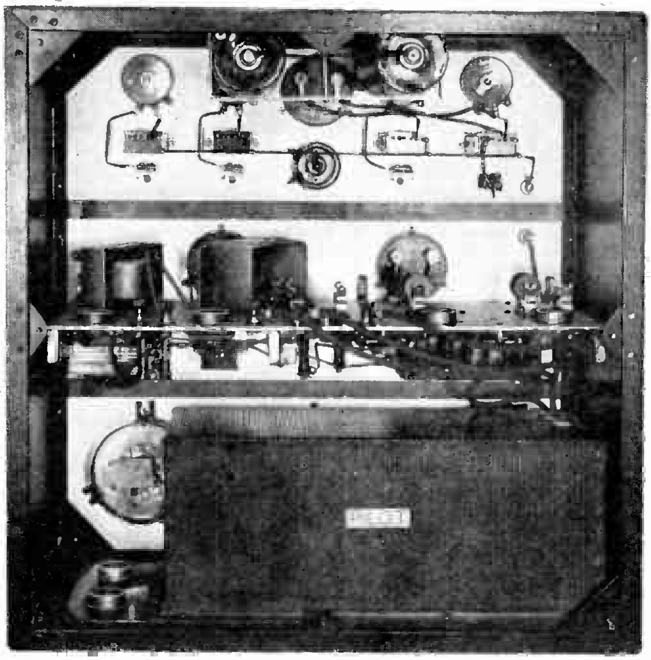
The Pilot amplifier will be available in both semi-kit and completely assembled form. The completed instrument is 22 inches square and 9 inches deep, and consists of three panel units built up on an angle-iron frame covered with perforated iron sheeting. The lower panel holds the power supply equipment, the middle one the amplifier components, and the top one the "mixing" and main control devices.

As can be seen in the accompanying diagram, the power supply comprises a high voltage step-up transformer, a full-wave rectifier system using two 281 tubes, and the usual filter consisting of a double choke coil and a three-section condenser. A line voltmeter and a primary rheostat are used to insure correct input voltage.

The amplifier itself comprises three high-quality resistance coupled stages, feeding into a 250 push-pull stage. Two meters are provided: a milliammeter in the plate circuit of the 250's, to indicate the general operation of the high-voltage circuit, and a highly sensitive galvanometer in the grid return circuit. The latter meter is an infallible distortion indicator. This audio amplifier has been designed very carefully, and possesses rather unusual characteristics. Its overall voltage amplification is 2,200, and its frequency response curve is really flat from 100 to



Front view of the Pilot public Address Amplifier, with Mr. Geloso, its designer, next to it.



Inside view of the public address amplifier, showing the arrangement of the parts. Top: mixing panel; center: amplifier panel; bottom: power supply panel. The round object in the lower left corner is the primary rheostat. The powerpack is enclosed in a metal case, which completely protects the instruments and the high-voltage leads. The dry cells which supply the microphone current are strung from the top of the frame.

9,000 cycles, with only a slight drop from 100 down to 60 cycles. These characteristics were determined with the aid of some very accurate and expensive General Radio laboratory measuring instruments.

THE MIXING PANEL

The mixing panel holds four sets of jacks, switches, and Volumgrads, and also a microphone transformer, microphone battery and microphone milliammeter. These jacks allow the quick connection of the "mike," phonograph pick-up, radio receiver or "talkie" apparatus. Each has its own volume control, so that the proper input level can be obtained and then quick changeovers made from one to the other without change in the loud speaker output. These individual volume controls must be balanced against the control on the grid of the second tube in the amplifier itself.

SYSTEM IS FLEXIBLE

The switch arrangement allows the volume of a phonograph or radio selection, for instance, to be lowered somewhat while the microphone is cut in and announcements made by voice. The whole system is very flexible and is easy to operate. Once it has been set up it can be manipulated without trouble by any intelligent person; the services of an expert operator are not required.

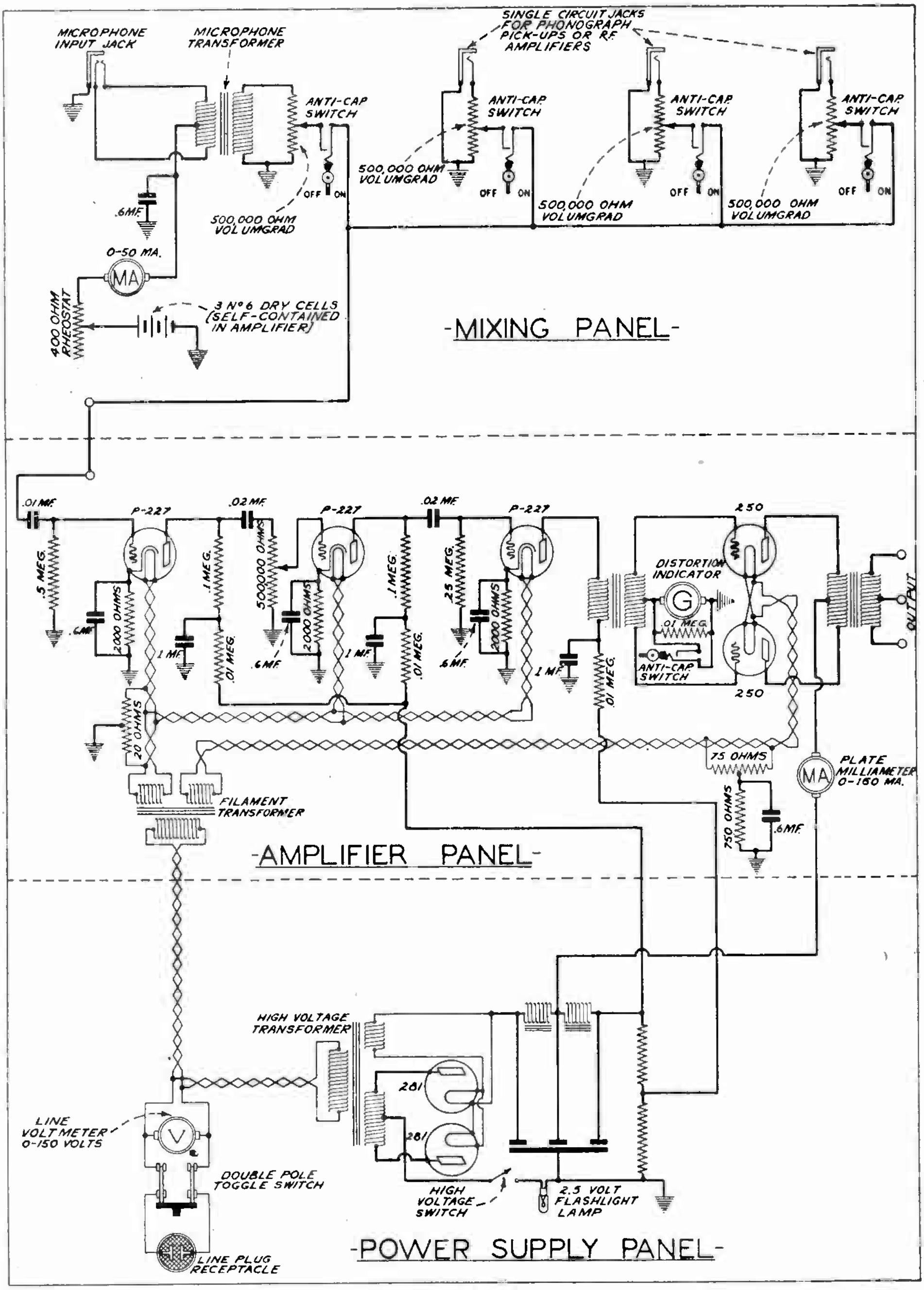
COMPLETE EQUIPMENT

The Pilot public-address amplifier will be sold complete with a table-model microphone, a phonograph pick-up and two sets of selected and matched tubes. Although it is high-quality instrument in every respect, its price will be considerably lower than that of similar amplifiers of corresponding capacity, because of the economies effected in the Pilot factory, the largest parts plant in the world. The cost of the whole equipment, already assembled and wired and including the four meters and the above-mentioned accessories, will be in the neighborhood of $450.

CORRESPONDENCE INVITED

The writer will be glad to discuss the application of this new amplifier in specific locations and to give prospective purchasers every possible assistance. He may be addressed in care of RADIO DESIGN, or directly at 323 Berry Street, Brooklyn, N. Y.

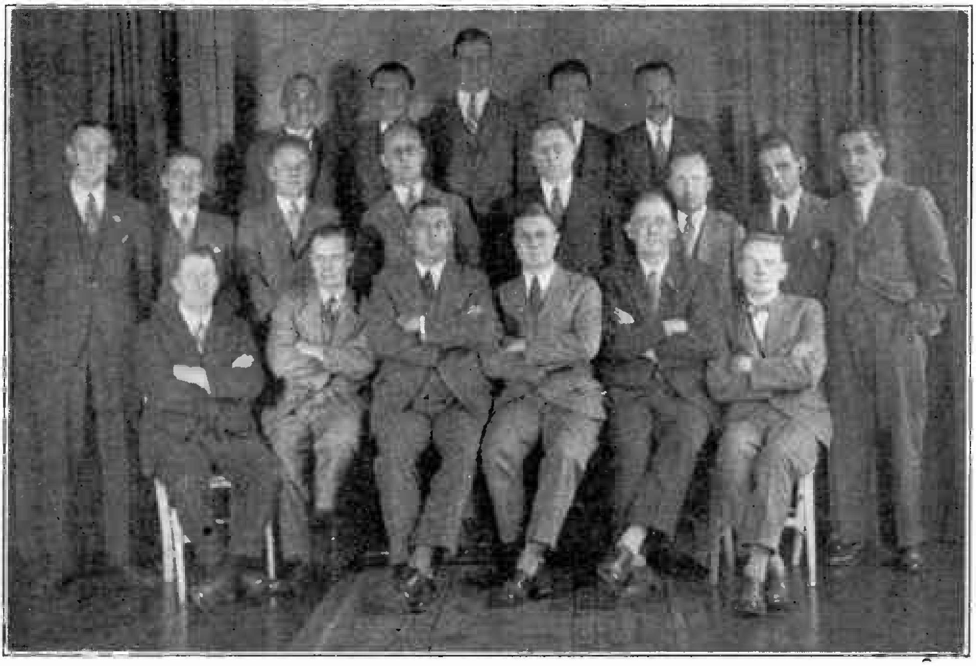
(EDITOR'S NOTE: The transformer, choke coils and filter condensers used in the power pack of the Pilot P.A. amplifier are special units and will not be available for sale separately. Many of the other instruments are also specially constructed for this particular circuit.)



Above is shown the complete schematic diagram of the new Pilot Public Address Amplifier. The actual hook-up is very similar to the usual systems found in ordinary radio receivers, except that a total of four stages of amplification are used. The individual instruments, however, are of special construction, being considerably heavier than ordinary parts in order to carry the heavy currents.

The switch connected in the high-voltage lead (power supply panel) allows the plate voltage to be cut off when adjustments are being made in the amplifier. It is more convenient than the main power switch for this purpose, because the tubes remain hot and the amplifier springs to life instantly when it is thrown on. The 2.5 volt flashlight bulb is both a pilot light and a fuse.

H. C. Walker of Australia Is Pilot Guest



Tne staff of the head office of Harringtons, Ltd., of Sydney, Australia. Top row, left to right: Messrs. Davies, Lovell, Hindmarsh, Searson, Mallard. Center row: Comrie, Harrington, Magee, Gee, Bailey, Chapman, Seaman, Good. Bottom row: Radford, Godley, Walker, Corfield, Hedberg, Grounsell.

RADIO DESIGN was honored recently by a visit by Mr. Harry C. Walker, general manager of Harringtons, Ltd., exclusive Pilot representatives in Australia and New Zealand. He arrived in New York on December 6, 1929, and sailed back for Australia from the West Coast on February 5, 1930.

Mr. Walker is a real "live wire" of a radio man. He went through the Pilot factory a number of times to acquaint himself with the many complicated manufacturing operations by which Pilot parts are produced, and he also visited the studios of the Columbia Broadcasting System, to see how American broadcasting methods differed from the Australian.

New Data Sheets Contain Useful Information; Write for Copies

A number of new data sheets have been issued by the Pilot Radio & Tube Corporation. Copies may be obtained free of charge from the company, at 323 Berry Street, Brooklyn, N. Y.

No. 113. *"The K-113 Push-Pull Amplifier for 245 Tubes."* Eight pages. Describes this high-quality power amplifier in detail.

No. 115, *"The A.C. Super-Wasp."* Sixteen pages. Full theoretical discussion of the first short-wave receiver that works on alternating current.

No. 122, *"The P.E.6 Receivers."* Eight pages. Describes the K-122, K-123 and K-124 screen-grid broadcast receivers.

No. 204, *"Large Metal Case Audio Transformers."* Two pages.

No. 6A, *"Plug-in Coils and Forms."* Two pages. Contains winding dope for short-wave coils.

There is also a special pamphlet for dealers, service men and custom set builders, entitled "New Voices for Old Radio Sets." This tells how the radio dealer can remodel old radio receivers by installing new audio transformers, power packs, etc. A postcard will bring you a copy.

The Loftin-White Amplifier

This Direct-coupled Audio System is an Interesting Development for the Experimenter. It Can Be Built Up of Standard Parts

by SYLVAN HARRIS

Mr. Sylvan Harris, the author of this excellent article, has long been an outstanding figure in the radio engineering and writing fields. You will recall him as former managing editor of Radio News and as research engineer for several large set manufacturing concerns.

THE search for a less costly audio amplifier still goes on! It has been going on for a long time and—well, who knows? It has been the ambition of manufacturers of both sets and parts to cut down the cost of the equipment that goes into their products, so that the completed receivers may get into the hands of the purchasers and set builders with less damage to their pocketbooks, resulting in a much greater and wider distribution for the products and a consequent improvement in business.

Much has been written concerning the Loftin-White direct coupled amplifier, and there probably remains to be written yet much more. This amplifier has quite a few admirable features. At the same time there are certain things, in connection with it, which must be borne in mind and of which the experimenter must not lose sight when working with it.

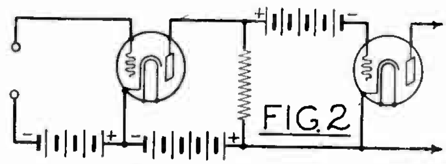
The circuit of the Loftin-White amplifier is shown in Fig. 1. It is seen that the elementary principle of the amplifier is exactly the same as that of the well-known resistance-capacity coupled amplifier. The voltage drop produced by a signal in a resistance in a plate circuit of the first tube is impressed directly upon the input (that is, the grid and cathode) of the second tube. This differs from the usual resistance-capacity coupled amplifier in that, in the latter, this voltage drop is impressed upon the input of a second tube through a coupling condenser. The coupling condenser produces a loss of voltage and also introduces a certain amount of distortion, due to the fact that condensers transmit lower frequencies with difficulty.

These objections are removed in the Loftin-White system. Directly coupled circuits have been used in the past for special purposes, and, in general, required a large "C" battery connected to the grid of the second tube in order to not only furnish the bias for that tube, but also to balance out the large positive voltage coming from the plate circuit of the first tube. The idea is illustrated in Fig. 2. Such an arrangement was necessary until the technique of supplying radio receivers with power from commercial lighting mains was developed. In addition to this, there was required the development of the indirectly heated type of tube so that the cathodes of the tubes could be isolated and operated at voltages independently of each other. Furthermore, there was required a knowledge of how to handle the various hum voltages arising from the rectifier which was used to supply power to the system. The filter circuit, used for hum suppression, involving as it does quite large capacity and inductance in the various circuits, is another costly item and any efforts to reduce this cost are certainly directed to a worthy cause.

An amplifier which can accomplish all these things at one and the same time, that is, increased amplification, reduced cost and improved quality, is a thing which is much to be sought after and desired. The design of the Loftin-White circuit is directed along these lines. The elimination of the coupling condenser results in better fidelity of performance; the employment of the more sensitive screen-grid tube results in greater amplification. As to the matter of improvement in hum, it appears that this is at the present time an open question, for, assuming the same hum voltage at the source of potential, it should make little difference in the resulting hum at the loud speaker as to whether many tubes of low amplification are used or few tubes of high amplification are used. A certain grid swing is required at the input of the power tube, in order to load it up. A certain modulated R. F. voltage is applied to the input of the detector tube. It is clear then that, regardless of what means of amplifying this signal may be used, the amount of amplification required must remain the same. Hence, whatever hum disturbance may be present in the cathode circuit of the detector, referring particularly to the bias resistor, it must be subjected to the same amplification which we have in our usual amplifiers.

Of course, since there are fewer stages there are fewer sources of hum voltage to worry about, so that if the hum voltage introduced into the cathode circuit of the first stage is properly balanced out, it may be possible to secure a sufficiently low hum at the speaker without employing a filter circuit as costly as the present-day filters. There is a distinct advantage gained in this type of amplifier in the absence of equipment which can cause hum troubles by induction, such as transformers.

The circuit of Fig. 1 is one which has been found to work satisfactorily by this writer. The values of the resistance are indicated in the diagram. The voltage was obtained from a Pilot No. 411 power transformer operating into the filter circuit



The fundamental circuit of the direct-coupled audio amplifier.

shown in the diagram. The resulting currents through the resistances and the voltages applied to the tube elements are also indicated. These voltages refer to the difference of potential at the tube terminals, that between plate and cathode, grid and cathode, screen and cathode. They cannot be measured very accurately and in some cases, not at all. The usual voltmeters, or even the high resistance voltmeters, require a small current to operate them which is sufficient to disturb the operating condition of the amplifier when making measurements. Consequently it is necessary to determine the voltages in the circuit by measuring the currents in the various branches and multiplying them by the resistances of the branches. For example, the current through the 100,000 ohm resistor was found to be 1.30 milliampere, hence the voltage drop in that resistor is 130 volts. The current in the 500,000 ohm resistor is 0.19 milliampere, since the voltage drop in it is 95 volts.

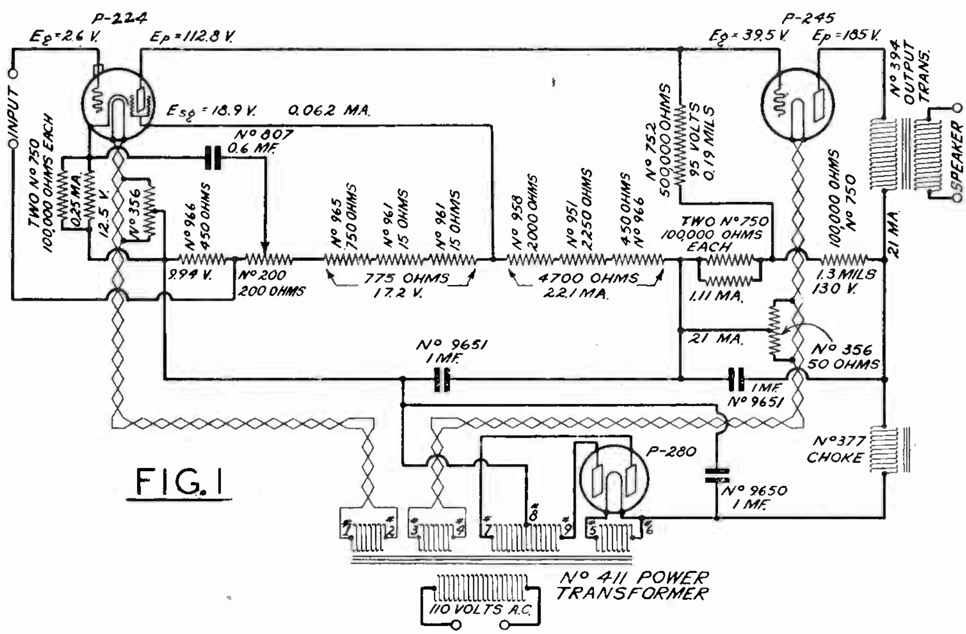
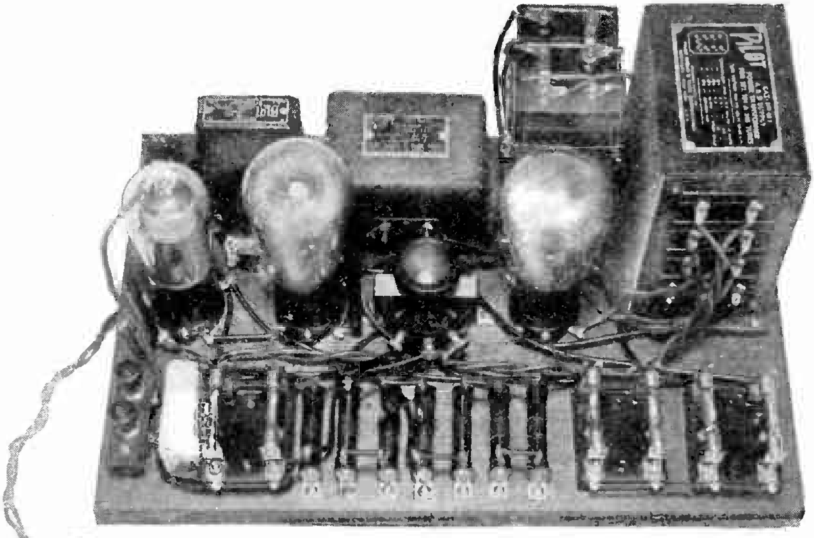


FIG. I

The complete hook-up of an experimental Loftin-White amplifier. Note carefully how the various resistors are connected.



