RADIO DESIGN

MAGAZINE OF CONSTRUCTION FOR STUDENTS & SET BUILDERS

A Portable "Super-Wasp" for Summer Use—A Simple 3-Tube A. C. Set—Figuring Kilocycles and Meters—Broadcasting a War from the Air

Articles by Robert S. Kruse, John Geloso, Robert Hertzberg, Zeh Bouck and Alfred A. Ghirardi

#4

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Volume 2 SUMMER ISSUE 1929 Number 2

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RADIO DESIGN

MAGAZINE OF CONSTRUCTION FOR STUDENTS & SET BUILDERS

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Vol. 2 No. 2

Summer 1929

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RADIO DESIGN

MAGAZINE OF CONSTRUCTION FOR STUDENTS & SET BUILDERS

EDITORIAL

A NEW STAFF MEMBER

David Grimes, eminent radio inventor, becomes associate editor of RADIO DESIGN with the next number, and will conduct an extensive section devoted to technical "dope" of real benefit to radio constructors. We are sure all our readers will welcome him with open arms, for he is an outstanding authority on radio questions. He has also been appointed chief research engineer of the newly-formed Pilot Radio and Tube Corporation, and will conduct investigations along a number of original lines of thought.

One of the leading technical figures in the radio industry, Mr. Grimes has had a long and distinguished career that dates back before the days of broadcasting. He is the inventor of the inverse duplex system of reception, the horizontal system of transmission, the Octamonic frequency changer, and of many other noteworthy contributions to the radio art. During the World War he was officer in charge of radio at Kelly Field, Texas, and at present is radio officer of the air corps of the New York National Guard.

Mr. Grimes is a prolific writer, and his contributions to RADIO DESIGN will be interesting as well as instructive.

IS TELEVISION HERE?

This question is being asked by all radio experimenters. The answer is both yes and no, and requires some explanation.

Last Summer a number of broadcasting stations in New York, Chicago and Boston spent a lot of money on television transmitters and put them on the air on the regular broadcast band. Radio fans became properly enthused and started to build television receivers, only to find that they couldn't buy the most important parts. While they were struggling with makeshift discs and inadequate neon tubes, the Federal Radio Commission decided, wisely enough, that the crowded broadcast band was no place for experiments, and ordered television down into special channels below 200 meters. This action, necessary as it was, promptly killed the mushroom television boom, which had gotten off to a bad start anyway.

This year the situation is a little different. A limited number of reputable concerns, licensed by the Commission for visual broadcasting, have quietly been conducting experimental tests to perfect their apparatus, and we know that by Fall at least one organization, the Pilot Radio and Tube Corporation, will be in a position to offer a really workable television receiver that will cost little and reproduce small but clear images as broadcast from its own station, W2XCL.

Right now you can pick up several television stations by tuning your short-wave receiver to about 150 meters, but the fluttering signals won't do you any good because the discs at the transmitting end are likely to be changed in five minutes. That is why we say the answer to the question "Is television here?" is both yes and no. It's here in that television is on the air, but it isn't in that few people can take advantage of the transmissions. RADIO DESIGN has been withholding the publication of television data until it can say, "This information is definite and you can use it with the assurance that you will obtain results." We do not intend to give the half-baked "dope" that other radio publications have inflicted on their readers.

If the Pilot engineers and the editors of RADIO DESIGN are satisfied with the apparatus, we will publish in the Fall number the first real how-to-make-it article dealing with a television outfit. The equipment will be given the usual RADIO DESIGN test; that is, it will be tried by different people in our laboratory in Brooklyn, and under typical operating conditions in several apartment houses and private homes in New York City and at a farmhouse in upper New York state. If it passes, you'll hear all about it; if it doesn't, you'll never lose any time or money trying to get it to work in your own home.

OUR NEXT NUMBER

The next number of RADIO DESIGN will be out September 16th, and will contain at least 96 pages,—more than ever published before. It will be crammed full of descriptions of new parts, new tubes, new power packs, new short-wave apparatus and new

kits that assemble into sets of factory-built appearance. There will be the new section by David Grimes and further interesting stuff from Robert Kruse, Zeh Bouck and Alfred Ghirardi, in addition to technical articles of explanatory nature. Don't miss this number, as it heralds the opening of the Fall season and will tell you how to obtain both pleasure and profit from your radio activities.

SUMMER RADIO

It is interesting to note how completely the old bugaboo about Summer "static" has disappeared and how thoroughly people continue to enjoy their radio receivers during the warm months. High-power broadcasting stations and super-selective receivers dispel the idea that static is annoying; indeed, static is now so trivial a disturbance that most set owners hardly recognize it when they hear it.

The development of the short waves has also helped. The daylight hours are usually the best ones for the reception of the European stations, and owners of short-wave sets are hearing many of them with loud speaker strength when they return from work with the sun still out. If you are a custom set builder you can capitalize on this fortunate state of affairs by assembling Super-Wasps and selling them as ideal vacation outfits. Elsewhere in this number you will find an article telling how the set can be built into a convenient box for semi-portable use.

CONCERNING THE A.C. TUBES

In the Spring number we ventured the prediction that eventually the filaments of all A. C. tubes would be designed to operate on the standard voltage of 2½, with a resulting simplification of wiring. This highly desirable circumstance has materialized sooner than was expected. Even right now, with the opening of the Fall season still a month and a half off, no one talks of anything besides 2½-volt tubes.

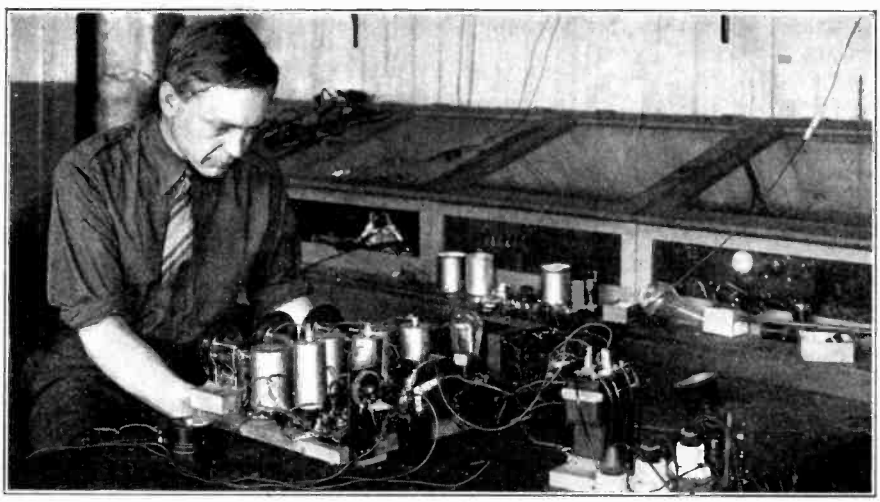
The 226 type of tube, operating on 1½ volts, has died an unlamented death. Its departure is definitely marked by the total absence of 1½-volt windings on all the new power transformers, which are being built to handle whole flocks of 224's, 227's and 245's.

The tube line-up as it appears for 1929-1930 is as follows: Two or perhaps three 224's (screen-grid tubes) as R.F. amplifiers, a 227 detector, a 227 first audio stage (or no first audio stage at all), with a power stage using one or more probably two 245's, in push-pull.

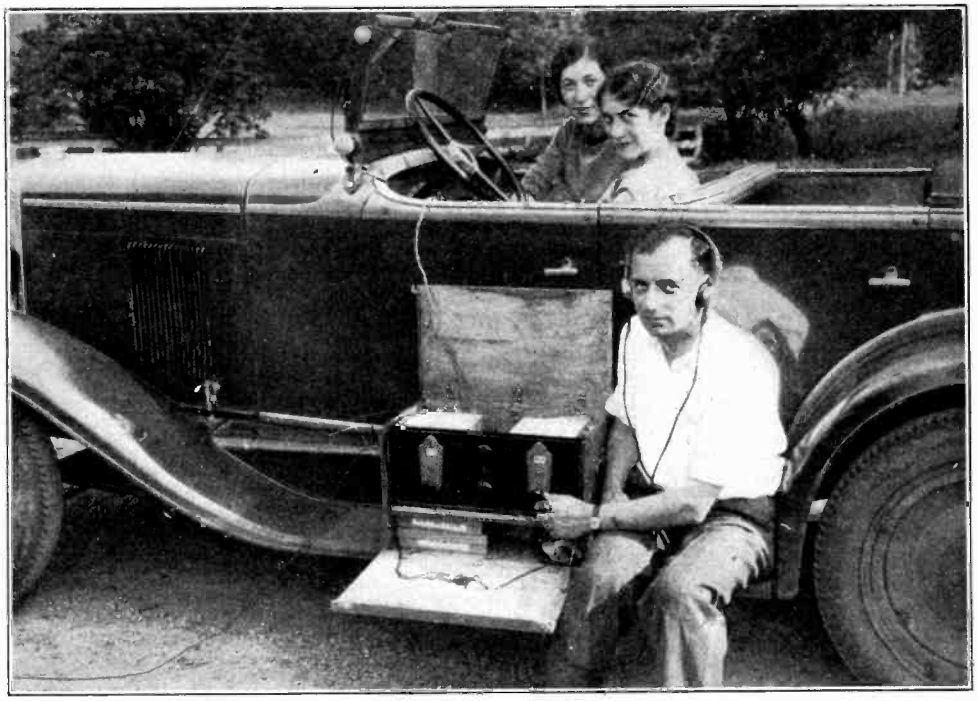
DX ON THE SHORT WAVES

The regularity with which Super-Wasp owners "pull in" broadcasting stations from odd corner of the world is little short of astonishing, and bears out what we said in our last number: the Super-Wasp is the best short-wave receiver. When the editor announced that he had heard England, Holland and even a tiny broadcaster in Costa Rica, Central America, he was afraid that he would be reprimanded for making extravagant claims, but other builders of the set think he was being very modest. They have discovered stations in France, Germany, Denmark and Australia, whose existence has heretofore been only suspected but never verified, and one particularly successful enthusiast in Buffalo has even picked up 7L0, in Nairboi, Kenya Colony, British East Africa! Look that up on a map and you'll get an idea of what the short waves and a good short-wave receiver can do.

—The Editor.



David Grimes, recently appointed chief research engineer of the Pilot Radio and Tube Corporation, at work in his laboratory.



The portable Super-Wasp set up and in operation on the running board of a small touring car. Notice the "A" wire running over the front door; it goes to the storage battery under the floor board. Note also the aerial wire on the ground in the lower left corner of the picture.

A PORTABLE SUPER-WASP FOR SUMMER USE

How the Car Owner Can Enjoy His Receiver While on the Road or at a Vacation Resort

By Robert Hertzberg

BECAUSE of its wide wavelength range, the Super-Wasp makes an ideal portable set for use by the automobile owner on week-end trips or longer vacations at summer resorts. With little trouble and expense the set can be built into a wooden case that will also hold the two boxes of plug-in coils, the "B" and "C" batteries, a roll of aerial wire, a spare tube or two, one or two pairs of earphones, and a few handy tools like a screwdriver and a pair of pliers. The "A" battery is no consideration, because the storage battery of the car is conveniently available when the receiver is set up on the roadside; for stationary use at a summer hotel a small battery can be rented from the local automobile service station and will require possibly one charging during a two-week period.

Now the word "portable" can stand some explanation. Don't think that it means the set can be slung around like a camera, or thrown into a suitcase along with the bathing suits and tennis sneakers. Anyone who figures on adding a radio set to the usual summer baggage has a car in which to transport the stuff, so weight is really not so important and ruggedness is. The set will be kicked at, stumbled over and sat on when it is kept inside the car, and it will be dropped occasionally and jarred frequently when it is being put into or taken out of it. It must be designed to withstand this kind of treatment and the incidental abuse it will receive when the roads are bumpy or when the shock absorbers are inoperative.

SUPER-WASP OKEY AS PORTABLE

The writer took a Super-Wasp, as as-

sembled from the standard Pilot kit, and built it into a wooden case that has proved to be satisfactory in every way. It has been taken on numerous trips around New York City and has showed itself to be thoroughly reliable from both the mechanical and electrical standpoints. Except for the drilling of a few additional holes in the sub-panel, the set itself has not been changed in any way, and on week days does its duty home as a short-wave and broadcast-wave receiver.

As there are many Super-Wasp owners who would like to take their outfits along with them on trips of various kinds, RADIO DESIGN is publishing herewith the details of this case. The box is made of wood and will be an easy job to anyone who has already assembled the radio set itself.

The wood used is five-ply veneer, which is just 3/8 of an inch thick. This material is considerably better than plain boards, as it will not warp. Even the most carefully selected pieces of plain lumber will warp after exposure to the weather, and when they do a closed case made of them becomes absolutely worthless.

Nine separate pieces of veneer are needed altogether. Give the following list to your carpenter or to your local contractor, and have him cut them exactly to size. The writer figured out the dimensions on paper, had the pieces cut, and then found they fit together perfectly.

Piece A: 18¾ by 11⅝ inches (bottom).

Pieces B and H: each 18 by 3¾ inches (partition and door).

Piece C: 18 by 10⅞ inches (shelf).

Pieces D and E: each 11⅝ by 11¼ inches (sides).

Piece F: 18¾ by 11¼ inches (top).

Piece G: 18 by 7⅞ inches (back).

Piece I: 18¾ by 12 inches (front).

These dimensions are accurate if the veneer is just 3/8 inch thick.

In addition to the wood, you will need eight strap hinges about 3 inches long and 1 inch wide, a pair of carrying handles, a pair of snap catches such as used on kitchen closets, a pair of strong hook latches, and at least three pieces of 1-inch brass angle strip, two pieces 11½ inches long and the other 18¾ inches long.

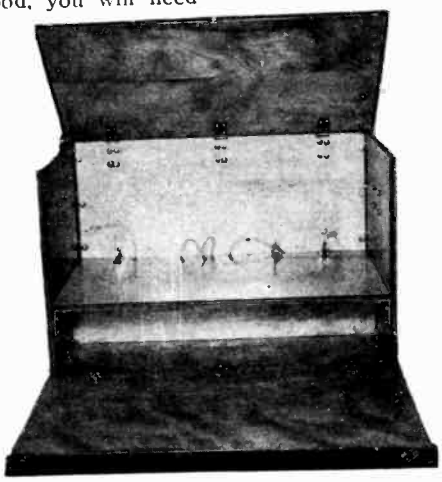
HOW THE CASE IS MADE

The case is so designed that the top opens upward. Inside is a shelf on which the Super - Wasp itself rests. The shelf is supported by a narrow upright board (piece B) which also acts as a partition. The front part of the compartment formed by the shelf, the partition and the bottom of the cabinet holds the two boxes of plug-in coils, the phones, tools and spare tubes; while the rear part, which is protected on the back by a hinged door (piece H), holds the "B" batteries.

The general construction of the case is clearly shown in the accompanying drawing. Start the work by laying the bottom (piece A) flat on a table and locating the partition (piece B) 4⅝ inches from the back edge. Mark the position with pencil lines. Now place the sides (pieces D and E) one end and put the bottom over them, so that you can drive a few one-inch nails through the bottom into their edges. The back and edges of the sides should be flush with the back edge of the bottom piece; the front edge of the latter will then overhang 3/8 of an inch, just enough to take the hinged front piece (I). Slide the partition between the sides up to the line you marked previously, and also hammer a few nails into it from the under side of the bottom piece.

If you really want to make a nice job of the cabinet, obtain two more pieces of 1-inch angle brass, each 11½ inches long, and use these as braces for the joints formed by the upright side pieces and the bottom piece. Drill holes through the brass and fasten the pieces down with either wood screws or machine screws and nuts. These angles will give the cabinet great strength and rigidity, and also will greatly improve its appearance.

The next piece to install is the back (G), the top edge of which comes up flush with the edges of the side pieces. You can merely nail this in place, but again you can do a better job by bracing it with more 1-inch angle strip.



The cabinet with the front folded down and the top pushed back. The partition separating the front compartment from the battery compartment, in the rear, is plainly visible.

THE BATTERY DOOR

You will notice that the bottom of the back piece is 3¾ inches above the bottom piece, just enough to accommodate the door (H). This piece is hinged at the bottom, so that it opens backwards. The picture on page 9 clearly shows how the two hinges and the snap catches are placed, so no explanation is necessary.

HINGING THE TOP

The top piece (F) is hinged to the back with three hinges. The two 11¼-inch pieces of angle brass are screwed to its left and right edges, so that when it is closed

down the overhanging sides of the angle strips will press against the side boards D and E and hold them tightly in place. Similarly, the 18¾-inch piece of angle brass is screwed to the top edge of the front piece I, so that when the board is swung up to close the cabinet, the overhanging edge will slide over the forward edge of the top piece F, and hold it tight. Of course, it will be necessary to saw away the corners of the brass strip on the piece F to accommodate the strip on piece I. The exact method of doing this will be evident when you are doing the assembly work.

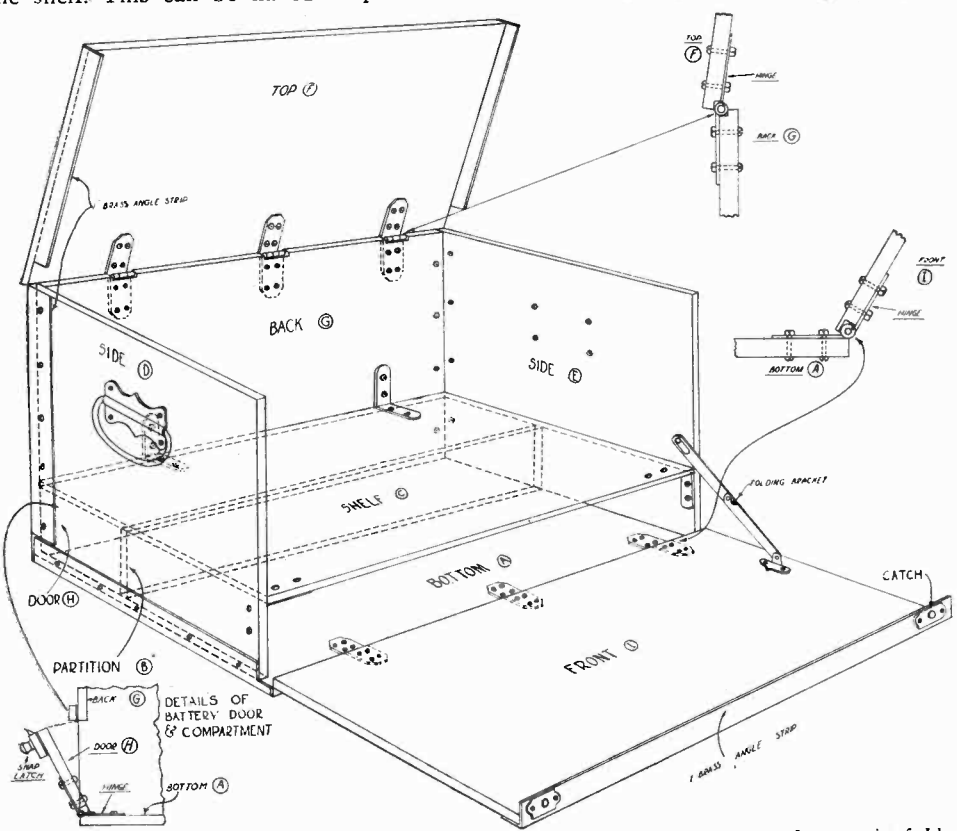
The front piece I is hinged to the bottom piece A by three hinges, so that it closes flush against the sides D and E and the top F. It is held closed by means of two hook latches, the respective halves of which are screwed to the brass angle strips, in the front right and left corners. There are many different kinds of hook catches; visit your local hardware store and you will be able to pick out a suitable pair in a few minutes.