Layout of the amplifier shown schematically on the preceding page. A wooden baseboard is used, with the parts screwed down on it.

The current in the 50,000 ohm resistor is therefore 1.30 minus 0.19, or 1.11 milliampere.

Proceeding in this manner, the currents and voltages indicated on the diagram can be calculated for the entire circuit. The bias voltage on the P-245 tube is the difference between the drop in the coupling resistor and the 50,000 ohm resistor in the voltage divider. That is, it is equal to 95 minus 55.5, or 39.5 volts. The voltage between the plate and cathode of the P-245 can be measured with sufficient accuracy by means of a high resistance voltmeter. The voltages applied to the screen-grid tube are indicated on the diagram as being 112.8 volts between plate and cathode, 18.9 volts between the screen and cathode, and 2.6 volts between the grid and cathode. The biasing voltage on the first tube is the difference between the voltage drop in the cathode resistor and that in the 450 ohm resistor, viz., 12.5 minus 9.9, or 2.6 volts. The values given in the diagram for the various resistors have been chosen so that there is little variation in the plate currents of the tubes with signals of different strength. A certain amount of variation of screen current must be tolerated, however, for the reason that tube voltages which cause the tube to operate on the linear portion of the plate characteristic will generally cause the operating point to fall near or at the bend of the screen characteristic.

This can be seen by referring to Fig. 3, which shows the plate current grid voltage curve and the screen grid voltage curve. This variation of screen current, however, will not result in distortion of any appreciable magnitude since it does not appear in the output circuit of the tube, that is the plate curcuit. This little sidelight on the operation of the screen grid may be of interest when considering this type of tube in the role of detector, e. g., a varying signal voltage applied to the grid of a screen grid detector may cause variation of the screen current and a consequent variation of screen to cathode resistance. The plate current may therefore be modulated by this means and result in very efficient signal detection.

THE REGULATION FEATURE

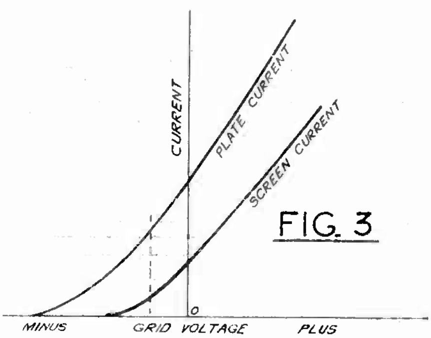
Referring to the circuit of Fig. 1, it will be seen that when, for any reason, an increase occurs in the plate circuit current of the 224 tube, the bias on the 245 will increase automatically. This will cause a decrease of plate current in the 245. The 245 plate current constitutes the major portion of the current through the 450 ohm resistor, so that when this current decreases the bias on the 224 increases, tending to maintain the 224 plate current constant. This is the regulation feature of this circuit, about which much has been written. The circuit shown in Fig. 1, using the values given, has been found satisfactory as a phonograph reproducer.

In attempting to apply the Loftin-White

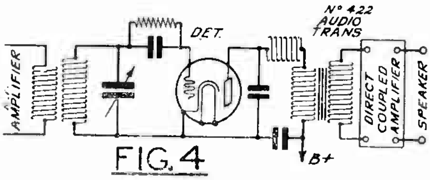
system to the rectification and amplification of signal voltages obtained from an R. F. amplifier, certain difficulties were encountered, which we must not fail to mention. Aside from the fact, which has been brought out by other writers, that changing the grid leak detector of a receiver into a "C" bias detector (as is required of the first tube of Fig. 1) will considerably change the stability conditions of the R. F. amplifier. It is well-known that the low dynamic input impedance of the grid leak detector assists materially in stabilizing the R. F. amplifier, because of the damping effect which it has upon the tuned circuit connected to it. An R. F. amplifier which has been stabilized for such a condition may no longer be stable when the detector is changed to a "C" bias detector without making proper changes in the R. F. amplifier.

A DIFFICULTY

But, aside from this, there is another difficulty which is far more serious: it is not possible to properly short circuit the radio-frequency component of the detector plate current by means of a by-pass condenser from plate to cathode, which we are so accustomed to doing. The reason for this is apparent when we consider that such a condenser would be in parallel to the coupling resistor of ½ meghom; e. g., the reactance of a .001 mf. condenser at 1,000 cycles is approximately 160,000 ohms. This consequently will act as a partial short circuit across the ½ meghom coupling resistor, and the high modulation frequencies will be lost. Without using such a by-pass in the plate circuit of a detector, large R. F. voltages will be passed through this tube and established in its place circuit. Three evils can result from this. If the impedance of the remainder of the system is sufficiently high,



Typical characteristic curves of the screen-grid tube.



To use the Loftin-White amplifier with a radio receiver, it is best to couple it to a regular detector through an A.F. transformer, as shown above.

or, if a radio frequency choke is connected at the plate of the detector, the R. F. voltage developed there may be forced to feed back into the R. F. amplifier and result in a hopelessly unstable condition. Again, the R. F. voltage at the plate of a detector may be passed on and amplified, for the audio amplifier, resistance coupled as it is, may also act as an amplifier of R. F. voltages. This may cause a disturbance in the operating conditions of the 245 tube with consequent deleterious effects on the fidelity of reproduction.

Another feature of the detector, which militates against the use of the power tube of the direct coupled system as a detector, is the very feature which tends to make the system stable as an amplifier. A change of plate current is required in a detector as it is by reason of this that the tube rectifies at all. Consequently, the self-regulation of the system, brought about by the opposing effects of the voltage across the bias resistor of the 224 and that across the 250 ohm resistor, will considerably reduce the efficiency of rectification.

GOOD PHONOGRAPH AMPLIFIER

We have had, thus far, no success with the direct coupling system when using the first tube as a detector connected to an R. F. amplifier. We have, however, had sufficient success with the system as a simple amplifier to recommend it to those who are interested in the setting-up and the studying of new circuits. For example, if we use the usual detector in our radio receiver, follow it by a transformer or the usual resistance capacity coupling, and then follow this by the Loftin-White system, we have a very powerful system which will operate very satisfactorily. Or, if it is so desired, the Loftin-White amplifier can be built up as in Fig. 1 and used merely to operate on a phonograph pickup.

The layout shown on the preceding page can be duplicated very easily. The baseboard measures 9 x 14 inches and is one inch thick.

The Radio Physics Course

For High School Students

by ALFRED A. GHIRARDI

CHAPTER 8

BATTERY ELIMINATION—CURRENT SUPPLY REQUIREMENTS—"B" ELIMINATOR SYSTEM—POWER TRANSFORMER—RECTIFIERS—HALF-WAVE RECTIFIER—FULL-WAVE RECTIFIER—FILTER VOLTAGE DIVIDER—CHOKES AND FILTER CONDENSERS—HIGH RESISTANCE VOLTMETER—A. C. TUBE FILAMENT WINDINGS—"C" BIAS FOR POWER TUBE.

EDITOR'S NOTE: *As the complete "Radio Course" is now available in book form, we have decided to skip around to various chapters, publishing those which our question and answer department indicates will be of most benefit to our readers at the time of publication. The figure and section heading numbers, however, will continue in consecutive order from one issue to the next. We would appreciate having our readers write in to tell us what subjects they would like to have explained in coming issues.*—DESIGN.

85. REQUIREMENTS: The power supplied to the "B" circuit of the receiver must be steady, non-fluctuating direct current. Alternating current cannot be used because the plates of the tubes must be maintained at a steady positive potential at all times. The direct current must be non-fluctuating because even a small variation in "B" voltage causes a change in plate current which is amplified in the set, and appears as an objectionable hum or audible note in the loud speaker, interfering with reception. The "B" eliminator must be able to supply various voltages, from 250 volts or more for the modern power tubes, to 90 and 45 volts for the amplifier and detector tubes, respectively, and enough "B" current to operate the entire receiver. The "C" voltage must always be negative and, therefore, the use of alternating voltages is impossible. Steady voltage must be used. As any variation in potential applied to the grid of a tube shows up about six to ten times as much in the plate circuit of the same tube, due to its amplifying properties, the "C" voltage supply must also have as little fluctuation as possible.

86. B-ELIMINATOR SYSTEM: A study of of the above requirements shows that a "B" battery eliminator operating from a 110-volt alternating current (A.C.) lighting circuit must do several things. It must step up the 110-volt A.C. to the higher voltages necessary for the operation of the power tube; it must rectify the alternating current; it must smooth out the resulting pulsating direct current and must provide some means for obtaining several intermediate voltages. (The D. C. eliminator will be discussed later.)

These functions are performed by the various parts of the eliminator and for simplicity they will be considered separately at first, as shown in Fig. 51. The 110-volt alternating current supplied by the electric light line is stepped up by a power transformer, the A. C. is changed to D. C. by a rectifier, the pulsating D. C. is

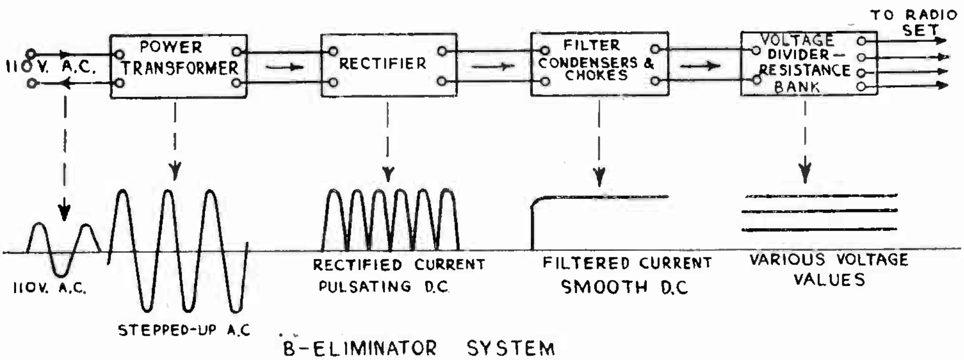


Fig. 51: Illustrating the various actions in a "B" power system.

changed to smooth D. C. by a filter, and various voltages are obtained by a voltage divider. (Fig. 51 shows the various sections of the eliminator and a pictorial representation of the kind of current existing in each section.) All conventional "B" power packs consist of these main parts.

87. **Power Transformer:** The power or voltage step-up transformer consists of a primary and secondary coil wound on a laminated steel core. The secondary contains more turns than the primary in order to secure the voltage step-up.

When a filament type rectifier is employed, another secondary winding of a few turns is put on for supplying the filament current for the rectifier. The transformer should be designed with ample copper and iron so that the secondary voltages remain practically constant even though the electric light line voltage varies slightly at different times.

88. **Rectifiers:** Two popular types of rectifiers have been used extensively in "B" battery eliminators, namely, the filament type and the gaseous type. Only the former will be considered here, as it is the most popular at the present time. The function of the rectifier is to change the alternating current to direct current. When an alternating voltage is applied to it, it allows the current to flow in one direction only, by offering a very high resistance to the flow of current in the opposite direction. Rectifiers are divided into two types, half wave and full wave. In half-wave rectification, only one part of the current wave is utilized, the flow

Mr. Ghirardi points out the windings on a typical "B" power transformer.

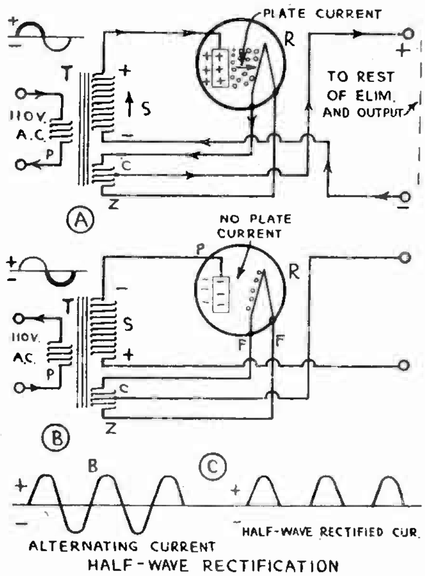


Fig. 52: How the half-wave rectifier works.

of current being stopped during each half cycle. In full-wave rectification the circuit is so arranged that both halves of the wave are utilized. Two half-wave tubes can be connected to form a full-wave rectifier.

89. **Half-Wave Rectifier:** A half-wave rectifier tube of the filament type consists of a heated filament and a plate or anode (two electrode tube), as shown in Fig. 52A. The filament (heavy-coated type) is usually heated by alternating current supplied by the winding Z on the power transformer T. The plate voltage is supplied by the winding S. As the transformer operates on A. C., the polarity of winding S reverses during each cycle. Fig. 52A shows the conditions when the top terminal of S is positive. This makes the plate of the rectifier positive and it attracts the electrons emitted by the filament. The plate current flows from plate to filament through half of winding Z to the center-tap C and out to the rest of the eliminator and set, back through the minus terminal of the eliminator to the lower terminal of S, making a complete circuit. The direction of the current is shown by the arrows.

On the next half cycle (Fig. 52B) the polarity of S reverses, the top terminal now being negative. As this is connected to the plate it makes the plate negative, thus stopping the flow of electrons and no current flows through the rectifier. This half of the wave is thus eliminated, and therefore the current flows in the external circuit in one direction only. Fig. 52C shows the A. C. wave applied to the eliminator from the lighting socket, and the pulsating D. C. at the output of the rectifier. Notice that the D.C. stops entirely during half of each cycle, making it rather difficult to completely filter and smooth out a current of this type, since the frequency of the pulsations is only half as great as for a full-wave rectified current. For this reason, half-wave rectifiers are not used greatly in home receivers, as the increased cost of the filter system necessary for quiet operation is a disadvantage. They are used where high voltages are to be rectified, as in the case of a "B" power unit supplying plate voltage to 250-type tubes, which require 450 volts on the plate.

Since there are only three connections to a half-wave rectifier tube, the fourth prong (corresponding to the G terminal of the ordinary vacuum tube) is not connected to anything, but is merely placed on the base of the tube to help hold it firmly against the socket contacts.

90. Full-Wave Rectifier: A full-wave filament type rectifier tube consists of a heated filament and two separate plates or anodes (Fig. 53). In Fig. 53A, which shows the typical circuit for a full-wave rectifier, each plate is connected to one

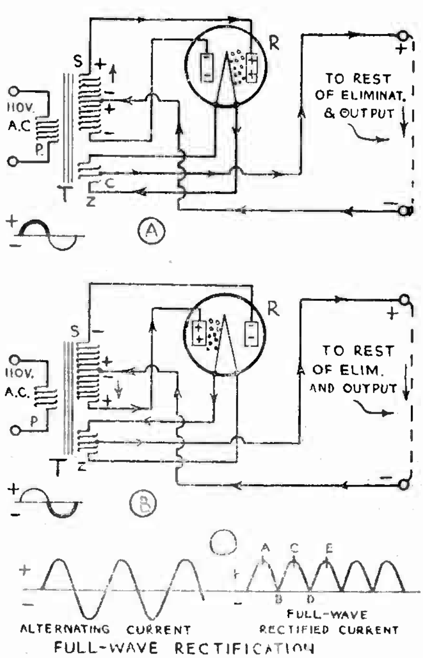


Fig. 53: The action of a full-wave rectifier system.

end of the plate winding S of the power transformer T. The filament is heated by A. C. from the filament winding Z. Both the plate winding and the filament winding have center taps connected to the external circuit as shown. A close study of Fig. 53 A and B will reveal the action of the tube.

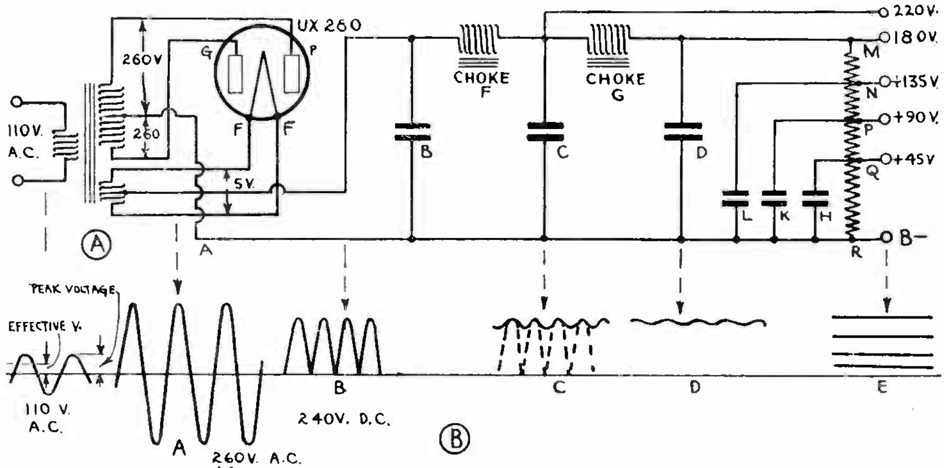
On the positive half of the A. C. cycle the upper terminal of winding S is positive, thus making the right-hand plate positive. The lower terminal of S and the left-hand plate are negative. The center tap on S is at a potential half way between these two; it is negative with respect to the upper terminal and positive with respect to the lower terminal. Since the right-hand plate is positive, a current flows from it to the filament through half of the filament winding, as shown, and out of the center tap to the positive terminal of the eliminator, back to the negative terminal to the center tap of S. The left-hand plate, being negative, takes no part in the action. Notice that only the upper half of winding S was effective during this period and, therefore, the effective voltage acting on the rectifier tube is half of the total voltage of winding S.

On the next half cycle, Fig. 53B, the polarity of S reverses and the left-hand plate becomes positive. A current flows from this plate to the filament and around through the circuit as shown. The right-hand plate, being negative, takes no part in the action. Notice that the direction of the current in the external circuit is exactly the same as in Fig. 53A, so the eliminator delivers a direct current.

Fig. 53C shows the A. C. wave and the rectified current. Notice that both halves of each A. C. wave have been utilized and the rectified current is much smoother than that produced by the half-wave rectifier and therefore much easier to filter and smooth out completely.

91. Filter: Now that we have seen how the line voltage can be stepped up and the A. C. rectified, let us study the operation of the filter which smooths out the pulsating direct current delivered by the rectifier. Examination of Fig. 53C shows that from A to B the current decreases and from B to C the current increases, decreasing again from C to D, etc. Any device which will keep the current constant from A to C to E, etc., will serve the purpose of filtering the current.

The filters most popular at the present time consist of combinations of iron-core choke or inductance coils and large capacity fixed condensers known as filter con-



FULL-WAVE "B" ELIMINATOR WITH TWO-SECTION FILTER

Fig. 54: Schematic diagram of a full-wave power system with a two-section filter.

densers, connected to produce the desired results. The choke coils are wound with a great many turns of wire on laminated steel cores, thus possessing high inductance and tending to oppose any change in current (Lenz's Law). The condensers store a charge of current when the voltage is maximum and discharge when the voltage decreases, thus tending to keep the current steady. Filters can be made of one or more sections; usually the completeness of the filtering increases as the number of sections is increased. Most "B" power packs employ filters of one or two sections.