The next to the last thing to put in is the shelf. This can be nailed in place or supported by L-shaped brass brackets. Before fastening it permanently, drill a row of holes along its back edge, to pass the battery wires to the "B" battery compartment just below. The last thing is the pair of carrying handles, which are screwed to the sides.

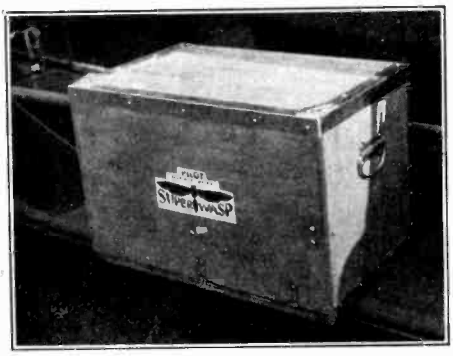
Fastening the Super-Wasp itself in the cabinet is merely a matter of drilling a few extra holes in the sub-panel and passing long screws through them into the shelf. Before mounting it in place, connect a short length of wire to the aerial post, and solder or clip it to one of the screws holding the left handle. The aerial can then be connected conveniently to the handle on the outside.

For the various "B" and "C" connections, cut short lengths of wire and pull them through the holes in the shelf.

The battery compartment will hold just seven of the small size 22½-volt "B" battesy blocks. Only six are needed, the extra space being occupied by a 9-volt "C" battery. Make all the connections to the batteries while the latter are standing on the inside of the door. After tightening all



This drawing clearly shows the assembly of the portable cabinet. When the top is folded down, and the front folded up, the two pieces are held together by hook catches fastened to their adjacent corners. If desired, the catches may be replaced by leather straps fitted with a carrying handle; such straps are inexpensive and may be purchased in any luggage shop. The folding bracket on the right side of the cabinet keeps the front (I) in a horizontal position when the box is open, so that it can be used as a writing stand.



The Super-Wasp completely folded up and ready to be put in the back seat or on the luggage carrier of the car.

the posts, push the batteries in. If they are a bit loose jam them in with pieces of cardboard.

STORAGE BATTERY CONNECTION

Making connection to the storage battery in the car is an easy matter, particularly if the dashboard lamp is in an accessible position. For a few cents you can buy a plug which will fit in the lamp socket and to which you can connect one wire of a 10 or 15 foot length of flexible lamp cord. The other wire is merely clipped to the frame of the car, as practically all present-day cars have one side of the battery systems grounded. In making the battery connection you also make the "ground" connection at the same time. Actually the car is pretty well insulated from the ground by the rubber tires, but it is such a large body of metal that it acts as an effective "counterpoise," or artificial ground.

For an aerial, a 100-roll of single flexible lamp cord, rubber covered, is plenty. This can be kept rolled up in the back of the set, as can the battery cable. When a stop is made and the Super-Wasp is hooked up, the wire can be strung to any available support or merely laid on the ground. A clip should be connected to one end of the wire, for contact with the left carrying handle.

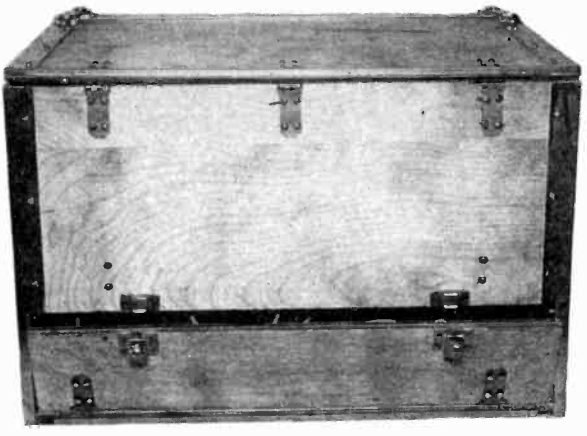
FORMS OF AERIALS

For broadcast reception, the best results will naturally be obtained when the aerial is as high and as free as possible. There are always trees at a parking stop, so you can easily throw the aerial wire up in the branches and thus get it pretty well up in the air. Don't worry about insulation; just tie the end of the wire to a small rock and let it heave. The rubber on lamp cord is good enough insulation for a receiving antenna. Of course, if you are staying in one place for a few days, put a little more care into the installation, so that it will not blow down with the first rainstorm—which is just when you'll want the radio set most.

For short-wave work, almost any piece of wire thrown on the ground or strung from a door handle on the car to a nearby fence post will produce excellent results. Wire fences, incidentally, sometimes make wonderful aerials, as many of them consist of heavy iron wire nailed to wooden posts and therefore pretty well insulated from the earth. Use the fence as the aerial and the car as a counterpoise, and you are likely to obtain extraordinary results.

When set up on the running board, on the back seat, or on the grass, the portable Super-Wasp will work just as well as if it were back home. If you want to take a loud speaker along, so much the better, as then you won't have to pass the earphones around. The best way of running the aerial and of placing the set will occur to you after one or two experiences with the outfit.

One good feature of having a set with you during daylight hours is that you undoubtedly will be able to hear many foreign broadcasting stations that you always miss during the evening. On a bright sunny afternoon during May the writer picked up station 5SW (Chelmsford, England) while he was parked on the Boston Post Road, and the thrill certainly was worth the effort spent on the outfit.



Rear view of the cabinet, with the door to the battery compartment partly open. Notice how the edges of the box are protected by the brass angle strip, and how the hinges for the top and for the battery door are arranged.

OPERATING HINTS ON THE PILOT SUPER-WASP

By Robert Hertzberg

MOST of the people who built Super-Wasp receivers in accordance with the article published in the Spring issue of RADIO DESIGN experienced no trouble in getting their sets to work satisfactorily. The directions were clear and complete, and those who followed them faithfully were rewarded with immediate results.

However, as the Super-Wasp is different from all other short-wave receivers, there was bound to be some initial confusion about its operation. This article will cover the little details that the constructional article did not deal with thoroughly.

HUNDREDS of people who have built Super-Wasps are hearing short-wave broadcasting stations in England, Holland, France, Germany, Denmark, Central America, Mexico, Siberia and Australia, and are experiencing the greatest thrills radio has to offer. Many of these listeners never built a set of their own before, and took a chance with the Super-Wasp because it is an easy set to assemble. Why don't you build a Super-Wasp, so that you can get in on the fun?

Write to RADIO DESIGN *for a copy of a 12-page booklet describing this wonderful receiver in detail. It is free for the asking. Just say you want Data Sheet No. 7.*

REGENERATIVE ACTION IMPORTANT

The success of the Super-Wasp will depend to a great extent on how smoothly you can make the detector tube regenerate. In general, use as little plate voltage as possible. Start off by connecting the "B" + DET post on the extreme right to 22½ volts, and see how the set regenerates with the various coils. Conditions are just right when the set goes into oscillation at the high end of any pair of coils with the regeneration condenser (the center one) all the way in. Sometimes regeneration is fine up to about 80 on the dials, but stops there. An increase in the detector "B" voltage from 22½ to 45 will invariably cure this, but with the higher value the regenerative action is likely to be too violent. Tubes vary a great deal, and if the particular one you have seems to require some value between 22½ and 45, simply connect a Pilot No. 350 Resistograd in the "B" + detector wire, with the latter running to the 45-volt tap on the "B" batteries. As shown in Figure 1, the wire may be bridged directly to the "B" + DET post on the left, which takes 45 volts for the screen-grid tube. A 1-mf. by-pass condenser across the Resistograd is highly desirable. By adjusting the Resistograd you will be able to strike just the right voltage for your own set.

DIAL READINGS NOT ALIKE

It is impossible to make the two tuning dials read alike, because of the different capacities and inductances associated with the R. F. and the detector circuits. In addition, the setting of the left-hand condenser is influenced a great deal by the size of the particular aerial and the adjustment of the midget condenser on the side of the left can. Don't feel concerned if the two dials read 15 or 20 degrees apart; the set will work perfectly well.

The sharpness of tuning on the broadcast band (with the blue ring coils) is determined to a great extent by the size of the aerial. We have found that most people who complain of broad tuning have failed to follow Kruse's directions, which call for a small fixed condenser connected in series with the aerial wire when the aerial is of the usual size used with broadcast receivers. Try .0005, .00025 and .0001 mf., all of which are standard condensers costing only a few cents. They make a big difference in results.

KEEP CONDENSERS CLEAN

A rather unexpected and for a while mysterious trouble developed with the detector tuning condenser. As the full 135 volts of

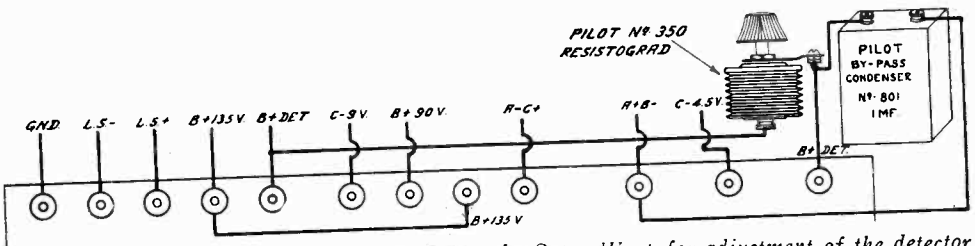


Figure 1: How the Resistograd is connected to the Super-Wasp for adjustment of the detector plate voltage.

the "B" battery is directly across the plates of this condenser, dust particles accumulating between them become conductive and cause much noise and sometimes even flashovers. The easiest way to overcome or prevent such trouble is to blow hard through the plates, or to run a pipe cleaner between them. All the new Super-Wasp kits are supplied with variable condensers having wider spacing than previous models, and both the noise and the short circuits have been absolutely eliminated. The new condensers have 11 plates instead of 8, and are listed as the No. 1611.

SHORT-CIRCUITED DIAL LIGHTS

Another slight trouble that developed was that the top screws holding the panel plates of the dials in place touched the nuts holding the dial lights, causing a dead short circuit on the "A" battery. The cure, of course, is merely to cut a bit of the screw off.

USING ONE AUDIO STAGE

The Super-Wasp develops such powerful signals that many owners have written in to ask how they can reduce the volume for headphone reception. There is not enough room on the panel for a volume control like the Volumgrad, but there is plenty of room for a small telephone jack like the Pilot No. 1165. When hooked up as shown in Figure 2, it allows the phones to be connected to the output of the first audio stage only, thus making reception more comfortable. The connections are so simple they need no explanation.

As the metal chassis of the set is part of the "B"— circuit, it is absolutely necessary to insulate the jack from it. Simply make the mounting hole a little larger than necessary, and keep the jack clear of the panel by means of two washers cut out of thin bakelite. fiber, or other insulating material.

171A FOR BEST QUALITY

For the best tone quality, a 171A should be used as the second audio amplifier, with 180 volts on the plate and 40 volts "C" bias. This means four "B" battery blocks and a single small "C" battery. The 180 volts is connected to the fourth post from the left, the one marked "B" + 135, and the 40 volts to the "C"—9 post. The other "B" + 135 post is connected to 135 volts, and all the other connections left just the way they are.

Of course, a 112A or even a 201A may be used as the second audio amplifier, and will produce perfectly satisfactory results. The 171A simply is better for the reproduction of voice and music.

LEARNING TO TUNE

In hunting for short-wave broadcasting stations, remember that the tuning is going to be very sharp, and you will skip right by many powerful stations if you do not proceed carefully. If you start listening some evening after 8.00 p.m., plug in the yellow ring coils first, as you can practice tuning by getting W8XK, the 63-meter short-wave transmitter of KDKA, which is an old stand-by. Set the right hand dial at about 20, the left about 25, and turn up the regeneration condenser until you hear the tell-tale rushing sound indicative of regeneration. Move the dials up or down a degree at a time until you hear a loud whistle. Tune in the whistle as loud as you can, and then start backing down the regeneration condenser. Juggle the tuning dials back and forth a trifle at the same time, and eventually you will be able to clear the whistle and hear the voice or music.

If the signals are very weak, you may have to "zero beat" them. This is the operation of throwing the detector into oscillation, obtaining the whistle, and then tuning the set so carefully that the voice comes through just as the whistle disappears. It will reappear if the detector condenser is turned either up or down.

Zero-beating is a very effective method of bringing in weak broadcasting stations, although it requires some experience in tuning. You will be able to master the trick after a few evenings.

GETTING THE FOREIGN STATIONS

In going after foreign broadcasting stations, you must bear in mind the time difference between the United States and the other countries of the world. Station 5SW, in Chelmsford, England, for instance, signs off at 7.00 p. m. Eastern Standard Time, it then being midnight in London. Thousands of short-wave set owners tune in this station regularly week days, and use its programs as dinner music. Station PCJ, in Holland, the star short-wave performer, is likely to be heard almost any time, as it puts on special programs for different countries of the world. It usually starts at about 10.30 p. m. Eastern time, and comes in with fine loud speaker strength. For the Australian stations you have to be an early riser—or a victim of insomnia—for they roll in toward about five o'clock in the morning.

The Super-Wasp will bring in these stations, if you listen for them at the right time and tune for them carefully. Don't expect to hear them all at once during one hour of listening after supper. Give the set a chance, learn how to use it properly, and you will obtain a million dollars worth of sport out of it. When your neighbor boasts about hearing the West Coast or the East Coast with his seven-tube, $200 broadcast receiver, you will be able to smile at him in a superior manner and say, "Huh, that's nothing; I get Holland on a four-tube set that cost me less than thirty dollars."

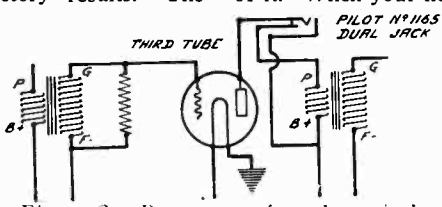
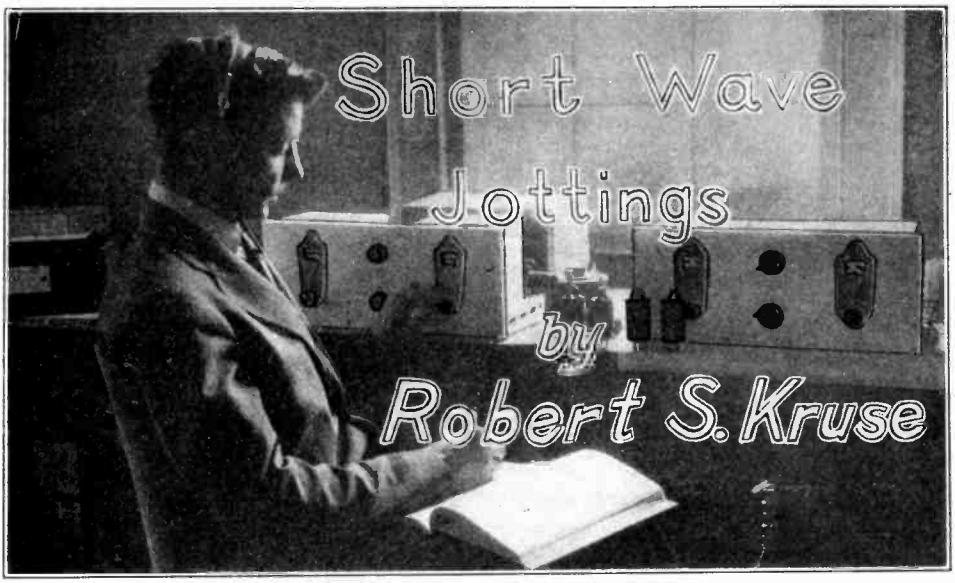


Figure 2: By means of a phone jack connected as above, you can use one audio stage instead of two.



MYSTERIOUS AND MAGICAL

ONE becomes fearfully weary of the insistence that short-wave radio is mysterious, miraculous and the proper work of radio magicians.

This is not altogether right, for the modern stage magician depends on neither devils nor angels, but operates his seeming miracles in exact accord with the laws of physics. The result seems wonderful to those out in front because Thurston knows something about physics which his audience does not know and has developed special skill which permits him to use that information and which puts his performance beyond copying by the outsider, even though he finds out "how it is done."

We have magicians who perform their tricks with a baseball, yet not one man of the thousands who have watched Walter Johnson could duplicate his feats.

The taxi driver may not know much about thermodynamics, but he can demonstrate a superb knowledge of the laws of physics where they concern motor cars moving at 30 miles per hour.

At Wallis' Restaurant in Washington there is a colored man who does incredible things with a hugh tray and 50 pounds of dishes—yet I am sure he is a deacon of his church.

In all these cases, including that of short-wave radio, the result is wonderful because the audience is unfamiliar with the process. Interesting and remarkable as that result may be, it is none the less entirely *un*-miraculous. Occasionally, of course, the performer takes to believing in his own magic and regards his own work with awe, but he is unlikely with *that* frame of mind to produce much that is really important.

OUR CHANGING IDEAS

The radio art has been the recipient of an extraordinary concentration of money and brains. Rapid development follows quite automatically. This is quite as true at the very long waves as it is at the very short ones, but the latter are at the moment receiving far more attention from our publicity mediums. The man outside the industry is thereby shown a rapidly changing picture which he finds remarkable because it is strange and irritating because it changes so fast. He demands, mainly by letter, that the parade slow down until someone tells him just exactly where it is going.

It is a natural feeling, but it applies to everything else just as well as radio. Every industry wanders around amongst obstacles, precedents, and authorities in the same aimless way as a road going through New England hills. The older and slower industries traveled these devious paths quite as comfortably as the horse and buggy followed the demented road. Higher speed has raised an objection to these wanderings. It is fortunate that most short-wave sets are not headed toward any particular destination and may therefore follow the gyrations of a trail which even the pioneers do not yet have clearly in mind. If we wander off the best path, there is still a chance that we may stumble over something interesting and possibly useful. Short-wave radio is still not altogether a business but partly a sport. Use it as such!

THAT SHORT ANTENNA

At short waves one may receive with a short antenna and still obtain very good

signals. Thus the broadcasts of English 5SW may be heard very nicely with an antenna so short as to be of no use in receiving KFI or WEAF. This does not prove that the short waves are "more powerful" or that they have a "higher efficiency." The real meaning is considerably simpler and may be explained by going from radio to sound.

You are to imagine yourself to be in a room which contains a grand piano. Remove the usual accumulation of near-rubbish from the sounding board and prop it open. Have someone push down the pedal which raises the dampers from the strings, while you sing into the piano the lowest note which you can reach. When you stop, one string of the piano will be vibrating. This string is of the same pitch as the note you sang and the effect is simply mechanical resonance. After doing this often enough to find out how well the string responds try the same thing with the highest note you can conveniently reach. A high pitched string will sing back at you and will respond as loudly as did the low pitched one.

The two strings were not of the same length by any means, yet each managed to pick up energy from the sound waves. As a matter of fact, not only these two strings but several on each side responded somewhat. To be sure, the low pitched sound waves struck the long string heavily, but the high pitched ones made up for this by striking more often. Thus the small one managed to get going very handsomely, although it apparently had a very small "grip on the air."

I am not at all sure that this makes the matter entirely clear; possibly we could have explained it just as well by sticking to radio, but you may make that change for yourself.

"IN THE CLEAR"

Of course, there are exceptions to what has been said. If a set is located on the third floor of a 9 story building with other tall buildings around it, we must not expect much from a short antenna, for it is practically screened. The long and tall antenna in the same location is not only longer and taller but also manages to get its nose out above the screen and to sniff at a few of the passing waves. It is likely to be better at both long and short waves than is the submerged small antenna.

Again, a small antenna will sometimes produce quite excellent results at medium and long waves by borrowing radio energy from nearby wires, furnace pipes or even rainspouts. If one has had experience enough the result can usually be prophesied somewhat. Fortunately anyone can "try it and see."

"SHORT LEADS"

L. W. Hatry has repeatedly commented on the "unimportance of short leads." He has good cause for the comment because mere shortness is not a virtue in sort-wave apparatus connections.

After all, the main point is to keep down connections in the tuned circuit and the tickler circuit (if any) to such an extent that the desired wavelength range can be comfortably covered while still permitting a decent amount of inductance to be placed at the coil form where the couplings are to be made. There is no particular need for going beyond this and at wavelengths above ten meters a perfectly normal arrangement of parts is possible and advisable.

From this it must not be altogether assumed that battery leads can be disregarded. In spite of our best efforts they are sure to carry some radio-frequency current. One had best begin therefore by reducing this undesirable radio-frequency current to a convenient minimum, and as a rule this is most conveniently done by the use of a metal base plate and panel. One may then ground one point of almost everything in the set to this metal frame, which is substantial enough so that its resistance and inductance are very low. Radio-frequency voltages between the different parts of the frame are therefore also very low. The remaining "A" lead and the various "B" leads can be made "cold" by means of chokes and by-pass condensers. The location for each by-pass condenser is, of course, at the point where we would like to detour the R.F. to ground, which is to say the frame.

That isn't all there is to it, of course. A little study and experiment will show that some chokes and condensers may be omitted without any chance of trouble. (When in doubt use them.) A little more study will also show that we will need to take the usual precautions against magnetic coupling caused by common leads. Since short-wave equipment mostly uses interchangeable coils, we cannot get rid of the inter-coil coupling by any convenient method excepting shielding. Enough has been said on the necessities of shield design, so that one needs to add here only one suggestion. Tuned circuits are, of course, unavoidably grounded at the condenser shaft in all ordinary constructions. Since one side of the filament circuit returns through the frame, one would naturally expect to let the frame complete the tuned circuit also, simply grounding one terminal each of the filament, tuning condenser and coil. Usually this arrangement is not satisfactory since it puts radio-frequency current in the shield, which thereupon stops shielding. It is safer to return the filament and coil directly to the condenser frame or at least to connect these three points through .01-mf. stopping condensers. The intention is, as far as possible, to so arrange the tuned circuit that it will have but one connection to the shield. The Pilot Super-Wasp is a practical illustration of most of the points mentioned.

EUROPE ON THE LOUD SPEAKER WITH THE SUPER-WASP!

Brooklyn Fan Hears His Report of Reception Read from PCJ, Holland; Costa Rican Station Sends Diploma of Verification

BROUGHT out in our Spring issue and on the market only a short time, the Super-Wasp achieved an instantaneous success that surprised even its sponsors. The set was something new and different in the way of short-wave outfits, and it was telt by some people that constructors would have trouble with it. As a matter of cold fact, the amount of trouble has been smaller than for any other receiver ever described in RADIO DESIGN, and in practically every case it has been possible to trace the trouble to some incidental factor like bad screen-grid tubes, incorrect battery connections, the use of unsuitable power packs, etc.

If you missed the Spring issue, by all means get a copy and read the article by Robert S. Kruse which explains the details of this extraordinary little set.

EUROPE ON THE SPEAKER

We did not dare promise that the Super-Wasp, with its four insignificant tubes, would produce loud speaker results on stations across the ocean, but it seems that it actually is doing so for many people! The following letter is typical of many that have ben written by satisfied owners of the set:

1640 *Ocean Avenue,*
Brooklyn, N. Y.,
June 26th, 1929.

Pilot Radio & Tube Corporation,
323 Berry Street,
Brooklyn, N. Y.
Gentlemen:

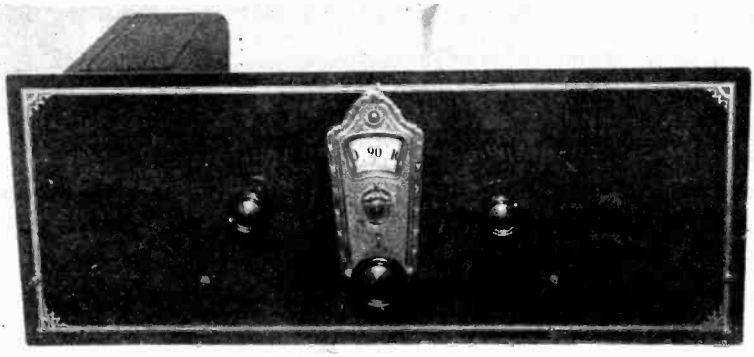
On May 18th I bought a Pilot Super-Wasp short-wave kit. On May 22nd I had it all mounted and wired. On May 24th I heard station PCJ, Eindhoven, Holland, very clear and loud enough to be put on the loud speaker.

Naturally I was overjoyed and immediately wrote to PCJ, telling them what a thrill I had and mentioning that I heard them on the Pilot Super-Wasp.

On Friday night, June 14th, I was listening again to PCJ. The program came in on the loud speaker and I had a few of my friends in the house enjoying it. At 10.20 o'clock we heard the announcer say: "Hello,

(*Continued on page* 45)

A reproduction of the unique certificate of verification issued by station NRH, Costa Rica, Central America. It is 13 inches long and 9 wide.



Front panel view of the A. C. Three. Note how the K-111 power pack fits behind the left corner.

THE A.C. THREE

A Simple Three-Tube, All-Electric Regenerative Receiver Possessing Unusual Sensitivity and Good Selectivity

By John Geloso

IN these days of screen-grid sets and complex circuits it is surprising to note how much interest there still remains in small, simple receivers using only a few tubes. The "Little Pal," described in our last issue by Alfred Ghirardi, was presented to meet what we thought was a limited demand, but it has turned out to be one of the most popular outfits RADIO DESIGN has ever sponsored.

A MORE ADVANCED SET

The "A. C. Three" was developed to fulfil the further demand for such receivers. It is a trifle more advanced than the "Little Pal" in that it is an all-electric set, deriving all its operating power from the electric light line, rather than from batteries as in the case of the latter receiver. This feature was incorporated in the set because so many parents inquired of their sons, "Why can't the 'Little Pal' be run from the lamp socket?"

In actual construction the "A. C. Three" is only a little more complicated than the "Little Pal," and will present no difficulties at all to the person who was able to build a "Little Pal." The special front and sub-panel are put out by the Pilot company, while all the individual components are standard Pilot parts.

FEATURES OF THE RECEIVER

The "A. C. Three" is an excellent receiver for the man who has little money to spend and wants to obtain the maximum results from a minimum number of tubes. It is highly sensitive and selective, and while it will not blow the windows out, it is quite loud enough for any small household whose members want to listen to radio programs in peace and comfort.

The circuit used is of the straight regenerative type, which is considered obsolete by many people but which has lost none of its effectiveness for broadcast reception. A three-circuit tuner of the good old-fashioned type is employed, with the usual fixed primary used as a tickler and the usual tickler used as a variable primary. The regenerative action is controlled by a variable condenser. This arrangement, a considerable improvement over the original one, allows the owner of the receiver to adjust the selectivity of the circuit to suit his own particular conditions.

If you live in the country, miles away from a broadcasting station, you can tighten the coupling between the primary and the secondary for best results. If you live in a congested district, you can loosen the coupling and make the set as sharp as you need it to prevent interference between stations.

THE "A.C. THREE" CIRCUIT

The complete circuit diagram is shown on the bottom of page 16. You will notice that the detector and the first audio tube are of the 227 type, while the second audio is a 171A. Filament and plate current are furnished by a compact power unit, the Pilot No. K-111, which is sold completely wired and assembled. Grid bias for the first and second audio tubes is supplied by the voltage drops across suitable fixed resistors in the plate return leads.

The main control is the variable condenser tuning the secondary (grid) circuit. This is equipped with a vernier dial, which occupies the center of the front panel. On the left of this condenser is another variable, which is the regeneration control. As its adjustment is not critical, it is fitted only with a knob. To the right of the tuning condenser is the three-circuit tuner, with the rotating primary coil facing it. The sub-panel holds the tube sockets and the audio

instruments, and on its underside, the incidental condensers and resistors. The sub-panel is cut short on its left side, the space behind the front panel being filled by the K-111 power pack, which is enclosed in a neat steel can.

THE NECESSARY PARTS

The following Pilot parts are necessary for the A. C. Three:

1—Front panel, 7 by 18 inches, special.
1—Sub-panel, special.
1—No. K-111 Power pack.
1—No. 121A three-circuit tuner, made especially for the A. C. Three.
1—No. 1623 variable condenser (.0005 mf. capacity.)
1—No. 1613 variable condenser (.00025 mf.)
1—No. 1282-L illuminated vernier dial.
2—No. 391 audio transformers.
1—No. 392 output filter.
1—No. 51M grid condenser, with grid leak clips (.00025 mf.)
1—No. 756 grid leaks (2 megohms.)
1—No. 216 socket (four prongs.)
2—No. 217 sockets (five prongs.)
4—No. 37 metal shelf brackets.
1—No. 130 radio-frequency choke coil.
1—No. 354 center-tapped resistance (20 ohms.)
1—No. 356 center-tapped resistance (50 ohms.)
1—No. 958 fixed resistance (2000 ohms.)
1—No. 951 fixed resistance (2250 ohms.)
1—No. 59 fixed condenser (.01 mf.)
2—No. 801 fixed condensers (1.0 mf.)
1—No. 46 snap switch.
4—Binding posts (ANT GND, LS and LS) with six sets of insulating bushings.

THE ASSEMBLY WORK

The assembly of any set can be made very difficult if the wrong method is followed. The assembly of the A. C. Three is very simple if you follow the following directions.

Screw two of the shelf brackets to the corners of the front panel, to give the latter a support and to keep it from scratching against tools or other parts on the table. Mount the vernier dial in accordance with the directions furnished with it, and fasten the No. 1623 variable condenser to it. To the left of the latter mount the No. 1613 condenser, in an upright position; and to the right, the No. 121A coil, with the rotating coil facing the center. Fit the No. 46 snap switch in the hole provided for it in the lower right hand corner of the panel, and then put the whole unit aside.

The photographs of the A. C. Three shown on pages 15 and 17 were taken just before the switch was added, so the instrument does not show thereon. However, it is shown in the picture diagrams on pages 18 and 19.

Mount the other two brackets to the under side of the sub-panel, to give it feet to stand on. Proceed with the mounting of the tube sockets, the audio transformers and the output filter, and the various fixed condensers and resistors. Before tightening a single screw, study the picture wiring diagrams on pages 18 and 19 and make sure that you understand where every part goes.

The center-tapped resistances appear to be hanging in mid-air, but actually their lugs are soldered directly to the lugs on the tube sockets. The grid condenser is mounted directly on the top side of the sub-panel, to the right of the three-circuit tuner, and is insulated from the metal by a pair of the insulated bushings.

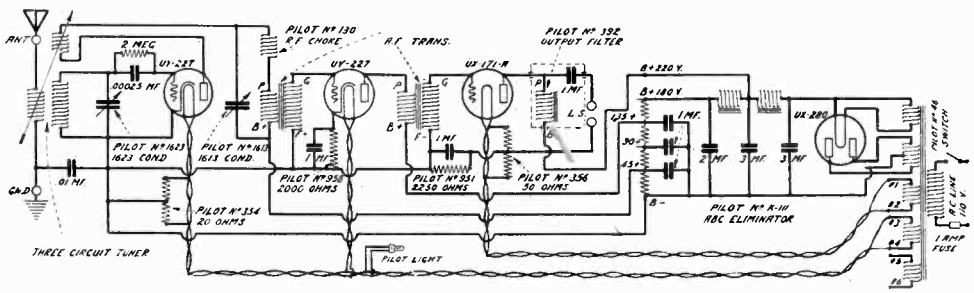
JOINING THE PANELS

With the sub-panel assembly completed, join this unit to the front panel, and put the No. 130 R.F. choke in place as shown in the illustrations. Test the fit of the K-111 power pack in the space provided for it, but do not mount it yet. The idea is to do all the wiring first, leaving flexible leads sufficiently long to reach the terminal strip in the can. The power pack is rather heavy, and if mounted first, will make the wiring a somewhat awkward job.

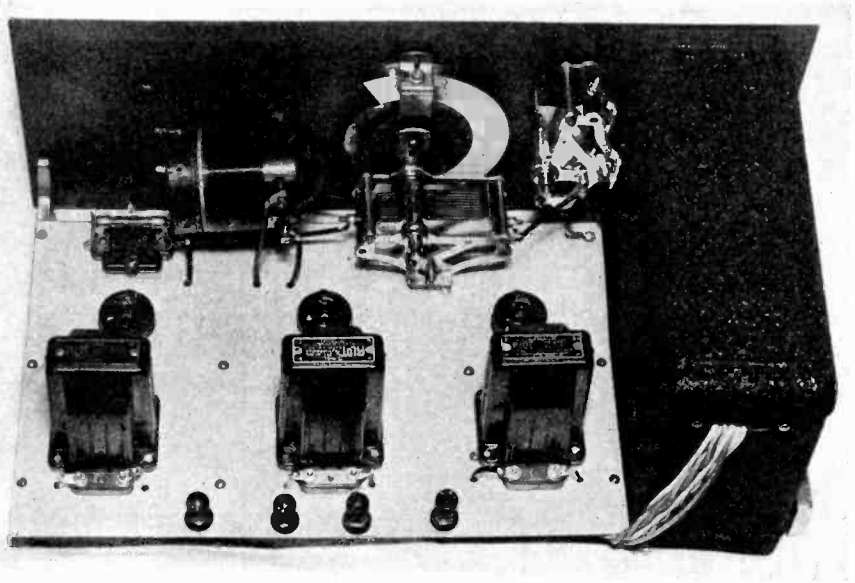
For the filament and "B" power leads, use flexible rubber covered wire, and leave generously long ends to reach into the power pack. You can see from the photograph at the bottom of page 17 how the leads are bunched next to the tube socket on the right. For the connections that go through the sub-panel, use bare tinned wire running inside spaghetti tubing. Solder all connections with a hot, well tinned iron. After you have finished the wiring and have checked it carefully to make sure it agrees with the diagrams on pages 16, 18 and 19, mount the power pack, with the wire-hole end toward the rear.

ADJUSTMENT AND OPERATION

The adjustment and operation of the A. C. Three is so simple there is little to be said about it. The center condenser is for tuning, the other for regeneration control, and the



Complete schematic diagram of the A. C. Three.



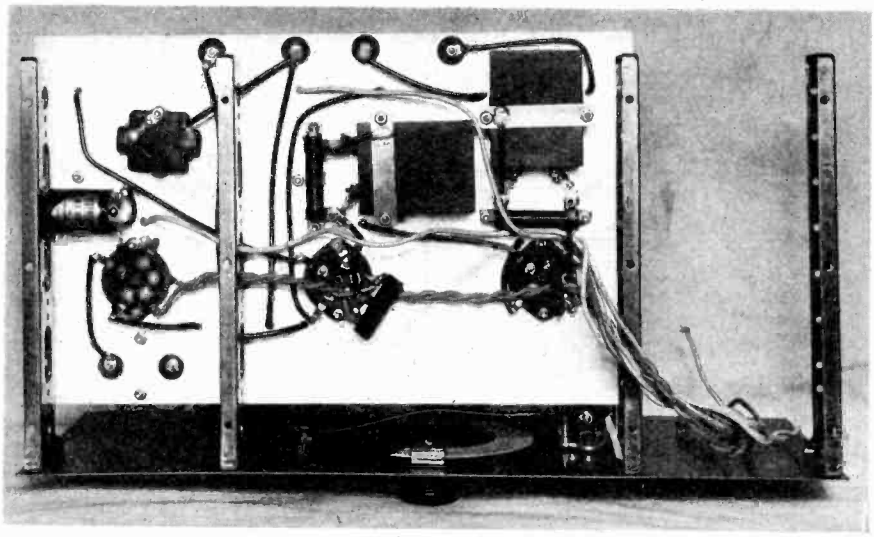
Back view of the A. C. Three, with the power pack in place.

rotating coil for selectivity. Grid bias for the first audio amplifier tube is furnished by the 2000-ohm fixed resistor, and for the second audio tube by the 2250-ohm resistor. In addition to the two 227's and one 171A, it is necessary, of course, to provide a 280 for the power pack.

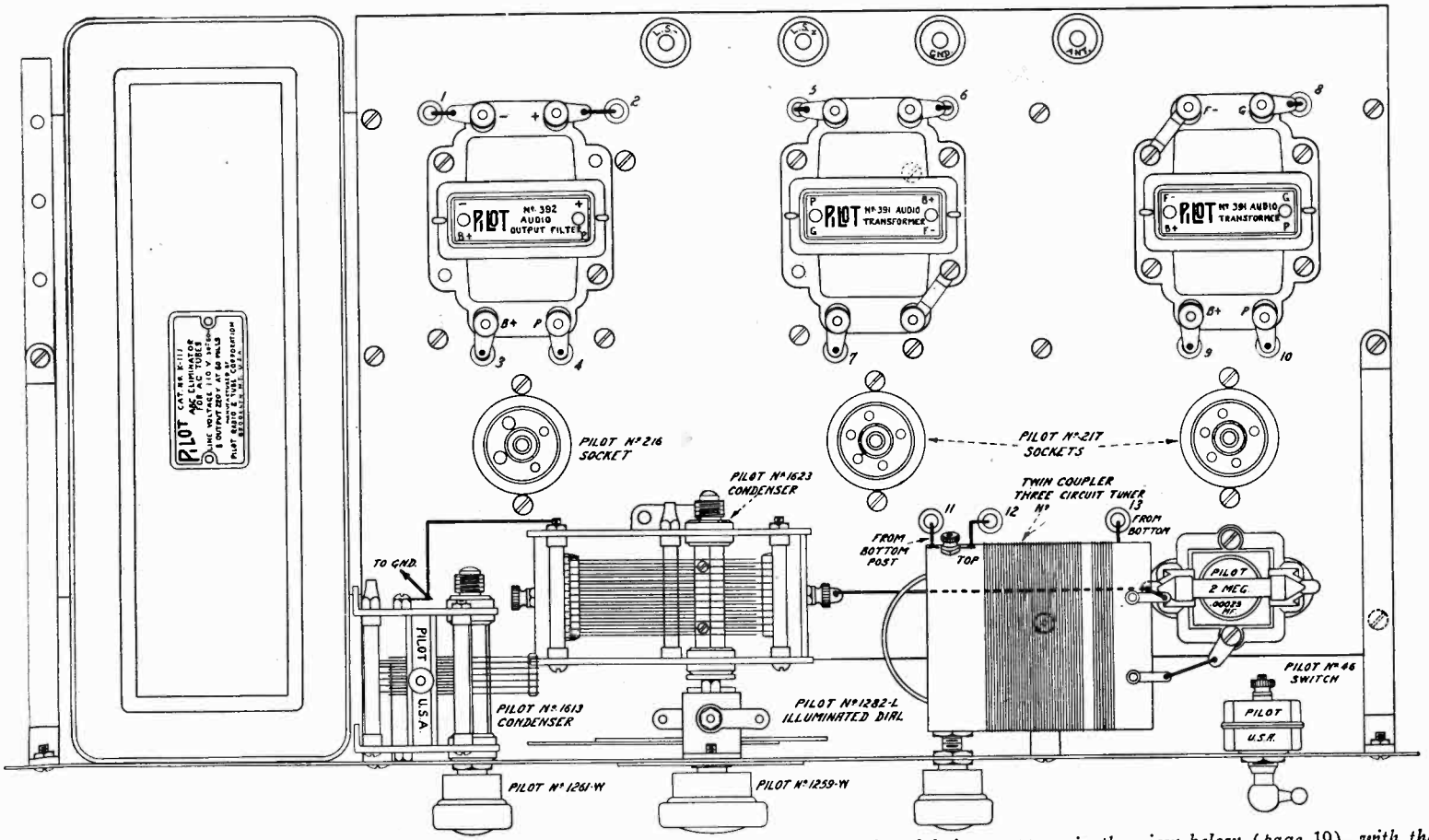
The sensitivity of the set is due to the regenerative action of the detector tube. It is therefore important that the regeneration condenser be handled with particular care. If it is advanced too far the detector will "spill over," and will cause a squeal or whistle to be heard in the loud speaker. The trick of balancing the tuning condenser against the regeneration condenser is a simple one, and can be mastered after an evening or two of practice.