Fig. 54A shows a two-section filter of the brute-force type, and a voltage divider connected to a 280 type full-wave rectifying tube. All voltages are shown. The successive changes in the current as it passes through the eliminator are shown in Fig. 54B. The first condenser B can be considered as a voltage regulator in so far as it absorbs each pulsation in taking a charge off the line and when the voltage drops, it feeds back into the line. The charge is absorbed at the peak, thus helping to fill in the valley between the peaks. The first choke coil F has a somewhat similar function, but operates in a different fashion. On account of its high inductance (30 henries or more) it prevents rapid changes in the current passing through it. It opposes the rapid building up of the current as it rises to a peak, by the building up of a counter-electromotive force. As the current reaches its highest value, and begins to decrease, the energy which has been stored in the magnetic field of the coil by the increasing current is now fed back into the circuit.

In the second stage C-G of the filter the same operation is carried on a second time, but the current on which it operates has had its pulsations smoothed out to a great extent before entering this stage and to a still greater extent on leaving it. The current that passes out of the second choke is usually a very smooth direct current.

The third condenser D normally floats on the line in a charged condition. If a powerful signal or a low note is amplified by the radio set, causing a heavy flow of current in the plate circuits, there is a consequent drop in voltage due to the increased IxR drop in the transformer windings, rectifier tube chokes, etc. When such a condition arises, the last condenser, having been charged at the higher potential, discharges on to the line and thus meets the momentary demand for a heavier current supply. In this way the last condenser acts as a current storage device. In some cases it must be of large capacity (3 to 10 mfd.) if good low-note reproduction is to be obtained. Thus condenser B controls voltage regulation, C controls hum elimination, and D controls current storage for good quality of reproduction.

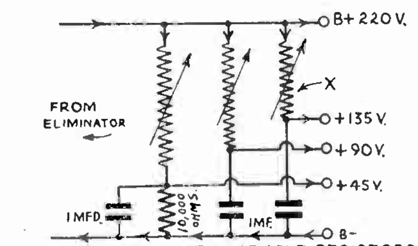
The 280 type rectifier tube can be used successfully in some circuits with a one-section filter consisting of B = 4 mfd., F = 30 henries, C = 4 to 10 mfd.

92. VOLTAGE DIVIDER: If only one value of "B" voltage were required by the receiver, the "B" would now be complete, but the various tubes in a receiver require different plate voltages. These intermedi-

ate values of voltages can be obtained by means of a series of fixed or variable resistors located in the circuit directly across the output terminals of the filter section.

In Fig. 54A a fixed resistance R, having taps located at predetermined positions, is used to obtain the various voltages. A commercial resistor of this type is shown in Fig. 54C. Each section is by-passed by a 1 mfd. condenser to prevent interstage coupling through the impedance drop of the resistor. The resistances of the various sections can be calculated by Ohm's law, $R = \frac{E}{I}$ when the total current consumption of the tubes connected to each tap is known. It must also be remembered that the currents in the various resistor sections are different. Thus, the current in section PQ is the sum of the current in OR and that taken from the 45 volt tap. The current in NP is the sum of the current in OR and that take from the 45 and 90 volt taps. This type of voltage divider is cheap and acts as a protective device against high voltage surges across the filter condensers when the external load is suddenly removed from the eliminator and the voltage rises suddenly due to the decreased IxR voltage drop. The resistance acts as a constant small load on the rectifier.

Fig. 55 shows a voltage divider employing variable resistors for producing the desired voltage drops. The resistance required for a given voltage drop is calculated by Ohm's law $R = \frac{E}{I}$. Thus, if 20 milliamperes is drawn from the 135 volt tap, the resistance required to reduce the voltage from 180 volts to 135 volts when this current is flowing through it is $R = \frac{E}{I}$, or R equals 180-135 divided by 0.020 ampere (20 milliamperes), from which



VOLTAGE DIVIDER WITH VARIABLE RESISTORS

Fig. 55: Obtaining different voltage values by means of variable resistors.

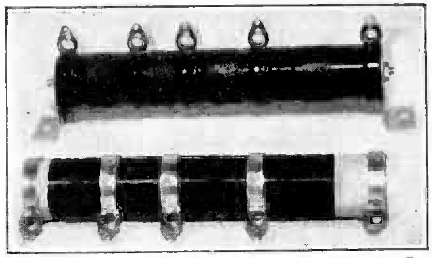


Fig. 54C: A Pilot fixed output resistor, with taps. The lower view shows the bare resistor before being covered with a coat of protective enamel.

R = 2250 ohms. This method of output voltage division gives exact adjustment of voltage but is more expensive than the fixed resistor method.

93. CHOKES AND FILTER CONDENSERS: The filter condensers used in eliminators must be built to withstand the *peak* voltages encountered. The condenser nearest the rectifier is subjected to the highest peak voltages. As the voltages at the input of the rectifier and immediately following it are alternating and pulsating direct current voltages, respectively, the values indicated are the "*effective values.*" The "effective voltage" is the value of voltage which gives exactly the same heating effect as an equal direct current of the same potential. This is the value which an A. C. voltmeter indicates. The peak value of an alternating voltage is the maximum value to which the voltage rises during any part of the cycle (see Fig. 54). The shape of the ordinary A. C. voltages encountered is such that the potential is proportional to the sine of an angle (sine wave), and when the voltage has such a form, the peak value is 1.41 times the effective voltage. As the condenser insulation must safely withstand the peak voltage twice during each cycle, the condensers used must have a voltage rating exceeding the peak voltage for safety.

Thus, in Fig. 54 the A. C. voltage applied to condenser B is about 245 volts. The normal peak value (which the condenser must safely withstand) is 245 $\times$ 1.41 or 345 volts. This should be remembered when constructing an eliminator. The chokes should have sufficient current carrying rating, so that at no time is the carrying capacity reached. When the current rating of a choke is exceeded it rapidly decreases in inductance value and does not then measure up to the requirements of a satisfactory choke. The D. C. resistance of the chokes should be low, to prevent excessive voltage drop through them.

In Fig. 54 a 220 volt tap is taken off before the last choke. This is often done to supply a higher voltage to the last power tube, since then the voltage drop through the last choke is eliminated. Not as much filtering is required for this tube since any slight hum introduced is not amplified by any succeeding tubes. Also any coupling which might exist between the last audio stage and other tubes in the set, due to the common heavy plate current flowing through the impedance of the chokes, is reduced, as the last choke is put out of the plate circuit of the power tube by this method.

It must be remembered that high voltages are present in "B" power packs and proper insulation and wiring precautions must be observed.

94. HIGH RESISTANCE VOLTMETER: Voltage readings on a "B" battery eliminator should be made only with a special high resistance voltmeter whose resistance is at least 100,000 ohms with a full scale deflection of 200 or 250 volts. Such a meter draws very little current. The ordinary inexpensive voltmeter of the low-resistance type requires considerable current for its operation, and in a "B" power unit the considerable current drain imposed by such a voltmeter causes a drop in the output voltage, so that it is impossible to secure an accurate voltage reading.

95. A. C. TUBE FILAMENT WINDINGS: Most power packs manufactured at the present time also contain several low voltage secondary windings designed to supply 1½, 2½ or 5 volts for filament current supply to the A. C. type tubes used in electric receivers. These windings are placed on the same steel core mentioned for the high voltage "B" winding, making the construction compact and cheap. Thus one power pack is used to supply all "A," "B" and "C" voltages to the entire A. C. tube electric receiver. Fig. 56 shows a commercial unit of this type, removed from its steel container. The power transformer is at the left, the two chokes are at the center and the condenser bank and rectifier tube are at the right. At the top is the terminal connection strip, and the output voltage dividing tapped resistor is at the bottom.

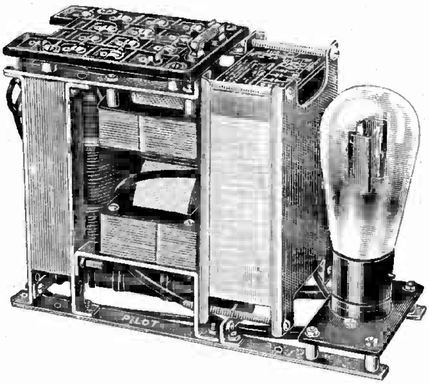


Fig. 56: The inside of a Pilot K-111 power pack. LEFT TO RIGHT: *power transformer, filter chokes, filter condenser, rectifier tube. Notice the output resistor under the chokes.*

96. "C" BIAS FOR POWER TUBE: If a power tube is used in the last audio stage of a receiver, its filament can be operated by alternating current supplied from a low voltage winding provided on the power transformer of the "B" eliminator. This is possible because the slight amount of hum introduced by the use of the A. C. is not amplified by any succeeding tubes and is not usually noticeable. The "C" bias for the power tube (a 171A tube in this case) can be secured by connecting a resistance R from either the center tap of the filament winding (or from the center tap of a center tapped resistance connected across the filament) to the "B"— terminal of the power pack. The grid return of the power tubes goes to the "B" —terminal. The plate current of the power tube flows through the filament to the five-volt filament winding, out of the center tap through R to the "B"—terminal and around through the eliminator. Since there is an IxR voltage drop in R, the potential of the grid return lead of the power tube is lower than that of the filament, *i. e.*, a "C" bias is put on the grid. The plate current taken by a 171A tube with plate potential of 180 volts is 20 milliamperes. Therefore IxR equals

$$\frac{20}{1000} \times 2250 = 45$$ volts which is about the

recommended "C" bias voltage for this tube. Similarly the resistance necessary to obtain a certain "C" bias for any other tube can be computed. For a 245 tube a resistance of 1350 ohms should be used when a plate voltage of 180 volts is employed. When 250 volts are applied to the plate, a 1500 ohm "C" bias resistor should be employed to give correct "C" bias voltage.

Who Invented Broadcasting?

Asks David Grimes

A History of Radio as We Know It Today That Corrects Some Popular Misconceptions and Describes the Work of the Real Pioneers of the Art.

PART I

David Grimes

MANY pioneers in this world never receive their just credit for early labors. This is generally true no matter what the field of endeavor. They struggle on and on with prophetic vision, only to have some later investigator arouse the public's interest and receive the acclaim. At the height of Lindbergh's triumph, few people realized that his was not the first non-stop flight across the Atlantic. He himself, with the true spirit of the real hero, called attention to the fact that Alcock and Brown had flown direct from America to Ireland some years before. The world, for some inexplainable reason, was ready for Lindbergh's accomplishment.

So it has been with other major developments, and radio is no exception. We have already seen in our last article on "Radio Understanding," which appeared in the winter issue of RADIO DESIGN, that Alexander Bell did much of the first work on radio telephony, that his was the first real analytical vision. Yet you, in your own mind, undoubtedly thought that Marconi was the "Father of Radio." Bell's work was done in about 1878, while Marconi struggled along after 1896. Bell's investigations created great interest among scientific men, but Marconi's first wireless message across the Atlantic in 1901 awoke the vast public, who immediately assumed that Marconi was the "inventor" of wireless.

Now that radio broadcasting has become such an important and permanent part of our daily lives, we hear claims on all sides to the honor of being the first broadcasting station. Modern radio entertainment dates back to 1921, when station KDKA started a series of regular programs, including the broadcasting of music, news, boxing matches, etc. For the same old inexplainable reason, the stunt took hold of the public's imagination immediately. Other stations around the country were set up and the subsequent progress spread like wildfire. Of course, you are quite familiar with all this. But you are probably not quite so familiar with the efforts of the real pioneers, which extended over a period of many years before this. Radio broadcasting is not new. It was fairly well developed long before 1921. Station KDKA of the Westinghouse Electric and Manufacturing Company at East Pittsburg, Pa., which is so proudly announced as "the pioneering broadcasting station of the world," is a mere upstart in the minds of pre-war radio fans.

TOO MUCH TERRITORY

This station reminds one a good deal about the story of the fellow who boasted to a room full of friends of his ability to "lick" anyone of them. No one moved to accept the challenge. Then he became more ambitious and extended his boast to cover anyone in that particular town. Still no offers to disprove the assertion. A statement that he could best anybody in the whole country excited his friends but aroused no opposition. Finally, to cap the climax, he arose to his full height and, with a grand gesture, stated that he could outbox anyone in the whole world. Thereupon, a diminutive but energetic young chap knocked him flat on the floor. The boaster slowly dragged himself up and, somewhat abashed, said that he guessed he had taken in too much territory. Everything would still be serene in the broadcast field if KDKA hadn't attempted to take in too much territory.

SOME CREDIT IS DUE

Undoubtedly, station KDKA was the first broadcasting in Pittsburg. It might have been the first station in the entire state of Pennsylvania. But for it to sign off every night as "the pioneer broadcasting station of the world" calls for just a little too much credulity and gullibility. The entire world is a lot of territory. We propose to occupy the position of a mere pigmy with pugilistic instinct; so we set about to acquire the facts with which to knock "the world" out of that famous slogan of station KDKA. It will interest you to know that a letter was dispatched to them relative to this discussion, but nary a reply was received. It is so embarrassing, don't you know, to have family skeletons dragged from the closet. Let's proceed with gloating to the disinterment.

But where does one find these graveyards in which to do this ghoulish work? It is but natural that the real, early investigators, who were trying to earn a living with radio, should ferret out its many possibilities. It is unconceivable that radio telephony should have advanced to a rather high degree of perfection during the war without somebody attempting to utilize it for the dissemination of entertainment over wide areas. A perusal of newspapers and technical publications just after the close of the war reveals any number of broadcasting efforts. But we are getting ahead of our story, for radio antiquity discloses even more startling data.

Wireless, or radio, as we now know it, really started with the experiments of Prof. Hertz in 1887. Alexander Bell, who had been telephoning over visible light beams some ten years earlier, had no knowledge of the wavelengths that penetrate in contradistinction to the visible beams which are easily absorbed by common objects. Bell's broadcasting could only go where the light beam would carry it—in a straight line with no intervening constructions. But Prof. Hertz's discovery was also limited as far as voice transmission was concerned. The beams of Hertz's invisible, penetrating light were very unsteady—they flickered badly. This defect was so serious that it was impossible to transmit the fine vibrations of the human voice over the beam without having them completely wiped out by the variations existing in the source of the beam itself. True, it was quite satisfactory for telegraph transmission by the dot and dash method, as any kind of a noise is sufficient so long as the time intervals between the noises spell out the Morse code. This drawback confined the use of the Hertz waves to wireless and telegraph work for many years. All of this carries us up to the work of Dr. Lee de Forest about 1908.

Of course, Dr. de Forest is best known by his invention of the three-element vacuum tube. This was conceived by him about the year 1907. This, together with his other numerous radio inventions, had brought him into great prominence. We find him building radio sets for the United States Navy under government contract in 1908. These sets were for

Dr. Lee de Forest

inventor of the vacuum tube and the real father of radio broadcasting.

use on battleships and were primarily telegraph instruments. However, they utilized an entirely different method of generating the radio waves than that devised by Hertz. De Forest employed the electric arc light in such manner that the proper invisible beams so necessary for practical radio transmission were generated as well as the customary visible light rays. The fact that the arc generated visible light was only incidental in this case, as the visible light was not used.

Earl Hanson, who did some of the earliest broadcasting on the west coast.

Now one of the peculiarities of this arc method of radio wave generation was that an almost steady beam was sent out through space. This resulted in much more efficient telegraph transmission and was employed for that purpose. But, at the same time, such a steady beam also offered possibilities for voice transmission. De Forest found this to be true and these navy transmitters were so equipped that they could be used also for short distance voice and music broadcasting. The radio installation on the flagship of Admiral Evans' "round the world" fleet in 1909 was often used to broadcast music to the rest of the ships in the squadron.

OPERA ON THE AIR

The success of the navy sets in the broadcasting of music and speech led Dr. de Forest into further researches along this specialized line of endeavor. He erected a radio broadcasting station on the top of the Terminal Building in New York City, truly the first in the world! This was run in connection with his other laboratory work, the "lab" being located on the eleventh floor of the same building. The date? Oh, yes, that is very very easily established. Mme. Mazarin, of the Metropolitan Opera Company, traveled way up to the laboratory one night to render a few selections from "Carmen" over the real pioneer broadcasting station of the world. This was in January, 1910. Now laugh that off!

Shortly before this an effort was made to have the immortal Caruso give of his talents over the air, but "Mohammed would not move to the mountain," so the "mountain was moved to Mohammed." Yes, sir! The entire broadcasting station was packed up and moved bodily over to the roof of the Metropolitan Opera House in New York and there installed for the famous event. Caruso's voice was picked up directly from the

A really historic event: Mme. Mazarin, of the Metropolitan, broadcasting from De Forest's station in January, 1910—more than twenty year's ago!

Will You Help Write the History of Radio Broadcasting?

Mr. Grimes is writing the first real history of radio broadcasting, which will run exclusively in Radio Design *and appear later in book form. Will you help him by sending in your recollections of the early days of the "game"? Send your letters to Mr. Grimes, in care of* Radio Design.—Editor.

stage during one of the regular operas and sent out over the air for all those who cared to listen. An interesting story is told of a newspaper reporter who visited de Forest a day or two later in hopes of learning something new that could be published. He was told about the Caruso broadcast, but he tossed this lightly aside as being of no moment. Fine thing and all that, but the public was simply not interested in radio broadcasting.

THE ORIGINAL RADIO GIRL

About this time, but even before the Mme. Mazarin broadcast of January 1910, another young woman journeyed up to the laboratory to render vocal selections over the air. She was indeed an enthusiast. She was the original radio girl, Miss Vaughn De Leath, and she is very popular to this day, being one of the star artists of the National Broadcasting Corporation. One evening in the winter of 1910 the chief electrician in the Brooklyn Navy Yard was tuning in his radio set to see what telegraph signals were in the air. You can imagine his surprise when he tuned into a wonderful radio program, the first he had ever heard. He simply couldn't believe his ears. After considerable deliberation, he figured that the only genius capable of such radio witchcraft was Dr. de Forest, so he called him on the telephone and substantiated his intuition. This was Mr. Davis, who later became the prime mover of the United Fruit Company and its subsidiary, the Tropical Radio Corp. of Boston, Mass.

Most things cannot long continue without public support and the pioneer broadcasting station of the world certainly had everything else but. The station soon discontinued its public philanthropy and Dr. de Forest turned his attention to more lucrative pursuits. Not even the voices of Caruso and Mazarin could jar the people from their lethargy. It remained for others to carry on the attempts.

The Doctor's experience in broadcasting was not such as to immediately encourage others to do likewise. It apparently served as a most effective damper on the aspirations of Eastern experimenters, for nothing further was forthcoming from that section of the United States. Three years later, word gradually filtered through from the Pacific Coast that a young fellow by the name of Earl Hanson was carrying on encouraging work in connection with radio broadcasting. On several occasions, during 1913 and 1914, the Los Angeles *Daily Tribune* and other publications ran feature articles on the inventions of this young genius. He had unbounded enthusiasm, for he carried on his efforts to arouse the public to the possibilities of radio broadcasting for several years until the war intervened. The newspapers were at least taking more interest in these programs than they had done for the earlier work of de Forest. But the people of the Golden West were no more alive to broadcasting than the more conservative Easterners. That mysterious something was still lacking. Thus passed into history the second pioneering broadcasting station of the world.

Vaughn De Leath, really the "Original Radio Girl" and now one of the brightest stars in the National Broadcasting Company's fold.

(*Continued in the next issue*)

Those Mysterious Short-Waves —How Do They Work?

Robert S. Kruse

A Masterly Explanation of a Subject That Is of Interest to All Radio Fans and Understood by Few of Them

by ROBERT S. KRUSE

A MIRACLE is, fundamentally, the same thing that it was in ancient times when gods were numerous and short-tempered. We still think of the wonderful or miraculous as being something which we cannot explain and must therefore credit to powers beyond present understanding.

It is no business of mine whether you prefer to call these powers "Will of God" or "law of nature." You may say that the universe was constructed by an Intelligence, which now operates it, or else you may prefer to think that the whole structure is an amazing and elaborate accident which continues to move because of its original impetus. In either case we are faced by the wholly incomprehensible fact that the amazing machinery of life and stars and planets *does* exist and does *run*, without any chance that we may understand its beginnings or any considerable part of its present operation.

FRESH MIRACLES!

Realizing this, we human beings still spend some part of our lives in trying to understand. Most of us make no progress at it, but now and then someone with better vision gropes his way toward an understanding of some small bit of the Universe. He then *explains away* one of our miracles, only to find that behind it are a dozen new and fresh ones. It is discouraging business; our researches are mainly discoveries of new ignorances and unsuspected stupidities.

Nothing could illustrate this better than short-wave radio. Our great-grandparents did not worry over radio's problems, for they had no radio and did not suspect their igonrance in this direction. Radio was discovered in the regulation manner: while explaining an earlier puzzle. This earlier puzzle had started out with light, and since it is a part of the story that is to follow, we may as well review it here.

Since the earliest beginnings it had been observed that sight was faster than hearing—the lightning's glare arrives before the thunder crash. (Fig. 1). Later it was noticed that light was not only faster, but that it ran in remarkably straight lines, while sound wandered and bounced around obstructions just as water waves do when they meet a shoal or some rocks. So far, so good, but unfortunately someone noticed that all water waves went at one speed and presently it was found that waves in other materials moved at different speeds—waves going slowly in soft and light things, but very fast in hard and heavy things. From this one would judge that light and sound, if they both traveled through the air as they seemed to, should go at the same speed, whereas nothing of the sort had ever happened. When the speed of light was measured it was found to be about a *million times* as fast as that of sound.

This was very upsetting and troublesome altogether, especially as there had begun to appear evidence that light also was wave motion. The invention of the air pump had shown clearly that sound traveled through the air. If one enclosed a bell in a glass jar and pumped the air

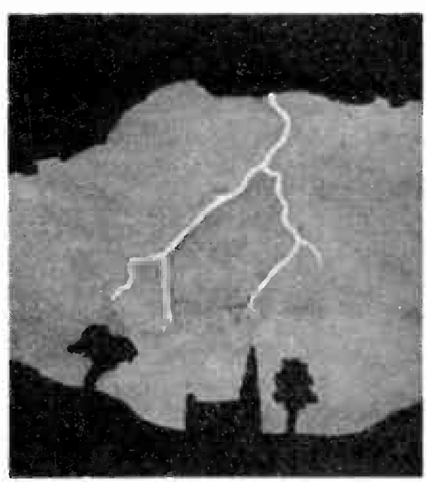


Fig. 1: You always see the flash of lightning before you hear the crash of the thunder.

out of the jar it became nearly impossible to hear the bell, no matter how hard the jar was shaken. (Fig. 2.)

There was only one possible conclusion: light must travel through something altogether different that is *mixed up with* the air!

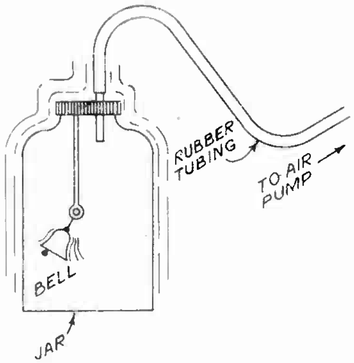


Fig. 2: This classic bell and jar experiment proved that sound travels through the air.

WHAT IS A WAVE?

Now what sort of material might this be through which waves could race at the dazzling speed of a hundred million yards a second? Is it possible to imagine such a material?

That depends largely on one's ability to answer some preliminary questions:

1—What makes a wave go fast or slowly?

2—What is a wave?

Complete replies are neither possible nor necessary here. Let us instead look at the pictures of Fig 3. In Fig. 3 it *looks* as if masses of water were rushing from X toward Y, yet this is not the case, as we can easily show. For in the first place, after dozens of waves have passed there is as much water at X as there was in the beginning, neither has the water piled up at Y. Again, the cork on the surface of the water has merely bobbed up and down while the waves slipped under it. The cork is certainly doing the same things as the bits of water nearest it and we may say without hesitation that the water particles also are only bobbing up and down.

That is not quite all they are doing. It is a trifle more exact to say that they are doing little ferris-wheel performances, one turn for each wave that goes by. If it is a big wave the water drops make a big circle, but they come back to their starting places just the same.

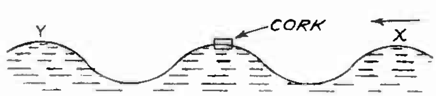


Fig. 3: The action of a floating cork illustrates wave motion.

Now if the water waves are NOT masses of water, moving toward Y, what are they? They must be moving *pieces of energy*. These pieces of energy are being passed along from one group of water particles to the next in the same fashion in which a bucket of water moved along the old-time fire-fighter's "bucket brigade."

Now let us look at the original problem again. How can we make the "bucket brigade" move a million times as fast, so as to handle light waves at the speed we know to be theirs?

THE INCREDIBLE ETHER

As was suggested above, waves tend to move faster in things that are very hard, because this usually means that they are very elastic. An elastic material is one which is very *quick* to recover its shape when it is bent, stretched or twisted. Rubber, in spite of our usual impression, is not very elastic. It is tough, because it can stand a very great amount of distortion, but is not at all fast about recovering its shape. Hard steel comes back vastly more promptly. If, as in Fig. 4,

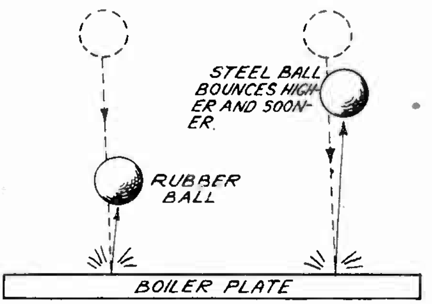


Fig. 4: This experiment shows the relative elasticity of rubber and steel.

we drop a rubber ball and a steel together, the steel one will bounce *higher* and *sooner* than the rubber one. The steel ball and the rubber one have each been distorted by the impact, but the steel one has recovered much more promptly and completely, showing that it is more elastic. Thus we might expect that some very hard material may be the mysterious light-carrier.

How can this be? Our light-carrier must be a thousand times as elastic (and as hard???) as steel, yet we know that light goes everywhere and must conclude that the light-carrier is also everywhere. If it is everywehere then we are constantly wandering about in it without even feeling it.

How can something be more steel-like than chilled steel and at the same moment be so gauzy that we can neither see NOR *feel it?* The combination is unreasonable—which means contrary to all experience—which is to say "miraculous." Quite properly the light-carrier was named "aether," which is the Greek word for the heavenly-fire of which stars and the moon were supposed to be made. We have changed the spelling to "ether" but have kept the word, for the semi-incredible nature of the material has been confirmed in many ways.

As one possible check on the actuality of ether, Maxwell suggested that it must, like other substances, be able to carry any number of waves per second. Light waves do not provide a good test for this, as the fastest and the slowest light-vibration all lie within an octave or a bit more. We know that air can do much more than this in the way of handling sound waves, for even the ordinary piano gives us eight octaves and the pipe organ goes above and below that.

Maxwell therefore suggested that it should be possible to make waves in the ether which were much longer (fewer per second) than light waves. He investigated the probable nature of these waves mathematically and prophesied that they would be both electric and magnetic and

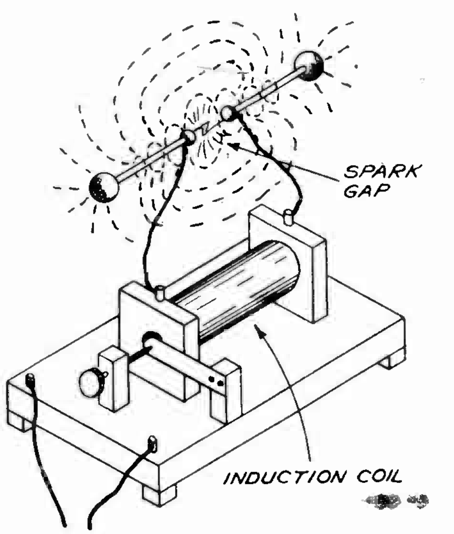


Fig. 5: Hertz created radio waves by means of an induction coil and a spark gap, as shown above.

should therefore be called "electro-magnetic waves."

Not a great deal later Heinrich Hertz devised apparatus (Fig. 5) for stirring up just such waves as Maxwell had predicted. He not only sent but also received the first "electro-magnetic" waves that had been knowingly generated by man. He found that they acted like light waves, could be focused, with a lens, bent by a prism, reflected by a mirror and that they traveled in straight lines *and at the speed of light.* Radio transmission and reception had arrived.

It now became necessary to believe in the light-bearer, "aether," or else to devise another explanation that would account for the similar manner in which light and radio behave. On this point there is division; another explanation for light has been offered, and it can be made to explain some radio phenomena. The acceptance of the ether-theory is, however, still the most widespread and the most convenient. As we shall see in a few moments, the nature of the "aether" has been modified in other manners than the spelling, but it will serve to explain some of the queer things that happen at short waves.

EXPLAINING THE EXPLANATION

Having temporarily agreed that there *does* exist this mysterious carrier of light, heat, radio, X-rays and cosmic rays, we are compelled to admit that it must be *everywhere*, because radio waves appear to reach all points and light waves most of them. We must also admit that it seems to occupy all space outside the earth, for light reaches us swiftly from the farthest stars. With these admissions we have elevated ether to the exalted position of the "universe substance," the thing-that-is-everywhere.

But, if it is everywhere, why is light not able to go everywhere at will? Why do such ordinary things as smoke and dust and fog delay it? Why do radio signals sometimes "come through" and at other times fail to arrive?

Let us back-track once more and see if the performance of sound will offer an answer. Sound travels through the air, we are sure. Air is reasonably universal all over the earth, though the quality of it is not uniform. Does sound travel equally well under all weather conditions, with or against the wind, through clear air and foggy, over water and over land? The question sounds silly, for none of us were 10 years old before we knew that sound is most uncertain. Clearly the mere presence of the sound-carrier—meaning air—is not enough to insure good sound transmission. The air must also be quiet, it must be free from obstructions, nor may it be too much mixed up with smoke and fog. There is air inside a fog-bank, but sound frequently bounces back from the fog, or slides over the top of it, as is only too well known to mariners who attempt to hear fog horns and sirens.

Quite similarly, the ether may be, and commonly is, strongly agitated and mixed up with other substances which cause radio waves to twist, turn, bounce back, and altogether act in every way except the one that Hertz and Marconi expected of them. The story of these etheric acrobatics will take up the rest of our time.

THE QUIVERING ETHER-WEB

Let us gaze intently at a tiny bit of the enormous ether-web and see what its construction is. If our microscope is sufficiently miraculous in its power we shall see an immense numbers of tiny dots, tied together by a mazy web of elastic bands. (Fig. 6.) The tiny dots are electrons, the elastic bands connecting them are the attractive *forces* between them—the "gravitation of these tiny earths." The nearest electrons look larger, simply because they are nearer. Actually they all turn out to be of the same size, though we cannot say with certainty if it is electrical size or physical size. However, let us not attempt to be too exact: let us rather allow a number of inexactnesses to pass, in preference to getting snarled up in a very complex discussion.

We have looked at a tiny part of the "universe substance." Our picture is very incomplete, for beyond the electrons we have shown lie others, and still others and then further millions, in every direction right out to the limits of our universe. All these millions of electrons are enmeshed in this same quivering web, which is in ceaseless agitation in every portion of its huge volume, for through it are rushing waves of light, electric waves, magnetic storms, and all the score of other kinds of disturbances which are constantly boiling forth from ten thousand places in the universe.

Thus our ether is anything but a placid sea. It is rather a storm-whipped and gale-torn ocean through which radio waves make a difficult and harried passage, often carried far from their courses and sometimes never arriving in port.

Nor is that all. When one comes near the earth the etheric ocean is polluted by all manner of things, just like any other ocean near its shores. Most important of these pollutions is the air-shell which surrounds the earth to a height of several hundred of miles. The lower portions of the air are in constant agitation by wind and storm and fog and smoke, while above that roar tremendous gales and still higher (where the air is thin) there glow and flicker the Northern Lights. This agitated air is mixed with the agitated ether and still further confuses its operation on radio waves.

We must now—hastily and most inexactly—explain how the air and ether interlock. Air, like everything else that we know of, is also made of electrons. Unlike the electrons of the ether, these air-electrons are grouped in little whirling colonies. Each colony is very intent on whirring around and around its own center, just as our earth and the other planets busily whirl round and round the sun with little attention to the other stars. Of course the etheric net and the whirling air-colonies are intermingled everywhere, but *they ignore each other with a good deal of completeness.* The whole thing changes when for any reason the whirling air colonies stop their whirling and break apart into loose electrons. Such wrecks are not at all uncommon, and all of us have seen them because there is always light when the thing happens, the light being either a cause or a result.

"IONIZATION"

Whenever a lightning flash takes place, whenever the sun blazes down onto the air, vast numbers of the little whirling groups burst apart and their electrons scatter about, mingling with the ether-web and changing its thickness-of-weave, or perhaps simply choking its openings. We then say that the air has been "ion-

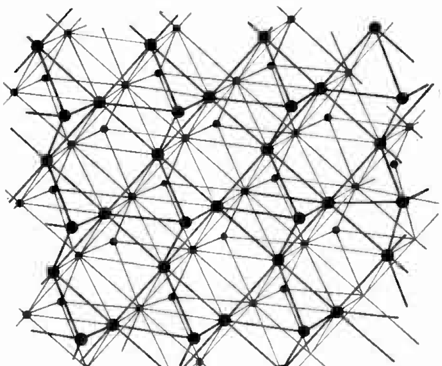


Fig. 6: An imaginative drawing of electrons in the "ether web."

ized." If an ether wave strikes such an "ionized" place its speed is changed, and usually its direction also.

Our stage is now set. Let us watch the radio-waves perform.

Actually a radio station sends out waves like huge shells which grow larger and taller with the awesome speed of light. To imagine these shells and to understand the changes they go through is altogether too laborious and for this story we can think of a station as simply sending out *rays of radiation*, as shown in Fig. 7. Though they are all part of the same waves we speak of the lower rays as "ground rays" and the upper ones as "sky rays."

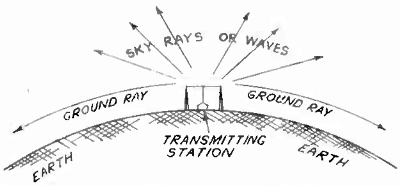


Fig. 7: The radiation from a transmitting station consists of ground rays and sky rays.

THE GROUND WAVE OR RAY

In all radio work both ground and sky rays are sent out, but their performances differ greatly, as we shall see.

The ground wave, following the earth's surface, plows through towns and forests, hills and fields, which is some work for even an ether wave. As a result the wave is slowed down a little and weakened a great deal. In the end it dies from sheer exhaustion. If the wave was weak it did not get far; if the wave was strong and the country not too terrible it may have gone a long ways, but in the end it dies off and more distant receivers cannot hear it.

From this one can see that signalling with the ground wave takes much power, since the greatest part of it will be wasted in stirring up electric currents in trees, hills and houses instead of in receiving antennas. The only good feature about the whole thing is that the performance is rather reliable, regardless of time, season or weather. The longer waves plow along the ground better, just as an ocean ground-swell plunges through shallows and reeds which stop small quick ripples altogether.

Thus if we want extreme dependability, and not too tremendous a range, we may secure it by using a long wave, plenty of power, and the ground wave or ray.

THE SKY RAY OR WAVE

Meanwhile the high-angle rays are shooting up into the sky. If we could get them to come down again at the receiving station we would have the same advantage over the ground wave that a mail plane has over a motorcar.

At first this seems not easy. How is one to reach up into the etheric network and signal a soaring radio wave to land? Fortunately this thing is altogether possible. We cannot only make the wave land *but can instruct it before its departure as to the proper point of landing.* To show how this is possible we must go back again to our working-model of the ether.

THE HEAVISIDE LAYER

It was said a little while ago that the sun's rays, blazing down on the top layer of our air, grind up many of the air particles and so fill the etheric net with a great floating mass of extra electrons in a state of partial freedom. When the sun is bright and close (Summer day) there is a great deal of this going on; whenever the sun is farther away (winter day) there is less of it, and when the sun is around on the other side the wrecked air-particles are busily recombing into ordinary air again. Thus from day to day there is a changing "ionization" of the upper air—a constantly shifting composition of that part of the ether-web which lies in the upper air, a few hundred miles, or a hundred miles above us. Besides the seasonal and daily changes there are other, very great changes caused by sun-spots which change the sun's light, and by eclipses which cut it off for a while.

Whether you say that the upper layer of the air is thereby choked up with loose electrons, or whether you make a more exact and scientific statement, does not greatly matter. The result in each case is that we have above us a sort of tent-roof of a nature which is greatly different from the ether outside and inside the layer.

Waves, in water, air or glass, are changed when they strike a different material. Our radio waves are no exception. They soar upward toward the tent-roof like arrows, and plunge through, glance down again or graze along the layer.

If the ray is from a long-wave station it generally plunges through the roof and is gone as far as we know. If it is from a medium-wave station the ray may bend and return or may go through while the short-wave rays usually glance and come down again.

THE AGITATED MIRROR

We have seen how the pressure of each day's sun pushes down the tent-roof, as if it were a weight, and how it rises again at night. If we know how this rising and falling takes place we can expect to shoot our signals upwards so as to make them glance downward wherever we please. This is not done by using a radio searchlight —throwing a thin beam to be reflected as we would reflect light from a mirror. This pleasant scheme is not very practical for a variety of reasons. For one thing the special sending antenna needed is a very clumsy affair, and for another thing the mirror is a very queer sort of a mirror.

A WRINKLED REFLECTOR

It has been said before that the ether is in endless agitation. Just so the upper air is ceaselessly in agitation. Not only does the shifting sunlight act as has been said, but in addition there are other things that cause our reflecting layer to billow ond ripple, so that we never know exactly what its shape or height may be at the moment. If we make our transmitter too exact a slight shift in the "roof of the world" will shift our descending radio ray hundreds of miles away and spoil the whole scheme. Therefore, we do not use a sharp beam but throw up from the sending station a great spray of rays, of which some are at all times nearly enough right, despite the tumblings and surgings of the reflector or roof. Fig. 8 attempts to show this.

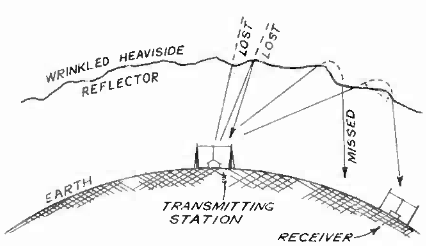


Fig. 8: The Heaviside Layer causes radio waves to bounce back to earth at irregular intervals.

Actually the thing is even worse than this. Our mirror isn't really a mirror at all. It does not have a shiny surface but is rough, nor is there any smooth backing like the silver of the usual mirror. Instead we have a "diffuse reflector," which may be compared to a real mirror by saying that it is somewhat like having to use a rough sheet of milky glass instead of a good silvered plate glass mirror. Thus our reflections are not sharp and clean but fuzzy, but that is not the most important part.

In a real mirror (See Fig. 9) light goes to the silver, then it turns a sharp corner and comes out again. It does not matter at what angle the light goes in; it always comes out again. Our rough mirror does not act this way. Light goes in at any angle—almost—but it may not come out at all. (Again see Fig. 9.) It may go on through or may wander around inside the thickness of the milky glass and gradually become lost. By trial and experiment we find that the upper air, mixed with the ether, is such a milky-glass reflector or refractor.

It does not seem to me that we need to go into detail on the very complex things that can happen. We need only show the general drift of the thing in Fig. 9. The rays that go too straight up will go through and disappear; therefore none will come down NEAR the sending station. Those that start out too near the earth will never get free. Between these are the rays which will slant up toward the wavering tent-roof and glance down again. Where they will light depends on the wavelength, the height of the roof at that time and to some extent on the power of the station. The combinations are exceedingly intricate but their practical effect is very completely represented by the curves that appeared on page 37 of the Winter, 1929, issue of Radio Design. It will be seen that we may land a message almost anywhere by merely putting it on board a ray of the right wavelength.

WHAT FADING IS

By this time you have certainly guessed what fading is. It is simply the variation in the reflected rays caused by the tilting and bouncing reflector, just as the rays of an approaching car vary as it bounces over the road.