The setting of the rotating primary coil is not critical and does not require much attention.

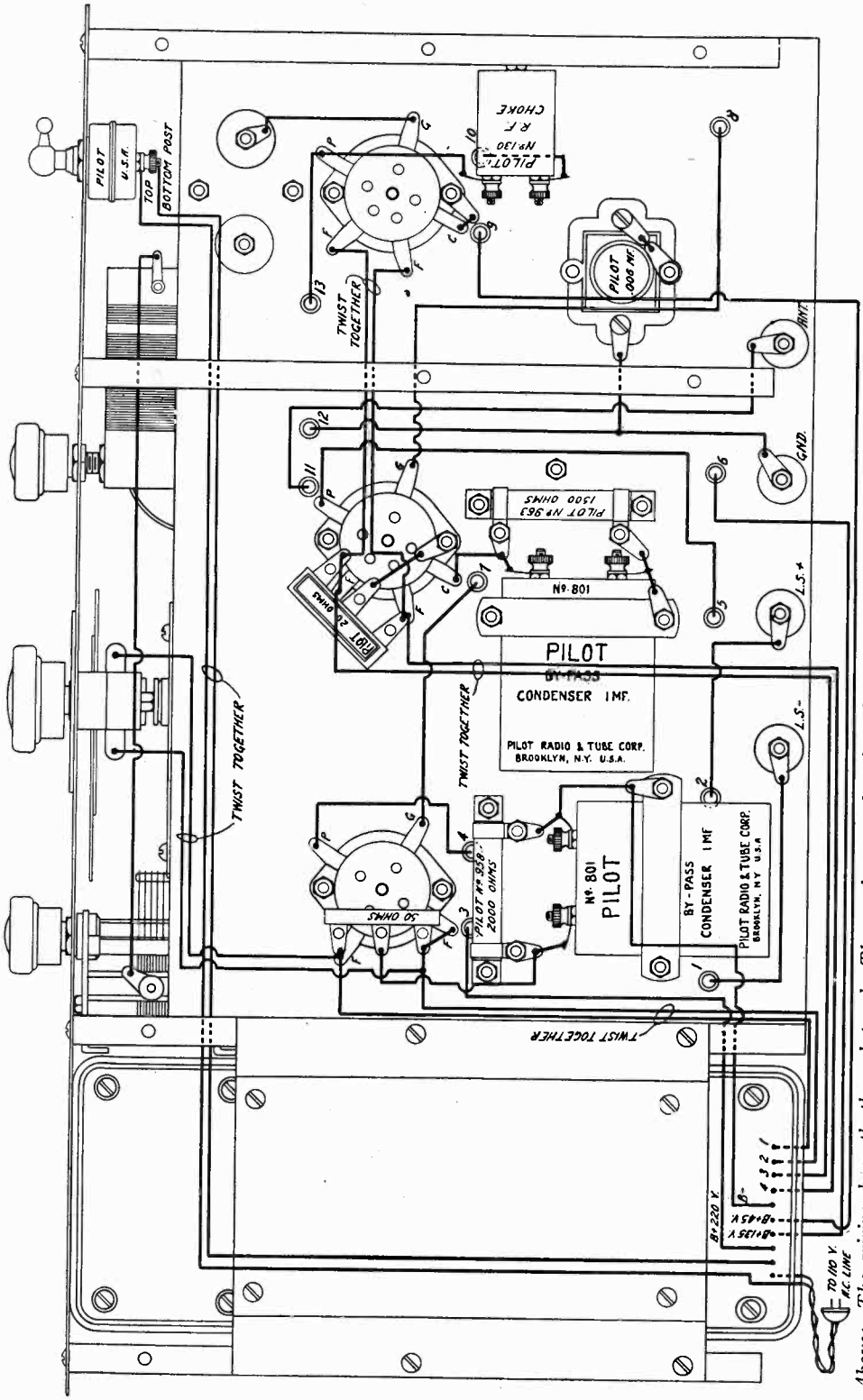
The editors of RADIO DESIGN are glad to give the A. C. Three their indorsement. The set is simple, costs little, and produces good results. That is all anyone can ask of any radio receiver.



Under side of the A. C. Three, with the power pack removed.

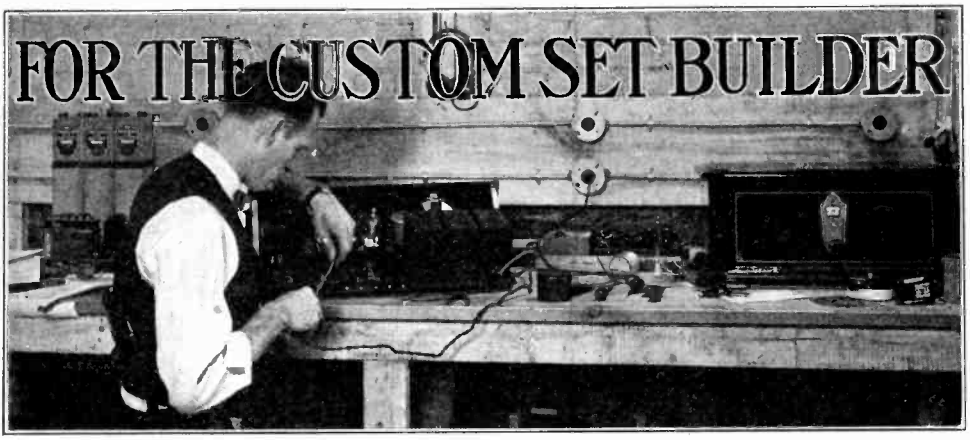


Above: *The A. C. Three as it appears from the top. Wires which disapp ear through numbered holes reappear in the view below* (page 19), *with the holes numbered correspondingly.*



Above: The wiring beneath the sub-panel. The numbers on the edge of the power pack are molded into the bakelite terminal plate opposite binding posts, to which the wires should be connected.

FOR THE CUSTOM SET BUILDER



THE modern A. C. receiver built up from a kit of parts is not a simple job, to be thrown together any old way. You are dealing with power equipment that generates strong magnetic fields, and unless you follow the exact instructions furnished by the producers of the kit, you will encounter trouble from hum.

* * *

MERELY following the schematic diagrams is not enough. Do not spurn the picture layouts as "beginner stuff," even if you are an experienced constructor; study them closely and note carefully how every wire is placed and how every part is located in relation to neighboring parts.

* * *

THE danger of not following the correct layout lies in the creation of undesired "loops" between circuits and the subsequent production of troublesome oscillation. This happens particularly in screen-grid sets, in which the capacity of two parallel wires may be enough to neutralize all the advantages the screen-grid tube offers.

* * *

WHERE the grid returns of the various R. F. transformers of a set are all supposed to go to a common ground like a metal sub-panel, do not rely on one connection from the common rotors of the tuning condensers; bring the grid-return leads from both coils and condensers directly down to the sub-panel, so that the individual tuning circuit of each coil in combination with its associated condenser is completed through a local section of the sub-panel, and not through a long single path common to all circuits.

* * *

THE diagrams and blueprints supplied by RADIO DESIGN are particularly valuable in the foregoing respects because the receivers as described are finished products that have been thoroughly tested in several different places. Every set is remade at least six times, or six entirely different sets incorporating the same circuit are built by different men.

* * *

IT is only after the receivers have passed the prescribed tests that they are put in the hands of our draughtsmen, who trace out every wire exactly as it lies in its actual position. This is why practically every one of the thousands of set builders who have followed the RADIO DESIGN patterns have been able to achieve immediate results without trouble. They have not found it necessary to wire and rewire half a dozen times, because the wiring as indicated in the drawings was right in the first place.

* * *

FURTHERMORE, each receiver or accessory described in these pages is designed for a specific and legitimate purpose, and is not thrown together for the purpose of selling freak parts. It is our constant endeavor to "debunk" the set building game and to furnish you with reliable receivers of the most advanced design, so that you may keep well ahead of the factory-built products and enjoy technical developments that will not be adopted commercially for months and even years ahead.

* * *

WITH this advantage, you can develop a healthy business, possible as a side line to your regular one, by selling these "up-to-the-minute" instruments to the many people who are always clamoring for the "latest." The efficient design of the parts used, and the low prices charged for them, assures you of a good profit.

JOHN GELOSO,
Technical Consultant for RADIO DESIGN.

SOME RADIO QUESTIONS AND THEIR ANSWERS

"B" POWER-PACK CIRCUIT FOR D. C.

1. Kindly furnish a circuit diagram for a "B" power-pack operating from the 110-volt direct current lighting line.

Answer: *Figure 1 shows a circuit diagram for the D. C. "B" power pack. You must determine the positive and negative sides of the electric light line with a D. C. voltmeter having a range of at least 110 volts, so that you may connect the unit to it with the proper polarity.*

TROUBLE WITH A D. C. POWER UNIT

2. I have attempted to use a D. C. "B" power unit with my set and every time I connect the ground wire on to the set I blow out the filaments of the tubes. How can this be remedied?

Answer: *This is caused by the fact that the positive side of the 110-volt line to which you are plugging your power pack is grounded. As the A+ and B— are connected in your set and the A—usually goes to ground, you create a short circuit across the 110-volt line when you plug the power pack in, since you ground both sides of the line. As this short circuit path is through the filaments of the tubes, it burns them out. This can be prevented by connecting a Pilot No. 801 1-mf. condenser in series with the ground wire running to your set. This breaks the circuit for the direct current and prevents short circuiting of the line. The condenser offers practically no opposition to the flow of R.F. currents, so the tuning and the signal strength are not affected at all.*

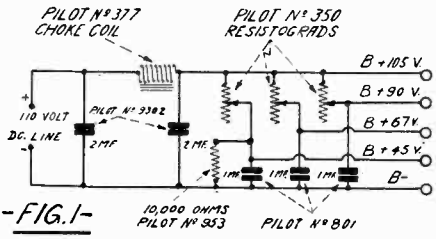


Diagram of a D.C. power pack.

WASP COILS IN SUPER-WASP RECEIVER

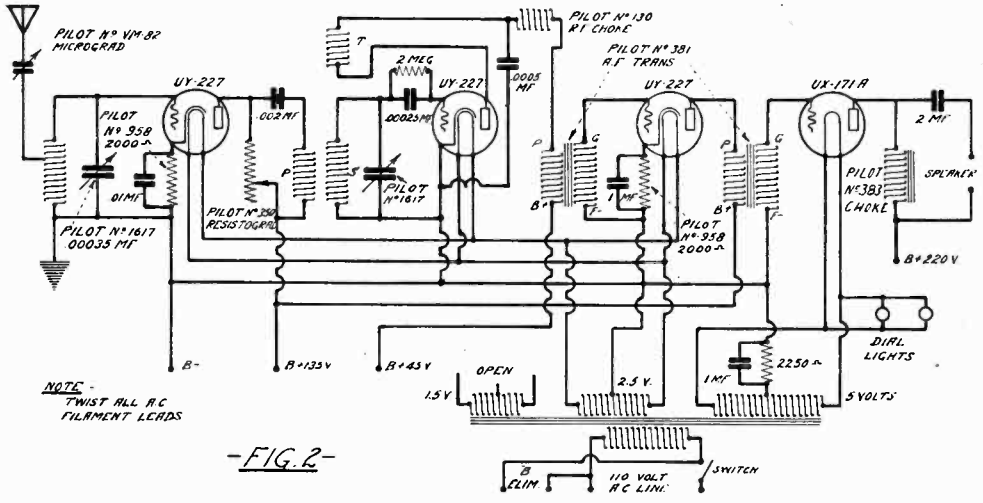
3. Can I use the coils from your Wasp receiver in the new Super-Wasp I intend to build?

Answer: *The coils in the Super-Wasp receiver are entirely different from those used in the Wasp set. They employ different numbers of turns of wire and different terminal arrangements. We advise you to use the two sets of plug-in coils designed especially for the Super-Wasp receiver.*

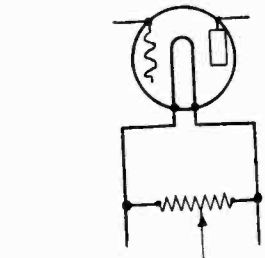
SHARPENING THE TUNING OF THE WASP

4. How can I sharpen the tuning of my Wasp receiver? Certain local stations come in all over the dial.

Answer: *You must remember that the Wasp receiver cannot tune as sharply as a*



Complete circuit diagram of the popular Air Hound receiver.



How a potentiometer is used as a hum control with A.C. tubes.

five- or six-tube set on broadcast waves, as it employs only one tuned circuit while the latter employs three or four such circuits. If inductive antenna coupling is used, that is, if the antenna is connected to the ANT. binding post, you can sharpen the tuning by connecting a VM-81 (.000045 to .0005 mf.) Micrograd condenser in series with the antenna. Vary this until the best setting is found. If still sharper tuning is required, remove from five to ten turns of wire from the primary winding on the blue ring coil. This will reduce signal strength somewhat. Of course, we assume that the aerial you are using for broadcast band reception is not over 75 feet long including lead-in.

TUBE HOWL IN PILOTONE

5. Why does my Pilotone Electric Six receiver howl while the A. C. tubes are warming up? As soon as they are warm the howl stops. Can I eliminate this in any way?

Answer: The howling in your set is due to the increasing plate current taken by the tubes as they heat up. This causes audio frequency oscillation due to common coupling. The detector tube is usually the worst offender. You can remedy this either by putting a new tube in the detector socket or reversing the connections to the primary of the first or second audio transformer.

25-CYCLE POWER EQUIPMENT

6. I live in a district supplied by 25-cycle current. Does the Pilot Company manufacture parts for an A-B-C power unit, for operation on this frequency?

Answer: The Pilot-Electric Mfg. Company does not manufacture power equipment for operation on 25 cycles. However, the standard filter condensers and tapped resistors can be used in units of this kind provided you can obtain the proper power transformer and choke coils.

IMPROVED AIR HOUND CIRCUIT

7. I understand you have developed an improved circuit for the Air Hound receiver described in the Vol. 1 No. 3 issue of RADIO DESIGN. Will you kindly publish this circuit?

Answer: Figure 2 shows the circuit diagram for the improved Air Hound receiver. As this employs practically the same parts as were used in the original design, the same parts layout can be used.

HUM CONTROL

8. How do you use a potentiometer across the filaments of A. C. tubes to reduce hum and what must be its resistance for the various type tubes?

Answer: A low resistance potentiometer is connected directly across the filament and the movable contact arm is moved to obtain the exact electrical center of the filament circuit, as shown in Figure 3. The arm goes either to B— or to the C bias resistors. For 226, 227 and 245 tubes, potentiometers of 15 or 20 ohms should be used, for 171 tubes 70 ohms should be employed, for 210 and 250 tubes about 60 ohms should be used.

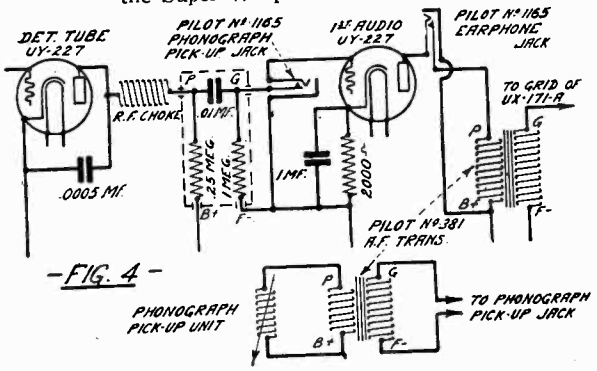
PHONE JACK FOR K-106 RECEIVER

9. Will you kindly show me how to connect a jack after the detector for earphone reception on the K-106 receiver? The resistance coupled first audio stage is what puzzles me on connecting the jack. Why is the phonograph pick-up jack placed after the first audio stage?

Answer: The jack in the diagram on page 22 of the Spring issue of RADIO DESIGN *was incorrectly labeled "Phonograph Pick-up." This jack is connected as an earphone jack. It is not practical to use a phonograph pick-up with this set unless one uses an extra No. 381 or No. 391 A. F. transformer for coupling the pick-up to the first A. F. tube, and uses the jack arrangement shown in Figure 4. This places the pick-up ahead of the two stages of audio amplification so that sufficient volume is obtained.*

BATTERY CONNECTIONS TO SUPER-WASP

10. As I am not very familiar with battery connections, will you kindly show a picture diagram of all the battery connections to the Super-Wasp receiver?



-FIG. 4-

How the earphone and phonograph jacks are connected in the K-106 receiver.

Answer: Figure 5 (below) shows a pictorial diagram of all batteries connected to the Super-Wasp when the following tubes are used: 222 for R. F., 201-A or 200-A for detector, 201-A for 1st audio, 112-A for output tube.

Right:

How the filament connections of the Super-Wasp are changed to allow the use of dry-cell tubes.

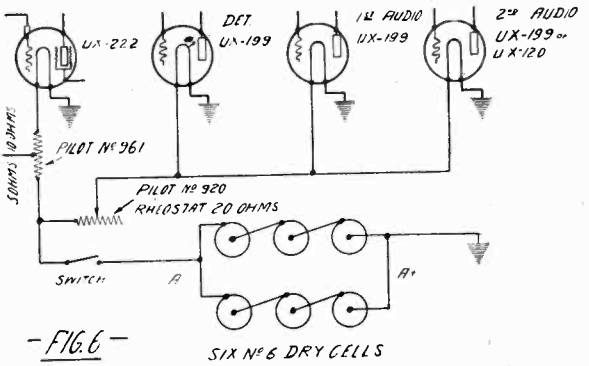


FIG. 6

OUTPUT OF JUMBO POWER TRANSFORMER

11. Is the No. 398 Jumbo Power Transformer used in the K-106 receiver able to operate five tubes with 2.5 volt filaments (total of 8.75 amperes) from its 2.5 volt filament winding? I understand that this winding was rated at 3.5 amp capacity.

Answer: The 2.5 winding and entire No. 398 transformer was designed quite liberally. It is capable of supplying 8.75 amperes from its 2.5 volt filament winding without danger, especially since the 1.5 volt winding is not used at all in this receiver.