However, it is quite possible that you have not guessed that there is such a thing as "audio fading," that is, fading which puts a *growl* on the signal. This

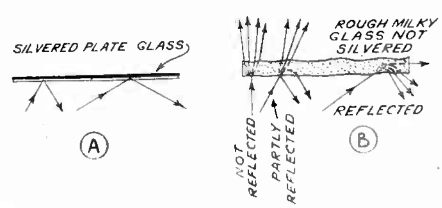


Fig. 9: Reflection effects in perfect and imperfect mirrors, comparable to the action of radio waves.

is supposed to be caused by rapid ripples in our unsteady reflector. As a result the signal *sounds* the way a tree on the opposite side of a pond *looks* when seen reflected in the water on a windy day. The comparison is not exact but clear enough. The majority of short-wave broadcast signals have more or less of this "audio fading" on them, sometimes so strongly that nothing else can be heard at all, both music and announcement being perfectly hashed up.

Still another sort of fading is "selective fading," in which the signal at one moment is all high notes and the next moment is all low notes. The thing sounds as if it were coming out of a large room with a terrible hollow echo which at intervals swells up and turns the music into meaningless boomings and the next moment dies down and leaves nothing but thin whisperings.

All these and other sorts of fading are related. There are kinds that take hours to complete, there are kinds that are done in 1/200 of one second. Although fading has been studied rather systematically since a series of tests initiated by me in 1922 at the Bureau of Standards, much still remains to be done, despite the very fine work of the Bell Telephone Laboratories.

A cure for fading is hard to imagine, since the disease is a hundred miles above our reach, yet certain dodges have been found useful in cutting down the seriousness of the effect. When they are more fully perfected we may expect very splendid long-distance broadcasting and telephone work.

ECHOES, AND ROUND-THE-WORLD SIGNALS

The upper air does not provide the only place where radio does queer things.

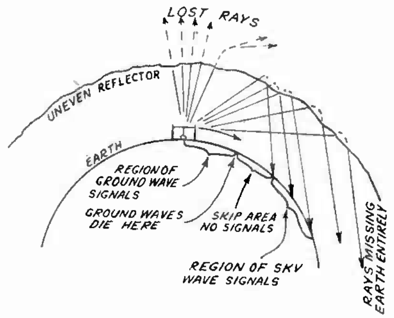


Fig. 10: Illustrating the "skipping" effects of the short waves and why it is sometimes impossible for people living quite near a station to hear it.

When high-power short-wave sending stations first began to work, the receiving operators complained that at certain times the signals "echoed": each dot and dash was followed by a weaker dot or dash.

When attempts were made to use high-speed sending and receiving machines at short waves trouble began in earnest. The

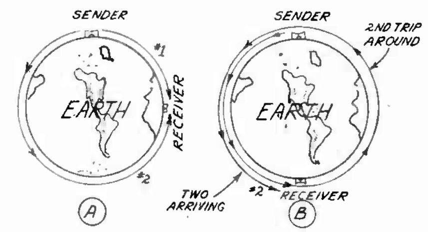


Fig. 11: Radio signals have a habit of echoing around the earth, not merely once, but twice!

machines put down two or three times the correct number of dots and dashes, making no sense whatever. Then the study began. Soon it dawned on someone that these echoes happened in one of the two ways shown in Fig. 11. The signal over the shortage route makes the first and strongest signal while the second one makes the weaker signal. The situation of Fig. 11A can be cured by directional senders and receivers, but what shall one do about the around-the-world echo? The signal has kept on going in the *same* direction and has arrived at the receiver a second time from the same direction!

If one weakens the sending station the *first* signal will fade out every little while, and if one makes it strong enough to prevent that, then the second one has a good chance to make trouble whenever the station "fades in." There are even cases where the round-the-world signal is likely to swing in more strongly than the "direct" signal. The effect on either code or broadcast music is easy to imagine. In extreme cases signals have been observed to go around four times.

In a number of cases the echoes arrive at a time which suggests that they came down out of the air, struck the ocean and rebounded again for a second flight.

STANDING WAVES

In some work at 5 meters we found "bumps" of signal close together, and standing still at the same places, 12 feet apart. We called them West's peaks because C. H. West, of Brooklyn, N. Y., first noticed them. They are found at all very short waves by the simple process of driving along with a receiver in a car. The distance between bumps changes with wavelength and with the nature of the soil or rock one works over, as does the strength of the peaks. A mathematical explanation has been offered which draws a picture very much like our upper-air arrangement, except that it is inverted. The waves go down into the ground, bend, and come out again to mix with the ground wave or ground ray. Depending on the time it took them to make the detour, they arrive at the suface again in time to either aid or hinder the ground wave, thus adding at some places and subtracting at others.

STATIONARY PEAKS

The very important *difference* is that the earth and the rocks stand still, and therefore West's peaks do not fade but stay in one place. Far away from the station these peaks cannot be noticed and one runs into the ordinary fading effects, etc.

There is also a good deal of opinion to the effect that the very bad and uncertain reception in some regions can be blamed on the ground underneath. It can easily be seen why such a region as New England may blame its very poor radio results on the rock and poor soil, but it is not so easy to see what accounts for the extreme daily variations in the results.

ECHOES FROM THE CLOUDS

Nor have we even then told the whole story. Echoes have been studied which clearly are too slow to come from anything on this world. Some of our man-made disturbances have run up the elastic web of the ether to heights far above the last faint trace of air, and have come back down to us many seconds afterwards, to bring with them new puzzles for us to solve. Here we can offer little more than the wildest guesses. Some are of the opinion that the moon, and even some of the planets, have tossed signals back to us. Possibly it is true, though their expanse is very tiny against the huge spaces of the sky. The proportion of the signal that reaches them must be so small as to paralyze the imagination, and of what they reflect only the minutest portion again comes in our own direction.

Nor is that all. Still other slow echoes have been found. These come back in strength too great to be accounted for by the tiny reflectors of the moon or the planets,—their time-of-absence is not right for a trip to those places,—yet much too great to be accounted for by a mere few hundred miles in the air. They too have been outside the earth, and have returned again, after meeting a reflector or lens that must—judging by the strength of the signals—cover a very great part of the sky. What now? Must we invent another ether? Here, too, there is but speculation.

THE SPINNING EARTH

The suggestion is made that the sun's energy arrives at our earth in the form of electron-streams, not becoming light until the air is reached. If so these streams may swerve by reason of the earth's spinning magnetic field and so assume forms from which signals may be shunted off. Someone, I cannot recall who, suggested that the spinning field of the earth may itself twist the very ether-net around it and so cause the departing waves to be gradually curved about and sent back to their point of departure.

But even these explanations do not take in enough immensity of space to include that which has actually been observed to happen. The earth's magnetic field may wind up curious forms in which a signal may wander around for a mere 60 seconds and travel a paltry 11,000,000 miles —but that does not account for the larger journeys radio waves have been observed to take. Jörgen Hals has observed radio echoes more than 4 minutes after the signal was sent.

WHERE DID THE SIGNAL GO?

In the 4 minutes and 20 seconds that elapsed the signal should have traveled some 48,000,000 miles, and even the great magnetic field of the earth provides no space for such a stately journey. The signal went—where? I do not know, nor do I know where to ask. The signal not only flashed out into space beyond the air, the aurora and the gauzy tendrils of the earth's magnetism; it also soared beyond our earth-bound knowledge. We are left sitting on our little ball of rock and water, speculating dazedly and vaguely as to our latest wonder.

What then? Simply that we are back where we started. After all out talk we have discovered only new puzzles and more questions without answers. Our stock of miracles under one code of Universal Laws is quite as impressive, quite as baffling, as it was in the days of tribal gods and devils.

PILOTRON TUBES

1. Can the new Pilotron tubes be used in any set where a regular tube of the same number is used, or is their use limited only to the A.C. "Super-Wasp" receiver?

Answer:—Pilotron tubes can be used in any set where a tube of the same type is specified, regardless of what kind of a set it is. Thus a P-224 can be used where a UY-224 is specified, etc. In the A.C. "Super-Wasp" receiver, it is absolutely necessary to use a Pilotron P-227 tube in the detector socket, at least. The reasons for this were explained in the Volume 2-No. 3 issue of RADIO DESIGN.

A.C. "SUPER-WASP" ON 25 CYCLE CURRENT

2. Is there any possible way of operating the A.C. "Super-Wasp" receiver from an 110-volt, 25 cycle A.C. electric light line? I live in Canada and we have 25-cycle current, instead of the 60-cycle current which you specify for this set.

Answer:—Mr. Charles W. Boughner of 75 Bertmount Avenue, Toronto, Canada, has been kind enough to supply us with the data on the changes he made in his A.C. "Super-Wasp" to adopt it for operation on 25-cycle current.

He finds it necessary to use a Pilot No. 750 (0.1 meghom) resistor in the plate circuit of the detector instead of the 0.5 megohm unit specified in the original circuit. He also uses a 0.1 mfd. fixed condenser instead of the 0.01 mfd. unit, between the P and G terminals of the Pilot No. 500 Resistoblock. These are all the changes in the set itself.

He built a special power pack using a special 25-cycle power transformer (25-cycle transformers are not manufactured by the Pilot Company). The filter section contains condensers of 2-4-4 mfd. capacity. Mr. Boughner reports that his set is entirely free from any hum or annoying noises. A Pilotron P-227 tube must be used in the detector socket.

LINE VOLTAGE VARIATION

3. My A.C. "Super-Wasp" works perfectly during the morning and afternoon, but the volume is very poor at night, especially from 5:00 to 9:00 p. m. What is the reason for this? I notice that when we turn on an electric heater which we have in the house, the volume gets still lower.

Answer:—Your trouble lies in the fact that you are supplied by an electric light line which has very poor voltage regulation; that is, the voltage varies considerably throughout the day and night. During the morning and afternoon, when very few electric lights are turned on, the voltage is either normal (110 volts) or above. Under these conditions your power pack receives its proper input voltage and supplies the proper voltages to the tubes in the set. At night, when electric lights are turned on, there is a considerable drop in voltage on the line. The low input voltage to the power pack results in insufficient output voltage to the tubes. The set, therefore, works weakly. When you turn your electric heater on, the large current drain causes a drop in the line voltage, reducing the volume of the set still further.

ADDITIONAL COIL WINDING DATA ON WORKSHOP SPECIAL

4. I have had some difficulty in understanding the coil winding data for the "Workshop Special" short-wave receiver. Can you furnish more detailed information on this?

Answer:—The coil form drawing which appeared on page 80 of the Fall Issue of RADIO DESIGN has been reproduced in Figure 1, together with a top view of the socket into which the plug-in coil fits. The dotted lines show exactly where each coil prong fits into the socket. The bottom end of the grid coil is connected to two prongs; one of these fits in the G terminal of the socket and the other in the F terminal, as shown. The grid and tickler coils are wound not more than ¼-inch apart.

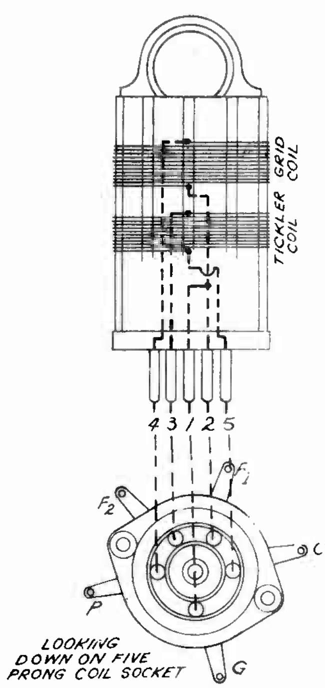


Fig. 1: Details of the connections of the "Workshop Special" plug-in coils.

PROPER OPERATING VOLTAGE ON 245 TUBE

5. I understand that the 245 tube should be operated with a maximum plate voltage of 250 volts. At this voltage it requires about 50 volts of negative grid bias. This means that the power pack should supply a total of 300 volts. Why is it that the power packs in many electric receivers using 245 tubes supply a total voltage of from only 260 to 280 volts when connected to an 110-volt line?

Answer:—A voltage of 250 on the plate is the maximum voltage which should be applied to a 245 tube. Many set manufacturers have found that the operating life of the 245 tubes can be materially lengthened without noticeably affecting either the volume or quality of reproduction, by operating the plate at 220 to 240 volts with correspondingly low grid bias voltages. This is the reason for the purposely low output voltages of their power packs.

Also, the filament of the 245 tube has been especially designed to give satisfactory operation when operated as much as 5 per cent below the normal filament voltage rating of 2.5 volts. That is, the filament can be operated at about 2.3 volts without noticeably affecting the volume or quality of the reproduction.

GLOW IN POWER AND RECTIFIER TUBES

6. I have an eight-tube electric radio receiver. Recently I noticed that one of the plates or filaments of the 280 rectifier tube emitted a bluish purple glow. I thought maybe the tube would blow up, so I purchased a new tube. When I placed the new tube in the socket, a stronger glow came from both plates! I returned the tube and the dealer tested it in his tester and also in another radio set and found it to be perfect. I am told this glow results from excessive voltage on the plate. Is this so? Will my tube blow up if I operate it this way?

Answer:—The glow you noticed is very common in tubes of the 280, 171A and 245 type. In some cases it is due to the fact that excessively high plate voltage (higher than the tube's rating) is employed. In these cases the plate voltage should be reduced to the normal value recommended by the tube manufacturer. In many cases these tubes glow even when normal plate voltages are applied, due to a slight amount of residual gas in the tube. This is not harmful in tubes such as the 171A, 280 and 245 types, which have oxide-coated filaments.

"SUPER-WASP" DOES NOT OSCILLATE

7. My "Super-Wasp" receiver does not oscillate when the red and orange coils are used. How can I remedy this? I checked up all my battery voltages and had my tubes tested. The set works perfectly on the other coils.

Answer:—If your set does not oscillate properly when some of the short-wave coils are used, try connecting either a Pilot VM-80 Micrograd condenser, or a No. J-7 midget condenser, in series with your antenna post. Vary the capacity of this condenser. Use an aerial from 30 to 50 feet in total length including lead-in and ground wires for best results with the set.

Also try increasing the detector plate voltage, and switching the 201A tubes around. Some tubes are much better oscillators than others.

BOOSTER UNIT FOR BATTERY-OPERATED "SUPER-WASP"

8. Can a "Super-Wasp" booster unit such as was described in the Volume 2-No. 4 issue of RADIO DESIGN be built for the battery type "Super-Wasp"? If so, will you kindly publish a circuit diagram for it? My "Super-Wasp" is operating splendidly, but there are some distant stations which I cannot bring in on the loudspeaker. I believe a booster unit would enable me to bring them in with loudspeaker volume.

Answer:—The circuit diagram for a booster unit for the battery operated "Super-Wasp" is shown in Fig. 2. The layout of parts can be somewhat similar to that shown on page 46 of the Winter Issue of RADIO DESIGN for the A.C. "Super-Wasp" booster unit. You will notice that a 112A tube is specified for the booster unit. A 171A tube could be used, but then 180 volts of "B" battery would be required, together with 40 to 45 volts of "C" battery. This would mean five 45-volt "B" battery units altogether. The use of the 112A tube is more economical, and is just as satisfactory for normal volume. No extra batteries are needed where a 112A is used. Connect the booster unit to the binding posts on the rear of the "Super-Wasp" panel as shown and, of course, connect the "A," "B" and "C" batteries to these binding posts in the regular way. The 112A tube used in the second audio stage of the "Super-Wasp" is still retained.

LOCATION OF CENTER-TAP RESISTORS

9. Where should the center-tap resistor connected across the filaments of 227 tubes and power tubes be actually located in the set? Should the resistor be located right near the filament terminals on the tube socket or should it be placed near the filament winding terminals of the supply transformer? What should be the values of these resistors for various tubes?

Answer:—The purpose of the center-tapped resistance is to obtain an artificial potential center-tap of the filament in the tube; that is, the center-tap potential should remain absolutely steady throughout each alternating current wave. To accomplish this, the center-tap resistor should be placed as near to the filament terminals of the tube socket as is possible,

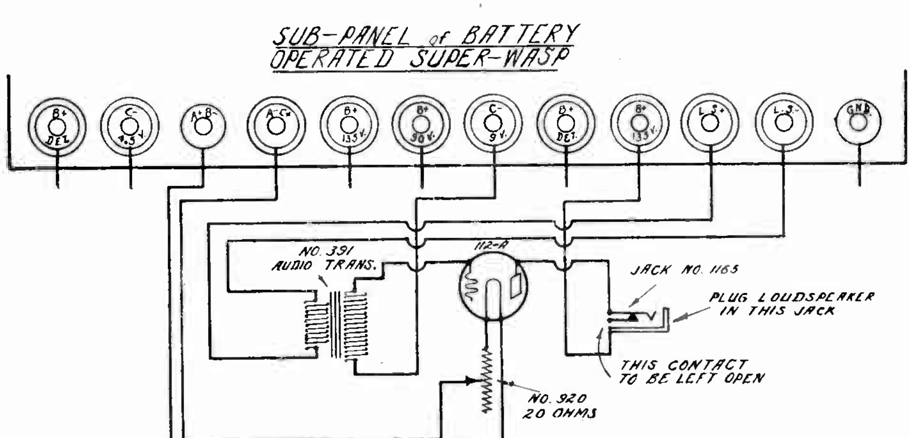


Fig. 2: Diagram of the connections of a "booster unit" for the battery-model "Super-Wasp."

as shown in Fig. 3A. The length of the two wires from the resistor to the socket should be exactly alike. If the resistor is placed at the transformer terminals, as shown at Fig 3B, it is possible that the two long wires from it to the filament terminals will not be of equal length and resistance. In this case, the center-tap on the resistor will not represent the true electrical center of the tube filament and a hum will result. The filament leads should always be twisted to prevent induction effects.

The proper resistance values of center-tapped resistances to be used are as follows:

226	Tubes	10 Ohm	No. 352
227, 224, 245	Tubes	20 "	No. 354
112A, 171A	Tubes	50 "	No. 356
250	Tubes	75 "	No. 358

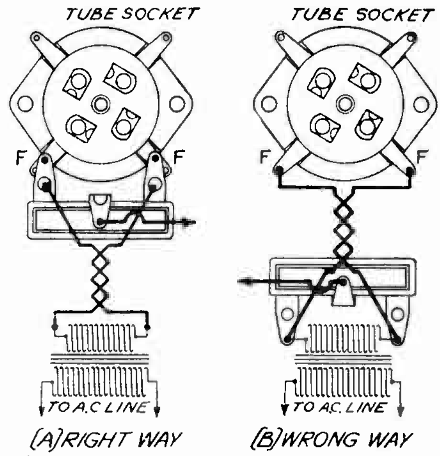


Fig. 3: The right and wrong ways of placing center-tapped resistors.

Facts for the Short-Wave Fans

GET A GLOBE

As pointed out in the last issue of RADIO DESIGN, an ordinary flat map gives a very distorted idea of the appearance of the earth. As the owner of a short-wave receiver you will jump around a great deal from one country to another, and you must have a globe to figure distances and to get a true conception of the position of one country in relation to another.

To give an idea of how far apart certain places are, the writer measured distances carefully on a twelve-inch globe and obtained the following figures:

New York to London.......3630 miles
New York to Eindhoven ...3800 miles
Boston to San Francisco ...2800 miles
New York to Sydney......10,230 miles
Manila to San Francisco ......7000 miles
Buenos Aires to New York..5200 miles
Khabarovsk to Ohio ....6105 miles
Costa Rica to New York....2310 miles
Georgetown to Ohio........2970 miles
South Pole to New York ...9200 miles
Bangkok to New York .....8910 miles
Berlin to San Francisco ....5940 miles
Berlin to New York........4125 miles
Kansas City to London .....4620 miles

Short-wave stations are springing up in remote places, because those are the very places that need short-wave radio for communication purposes. Your enjoyment of your short-wave receiver will increase if you spend a few minutes during the evening with your son's or younger brother's geography book.

HARMONICS

Many listeners who report the reception of short-wave signals of certain American stations are informed, much to their surprise, that these stations are not transmitting on the short waves at all! What they have picked up are really "harmonics" of the regular broadcast waves.

Harmonics are secondary oscillations or vibrations that appear in any oscillating system. They are always of higher frequency (meaning lower wavelength). Certain types of radio transmitting circuits are more virulent producers of harmonics than others; even in the best systems harmonics are created as a result of the antenna radiation itself. Fortunately most of the harmonics that appear in the short-wave bands are pretty weak, and not in the ranges devoted to short-wave broadcasting.