SUPER-WASP WITH 199 TUBES

12. Can the Super-Wasp be operated with a 222 tube, two 199 tubes and one UX-120 tube? If so, what changes in wiring and value of filament rheostat must be made?

Answer: UX-199's and a UX-120 tube can be used satisfactorily in the detector and audio positions of the Super-Wasp. Of course, the volume will be slightly less than when standard type tubes are used. It is necessary to take the 222 out of the rheostat circuit and to connect it so that the full 4½-volts of the "A" battery (six dry cells connected in series-parallel) is placed between the grounded filament and the end of the 15-ohm resistance. The rheostat is left so that it controls the current to the other three tubes. With this arrangement the rheostat loses its incidental value as a switch and a separate filament switch must be provided. There is plenty of room for a small toggle switch on the front panel, between the rheostat and the regeneration condenser. A diagram of this connection is shown in Figure 6. The UX-120 dry cell power tube is used in the last stage.

INSULATING THE GROUND WIRE

13. Is it necessary that the ground wire of a radio receiver be insulated from the sides of the house when it runs to a water pipe just abov the earth?

Answer: No; just nail it down without insulators. The wire s supposed to make contact with the ground, and the house touches the ground, so no harm is done.

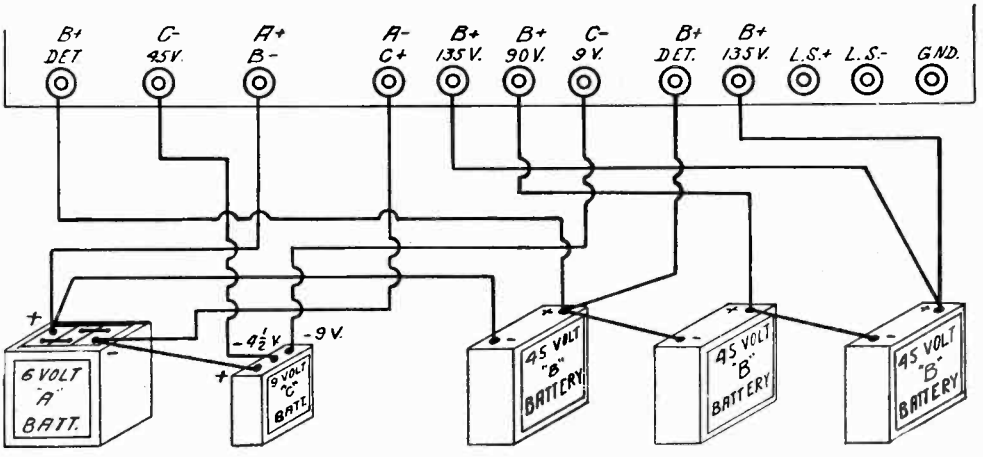


FIG. 5

Detailed picture wiring diagram of the battery connections to the Super-Wasp.

—Photo by Signal Corps, U. S. Army

A NEW war book, "All's Quiet On The Western Front," by Erich Maria Remarque, has just been transferred into English. We finished the book a few hours ago, and the thought came to us that, had these pictures of war that obliterate the chimera of glory under the brown muck of blook and ashes been broadcast eleven or twelve years ago, the peoples of every warring nation would have arisen in protest—would have recalled their armies from the field, and sent a few kings and generals out there in no man's land to scrap it out among themselves!

Perhaps the next war will be brought home to us all through an international network of broadcasting stations by the words of an announcer viewing the individual conflicts from an airplane and describing them as Graham McNamme does today a right to the midsection or a home run by Babe Ruth. If those interested in the promotion of the war do not definitely forbid its broadcasting, even the most partial and biased description of the conflict cannot veil the sordidness of it all, and bring an immediate realization that there are better ways of deciding international disputes.

IT CAN BE DONE

That the next war—and there may be one more—can be broadcast was demonstrated in a thrilling but innocuous way during the combined aerial and ground maneuvers in the recent mimic war in Ohio.

The State of Ohio was divided into two sections, with an international boundary running north and south about twenty miles west of Columbus. The territory east of the boundary line, including Columbus, was held by the Red Army, with the Blue Army, on the other side, assuming the offensive ultimately directed toward the capture of the capital city.

WLW BROADCASTS THE FIGHT

The Pilot flying laboratory, radio station W2XBQ, was invited by B. H. Darrow, in Charge of Educational Broadcasting for the State of Ohio, to broadcast a description of the battle over its short-wave transmitter. It was arranged to have these signals picked-up on a Super-Wasp radio receiver installed at station WEAO, the Ohio State University, and transferred to WLW, the Crosley station at Cincinnati, over a landline. At this point the speech from the airplane would be transferred to WLW's control board, and put out on the air again on their usual wavelength for the world at large to hear.

The day of the battle, May 24th, dawned thick and foggy. With a low ceiling we took off at the Columbus airport for a test with the ground receiver, and found everything O. K. with the exception of a bit of microphone trouble, which we cleared up later. About fifty pursuit and bombing planes could be discerned flying overhead for the front. At noon we took off again and circled back toward the city for a final O. K. from the college. Higgy, engineer in charge of WEAO, told us that everything was ready, and to standby for a go ahead signal. We then headed west for Big Darby Creek, and tuned in the airplane receiver to WLW. Fifteen minutes later the announcer said that he was transferring the radio audience to the plane. This was our cue, and meant that the shortwave receiver, tuned to W2XBQ, was connected, through WEAO, to the control board at WLW. I threw the transmitting switch, spoke into the mike, and introduced Mr. Darrow, who broadcast the following description of the great fight:

PUTTING WAR ON THE AIR

"Much activity can be seen along and in the territory both to the north and south of the National road leading east to Columbus. The Blues are driving forward, meeting stubborn resistance by the Reds, occupying prepared entrenched positions on the higher ground to the east of Darby Creek. The Reds, naturally, are making a determined effort to defend their important base and capital, Columbus, and the Blues are as determined to capture it.

"The Blue forces crossed the International boundary, a line running generally north and south through Toledo, Bowling Green, Findlay

and about thirty miles west of Columbus. They are opposed by two Red Cavalry Divisions, which our advance Cavalry detachments drove off. On the 22nd reconnaissance continued while Blue heavy artillery, supplies and ammunition were being moved forward and orders prepared for the forthcoming Blue offensive. On this day contact with the enemy patrols was maintained.

THE GRAPHIC DETAILS

"At daybreak of the 23rd, the Blue Army launched a determined attack all along the line, and quickly drove the Red outpost into the hostile battle position which had been entrenched to the east of Darby Creek. At 3:00 P. M. today the entire 1st Corps had crossed Darby Creek and were well into the enemy territory. The 83rd and 100th Divisions to the south had just crossed Darby Creek and held the east bank. The 5th Division, veterans of the World War and known as the Red Diamond Division, has met with more determined resistance to the south and had not crossed Darby Creek up to late last night.

"To the north I can see the fighting 37th Division of the Ohio National Guard, veterans of the battle fields of France, pushing forward towards Hilliard. They are opposed by the Red Second Division and part of the Red First Division. To the north of the Ohio contingent and fighting by the side of the troops of its sister state, is the famed 38th Division of the Indiana, Kentucky and West Virginia National Guard. The regiments of this Division also have streamers and citations won on foreign battle fields during the World War.

"We have just swooped down low over a small farm which I identify on my map as that of W. A. Geyer, which is located about 4 miles northeast of West Jefferson. Blue Infantry patrols of the 100th Division can be seen working rapidly eastward, apparently not encountering very determined enemy resistance. However, just to the south of this place the Blue line has not progressed as far. Much activity can be seen in the Red territory, where reserves are being marched along the National Route to reinforce their front line troops.

"Over and above the roar of our plane can be heard the rumble of our heavy artillery and that of the enemy. I can occasionally see puffs of smoke in the rear areas of the opposing forces, where heavy artillery is supporting the attack of the Blues, and the defense of the Reds.

"We have traveled southward over the area being crossed by the 'Fighting Fifth Division.' This Division was held up in the crossing of the Darby yesterday afternoon, but by renewed vigor and energy have pushed forward aggressively in their zone of action, bringing their part of the line considerably east of Georgesville, where at 3:00 P. M. they are meeting with resistance from the veteran enemy 9th Division, which has been in the front line continuously since the beginning of hostilities.

AS IT LOOKS FROM THE AIR

"We have turned our plane northward and again passed over the troops of the 100th Division. I can see their leading elements in the vicinity of J. Dortz Farm. From the continued sputtering of machine guns, it is apparent that a stiff fight is taking place in that vicinity. As we continue northwest over

Discussing their plans before going up to broadcast the war from the air: (left to right) Louis Meier, pilot; Zeh Bouck, author; and B. H. Darrow, announcer, standing in front of the Pilot flying radio laboratory, from which the description of the fighting was transmitted

Mr. Darrow talking into the microphone of the short-wave transmitter in the Pilot flying radio laboratory, a Stinson monoplane. The transmitter, which uses two five-watt tubes operating on "B" batteries, is in the framework behind the 'mike." The receiver, which is under the transmitter and therefore not visible in this photograph, is a "Super-Wasp," which works with perfect satisfaction in the air.

the area occupied by the 83rd Division, we can see the front line units of its regiment being held up by heavy machine gun fire in the vicinity of woods just north of Caldwell Corners. Apparently they have called for artillery support, for at this moment I can see shells bursting all over the wooded area and as we are at a low altitude can see the Blue troops preparing for an assault on this tract of woods, under the protection of their own artillery fire. You see that I have a good opportunity to see how the artillery fire can help out the 'doughboy' when he gets up against a tough proposition.

GETTING HOT!

"Oh boy! We had better leave this sector. We either got too close to that shelled wooded area or that Blue artillery is doing some poor shooting. Maybe they took us for an enemy plane.

"We have just received a radio that severe fighting is taking place up north in the area now occupied by the 84th Division. We will now start north; it being about 12 miles it should take 7 or 8 minutes to get up there.

"As we continue north we can see the Blue line in general in the vicinity of the C. E. Jolley Farm—Pleasant Ridge School House—The H. Keeler Farm—Hayden, the A. Cary Farm, just east of the T. & O. C., railroad, to the vicinity of Lambs Corner.

"Here we are down low where the 'sput,' 'sput' of machine guns, automatic rifles, and rifles indicate terrific fighting. In the open fields can be seen many prostrate figures, indicating that casualties have been heavy on both sides. Information we received by radio was to the effect that at 2:00 P. M. the Blues had reached the road running north and south across Indian Run Creek, but the enemy immediately launched a counter attack and drove the Blues back to their present position, about 1,000 yards back to the west.

"Due to heavy artillery shelling, apparently called for by the 84th Division to assist them in their advance, we have climbed to considerably over 5,000 feet, where a misty panorama of the entire battle field can be seen.

"Much activity can be observed in the Red rear areas, where both reenforcements and artillery are being brought up in a frantic endeavor to stem the Blue attack coming down."

A NARROW ESCAPE

At this point the weather became so thick as to make flying too dangerous for non-combat aircraft. While we could make out the ground fairly well at one thousand feet, visibility on a level of the plane was next to nothing. We realized this when three pursuit planes sudenly zoomed out of the mist, and missed us only by skillful banking on the part of their pilots. With this visibility, anything coming head on would hit us in the split fraction of a second it would require to cover the few hundred feet of visibility. So we signed off, and returned to the airport.

The next day Armistice was declared!

RADIO PHYSICS COURSE

FOR HIGH SCHOOL STUDENTS

By ALFRED A. GHIRARDI

CHAPTER 5

The Edison Effect, the Electron Theory and the Three-Electrode Vacuum Tube

55. VACUUM TUBES: Possibly the greatest single invention in radio has been that of the vacuum tube (commonly called audion, valve, or bulb). This versatile instrument, which is daily opening up new fields of application for itself in numerous branches of the industrial world, is the backbone of the present radio art. It is used in transmitting stations for rectifying alternating current, and for generating and modulating high frequency currents. In the modern receiver, vacuum tubes are employed for rectifying and amplifying the weak currents received by the antenna. They have also done a great deal toward solving the "A" and "B" battery elimination problem, by their use as rectifiers.

A vacuum tube resembles an ordinary electric light bulb somewhat, but in addition contains a network of wires known as the grid and surrounding the filament, and a strip of metal called the plate, enclosing the grid. Connections to the various elements are made by prongs extending from the insulating base, Fig. 40. The operation of the three-electrode vacuum tube as a detector and an amplifier can be understood better by first studying the various fundamental phenomena which control its action.

56. EDISON-EFFECT. In 1884 Thomas A. Edison, during the course of investigations on his incandescent lamp, discovered that when he took an ordinary incandescent lamp containing a filament, and introduced a second cold wire called a plate, insulated from the filament and maintained at a potential positive with respect to the negative end of the latter, current flowed from this wire across the vacuum to the filament as long as the filament was hot and incandescent. The current ceased as soon as the filament was allowed to become cold. If the wire was maintained at a negative potential with respect to the filament, no current flowed. This action has generally been known as the Edison Effect.

The effect was unusual but not deemed important at the time. It was taken up again years later by several other investigators.

57. ELECTRON THEORY: The underlying principle governing the action is the electron theory of matter and electricity. According to this theory all substances consist of myriads of atoms. Each atom in turn is made up of a center nucleus having a positive charge of electricity, around which revolves a number of small negative charges called electrons, shown in an elementary way in A of Fig. 36. Under normal conditions the positive charge of the nucleus is equal to the sum total of the negative charges around it, so that a state of balance exists and there is no external electrical manifestation. The chemical nature of the atom depends on the number and arrangement of its atoms, and the value of the positive charge of the nucleus of an element expressed in terms of the unit of electric charge is called the atomic number of the element.

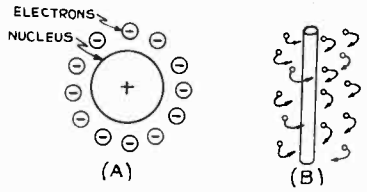


Figure 36: The atom, and electron emission.

At least one of these electrons is loose or free to circulate around among its neighbors, the number increasing with the conductivity of the substance.

58. ELECTRON EMISSION: As the temperature of the substance rises from absolute zero (—273 degrees Centigrade) the molecules begin to vibrate, their velocity increasing greatly as the temperature is raised. When the temperature is high it is relatively easier for the free, wandering electrons to become detached from their groups, and some of them, near the surface of the substance, are thrown off into space. Thus there is an emission of free electrons from a heated body out into the surrounding space, forming a sort of cloud around it. Some substance give off electrons more freely than others, as we shall see later.

When the electrons separate from the atom, the charge on the nucleus more than balances that of the remaining electrons, so

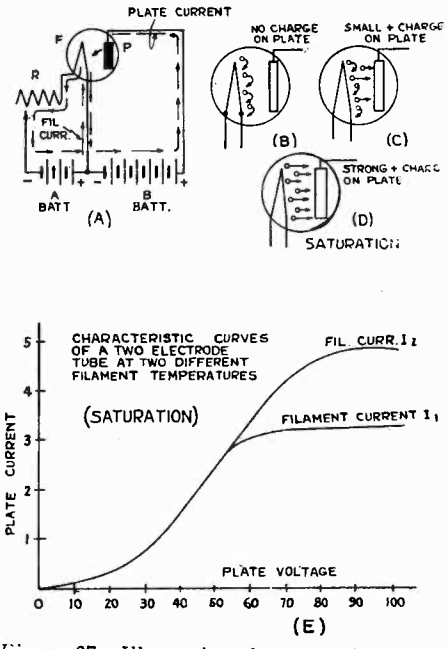


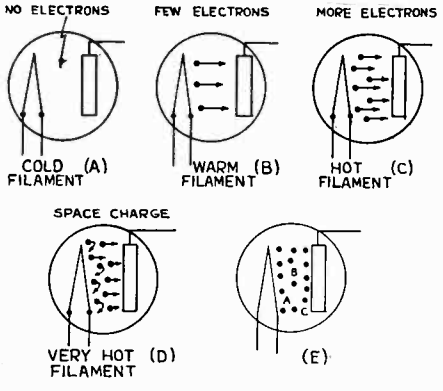
Figure 37: Illustrating the saturation effect in a tube.

that in an isolated body the free electrons are thrown off into space for a short distance and are attracted back by the unbalanced positive charge on the nucleus, somewhat as shown in B of Fig. 36.

As the temperature is raised, the agitation of the atoms increases and electrons are boiled off into space at a faster rate. Since the electrons are negative charges of electricity, if a cold positively charged body is placed near the hot substance emitting the electrons, they will be attracted to it and will travel from the hot body to the positively charged body—since unlike charges attract. The space between the two bodies is then filled with a stream of free electrons moving from the hot body to the cold one, Fig. 38. The second body must be relatively cold so it does not also emit electrons. It was shown in Chapter 2 that free electrons in motion constitute an electric current, the direction of the current flow conventionally being considered as opposite to that of the electron flow. This means that an electric current is established in the intervening space.

59. TWO-ELECTRODE VACUUM TUBE: In 1890 Dr. J. A. Fleming made practical use of the Edison effect in his two-electrode vacuum tube, Fig. 37-A. F is a metal filament heated to incandescence by a source of current A, the current being controlled by a resistance R. B is a battery (source of potential) connected between the plate P and the filament. It serves to maintain the plate electrically positive with respect to the filament. Both the plate and filament are sealed in an evacuated glass bulb to prevent oxidation or burning up of the white hot filament and to remove any air or other gas atoms which would interfere with the movement of the electrons, as explained later. As the filament is giving off free electrons and the plate has a positive potential, there is a flow of electrons from the filament to the plate, called the plate current.

60. SATURATION CURRENT: If the filament temperature is kept constant, the number of electrons emitted by it per second will be constant. Some of these electrons are attracted to the plate by the positive plate charge and others go out into space for a short distance, only to be attracted back to the filament by the unbalanced electrical charge of the atoms. The proportion of the electrons attracted to the plate depends on the magnitude of the plate potential. When the filament temperature is kept at a constant value, and the plate potential is gradually increased, the number of electrons reaching the plate, and therefore the current in the plate circuit, will gradually increase. This will continue until a condition is reached where all of the emitted electrons are drawn over to the plate, so that a further increase of plate potential will not result in any increase of plate current. This maximum plate current, beyond which there is no increase for increased plate potential, is known as the



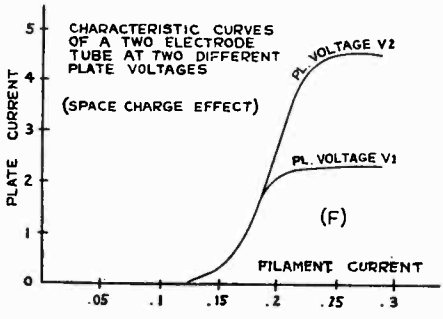


Figure 38: Space charge effect in a vacuum tube.

saturation current of the tube for the corresponding filament temperature or plate voltage.

If the plate current is to be increased beyond this point, the filament temperature must be raised, thereby increasing the electron emission. For any given filament temperature then, there is a definite value of maximum plate current which can be obtained, occurring when the plate attracts the electrons at the same rate that they are emitted.

The action is shown by the graphs of Fig. 37-E, where the plate potentials are laid out along the horizontal axis and the plate currents along the vertical axis. It will be seen that, for any fixed filament current or temperature, as the plate potential is increased the plate current rises up to the saturation point, where the curve bends over and becomes horizontal. It is evident that in order to obtain at the plate all of the emitted electrons, a certain minimum voltage must be impressed on the plate; increasing it beyond this does not result in any gain.

61. SPACE CHARGE: Now consider a tube with fixed plate potential. When the filament is cold, since no electrons are being emitted, there is no current in the plate circuit, Fig. 38-A. If the filament is gradually heated, by increasing the current from the "A" battery, it begins to give off electrons when it has attained a dull red heat, Fig. 38-B. The number of electrons emitted by the filament increases approximately as the square of the excess filament temperature above red heat.

At any instant the space between the hot filament and plate contains those emitted electrons moving on toward the plate to be absorbed there. As the filament current is increased, Fig. 38-C, the rate of emission of these electrons increases, so that any any instant the number of electrons present in the space between the filament and plate depends on the rate of emission by the filament and the rate of attraction by the plate. The steady increase of filament temperature increases the electron emission from the filament and also the number in the space. Since these electrons are negative charges of electricity, they act upon each other.

In Fig. 38-E let A, B, and C be three electrons occupying different positions in the space between the filament and plate. Electron C is attracted by the plate, and is repelled toward the plate by all the electrons back of it, since they have like charges, so it will undoubtedly go to it. Electron B is attracted by the plate, repelled back by the electrons in front of it and repelled toward the plate by the electrons behind it. Electron A is urged toward the plate by the hot filament, attracted by the plate, and repelled back by all the electrons between it and the place. Whether it will move toward the plate or reenter the filament depends on which of these forces is the greatest.

It is evident that when the electrons in the space become so dense that their combined negative charge—"space charge"—is equal to, or greater than, that of the plate, they neutralize the action of the plate and the electron flow to the plate cannot increase even though the temperature of the filament is raised. At this point any additional electrons in the space of the tube makes the space charge over-balance the plate charge and repell the excess emitted electrons back to the filament, as shown in Fig. 38-D. In order to increase the plate current at this point, the plate potential must be increased. Thus for every value of plate current, there is a certain value of filament temperature beyond which no increase in plate current can be obtained.

The phenomenon of space charge is illustrated in the graph of Fig. 38-F, where filament temperatures are plotted along the horizontal axis and plate currents along the vertical axis. For any given plate potential the plate current increases as the filament temperature rises, up to the point where the space charge becomes predominant, where the curve bends over and becomes horizontal. If the plate voltage is increased to a new value, the plate current curve rises higher before bending over, because it takes a greater space charge to offset the effect of the plate at the higher potential.

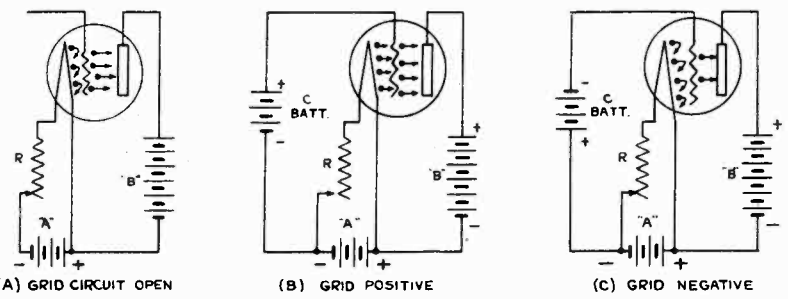


Figure 39: Action of the grid in a three-electrode vacuum tube.

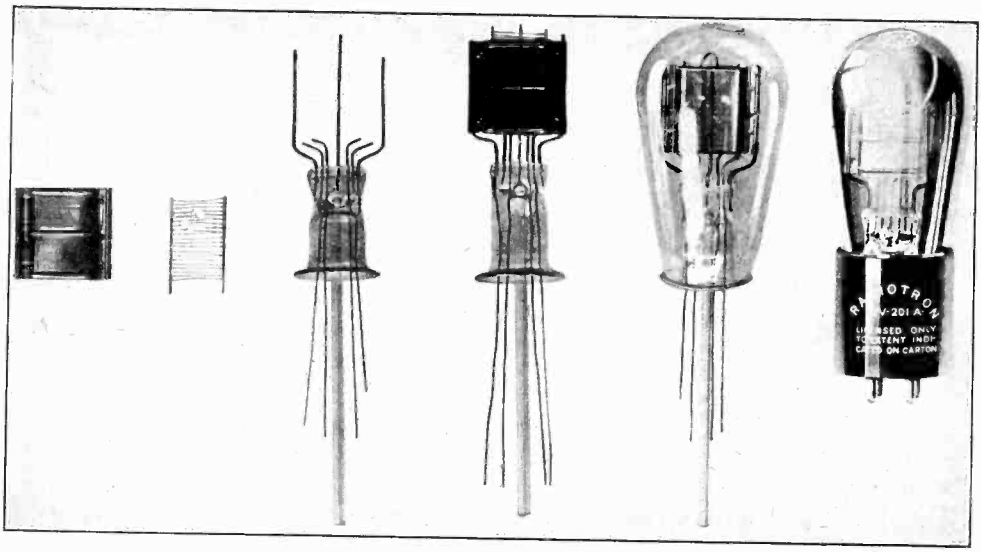


Figure 40: Stages in the assembly of a standard three-electrode vacuum tube.

62. RECTIFIER: The two-electrode tube described above was used in the early days of radio as a detector. When an alternating signal voltage is introduced in the plate circuit instead of the "B" battery, no current flows during the half cycle when the plate is made negative with respect to the filament, since the electrons do not leave the filament, on account of the repulson from the plate; but current does flow when the plate is made positive. Thus only one half of the alternating current voltage wave is effective in producing a plate current and the tube acts as a rectifier.

63. THREE-ELECTRODE TUBE: The main application of the two electrode tube at present is as a rectifier of alternating current in battery charges, and power units of socket-power radio receivers.

For amplifying and detecting, it has given way to the three-electrode tube, developed by Dr. Lee DeForest in 1907. This tube is essentially the same as the former, but has in addition a third electrode in the form of a metallic mesh, called the grid, which is interposed between the filament and the plate. Since in the two-electrode tube, with a given filament temperature, the flow of electrons depends on the potential of the plate, if a third electrode, or grid, is inserted between the filament and plate so that the electrons must go through the open spaces in it on their way to the plate, then, by varying the potential of this third electrode the electron flow can be controlled. When it is made positive with respect to the negative end of the filament by means of a battery or some other source of potential, Fig. 39-B, it tends to neutralize the effect of the space charge, thus permitting more of the electrons to get to the plate, and so increasing the plate current. When it is made negative (by connecting the negative terminal of the battery to it), Fig. 39-C, it assists the space charge in repelling some of the electrons back to the filament, so fewer electrons get to the plate and the plate current is decreased. When the grid is made positive, it collects a few electrons itself, acting like a second plate, giving rise to a current in the grid circuit from grid to filament. This should be remembered, as it becomes important in the practical use of the three-electrode tube in modern receiving sets.

64. AMPLIFYING PROPERTY: The grid of the tube, being much closer to the filament than the plate, can when a potential is applied to it, control the electron emission far more effectively than the same potential applied to the plate. In other words, two volts applied to the grid of the tube can cause say five times as much change in emission as would be caused by two volts change of voltage on the plate. We thus have a sort of trigger action here, a small voltage on the grid controlling the plate current just as effectively as a much larger voltage change on the plate would do it. The relative effects vary inversely as the cubes of the relative distances between the elements in the tube.

This means, that in the radio set, instead of applying the signal voltage to the plate circuit of a two-electrode vacuum tube to produce a variation in the plate current, if we apply it to the grid of a three-electrode tube, the same signal voltage will produce a much larger change in the plate current and hence a greater movement of the earphone diaphragm and consequently more volume of sound. This amplifying property of the three-electrode tube is one of its valuable properties.

In Fig. 40 are shown the various parts of a UX-201A tube. Looking from left to

right we have the plate, grid, mounted filament, three-electrode assembly, assembly sealed in glass bulb, and the complete tube. Notice that in the final tube the V-shaped filament is in the center; around this is the spiral wire grid; and surrounding these is the metal plate.

65. CHARACTERISTIC CURVES: The behavior of vacuum tubes is best indicated by the curves showing the relation between various factors. The actual change in plate current due to a change in potential on the grid of an ordinary radio detector or amplifier tube is shown in Fig. 41 by the characteristic curve. This can be obtained by measuring with a milliammeter (a sensisive current measuring instrument) the amount of plate current passing when there is a definite voltage on the grid. The use of a "C" battery, Fig. 39, presents a convenient way of placing a potential on the grid. It can be made stronger or weaker by varying the battery, and can be made positive or negative by reversing the connections of the battery.

The grid voltage can be varied and the plate current measured for each step, the plate voltage and filament current remaining constant. Three curves are given for various plate voltages. At zero grid potential (point A on the curve), the plate cur-

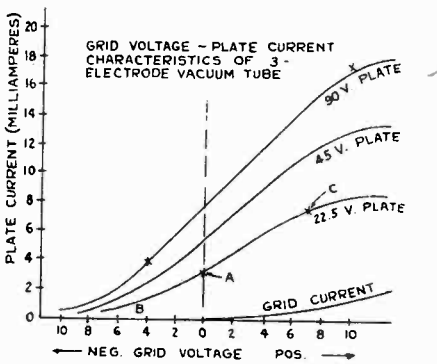


Figure 41.

rent has a definite value. As the grid potential is made more and more negative, the plate current decreases. As it is made more and more positive the plate current increases. The curve has two distinct bends, one at B and one at C. These are called the "knees' of the curve.

It is interesting to note that in the region of the negative grid potential, since there is no grid current flowing, we have the condition where a mere change of potential on the grid circuit controls the energy in the plate circuit.

In the practical operation of the tube, the temperature of the filament and consequent electron emission must be sufficiently high so that the normal plate and positive grid voltages do not cause saturation of the tube, for if this happens, the grid cannot control the plate current and the tube becomes inoperative.

66. EFFECT OF GAS IN A VACUUM TUBE: The forgoing explanations of the actions taking place in the vacuum tube were based on the supposition of a very perfect vacuum in the tube. Under these conditions the tube operates entirely by the normal, unimpeded electron stream in the tube. If the space in the tube contains more than the slightest trace of gas, and the plate voltage is high, the operation is somewhat more complicated, and a larger plate current will usually flow for a given plate voltage, provided ionization takes place.

The actual rate of emission from the filament is not affected, but the liberated electrons on their way to the plate collide with the atoms of the gas. The electrons in the gas atoms revolve in orbits around the central nucleus and some of these orbits are quite distant, relatively, from the nucleus. Some of these far-out electrons of an atom collide with the emitted electrons from the filament and are carried along to the plate, by the action of the positive charge on the plate. The process of losing electrons from an atom is called ionization, and the part left behind is called an ion. Since the ion has a preponderence of positive charge because it is derived from an atom minus an electron, it moves toward the filament and tends to reduce the negative space charge in the tube. Thus both parts of the disrupted atom contribute to the increased electron and plate current flow through the space. The action of a colliding electron upon an atom is called ionization by collision, and on account of it, larger plate currents will usually flow with given plate voltages in tubes having a poor vacuum. Air, of couse, is a gas.

Present day vacuum tubes of the common type are made with a high degree of vacuum so that no appreciable ionization takes place. In some special purpose tubes, as the Donle Sodion detector (now obsolete), ionization is employed to produce certain desired characteristics.

Ionization in a tube might at first seem desirable, since its effect is to increase the plate current. Actually, however, it is undersirable since it stops the normal operation of the tube. Also, since the ions which are driven violently against the negatively charged filament are much more massive than electrons, the bombardment actually seems to tear away the surface of the filament, disintegrating it and reducing its useful life. Ionization in a tube is accompanied by a visible blue glow discharge. The tube usually becomes very erratic in behavior when in this condition. It is not sensitive as a receiver since the plate current becomes so large it is unaffected by variation of the grid voltage. Some of the old gas filled detector tubes could be made to ionize strongly at plate voltages as low as 100 volts.

THE "LITTLE PAL" GROWS UP

Instructions for Adding Two Stages of Audio Amplification to the Popular "Little Pal" Tuning Unit.

By Alfred A. Ghirardi

THE many letters which we have received since the publication of the Spring Issue of RADIO DESIGN indicate that a great many "Little Pals" have been built by young boys all over the country. In nearly every case the builders were so enthusiastic about the results obtained with the simple R.F. and detector unit that they wanted to add two stages of audio amplification to obtain loud-speaker volume. Many boys have told us how proud they were when the family gathered around the "Little Pal" on the night of its first tryout and the set actually performed perfectly when the switch was turned on. "The greatest thrill I ever had," writes one fifteen-year-old boy.

In the last article we promised to give detailed instructions for adding the audio amplifier to the Little Pal. The instructions contained here should enable anyone to do this in an hour.

The audio amplifier consists of two amplifier tubes coupled together by audio transformers. You will notice that an additional 45 volt "B" battery is employed to boost the amplier tube plate voltage to 90 volts. The B+ lead from the original R.F. tube is also connected to the 90-volt tap on the "B" batteries for more efficient operation.

ADDITIONAL PARTS NEEDED

The complete lists of additional parts needed is as follows:

2 No. 391 3½ to 1 ratio audio transformers.
2 No. 216 4-prong S.C. type sockets.
Hookup wire, wood screws, soldering lugs, solder.

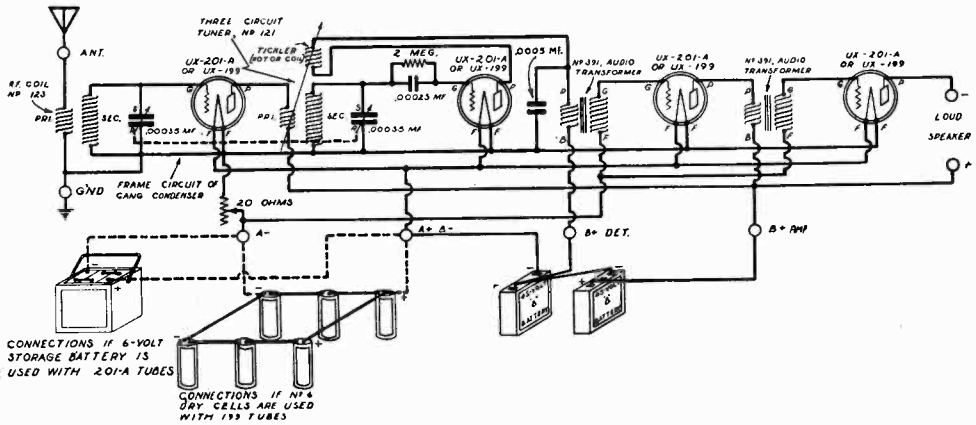
ADDITIONAL ACCESSORIES

2 Tubes, either UX-201A or UX-199.
3 Additional No. 6 dry cells if UX-199 tubes are used.
1 45-volt "B" battery.
1 Loud speaker.

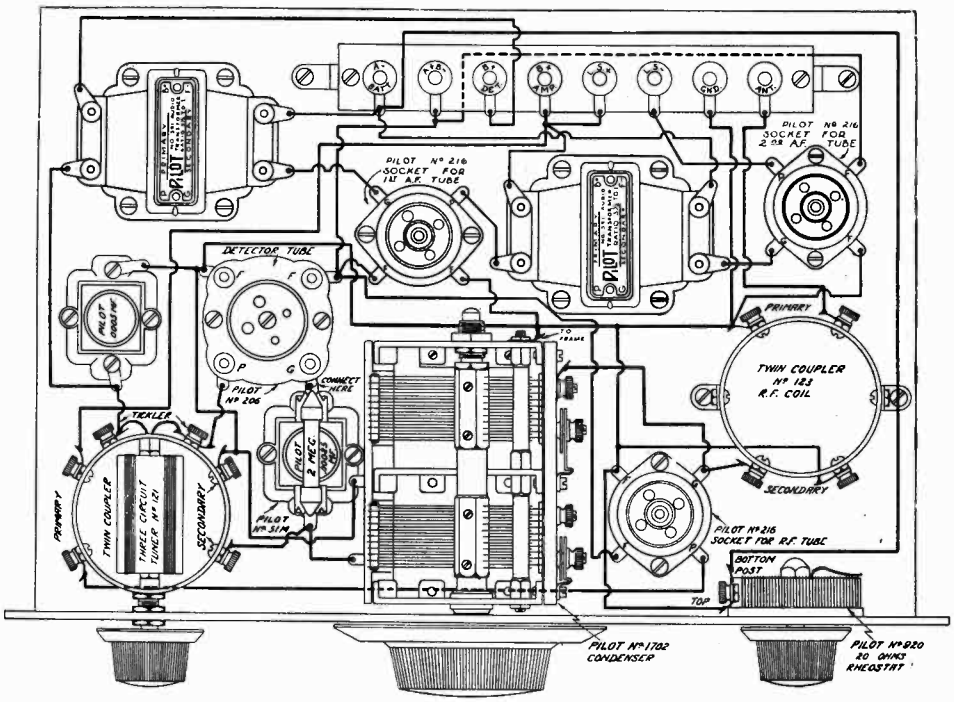
WIRING THE PARTS

First mount the two sockets in the positions shown in the accompanying picture wiring layout. Make sure that the sockets are placed so their terminals are arranged as shown. Now make the various connections to these sockets, placing the wires in the positions shown by the heavy lines in the diagram.

Mount the two audio transformers with their terminals in the positions indicated. Disconnect the wire running from one terminal of the .0005 mf. fixed condenser to the L.S.- binding post. Connect this same terminal on the condenser to the P terminal of the first audio transformer. Remove the jumper wire between the B+ det. and L. S.+ binding posts. Connect the latter post to the B amp. post, as shown. Make all other changes in the wiring as indicated in the picture wiring layout. When you have finished, carefully check over all connections to make sure they correspond with both the picture diagram and circuit diagram.



The schematic diagram of the complete "Little Pal" receiver, showing the two-stage audio amplifier and all the required "A" and "B" batteries.



Picture wiring diagram of the complete "Little Pal" receiver. This corresponds exactly with the schematic diagram shown on the opposite page.

TUBES AND BATTERIES

You must add another 45-volt "B" battery as shown in order to operate the plates of the amplifier tubes at 90 volts. If UX-199 tubes are used, three additional No. 6 dry cell "A" batteries must be connected in series with each other, and the group must be connected in parallel with the original group. This is necessary because of the increased filament current drain due to the two added audio tubes. If you operate four 199 tubes from only three dry cells the batteries will not last very long.

OPERATION OF THE SET

Insert the two audio tubes in their sockets. Now connect a pair of earphones or a loud speaker to the speaker terminals. Operate the set exactly as you did before you added the amplifier. You will now be able to hear your favorite stations louder than before and will no doubt be able to pick up a lot of new ones. Always keep the filaments of the tubes turned down as low as is consistent with good quality and volume. This lengthens the life of both the tubes and the "A" and "B" batteries.

DATA ON TUNING UNIT

The assembly of the two-tube tuning unit of the "Little Pal" was described in detail in the Spring issue of RADIO DESIGN. If you missed this, send fifteen cents United States stamps to RADIO DESIGN, 103 Broadway, Brooklyn, N. Y., and we will send you a copy. It contains a lot of good "dope" that will interest you greatly.

For the benefit of those who might want to build a complete four-tube "Little Pal" from the picture diagram above, we are printing herewith a list of the parts needed for the tuning unit itself. Also get the material listed on the preceeding page, and you will then have everything you need.