W9XAA, CHICAGO

According to advices from Chicago, station WCFL of the Chicago Federation of Labor has a short-wave transmitter licensed under the call letters W9XAA. Wave length is 49.36 meters, hours of operation 7:00 to 9:00 a. m. and 11:30 a. m. to 6:45 p. m., Central Standard Time,

Station W9XU, Mono Motor Oil Co., Council Bluffs, Iowa, is licensed for 6,060 kilocycles (49.5 meters) and will be on the air shortly from 6:00 a. m. to 12:00 midnight, Central time.

New Parts for the Set Builder

"Vaultype" Variable Condensers and Large Metal Case Audio Transformers Are Latest Products of the Pilot Laboratories

TWO new series of instruments for the radio constructor and experimenter have been brought out by the Pilot Radio and Tube Corporation. The first is a series of four variable condensers known as the "Vaultype" because of their strong and protected construction; the second is a series of heavy, high quality audio amplifying transformers and choke coils.

The "Vaultype" condensers are made in single, double, triple and quadruple units, the maximum capacity per section being .000365 mf. The calibration curve is of the "centraline" type, which strikes the best balance for tuning purposes in a broadcast receiver. The sections of the multiple units are matched within ½%.

The cases are made of pressed steel, and are chromium plated so as to be rustproof. They are also dustproof and completely shielded, the plates being entirely enclosed. The plates are extremely rigid and will not bend. The condensers are very flexible for set building, as they may be mounted from either end or on any side. The rotor friction may be adjusted without changing the capacity.

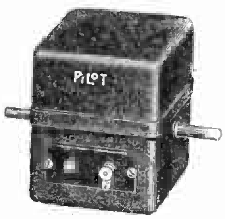
Each .000365 mf. section is provided with a balancing condenser, which, because it is grounded to the frame, may be adjusted with the fingers while the set is in actual operation. This feature is a great improvement over older methods which required special long insulated screw-drivers. The insulation between the rotor and the stator is of molded bakelite.

The "Vaultype" condensers are 4" wide and 3⅝" high, and vary in length as follows: single condensers, 2⅞"; double, 4⅞"; triple, 6⅞"; quadruple, 8⅞". The ¼" shaft extends ⅞" from each end. Any combination of these condensers may be "ganged" by means of the No. 12A condenser couplings.

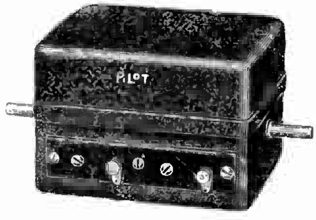
The catalog numbers and code words are as follows:

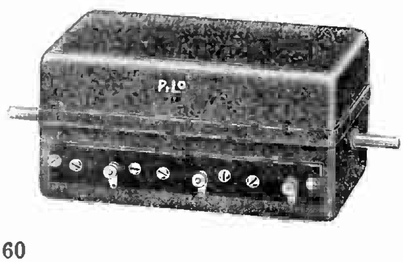
	No.	*Code*
Single Vaultype condenser........	3021	YETEM
Double Vaultype condenser........	3042	ZENEG
Triple Vaultype condenser........	3063	ZEHUD
Quadruple Vaultype condenser....	3084	ZARDA

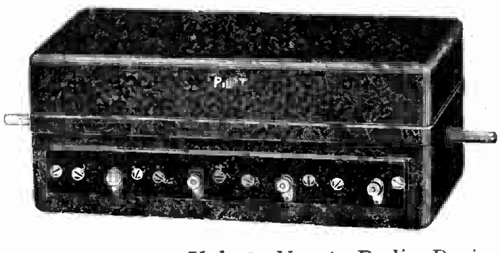
The Pilot large metal case audio amplifying transformers and choke coils are heavy, substantial units of the highest quality. The cases are of steel, pressed out in one piece and finished in beautiful black Japanese lacquer. The bottoms are sealed air and moisture proof, and are fitted with covers of the same thickness as the cases themselves. The instruments are thus fully shielded electrically and thoroughly protected mechanically. The various connections are brought out to non-removable binding posts mounted on small bakelite strips, which assure permanently good insulation. The Nos. 422 and 423 transformers have four binding posts apiece; the No. 426, five; and the No. 427, six;

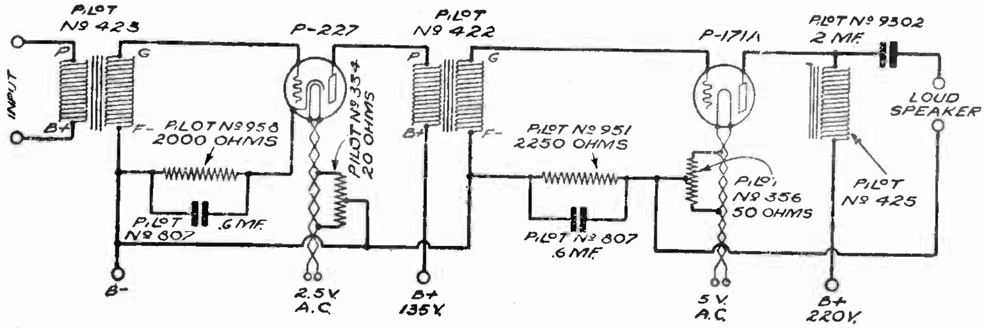


The single, double, triple and quadruple "Vaultype" variable condensers are shown in these illustrations.









A straight two-stage audio amplifier using a P-171A output stage

and the Nos. 424 and 425, two apiece. The same size case is used for all six units. It is 3 7/16" long, 3 5/16" wide, and 2 9/16" high.

The instruments are made in the following types:

Large metal case transformer, 2-1 ratio—
No. 422 .... Code: ZYIXT

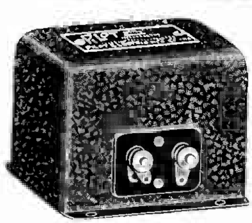
Large metal case transformer, 3½-1 ratio—
No. 423 .... Code: ZYHID

Push-pull input transformer, 2-1 ratio—
No. 426 .... Code: ZYLLY

Push-pull output transformer—
No. 427 .... Code: ZIYMP

30-henry filter choke, 60 milliamperes capacity—
No. 424 .... Code: ZYJOG

30-henry output choke—
No. 425 .... Code: ZYKYK

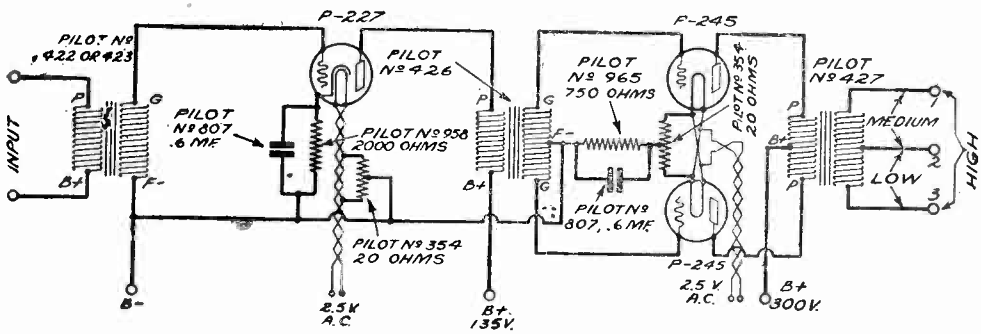


Appearance of the large metal case audio units.

A feature of the No. 427 push-pull output transformer is its tapped secondary, which permits the most advantageous impedance match between the amplifier and the particular loud speaker the builder possesses. The speaker may be connected to posts 1 and 2 for medium value of impedance to posts 2 and 3 for low values, or to posts 1 and 3 for high values. All three combinations should be tried and the one that sounds best used.

Two excellent audio amplifier circuits, suitable for use with any type of tuner, are shown on this page. Where volume enough for comfortable home reception is desired, the straight two-stage hook-up at the top is recommended. This makes use of a No. 243 transformer with its primary leading to the detector tube and its secondary working into a P-227 tube. The latter feeds into a No. 422, which in turn works into a P-171A output tube. The correct values of "C" bias resistors are indicated, as are the various filament and plate voltages and the capacities of the required by-pass condensers. A Pilot K-111 power pack is suitable for operating a combination of this kind.

When exceptional volume is desired, the push-pull arrangement shown at the bottom of the page is recommended. Here either a No. 422 or 423 is used in the first stage, feeding into a P-227. This works into a push-pull stage using a No. 426 input transformer and a No. 427 output transformer, with P-245 tubes in the amplifier positions. A Pilot K-112 power pack is ideal for this combination.



A two-stage amplifier with a push-pull output stage using two P-245 tubes

RADIO INTERNATIONAL GUILD INC.

Increasing Foreign Membership Shows Truly International Character of the Guild; First Woman Member is Enrolled

by ***ALBERT L. RUDICK,***

Executive Secretary, Radio International Guild

THE best indication of the growth of the Radio International Guild is the fact that the circulation of Radio Design right now is around 60,000 copies. These readers are not all members of the Guild, as many copies are sold in radio dealers' stores and on newsstands. The greater percentage of readers are, however, members of the Guild. There are many regular subscribers to Radio Design whose subscriptions began before the Guild was started with the Fall, 1929, issue. When these readers renew their subscriptions they will automatically become members of the Radio International Guild.

At the present rate of growth it would be foolhardly to attempt to estimate the eventual size and scope of the Guild. We are receiving between one and two hundred applications daily at this writing. The international character of the organization and the enthusiasm of its members, which is in a large measure due to their appreciation of the merits of its official organ, Radio Design, means that this will ultimately become or perhaps already is the largest radio society in the world.

FROM ALL THE WORLD

We are receiving enrollments from the most remote corners of the globe. India, Siam, Egypt, Borneo, Australia, Asia, Africa and all of the South American countries are represented. The foremost countries of Europe are commencing to take an active interest in the affairs of the Guild. Holland, Germany, France and Great Britain have been most prominent. Russia has been heard from. Japan, China and the Phillipines, not to mention Hawaii and Alaska, have been surprisingly communicative. The Dominion of Canada has supplied hundred of members.

Many of the large cities of the United States have already established local chapters and we are in hopes of receiving reports of constructive work being done by these pioneers. It is our aim to encourage the formation of chapters all over the world. The best work of the Guild will be done by these chapters. Charters are being issued daily to those members evincing a desire to be active in such undertakings.

SHORT WAVES IMPORTANT

The era of international broadcasting is at hand and the short-waves present the most absorbing and, at the same time, the most useful means of radio advancement. The ability to receive radio programs direct without dependence on local re-broadcasting, which permits the radio fans to widen his circle of entertainment, holds the promise of interesting developments. The intriguing short-waves will be the means of keeping alive the interest of radio experimenters and the geniuses who are bound to blossom forth through their delving into these ethereal mysteries.

We have been in receipt of many interesting letters, and it is our privilege to present a few selected for their general interest and others to show the far-reaching powers and influence of our comparatively new organization.

Here is a very fine letter from Melbourne, Australia, which speaks for itself:

7 Hughenden Road,
East St. Hilda S. 2,
Melbourne, Australia
November 26, 1929.

SEC'Y. RADIO GUILD,
Dear Sir:

It was with much pleasure that I

You can get a cut of the Guild Insignia for use on your stationery. Send 25c in U. S. postage stamps to Radio International Guild, 325 Berry Street, Brooklyn, New York.

opened your envelope in this morning's mail. I was quite delighted with both the coat badge and the certificate. I thank you heartily. I am wearing the badge, the certificate I immediately sent to be framed.

Just glancing over the pages of RADIO DESIGN, I have found much to interest me; I do not intend to forget to renew the subscription. Would you kindly let me know at what time each year I am to forward same? One forgets time when one is so many miles away from the United States. However, I am with you in spirit.

Although I am so distant from you all, I hope in some way (you could suggest) to take an *active* interest in the doings of the Guild. Over here, we are, it seems, a little out of touch with the advancement of new ideas in wireless; although we have several stations and wireless journals, here, the latter are not of a very high standard.

I hope in some way or other that we can keep in touch with one another, to exchange ideas and views, etc.

Once again thanking you, I am,

Yours very truly,
ALEX. JOACHIM.

Margaret Lipcsey

Perhaps the most interesting communication is one received from Miss Margaret Lipcsey, who has the honor of being the first lady member of the Guild. Here is the letter:

January 5, 1930.

RADIO INTERNATIONAL GUILD,
325 Berry Sereet,
Brooklyn, N. Y.

MR. ALBERT L. RUDICK,

Dear Sir:

I would like to become a member of your Radio International Guild. Is it possible for a female to become a member? I am taking up a radio course, and find it very interesting.

Respectfully,
MISS MARGARET LIPCSEY,
202 Osborne Street,
Bridgeport, Conn.

The Radio International Guild is open to all radio experimenters, students, listeners and professional people, regardless of age or sex. It is with a great deal of pleasure that we welcome Miss Lipcsey, and we invite other interested women to likewise join.

The following letter from an attorney of Chicago, E. Stanley Brin, is most heartening and welcome:

Chicago, Illinois,
2611 Pine Grove Ave.,
January 20th, 1930.

RADIO DESIGN MAGAZINE,
103 Broadway,
Brooklyn, N. Y.

Gentlemen:

From what I have read and heard of the Radio International Guild, I can see a great future for its members. They undoubtedly have an almost jealous interest in the air, and any unwarranted violation of air rules by transmitting stations will probably be brought to light by some member who notes the same. Such a surveillance of transmitting stations will prove of great help to the DX man living in big cities or near local interference which prevents him from stepping out and getting the small, far away stations, unless conditions are just right.

If I can be of assistance to the Guild, I would consider it a privilege to do so, and I, in my professional capacity, will be ready to aid you if necessary.

Very truly yours,
E. STANLEY BRIN.

Nassau Broadcasting Corporation
Station WPOE
Patchogue, Long Island, New York
January 5th, 1930.

Gentlemen:

I have been requested to inform you that WPOE is in all probability the first broadcasting station to join the Radio Guild, and would appreciate it very much if you mention this in the next issue of RADIO DESIGN. The staff of WPOE have all joined the Guild, of which I am now a member. This includes the Manager, Engineer, Operators and several of the artists who are interested in radio.

Very truly yours,
LESLIE SATTERLY.

A Few Operating Suggestions on the Super-Wasp

How to Control the Detector Plate Voltage and How To Revamp the Set for the Amateur Wave Bands

by ROBERT HERTZBERG

THE reception of foreign short-wave broadcasting stations on both the battery and A.C. models of the "Super-Wasp" is getting to be a daily affair. During the now-famous Christmas and New Year's re-broadcasting of European stations by the local broadcasting systems, thousands of "Super-Wasps" owners throughout the country picked up the programs *direct*. In fact, many of them tuned in the special programs from Australia with fine strength and clarity although one of the big national radio systems, which was scheduled to rebrodcast them, was unable to do so.

A great deal of useful data relative to the foreign stations is printed elsewhere in this issue. It might be mentioned that the early morning hours now seem to be the best time for short-wave reception, as the Australian, Russian, Siamese and Dutch stations (the latter in both Holland and the Dutch East Indies) are then very active. Listen a little before breakfast, and you will probably be able to hang up some new DX records.

Incidentally, the air is nice and quiet in the morning, as many noise-producing electrical machines are then still inactive.

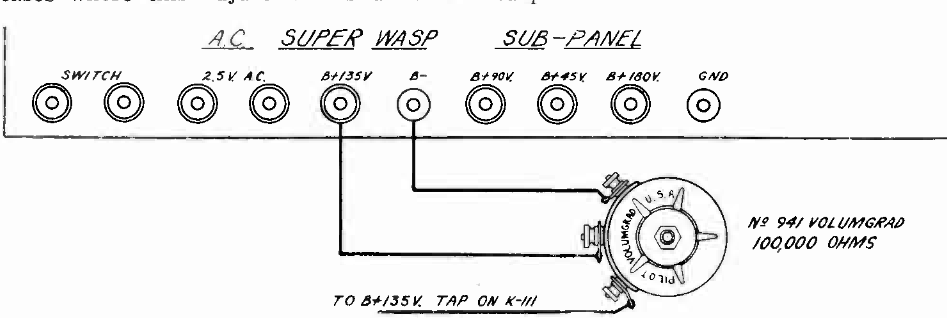
In the Winter issue of RADIO DESIGN we suggested the use of a Volumgrad potentiometer as a control on the screen-grid voltage of the P-224 in the A.C. "Super-Wasp," when the K-111 power pack delivers a little too much voltage. Many owners have written in to tell us that in cases where this adjustment is unnecessary the Volumgrad (No. 941, 100,000 ohms) can be used to even better advantage as a control on the detector plate voltage. It is connected as shown in the diagram below.

The value of the Volumgrad in this position is that it permits an adjustment of the detector plate voltage that will make the detector tube slide into oscillation very smoothly and gently. With the set working in this fashion many weak and distant stations can be brought up to fine volume. If the detector goes into oscillation with an abrupt "plop" as the regeneration condenser is turned, the tuning will be critical and cranky.

As the detector circuit tends to oscillate more easily on some wavelengths than others, vary the Volumgrad with each pair of coils, and determine the best setting for each wavelength range.

USE HEAVY WIRE

Additional note: In making the connections between the 2.5 volt filament posts on the "Super-Wasp" and the K-111 power pack, use wire that is at least No. 18 in size. If the power pack is more than two feet away, use No. 14. A long length of thin wire causes a drop in the voltage actually delivered to the tubes, with a subsequent loss in signal strength. Many perfectly good sets are suffering from this trouble. If your set seems weak and you have tried every possible trick, install heavier filament connections; you may be surprised at the difference.



A Volumgrad connected in this manner permits a very fine control of the detector plate voltage.

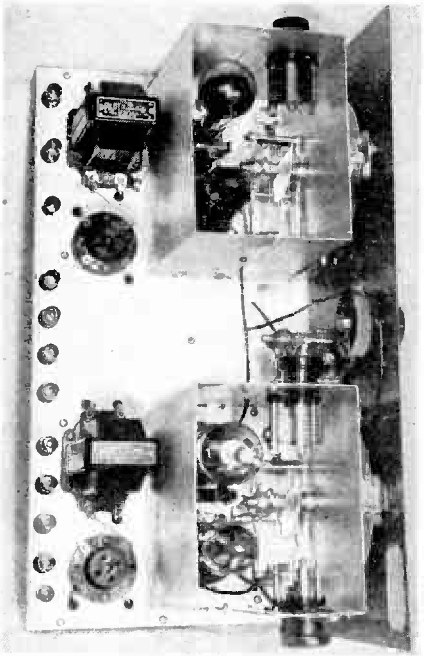
"HAM" TUNERS

Many amateur operators interested in spreading out the tuning of the "Super-Wasp" on the narrow "ham" bands have written in to inquire as to the simplest way of revising the set. Several methods have been described in past issues, but for the benefit of those who missed them, the "dope" is repeated herewith.

The easiest method calls for the removal of all but one rotor plate from the two No. 1611 tuning condensers, and the addition of J-23 (.0001 mf.) midget condensers on the sides of the antenna and detector shield cans. The rotors of the midgets are automatically grounded to the chassis, while the stators are simply bridged by short wires to the stator posts of the No. 1611's.

In cutting down the tuning condensers, simply pull out the plates with a pair of pliers. The J-23 for the antenna stage should be mounted on the right side of the shield can, as in this position the connection from its stator to the stator of the No. 1611 is shortest. The J-23 for the detector stage may be mounted on either the left or the right side of the shield can. If it is mounted on the right it can be connected to the right hand stator binding post of the No. 1611 condenser, which was not used before.

A battery-model "Super-Wasp" revamped in this fashion is shown in the accompanying photograph. The A.C. model may be revised in exactly the same way. In either case the plug-in coils are left just as supplied with the kit.



A battery-model "Super-Wasp" revamped for "ham" operation. Note the single plate tuning condensers and the midgets on the sides of the cans.

FIND SETTINGS BY EXPERIMENT

The settings of the J-23 condensers which will tune the set to the amateur 20, 40 and 80 meters bands are easily found by experiment. Of course, the revamped set will now be useless on the broadcast band, but if you are interested primarily in short-wave reception this will be a small loss.

Following are two typical letters received recently from owners of the A.C. "Super-Wasp," telling of their reception of short-wave broadcasting stations.