PARTS FOR ORIGINAL SET

1 No. 1702 .00035-mf. 2-gang Compact condenser.
1 No. 121 3-Circuit Tuner.
1 No. 123 R. F. coil to match No. 121 coil.
1 No. 920 20-ohm rheostat.
1 No. 51M .00025-mf. fixed condenser with grid leak clips.
1 No. 756 2-megohm grid leak.
1 No. 52 .0005-mf. fixed condenser.
1 No. 206 Shock-proof 4-prong socket.
1 No. 216 4-prong S.C. type socket.
1 No. 1274 4-inch round dial.
8 engraved bakelite binding posts.
1 14x7x1/8-inch formica front panel.
1 7x1x1/8-inch formica binding post strip.
1 13x9x1/2-inch wood baseboard.
Hookup wire, wood screws, soldering lugs, Two small metal brackets.

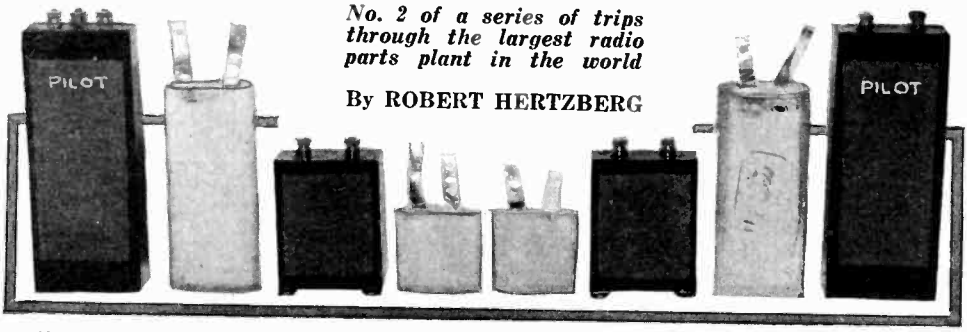
ACCESSORIES

2 Tubes, either UX-199 or UX-201A.
1 Six-volt storage battery if 201A tubes are used.
3 No. 6 dry cells if UX-199 tubes are used.
1 45-volt "B" battery.
1 Pair of earphones.
Aerial and ground wire and insulators.

HOW FILTER CONDENSERS ARE MADE

No. 2 of a series of trips through the largest radio parts plant in the world

By ROBERT HERTZBERG



Above: A group of Pilot filter condensers, showing the wound units before being sealed, and the completed condensers themselves.

WHEN you go into a radio store and ask for a filter condenser you receive a little metal can with a pair of binding posts stuck in the top. You look at it and say, "Gosh! that's a simple thing. I bet the manufacturer makes a lot of money on it."

The filter condenser *does* look rather simple, but in this case, as frequently happens, appearances are misleading. All you see on the outside is a metal can, a label and some connection terminals; what you cannot see, inside, is a roll of paper and metal foil that represents numerous operations performed by expensive and complicated machines, and the skill and efforts of highly-trained engineers and mechanics.

So that you may be able to fully appreciate the filter condenser, which performs an important function in radio circuits, let us make a trip through the condenser department of the Pilot Electric Manufacturing Company, of Brooklyn, the largest parts firm in the world, and learn just how a filter condenser comes into being. The visit will be interesting as well as instructive, and after it's over you will be able to talk intelligently about condensers and what goes into them.

Perhaps you have obtained the idea, possibly from some old textbook, that all condensers consist of layers or stacks of tinfoil separated by sheets of paper or mica. When you enter a large sunlit room on the sixth floor of the Pilot factory you will be surprised to learn that filter condensers are not stacked, but are wound just as coils are. In this room, which is thoroughly ventilated to make it dust-proof, are half a dozen condenser winding machines like the one shown in Figure 1. You will ask immediately,

"Why must the room be dust-proof?"

NO DUST ALLOWED!

The answer is that if dust gathers on the surface of a condenser while it is being wound it will tend to break down later when it is subjected to high voltages. Many mysterious failures of condensers that seemed to be absolutely perfect were finally traced to dust, so now the Pilot condenser room is kept as scrupulously clean as a hospital operating room.

Each winding machine consists of an upright case on the inside of which are mounted a number of spindles, which in turn support large rolls of paper and of aluminum foil. After a machine has been "loaded," and the ends of the various rolls brought out through slits in the front of the case, it is closed tightly. The side of the case is of glass, so that the operator can observe the rolls constantly. To start a condenser, the girl first pulls out the ends of the papers and secures them around a polished spindle. She presses her foot against a lever, and a motor causes the spindle to wind on a few turns of paper. Then the girl carefully pulls out the ends of the aluminum foil, centers them accurately on the papers, and again starts the motor. A counter on the spindle shaft tells her when the correct number of turns for any particular size of condenser have been wound on. She stops the machine five turns before the actual required number, and places small strips of tinned copper against the foil. These are the connection lugs, which are held securely in place by the tightness of the winding.

The girl then runs off the final five turns, and clips the ends of the aluminum coil. She lets the paper run a few more turns before cutting it. After cutting, she pastes down the end of the outermost paper and pulls the completed condenser off the spindle. She simply squeezes it flat and places it in a tray.

The paper used in Pilot condensers is .0004 inch thick, and is of the highest grade available. It is exceptionally free from carbon and dust, a fact that accounts for the

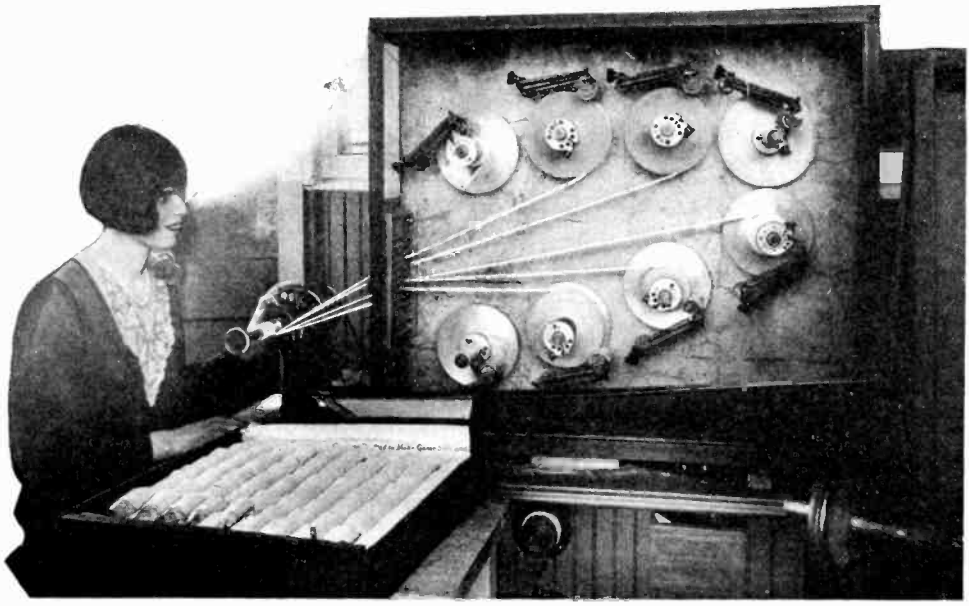


Figure 1: Side view of a condenser winding machine. Notice how the sheets of paper and metal foil feed through the end of the case onto the winding spindle.

strength and long life of the devices. The aluminum foil is .00025 inch thick. Both paper and foil are supplied in rolls of various widths, for the various sizes of condensers.

The foil in all cases is ⅜ inch narrower than the paper, so that there is a 3/16 inch overlap of paper on each side of the foil. This is more than enough to prevent arc-overs.

The setting of the foil inside the papers is a very delicate operation, and is done by highly skilled girls. If either foil or paper is offset the merest fraction of an inch on the winding spindle, the condenser will wind unevenly and after a few turns the foil and paper will wrinkle.

After the winding operation, the rest of the condenser assembly process is one unending fight against moisture. Moisture is the deadly enemy of condensers, just as it is of transformers, and the same precautions that make the famous Pilot moisture-proof transformers so reliable are exercised in the construction of the Pilot filter condensers.

HEATED IN OVEN

The condensers, after being wound, are loaded in a huge three-ton oven, which holds 1,600 of them at a time. The door of the oven is left open one inch, and the condensers are steam heated for two hours. The door is then shut tight, and all the moisture that has been driven out of the condensers by the heat is drawn out of the oven by a big vacuum pump (Figure 4). The vacuum is left on for an hour and a half, and thoroughly removes every last remaining trace of vapor.

The drying oven, as shown in Figure 2, is as high as a man and is fitted with shelves on which the condensers are placed in long racks.

After the door of the oven has been opened, the condensers are shifted quickly to the impregnating tank, which is six feet high and four feet in diameter. This tank is a combination vacuum and pressure tank, and is surrounded by a steam jacket by means of which its contents can be heated. It is protected on the outside by a covering of asbestos. (See Figure 3.)

The racks holding the condensers are suspended inside this tank, and the heavy cover lowered down and clamped air-tight. The vacuum pump is turned on for fifteen minutes, to draw out any slight moisture that the condensers might have absorbed from the air during the brief handling period.

After this initial measure, the vacuum pump is shut off, and molten halowax is drawn from a reserve tank into the impregnating tank. The condensers are left to soak in the wax for one hour and twenty minutes. Then the valve leading from the reserve tank to the impregnating tank is shut off, and air pressure of 60 pounds is applied to the latter tank for ten minutes. This pressure forces the wax into any tiny crevices in the condensers that may have escaped the previous soaking. Finally, the valve leading to the halowax tank is again opened, and the air pressure forces the remaining wax of the impregnating tank back into it, leaving the latter tank empty for the next batch of condensers.

Each stack of condensers, after it leaves the impregnating tank, is placed in a large arbor press, and a certain predetermined

pressure is exerted on them. This is done to make the condensers assume their rated capacity. The capacity of any condenser consisting of a large number of plates or of many rolls of paper and foil is dependent to a considerable extent on the pressure applied to it. The tighter the assembly, the higher the capacity, usually; and vice versa.

After being squeezed down properly, the condensers are swung from the press by chains and left hanging over night in a cooling tank. This is simply a large open tank from which moisture and other vapors are drawn away by a powerful exhaust fan.

Figure 3: The impregnating tank, in which the dried condensers are impregnated with wax.

If we were to come back the next day, we would see the now thoroughly dried condensers ready for their initial tests. They feel as hard as rocks, and can be subjected to the most punishing treatment without suffering more than dented edges.

The matter of testing is an extremely important one, and some complicated and expensive apparatus has been installed for the purpose in the Pilot plant. Two big motor-generators, connected in series, supply 5,000 volts of direct current, lower values being obtained through resistances mounted behind the control panels shown in Figure 5. These generators are enclosed in double locked wire cages, which cannot be entered unless the current is turned off first.

The smallest Pilot condenser, the No. 801, which has a capacity of 1 microfarad and an operating voltage rating of 180, is tested for one second at 800 volts. If it is defective in any way it will immediately break down under this high voltage, and a red lamp will light. The No. 9302 condenser, of 2 mf. capacity and 300-volt working voltage, is subjected to 1,200 volts. Other sizes are tested with proportionately high voltages, up to 5,000 volts.

It takes a pretty good condenser to stand up under these flash voltages. Those that pass the test very rarely develop trouble later when they are operated on their normal voltages; in fact, the percentage of returns is so small that the condensers might be said to be perfect. Of course,

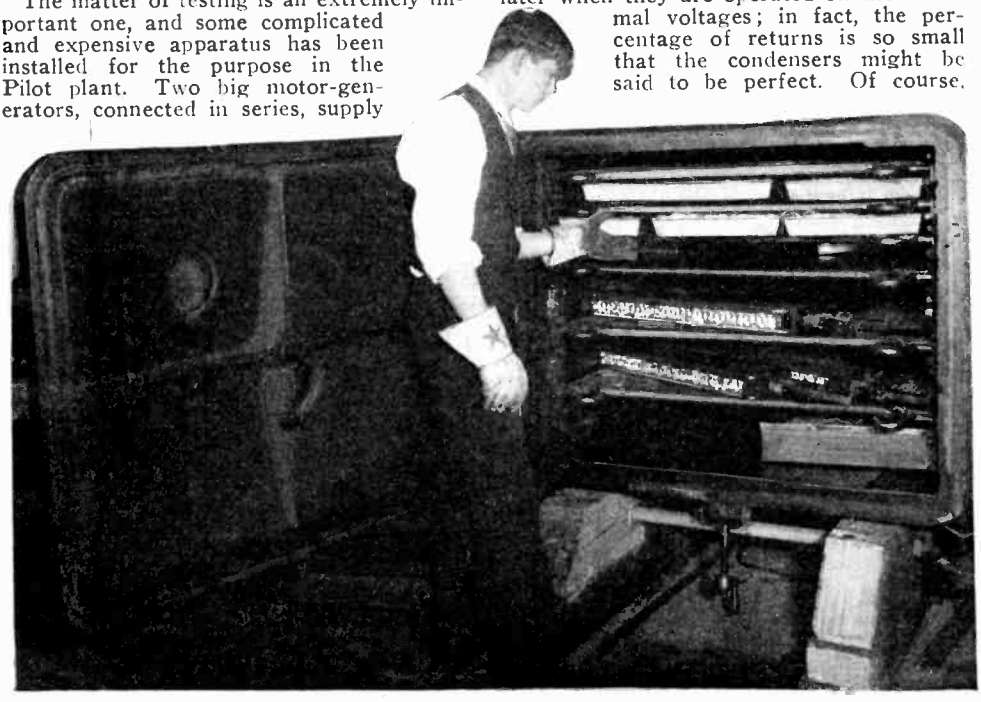


Figure 2: The three-ton oven in which the condensers are thoroughly dried before they are impregnated with wax.

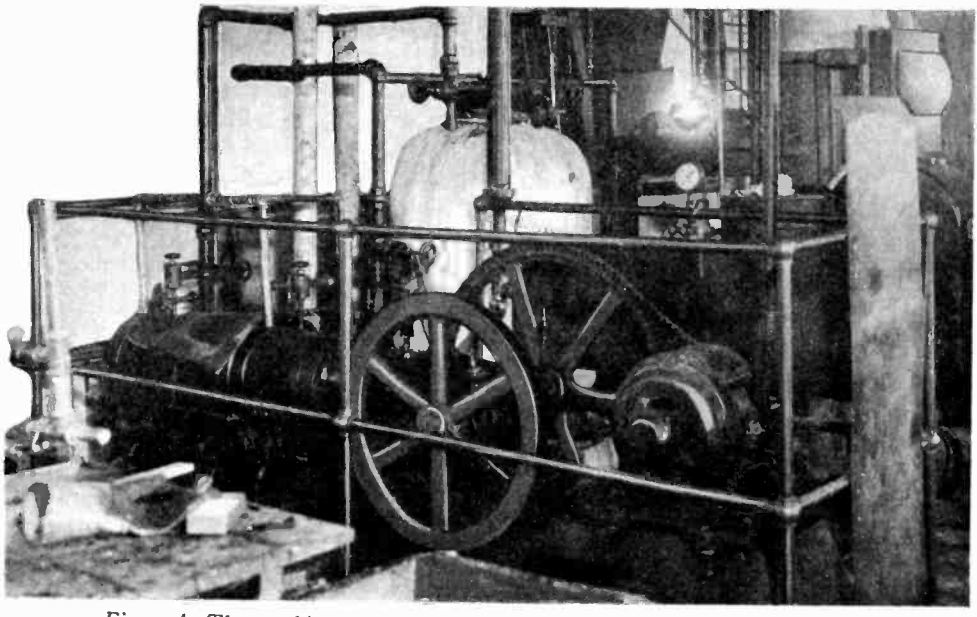


Figure 4: The machinery that creates the vacuum for the drying oven and the impregnating tank.

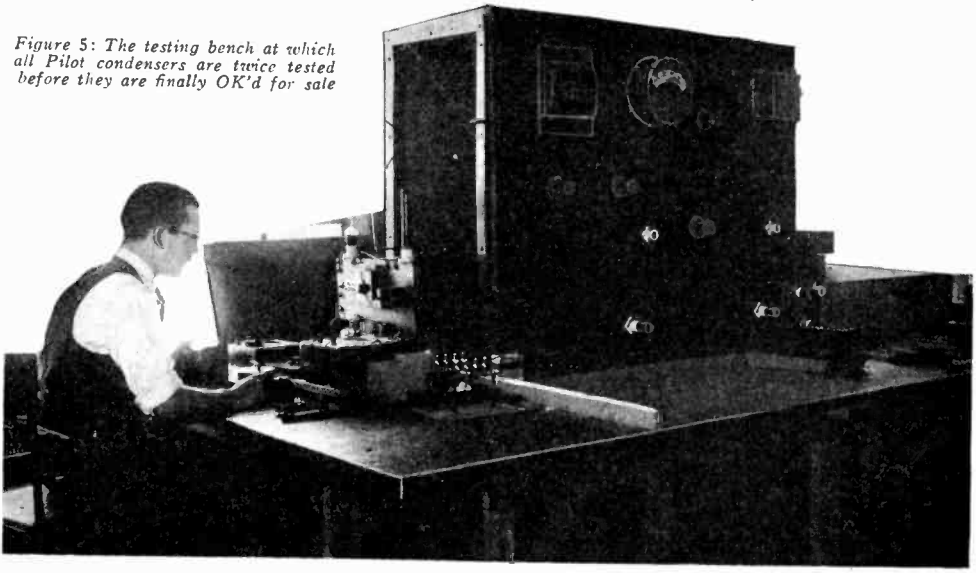
many condensers break down during the initial test, because of some microscopic weakness in the paper; tiny flaws of the trouble-making kind cannot always be detected in the paper before the winding process, and if they are discovered in the flash test, the condensers are thrown away.

The rest of the assembly process is simple. The lugs of the tested condensers are riveted to a moisture-proof fiber strip, on which are two screw binding posts. The whole unit is placed in a steel can, which has been lined with impregnated paper to guard against "grounds" to the metal. The cans, 100 at a time, are filled with paraffin to the level of the fiber strips, and after the paraffin has cooled, they are topped off with a layer of black pitch.

Not yet fully satisfied, the Pilot engineers route the completed condensers back to the testing benches, where they are again flash-tested at the same voltages as before. After this final inspection they are labelled and packed, and shipped to every corner of the earth where radio is known and used.

After you leave the factory you will draw a breath of fresh air (that odor of wax *is* irritating) and you will now say, "Gosh, a filter condenser isn't as simple as it looks, after all. It's a real job to make one."

Figure 5: The testing bench at which all Pilot condensers are twice tested before they are finally OK'd for sale



RADIO ENGINEERS NOW THINK IN TERMS OF KILOCYCLES

RADIO engineers started so long ago to think and calculate in terms of wavelength (meters) that no one remembers just *why* they started that way. Today, however, with the governments of all countries allocating transmitting stations by definite frequency separations (in kilocycles), it is much more convenient and accurate to work in terms of frequency.

This new habit, unfortunately, is not easy to acquire, because the kilocycle difference per wavelength is very great at short wavelengths (that is, below about 50 meters), and very small at the usual broadcast wavelengths, between 200 and 550 meters.