"These are some of the broadcasting stations I have received on my A.C. 'Super Wasp': PHI, Huizen, Holland; PLF, Bandoeng, Java; PCJ, Eindhoven, Holland; FW, Ste. Assise, France; DHC, Nauen, Germany; G5SW, Chelmsford, England; G2GN, S. S. *Olympic* at Cherbourg; WBSN, S. S. *Leviathan*, 2,000 miles off U. S. coast; W6XN, Oakland, Calif.; W8XK, Pittsburgh, Pa.; W8XAL, Cincinnati, Ohio; W2XAF, W2XAD, Schenectady, N. Y.; W2XE, New York, N. Y.; W3XAU, Philadelphia, Pa.; W2XAL, New York, N. Y."—*H. F. Mathe, 94 Bradford Avenue, Flushing, N. Y.*

Following is a letter sent to station 2ME, in Sydney, Australia. A copy was sent to the Pilot company with the notation "Thought you might be interested to know the power of your set."

"Station 2ME, Sydney, Australia, Gentlemen: I listened to a conversation between your station and the United States from 7:00 a. m. to 9:00 a. m., Tuesday morning February 4th, Eastern Standard Time. During this conversation you mentioned the following: that a directional aerial (?) was deflected back to you at approximately a distance of 1400 miles and you laid this cause to the mountains of New Zealand.

"You also mentioned that next Tuesday you were going to broadcast from Wellington, as it was a more powerful station. Your conversation was picked up on a Pilot A. C. 'Super-Wasp.' ALL THIS CAME IN ON OUR LOUD SPEAKER AND COULD BE HEARD ALL OVER OUR HOUSE. Will you please verify this reception?"—*R. M. Cady, 444 South Salina Street, Syracuse, N. Y.*

THE PENTODE

THE pentode has recently been brought into prominence by two factors: an effort to condemn it as useless, and a general ripening of the situation as the tube actually became useful. The situation can be clarified by the consideration of several simple facts regarding this three-grid tube, and the reader may draw his own conclusions.

The pentode is a modified screen-grid tube, in which another grid has been added between the screen grid and the plate. This third grid is known as the cathode grid, and as it is connected within the tube to the filament or cathode, there is no extra connection and the pentode plugs into the standard socket. The addition of this grid, by the elimination of a phenomenon known as secondary emission, makes possible the design of the most efficient power tube yet known to the science—a power tube that combines high amplification with ability to handle considerable power in the output or loud speaker circuit.

For instance, if you are at all familiar with radio circuits, one pentode, working directly from the output of the detector tube, will give as much undistorted volume as two 245's in push-pull (with slightly less plate voltage on the pentode) following a first audio stage. In the final analysis this means two tubes less, with the reduction in distortion and hum associated with the first audio stage, and simplified power supply apparatus; in other words, a somewhat better set for your money where alternating current is available.

However, in D. C. districts, the improvements may be radical. The pentode should make direct-current receivers really practical, through the improvement in output at low plate voltages over standard type power tubes.

As far as present-day receivers are concerned, the advent of the pentode should have no great effect on the popularity of the better designs. One of the finest receivers obtainable today, and another big seller in the popular class, do not employ screen grid tubes despite the ballyhoo and genuine screen-grid possibilities. The exact utility and field of the pentode will be determined in the future by the engineers who design receivers. When they are ready for the pentode, the tube will be ready for them.

EPITAPH

Step lightly on this ground, beneath the flower
There lies a girl addicted once to a Women's Hour;
She gave cooking talks—a half-cup of this to make a salad—
It got on some one's nerves, alas!—and so I write this ballad.

SOME NOTES ON EVOLUTION

Specific evolution may be defined as the change brought about in a species by the influence of environment. It is accomplished, for the greater part, by natural selection. Natural selection functions by means of the natural differences among individuals, which can be transmitted to the offsprings. For instance, an animal born with such variations from normal as better enable it to accommodate its particular mode of living will be more likely to survive and transmit its superiority to posterity than a somewhat similar animal less happily endowed. Thus it is, so science would tell us, that we have adjusted ourselves to the conditions about us, emerging from the chaos of lost species to our present state of evolution as *homo sapiens*.

Just what the immediate ancestors of the human race were like is subject to conjecture. Some scientists are rash enough to find, in this forefather of ours, a likeness to the ape. Be that as it may, a careful analysis of our environment, a synthesis of its probable effects on the human race, should show us the more interesting branch of our family tree—the human being of to-morrow, what our distant children will look like! Let us examine this logically, analyzing our life of today to find what it will make of us a million years from now.

Indubitably, the radio is the most powerful environmental factor existing today. Radios are to be found in every home, and must, in the course of time, have a very definite influence upon the evolution of future man.

It is the custom in the average home to turn the set on at 6 o'clock in the evening and leave it on until midnight, regardless of howls, squeaks or excellence of program. Such a process must have a decidedly detrimental if not toxic effect upon members of the family and neighbors afflicted with large and sensitive ears, driving such unfortunates to suicide and to less direct but equally efficacious deaths from nervous disorders. Small ears will naturally survive (the survival of the fittest), bequeathing the legacy of diminishing auricular organs to our remote descendants, who will thereby have small ears.

The evolution of a large mouth is a concomitant variation. Persons with large mouths will be better heard by the small eared humans ten thousand years from now, and will therefore be better able to make a living, buy and sell and so on. The large mouth will also enable its possessor to compete with the radio, enhancing his chances of getting on in the world turned over to bedlam. And the small mouth race, unfit for existence in this turbulent globe, must perish from the earth as did the paleozoic cotylosaur.

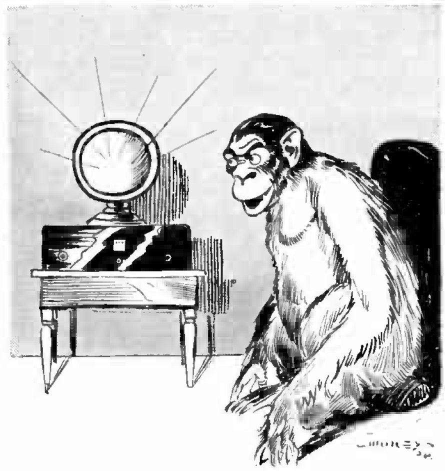
The enlargement of the mouth will be accompanied by a natural revision of the facial contour, with the probable lowering of the nasal bones and the building up of a prognathous jaw.

Persons most skilled in the operation of radio sets will be honored. As radio enters more and more into the psychology of living, the expert at tuning will be venerated like the athletes of olden Greece, while less dexterous and unhappy mortals, like its exposed children, will be exiled and persecuted into oblivion. This discrimination will doubtless result in the evolution of a long armed race, ultimately capable of tuning with both hands and feet.

As time goes on there is every reason to think that the fan will become more and more extravagant, eventually selling his last shirt for another tube or a new loud speaker. Thus deprived of civilized clothing, only the fan especially prepared by nature to withstand the cold of winter —perhaps by an unusual growth of the down-like hair that covers the entire body —will survive. The pale, shivering wretch, endowed with a protective coat of natural fur, must perish miserably, leaving the world eventually to a furry race of human beings.

Bearing all of these probabilities in mind, it is possible to prophesy the appearance of to-morrow's men — to make what our tabloid newspapers are pleased to term a "composite photograph" of a gentleman listening to his radio set two hundred thousand years from now. It is possible to depict with undoubted accuracy the characteristics of that distant and radio-environed human.

You will find his picture immediately below.



The "Country Special"—A Good Battery Operated Receiver

An Inexpensive, Up-to-the-Minute Screen-Grid Set For Use in the Many Places Where No Electric Light Power is Available

by ALFRED A. GHIRARDI

THE following letter received by us is representative of the hundreds of similar ones which were responsible for the design of the "Country Special" Receiver.

"Gentlemen:

"What has happened to the radio magazines and manufacturers? For the past two years I have eagerly read nearly every radio magazine published, hoping to find a description of a real battery-operated receiver, one that would not need to take its hat off to the usual A. C. electric set. Thus far I have not been successful in finding one.

"You could perform a real service to the thousands of your readers who live in the rural communities where electric light companies have not seen fit to extend their lines, or in city houses where, for one reason or another, electric light service is not available, or electric receivers are not desirable. Develop a real battery-operated receiver and describe it in your wonderful little magazine.

"We know that electric receivers are cheaper to operate with less care and bother. But what are we going to do if we do not have electric-light current available? Surely your engineers can design a good set for us, one that will use only a few "B" batteries and a six-volt storage battery for filament supply."

PE-6 THE MODEL

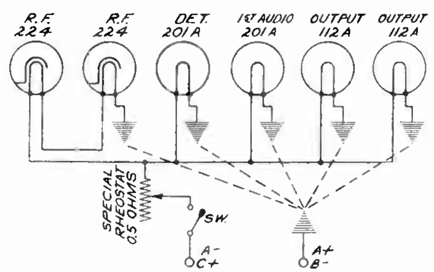
The demands of our correspondents started us thinking. We would not even consider building a set for dry cell tubes, on account of the difficulty of obtaining uniformly good 199's. Our first thought was to use 201A tubes, but we felt that the set would have to be even better to meet our friend's specifications. It was along about this time that the development work on the PE6 receiver (described in the Volume 2, No. 4 issue of RADIO DESIGN) was progressing. The performance of this set was so fine that we determined to set it as a standard for our battery set. A study of the layout of the PE6 revealed the fact that it would be admirably suited for our receiver, so we decided to rebuild it for battery operation.

Our first idea was to use 222-type tubes, on account of their low filament current consumption. However, we never did have much love for the 222 battery type of screen-grid tube in broadcast receivers, simply because its plate impedance is so high (850,000 ohms at 135 volt plate potential and 1.5 volts grid bias) that it is difficult to effectively load the plate circuit with a coil of high enough impedance at broadcast frequencies to produce anywhere near the high amplification we should expect to obtain. For short-wave work this tube is O. K., since its interelectrode capacity is smaller than that of the 224-type tube, and this reduces oscillation tendencies, which are very important at the high frequencies.

A.C. TUBES ON D.C.

Well, why not use the 224-type of screen-grid tube? The plate impedance of the 224 tube is about 400,000 ohms, which can be more effectively matched by the plate load for high amplification at broadcast frequencies. This tube was designed for filament operation on alternating current, but there is absolutely no reason why direct current from a storage battery cannot be used just as well. The only apparent stumbling block to the use of 224 tubes in our battery receiver was the fact that the filaments of these tubes draw about 1.75 amperes at 2.5 volts. We could reduce the battery voltage of 6 volts down to 2.5 volts all right with a resistance, but the current drain of twice 1.75 or 3.5 amperes for the two screen-grid filaments, plus about ¾ ampere for the rest of the tubes, made a total of 4¼ amperes for filament current. Remembering that a storage battery must be recharged at least when it has discharged about ¾ of its current, a 100 ampere-hour battery would have to be recharged after about 17 hours of use. If the set were used 2 hours per day, the battery would have to be charged every week! Not so good!

It then occurred to us that we could reduce this filament current drain by using two 224 screen grid R.F. tubes and wiring their filaments in series instead of in the usual parallel arrangement. The current required would then be 1.75 amperes and the total voltage would be 5 volts. We could connect this combination in parallel across the 5-volt filament line of the 201A and 112A tubes, putting a special low-resistance, high-current carrying rheostat in series with the whole line to reduce the 6 volts of the battery to 5 volts. An inspection of the schematic circuit diagram will show how simple this is.



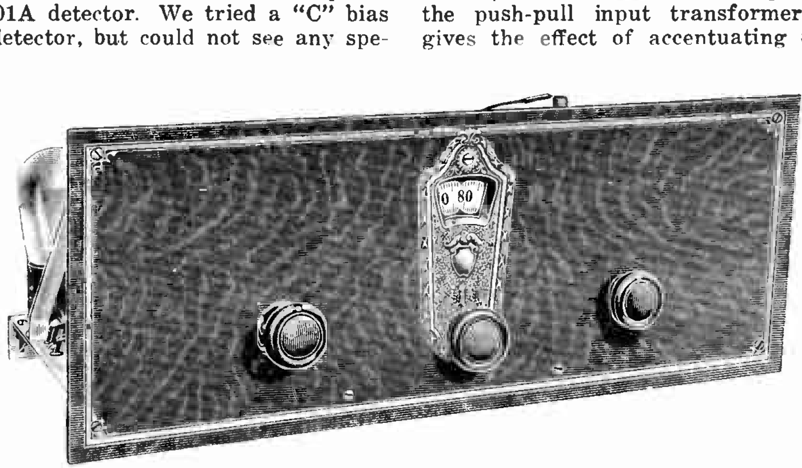
The filament circuit of the Country Special

The solution to the filament circuit problem led to a fast series of developments. We found that we could use the same Pilot No. 235 shielded screen-grid coils, which had been designed for the PE6. The grid bias for the 224 tubes was obtained in the same way as is common practice in A. C. sets, by connecting a bias resistor of 225 ohms in the common cathode lead and by-passing this with a .2 mfd. condenser.

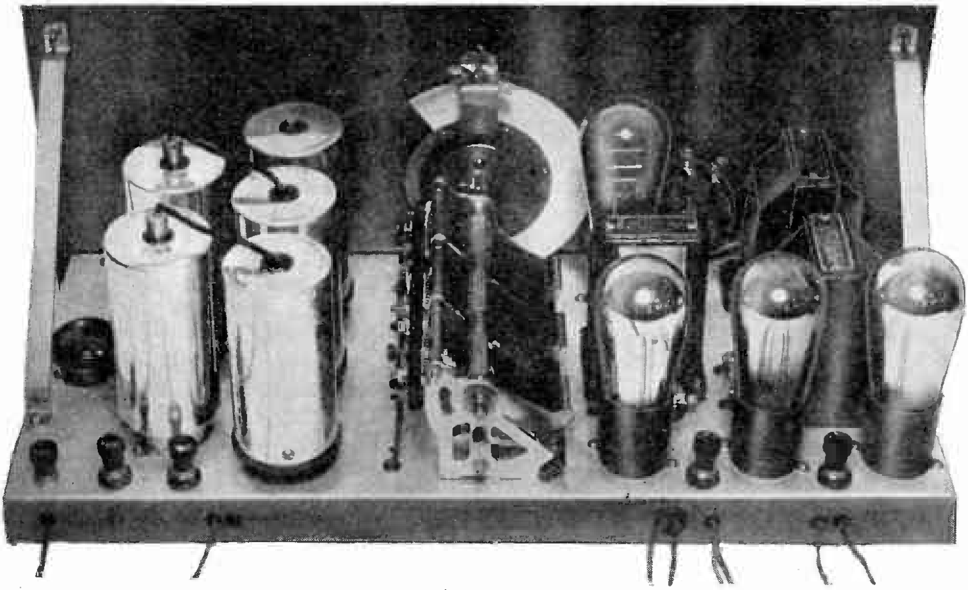
We tried using a screen-grid detector, but the slight gain in amplification did not warrant putting up with the extra circuit complications and the heavy filament current drain of this tube compared to a 201A detector. We tried a "C" bias 201A detector, but could not see any special advantage over the grid-leak-condenser detector finally adapted. We did feel, however, that a single 112A power tube in the last stage overloaded on the tremendous volume which the set produced, especially on the local stations, so we changed this to a push-pull stage with two 112A tubes. This worked perfectly.

We settled on 112A tubes for two reasons: First, it was found that the 112A's would handle without serious distortion all the volume required for the average room, and secondly, the use of 112A's meant that only three 45 volt "B" batteries and two 4½ volt "C" batteries would be required. To use 171A tubes properly, 180 volts of "B" and 40 volts of "C" potential would be required. This would mean four "B" batteries for the plate supply and one 45 volt "B" battery used as a "C" battery. Furthermore, the plate current drain would be so great that the "B" battery life would be comparatively short, resulting in expensive operation.

In its final form the "Country Special" consists of two stages of tuned screen-grid R.F. amplification with 224 tubes, a 201A detector, 201A first audio stage and 112A push-pull output. Transformer coupling is used in the audio amplifier, and a "tone equalizer" (consisting of a 6,000 ohm resistance in series with a 0.1 mfd. condenser) is connected across the primary of the push-pull input transformer. This gives the effect of accentuating the low



Front panel view of the K-121 model of the Country Special. This set will fit any 7 x 18-inch cabinet.



Back view of a completed Country Special. This set is almost identical with the PE-6, except that the Volumgrad is behind the detector tube and a rheostat is on the sub-panel at the extreme left.

notes and makes the tone quality of the receiver very pleasing. The volume control is a 50,000 ohm Volumgrad, which regulates the voltage to the screen-grids of the P-224's. This is a very smooth and effective control, permitting reduction of the volume to a whisper. The cathode, screen and plate elements are by-passed by a No. 806 condenser having three sections of 0.2 mfd. each.

With the circuit arrangement and tubes employed in the "Country Special," the set operates properly when the filament voltage is reduced a bit below 5 volts by means of the rheostat mounted on the sub-panel. Under these conditions the total filament current is less than 2.5 amperes, so that a 100-ampere hour, 6-volt storage battery need be recharged after about 35 hours of use. The "B" battery drain of the set is about 17 milliamperes. A set of heavy duty "B" batteries should last many months.

THE FINAL SET

After finally ironing out all the details of construction, the set worked beautifully, having exactly the same sensitivity and selectivity as the PE6. The same front panel and sub-panel as in the PE6 are used. The main parts and their layout are also practically the same as in the PE6, as you will see by comparing the accompanying drawing with those in the Winter, 1929, issue of RADIO DESIGN. The wiring is extremely simple. The assembled set looks like a real factory-built job and will make any owner proud of it.

RHEOSTAT IS INSULATED

The set employs all standard parts. The front and sub-panels are exactly the same as those used in the Pilot PE6 receiver. They are already drilled with all necessary holes, including the three holes for the filament rheostat. This is fastened to the sub-panel with two machine screws. A large hole is drilled for the shaft to go through the sub-panel, so that no part of the shaft touches the metal panel, for then a short circuit would occur. The collar nut which comes with the rheostat is not used at all; two machine screws hold the instrument to the sub-panel.

If it is desired, the set can be built into one of the handsome metal cabinets described in the last issue of RADIO DESIGN. (Also used for the "Pre-Selector.") The front of the cabinet is already drilled to take the tuning dial, the on-off switch and the volume control. In this case no separate front panel is needed for the set, as the front of the cabinet acts as the front panel.

LIST OF PARTS

No.	Description.
1-787	Metal Front, 7 × 18 inches.
1-788	Metal Sub-Panel, 7½ × 17¼ inches.
1-1703	Triple Gang Condenser.
1-1282L	Illuminated Vernier Dial.

1-44	Filament Switch	
1-940	Volumgrad, 50,000 ohms	
1-235	Set of Plug-in Coils Consisting of: 1-235A Antenna Coil 1-235B R. F. Coil 1-235C Detector Coil	
2-222S	Screen-grid tube shields	
1-391	Audio Transformer, 3½ to 1 ratio	
1-399	Push-Pull Input Transformer	
1-401	Push-Pull Output Impedance.	
1-51	Fixed Condenser, .00025 mf.	
1-64	Fixed Condenser, .002 mf.	
1-806	By-pass Condenser, 3 sections, .2 mf. each	
1-808	By-pass Condenser, .1 mf.	
1-968	Fixed Resistor, 6000 ohms	
1-959	Fixed Resistor, 900 ohms, tapped at 450 ohms	
1-756	Grid leak, 2 megohms	
6-216	4-prong stocks	
3-217	5-prong sockets	
1-900	Special 0.5 ohm rheostat, copper wire wound	
5	Binding Posts; Ant.; Short Ant.; Grid.; L.S. + and L.S.	
1-789	Hardware Package: (Binding Post Insulators; Condenser Mounting Brackets: Wire, Spaghetti; Screws; Nuts; Washers; Lugs, etc.)	

The symmetrical arrangement of the parts makes the assembly and wiring very simple and easy. The position of the various parts and wires are clearly shown in the accompanying picture diagrams on these pages. The wiring must be put in *exactly* as shown. If the diagrams are followed very carefully, the set will go together easily and will work the first time the switch is snapped on.

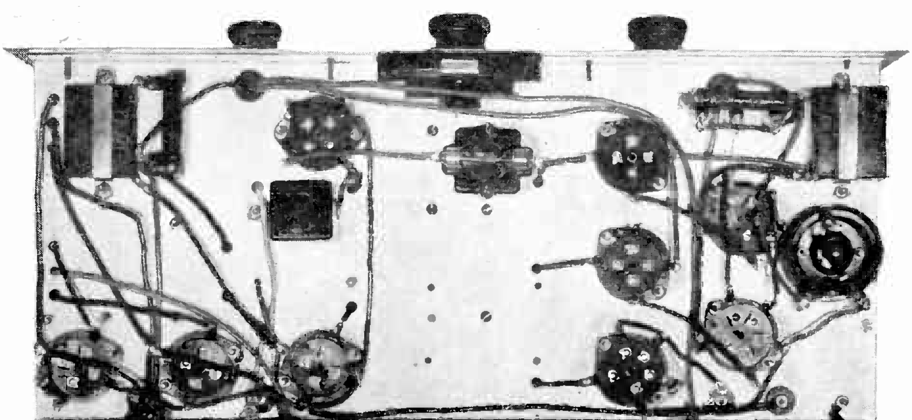
GETTING STARTED

Start by mounting the vernier dial, the snap switch and the Volumgrad on the front panel, or on the front of the cabinet, as the case may be. If you have a cabinet remove the top and unscrew the bottom. Put all this away now, and start on the sub-panel by screwing down all the tube sockets and the binding posts. Note carefully from the drawings how the sockets face, and that all the binding posts except the "GND" are insulated from the sub-panel by means of the double washers supplied in the hardware package. Before tightening the screws holding the two sockets for the P-224's (on the extreme left in the top view drawing) slip the bottoms of the 222S tube shields under their heads, and then tighten. When mounting the sockets remember to place the soldering lugs under the nuts on the screws wherever shown in the drawings. These serve as ground return connections for the positive side of each filament.

Now mount the No. 806 condenser and the No. 959 resistance by four separate screws in the lower left corner of the sub-panel (see bottom view drawing). All these screws are pushed through the top of the sub-panel and secured on the underside by lock washers and nuts. The condenser is held by a special little strap.

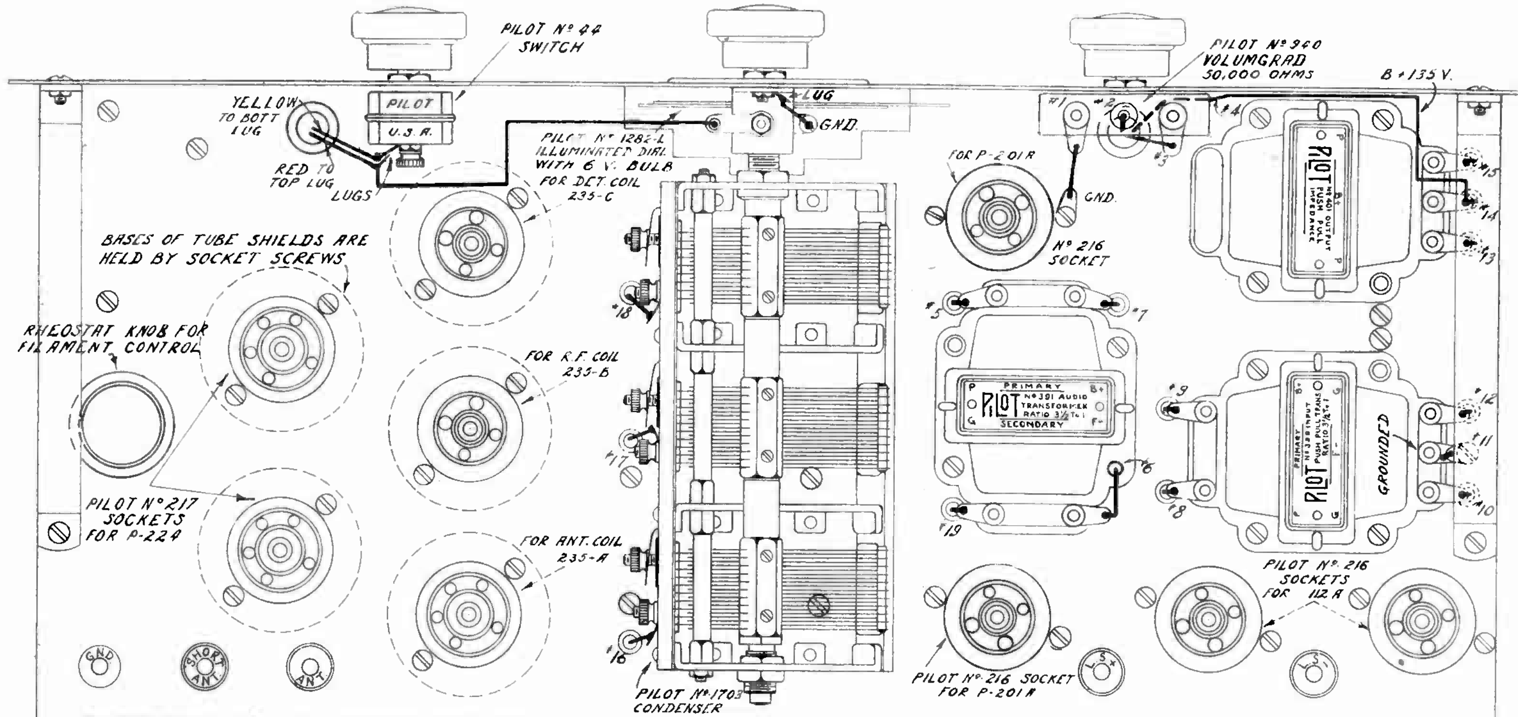
MOUNTING THE TRANSFORMERS

In the lower right hand corner, mount the 6000 ohm resistor and the No. 808 condenser with the same three screws that pass through the No. 401 impedance on the top side of the sub-panel. A fourth and separate screw to hold the upper end of the condenser strap is passed through the sub-panel right at the edge of the impedance case. Now mount the No. 399 input transformer with three screws and nuts. In mounting the No. 391 transformer, fasten one metal lug of the .002 mf. fixed condenser to the underside of the sub-panel by the screw near the B post. Bend up the other lug so that it does not touch the sub-panel. No screws are put in the mounting holes near the P and F terminals of the transformer. The wire going

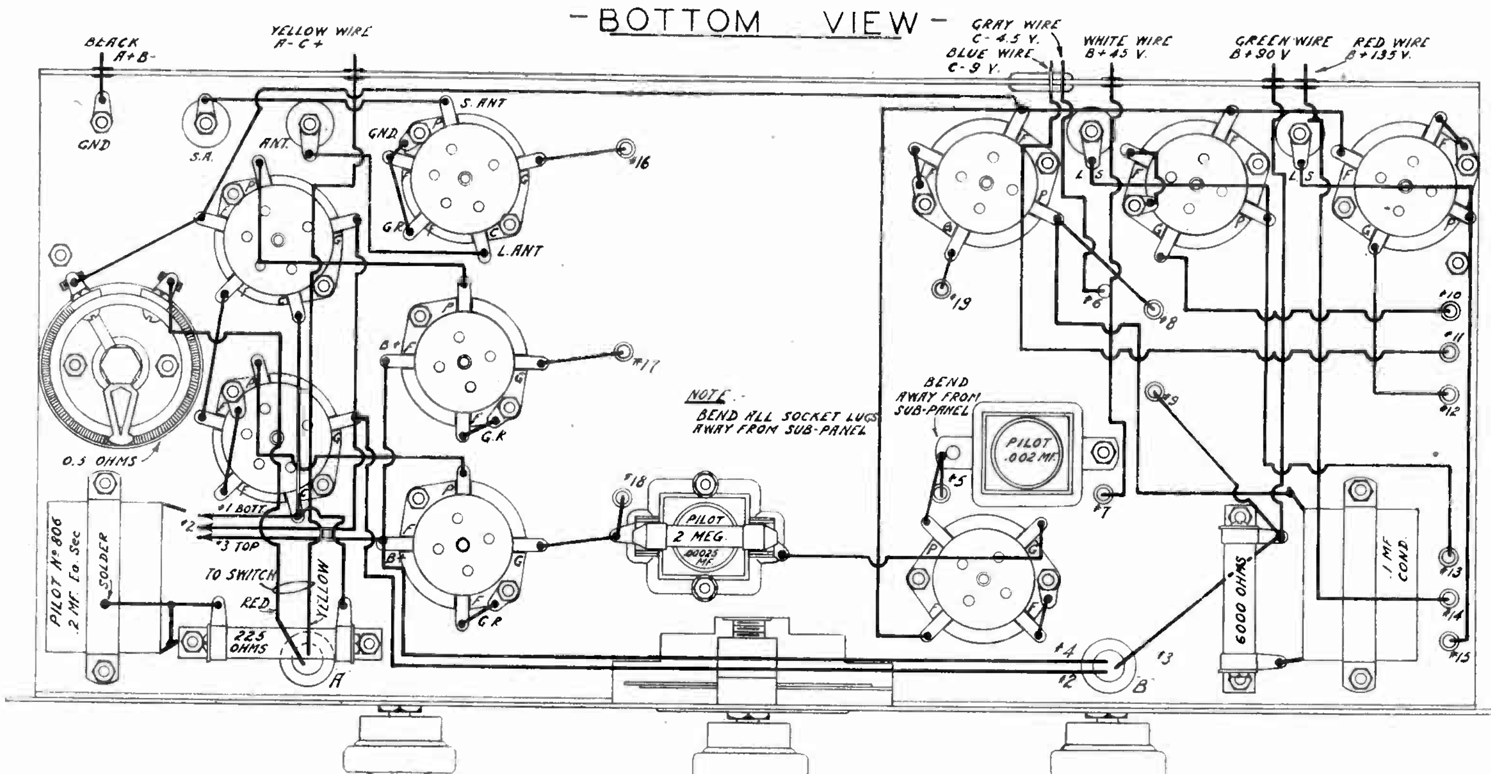


Under view of a completed Country Special. Note the rheostat at the extreme left. The wiring of this set is even easier than that of the PE-6.

— TOP VIEW —



Top view of an assembled and wired Country Special, showing the exact placement of the parts. Very little wiring is visible, practically all of it being hidden underneath. Note carefully that one of the pilot light lugs on the dial is grounded to the panel, and that the F connection of the No. 391 transformer goes through the base of the instrument to the underside of the sub-panel.



Bottom view of the Country Special, showing the placement of the parts and all the wiring. Where a wire disappears through a numbered hole, it reappears on the top side of the sub-panel in a correspondingly marked hole. All the binding posts except the one marked GND are insulated from the sub-panel by means of double bakelite washers, in the manner illustrated on page 11 of this issue.

to the F terminal will be run up through the latter hole later.

Now mount the .00025 mf. grid condenser and the big triple condenser. Pass a screw up through the upper hole in the bakelite case of the grid condenser (upper as seen in the bottom view drawing) and fasten with a nut on the top side of the sub-panel. Now place the 1703 condenser along the center of the sub-panel, and you will readily see how the threaded mounting feet slip over the screw holes. Pass screws up from the underside of the sub-panel, putting one through the bottom hole of the grid condenser. Now mount the rheostat under the panel with two screws and nuts.

In one of the hardware envelopes you will find two little fuse-type clips. Spread them apart so you can slip short 6-32 screws through the holes, and fasten them to the threaded brass terminals of the .00025 mf. grid condenser, putting a soldering lug under each.

Place the rubber bushings in the three large holes in the base panel. These prevent the wires from being cut on the sharp edge of the sub-panel.

WIRING IS EASY

The wiring is easy. Carefully study the schematic circuit diagram and the picture wiring diagrams before proceeding. Before wiring be careful to bend each tube socket lug up away from the base panel at an angle of about 45 degrees. This is important to prevent any drops of solder from running around underneath and touching the sub-panel, causing short circuits.

Leave the various wires for connection to the batteries at least two feet long. You can always cut them down later. One wire, which is perhaps not clear in the drawings, runs from the B terminal of the No. 401 impedance, around on top of the sub-panel, down through the rubber bushed hole near the impedance, across under the sub-panel to the F terminal of the detector coil socket which is nearest to the P terminal.

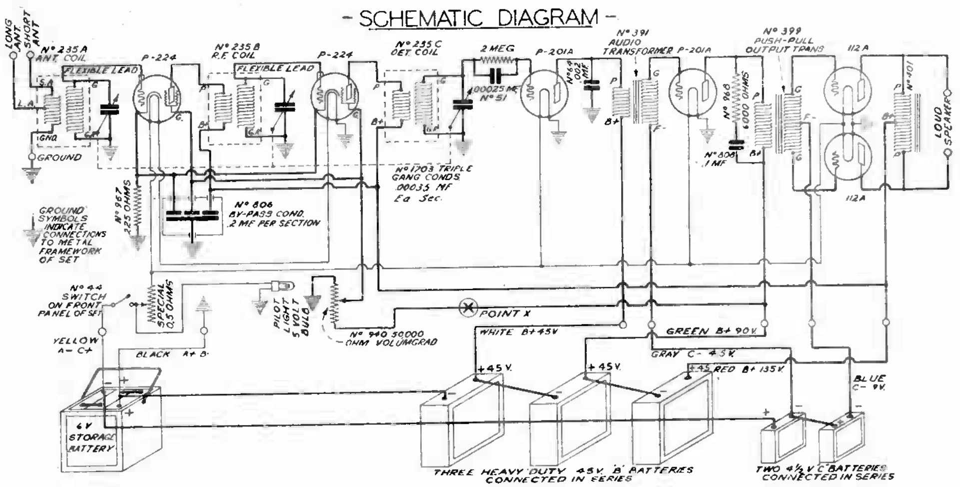
COMPLETING THE JOB

To complete the job, slide the sub-panel against the front panel, or the inside back of the cabinet, and screw it in place by putting four screws through the front edge, bracing it with the two side arms, fastened with short screws and nuts. Tighten the condenser shaft in the stud of the dial, and complete the wiring to the dial light and Volumgrad.

Connect the "A," "B" and "C" batteries as shown in the schematic diagram.

For "B" supply you will need three heavy duty 45 volt "B" batteries. Do not try to save money by purchasing the small size of 45 volt "B" batteries, as these will not last very long. The heavy duty type (Layerbuilt if possible) cost more at first, but last very much longer and are the most economical in the end.

When the filament circuit is broken by opening the switch, there is still a complete circuit for the 50,000 ohm potentiometer across the 90 volts of the first two "B" batteries. There will thus be a constant drain of slightly less than 2 milliamperes of current from these two "B" batteries regardless of whether the set is



Complete wiring diagram of the Country Special, showing the connections to the batteries in full.

used or not. This small drain will reduce the life of the batteries slightly, but is really not serious. If it is desired to eliminate this altogether, a No. 44 switch can be connected in at the point marked "X" in the schematic diagram. The switch can be mounted on the front panel if desired and should be opened when the set is turned off, and closed when the set is to be used.

OPERATING THE SET

To get the "Country Special" into actual operation, insert the tubes in their proper sockets, and connect the aerial and ground. An aerial from 25 to 75 feet in total length (including lead-in and ground lead) will be suitable for use with this set. Connect the aerial to the short antenna binding post first. An inside aerial can be used if desired. Now insert the three plug-in coils.

The antenna coupler, No. 235A, has five prongs, and fits in the rearmost socket. The interstage transformer, No. 235B, has four prongs, and like the 235A, has a flexible wire with a cap soldered to it coming out of its top. The detector coil, No. 235C, has four prongs but no top wire. Put the two P-224's in their sockets, slip the upper sections of the tube shields over them, and snap the caps from the coils over the protruding electrodes. Now push any surplus wire of the screen-grid leads from the coils down inside the coil shields. This is important, for if the full lengths of these wires are allowed to stay outside the shields, whistling and oscillation may result.

Connect the loud speaker cord tips to the two L.S. posts. Magnetic speakers will undoubtedly be used in the majority of cases, because of the field excitation required for a dynamic speaker. However, a 6-volt type of dynamic speaker, designed to obtain its field current from the 6-volt storage battery, may be used if desired. However, a good magnetic speaker is entirely satisfactory. Make sure that all battery connections are correct, and that your storage battery is fully charged. Turn on the filament switch and turn the rheostat on the base panel nearly all the way to the left (full resistance position).

Rotate the tuning condenser knob slowly until you hear a station. Tune it in as loud as you can. Try to tune in a station around 50 on the dial. Now, with the station coming in, try varying the little compensating condensers on the right side of the triple tuning condenser. Once you find the best adjustment, there is nothing else to touch; merely turn the tuning dial, and control the volume with the Volumgrad.

When the storage battery is fully charged, the rheostat on the sub-panel may be set at maximum resistance (knob nearly all the way to the left.) If the battery is used until it is almost completely discharged, this may be set at minimum resistance (knob to right) to secure the full "A" battery voltage. When any of the "B" batteries drop in voltage to about 32 volts (measured while set is operating) it should be discarded and a new one substituted.

If the set tunes too broadly, connect the antenna to the "Ant." binding post instead of the "Short Ant." post.

If the set oscillates (whistles), try reversing the 224 tubes in their sockets. If this does not stop it have your tubes tested by a reliable radio dealer.

THE RIGHT TUBES

In buying tubes for the "Country Special," get two Pilotron P-224's, two P-201A's and two 112A type tubes. Be sure to purchase 112A tubes of reliable manufacture, because these draw only ¼ ampere of filament current. The 112 tubes and some of the cheaper 112A tubes require ½ ampere of filament current. This not only overloads the rheostat but requires the "A" battery to be charged oftener. A 112A tube may also be tried in the detector socket without changes in either set wiring or battery voltage. It sometimes improves the sensitivity and tone quality somewhat.

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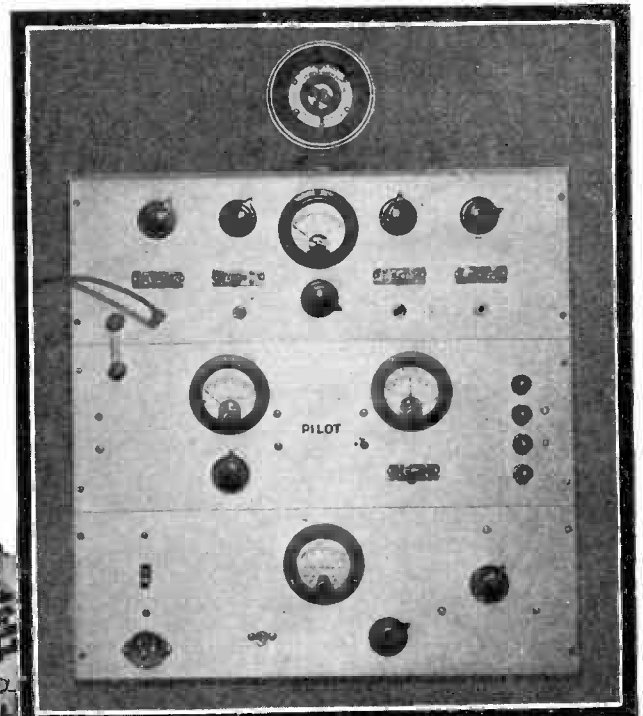

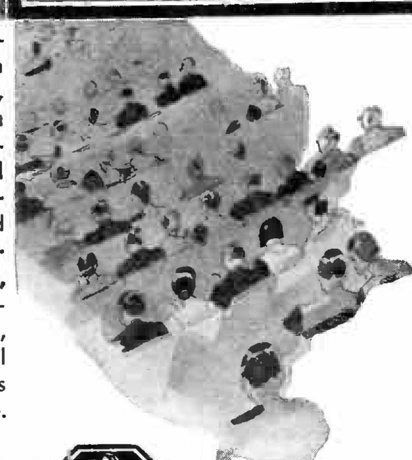

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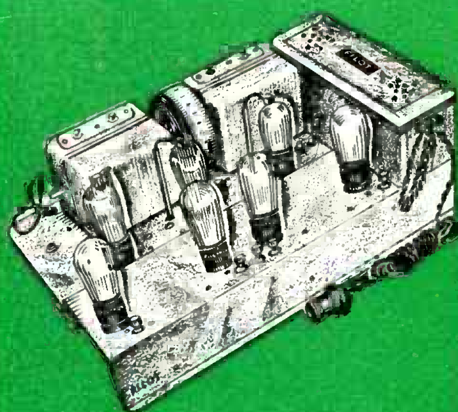

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