The relation between frequency and wavelength is just this: Radio waves travel at the same speed as light, approximately 300,000,000 meters per second. This corresponds to about 186,000 miles per second. If the wavelength of a particular transmitting station, for instance, is 100 meters, each wave will travel 100 meters before the next one starts. During one second there will be time for 3,000,000 such waves. In other words,

$$\text{Frequency (in cycles)} = \frac{300{,}000{,}000}{\text{Wavelength (in meters)}}$$

In general, the frequency as expressed in cycles is a large and unwieldy number, so radio engineers use the term "kilocycle," which stands for one thousand cycles. Thus, instead of saying 1,000,000 cycles (equivalent to 300 meters), we say 1,000 kilocycles. The term is usually abbreviated into the letters "kc." On the very short wavelengths the frequency runs up into several million cycles, so the term "megacycles," meaning one million cycles, is frequently found to be more convenient than "kilocycles."

Nowadays we work in terms of frequency rather than wavelength because it has been found that a uniform separation betwen stations of ten kilocycles is enough to prevent the transmitters from causing interference with each other in receiving sets. There is no way of expressing this separation as a uniform quantity in terms of wavelength. For example, the difference between 590 and 600 meters is approximately 10 kilocycles, while the difference between 10 meters and 20 meters is 15,000 kilocycles.

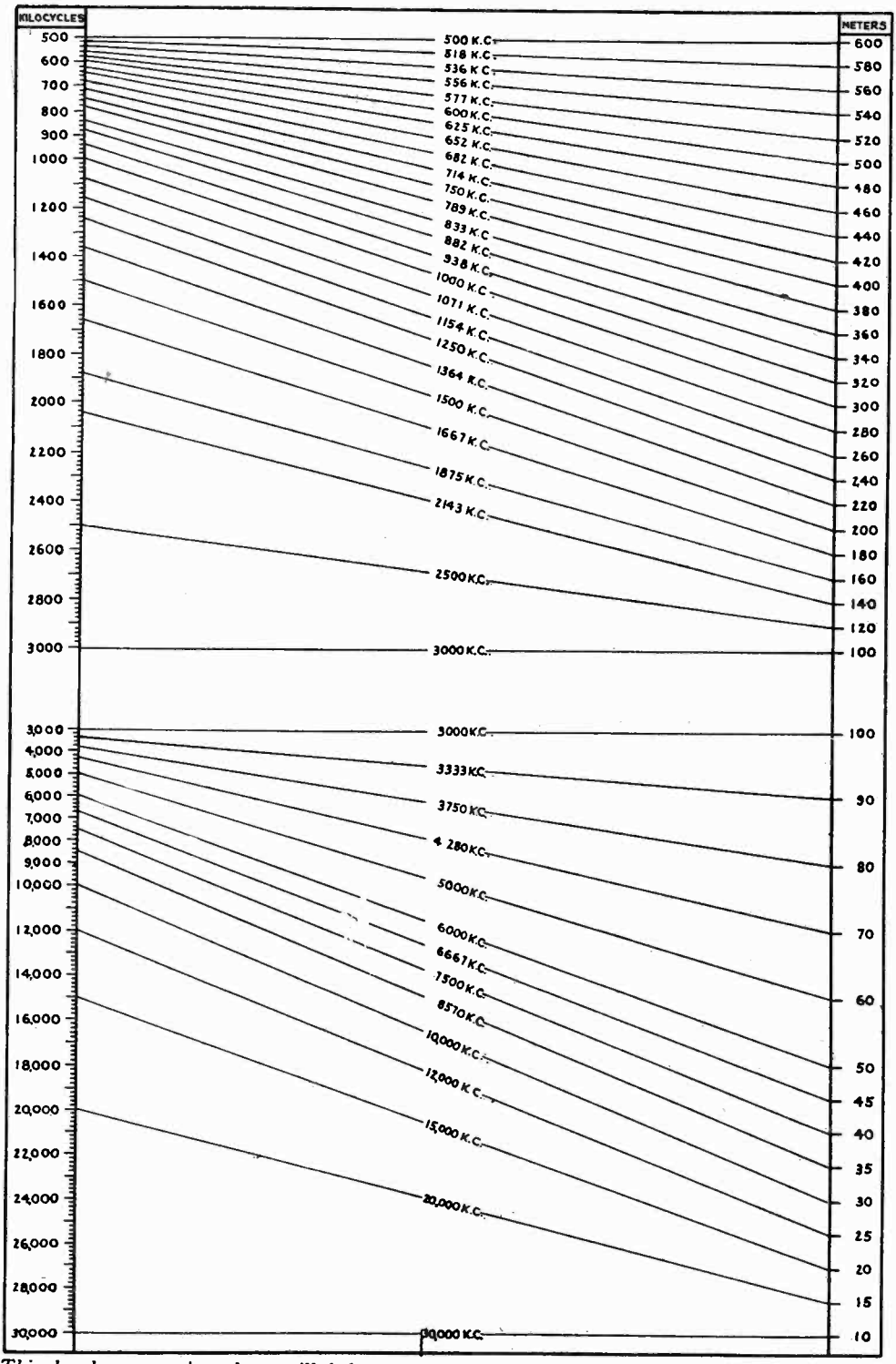
The chart on the opposite page was prepared to enable you to tell at a glance the relation between frequency separation, as expressed in kilocycles, and wavelength, as expressed in meters. By referring to the numerals in the right-hand column of the chart, you will see that 600 meters is equal to 500 kilocycles, while 200 meters is equal to 1,500 cycles. It is a good idea to cut out this chart and to paste it on a piece of cardboard, or to tack it on the wall in front of your radio set, as it will be very useful. You might hear an announcer give the frequency of his station in kilocycles, without mentioning the corresponding wavelength figure in meters. If you want to know the latter for purposes of record, or for checking the wavelength setting of the dials, all you have to do is look at the chart, and you have the number.

The chart discloses one very interesting fact that many people do not appreciate. If we take the range from 200 to 500 meters, for broadcasting, we find it equal to a band 900 kilocycles wide. This means it is big enough to accommodate ninety transmitting bands or "channels" each 10 kilocycles wide. In the space between 10 meters and 200 meters, a band only 190 meters wide compared to 300 meters for the 200-500 range, there is a frequency difference of 28,500 kilocycles, which will give us 2,850 ten-kilocycle channels. In other words, between 10 and 200 meters there is room for 32 times as many broadcasting stations as between 200 and 500 meters. There is room for even a greater number of code stations, which do not take up as much room on the air as broadcasting stations. When you consider this you will realize why short waves have assumed such a tremendous commercial importance, with many different communication companies asking for more channels than there are available.

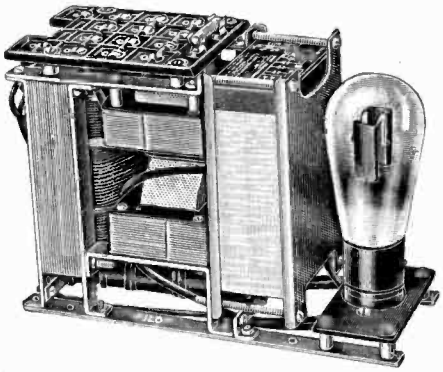
Even though you are not in the habit of thinking in terms of frequency, when you read that the band between 6,000 and 6,150 kilocycles is reserved for broadcasting you can look at the chart, find 6,000 kc., and, following the line from left to right, see that this refers to a space between 50 meters and about 51 meters. Then you will realize that although the wavelength separation is only one meter, the band has fifteen 10-kilocycle bands, or room for one-sixt as many stations as can operate between 200 and 500 meters.

Again, the band between 28,000 and 30,000 kc. has been assigned to amateurs and experimenters. Here is a separation of only .7 meters, yet there are two hundred 10-kc. bands in what appears to be a very small space in the ether.

It is suggested that all radio experimenters make use of this chart to accustom themselves as quickly as possible to kilocycles in referring to transmitting stations, for the sooner this is done, the sooner will we have an accurate idea of the places for each station in the method of allocation now in use throughout the world.



This handy conversion chart will help you to understand the relation between frequency in kilocycles and wavelength in meters. Cut it out and save it; you will have frequent occasion to use it.



Left: External appearance of the K-111 and the K-112 power packs. Right: Inside view of the K-111, showing the compact arrangement of the parts.

NEW PILOT PARTS ANNOUNCED

Include 171A Power Pack, Power Equipment for 245 Tube, Audio Transformer, Vernier Dial and Snap Switch

JUDGING from advance announcements released by the Pilot Radio & Tube Corporation, the new radio parts to be placed on the market soon are much more simple and compact than the instruments that have been made heretofore. This is particularly true of the power equipment, which in the past has been large and bulky. The new packs for the 245 tubes take up less room than most previous "B" transformers alone, in spite of the fact that they contain chokes, condensers and voltage divider all in one case.

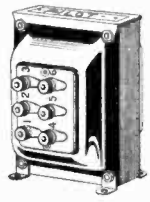
RADIO DESIGN is privileged to describe some of the new Pilot parts, which will be available soon after this number appears. Our readers should familiarize themselves with them, so that they may plan their Fall receivers for them.

171A POWER PACK

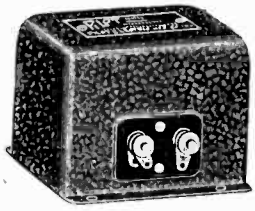
The Pilot K-111 "B" power pack is suitable for use with any receiver employing either A.C. or D.C. tubes in which the total plate current load is not more than 60 milliamperes. It will furnish plate current for one or two 171A's in the last audio amplifier position, and for five or six 201A's, 226's or 227's. The direct current output is thoroughly filtered and will cause no noticeable hum in the loud speaker. The maximum available voltage is 220, lower values of 180, 135, 90 and 45 volts also being available. The output resistor which gives these voltages is carefully by-passed by fixed condensers of suitable size.

The power transformer in the pack has three low voltage windings for the lighting of A.C. tubes. The first gives 5 volts at .8 ampere, and will heat three 171A's. The second gives 2½ volts at 6 amperes, and will handle four 227's, or five if the third winding is left idle. This latter winding delivers 1½ volts at 4 amperes, for four 226's.

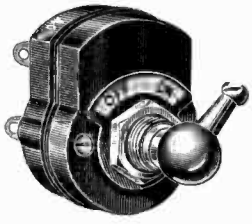
The parts of the K-111 pack are mounted compactly in a neat can 9½ inches long, 6⅞ inches high and 3½ inches deep, attractively finished in black Japanese lacquer. The 280 rectifier tube fits inside this can, adequate ventilation for it being provided. All connections are brought out to a molded bakelite terminal plate, which also holds a fuse connected in the 110-volt power circuit. The cover of the can is removable, and allows convenient access to the terminal plate and the rectifier tube. Because of its compact construction, the K-111 can be placed behind or on one side of a receiver installed in a



The No. 407 filament lighting transformer for 2½-volt tubes.



The No. 412 small metal case type audio transformer.



The No. 46 lever-type snap switch, showing ON-OFF plate.

cabinet, and is therefore particularly valuable to the custom set builder who has occasion to "electrify" old battery-type receivers.

POWER PACK FOR 245 TUBES

The K-112 power pack is similar to the K-111, but is designed to supply filament and plate current for the 245 tube and the others of the 2½-volt family. The transformers, chokes, resistances, etc., are mounted in a can exactly the same size as that used for the K-111, but the socket for the 280 rectifier tube must be supported externally. All connections are made to terminals on a molded bakelite plate under the removable cover of the can. The wires are led in through a hole in one end of the latter.

The "B" pack will deliver a maximum of 90 milliamperes at 200 volts, and will take care of two 245's in push-pull and five or six extra tubes of the 227 and 224 variety. It is thus suitable for practically any present-day receiver. Taps are provided for voltages of 300, 180, 90 and 45. The 300-volt tap for the 245 tubes is taken between the filter choke coils, so there is no audio coupling between the last audio stage and the preceding circuits. A feature of the "B" pack is the use of a variable resistance to insure the delivery of the rated voltages from the various taps. This does not affect the 300 volts for the 245's, but only the output of the voltage divider. This resistance is highly valuable because it allows the power unit to be adjusted to the exact current requirements of each individual receiver.

There are three filament windings. The first develops 5 volts at 2 amperes, and is intended for the filament of the 280 rectifier tube. The second delivers 2½ volts at a maximum of 12 amperes, and will handle 6 or 7 tubes of the 224 or 227 type. The last winding also gives 2½ volts, but at a maximum of 3.6 amperes, and is for one or two 245's. These ratings are quite conservative, and the transformer will not heat up unduly under the load.

The K-112 pack, like the K-111, is a most handy unit because of its compact mechanical construction and its flexible electrical arrangement.

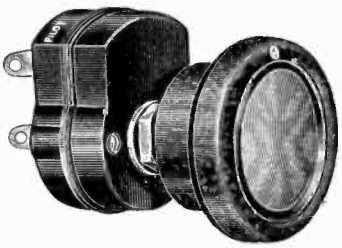
245 PUSH-PULL AMPLIFIER

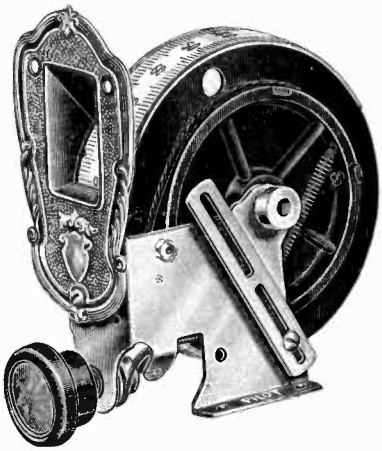
To satisfy the increasing demand for an audio amplifier powerful enough to be used for radio, phonograph and sound motion-picture reproduction in small halls and theatres, the Pilot company has developed the K-113, a compact unit supplied in semi-kit form. This consists of the K-112 power pack, which is already wired, and an aluminum base panel, drilled for five tube sockets, two push-pull transformers, a Resistoblock, a grid-leak mounting and six binding posts. Despite its lightness, the base panel is extremely rigid, because of the manner in which it is formed. It is 16 inches long and 9¾ inches wide. When the amplifier is completely assembled, it stands 8 inches high.

The first amplifier tube, a 227, is not accompanied by any coupling device, the choice of the input system being left to the constructor. Some people may want to use the amplifier for public address work, and will therefore connect the microphone modulation transformer to this tube. Others may want to use the first transformer in their radio receivers, or a resistance coupling unit.

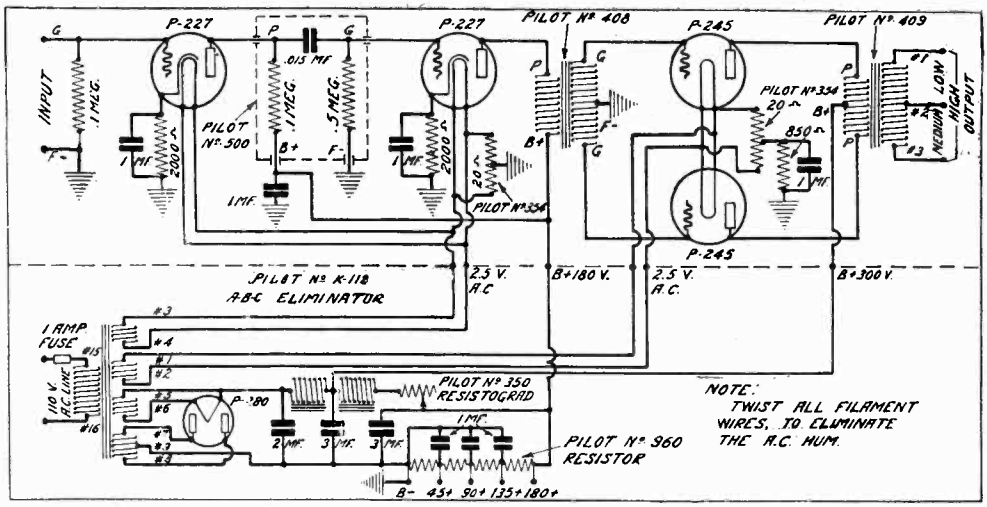
The first tube is resistance coupled to the second, which is also a 227, and this in turn works into a push-pull stage using 245 tubes. The output transformer is a special instrument with a tapped secondary giving output impedances of 1500, 2500 and 4000 ohms, respectively. The amplifier may thus be matched to any speaker or combination of speakers; it will handle two large dynamics or from three to five magnetic speakers. The unit is completely self-contained, all "A", "B" and "C" voltages being supplied by the K-112 pack.

The K-113 will appeal to custom radio builders because of the ease with which it can be assembled and because of its numerous applications. It is low priced, and can be sold to owners of small theatres, soda parlors, department stores, dance halls and other places of business which can be made more attractive by a good loud-speaker system adaptable to a radio set, a phonograph or a hand microphone.





Above: The No. 45 knob-type snap switch. This is the same as the No. 46 except for the knob. Right: The No. 1285 vernier drum dial. The No. 1286 has the same mechanism but a different panel plate.



Complete schematic diagram of the No. K-113 push-pull amplifier. The lower section shows the wiring of the K-112 power pack.

JUMBO POWER TRANSFORMER FOR 245 TUBES

Using the same case as the No. 398 transformer, the No. 411 transformer is designed to fill the power requirements of a set using one or two 245 amplifier tubes and the usual assortment of 227's and 224's. It has one high voltage plate winding and three filament windings. The plate secondary gives 300 volts on each side of its center, or 600 volts altogether, and will deliver 90 milliamperes of current through a 280 rectifier tube and a standard filter circuit. One filament winding gives 2½ volts at a maximum of 12 amperes, the second 2½ volts at 3.6 amperes, and the third 5 volts at 2 amperes.

A flexible cord is provided for connection to the power line. The filament and plate windings are connected to screw connections on the front panel plate, which is of molded bakelite.

FILAMENT TRANSFORMER FOR 2.5-VOLT A. C. TUBES

The trend of modern set design toward the use of 2.5-volt tubes exclusively has made special heavy duty filament lighting transformers necessary. The No. 407 transformer fills the need very nicely, having ample capacity for receivers employing as many as eight or nine tubes. It has three secondary windings, brought out to three pairs of binding posts. Two of them deliver 2.5 volts, one at a maximum of 3.6 amperes (enough for a pair of 245 tubes used in a push-pull amplifier) and the other at a maximum of 10 amperes (enough for six tubes of the 224 or 227 type). The third winding develops 5 volts at a maximum of ½ ampere, and is useful if some 171A's are on hand and the constructor wants to use them instead of the more powerful 245's.

This transformer is of exactly the same size as the No. 386. It is a strongly built unit possessing a generous overload safety factor, and is suitable for use in the most advanced receivers.

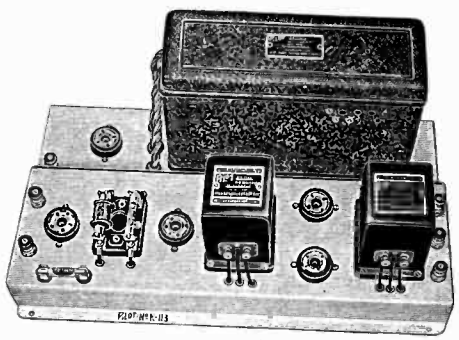
TRANSFORMERS AND CHOKES—METAL CASE TYPE, SMALL SIZE

The small metal-case transformers and chokes will appeal to the constructor because they are small enough to be mounted on the under side of sub-panels. The cases are 2⅞" square and only 2⅛" high, and have drilled feet by means of which the instruments are mounted. The No. 413 is the 3½-1 ratio transformer, the 412 the 2-1 ratio, the 414 the "B" choke, and the 415 an output choke. They are constructed with the same high degree of precision that makes all the Pilot parts so outstanding.

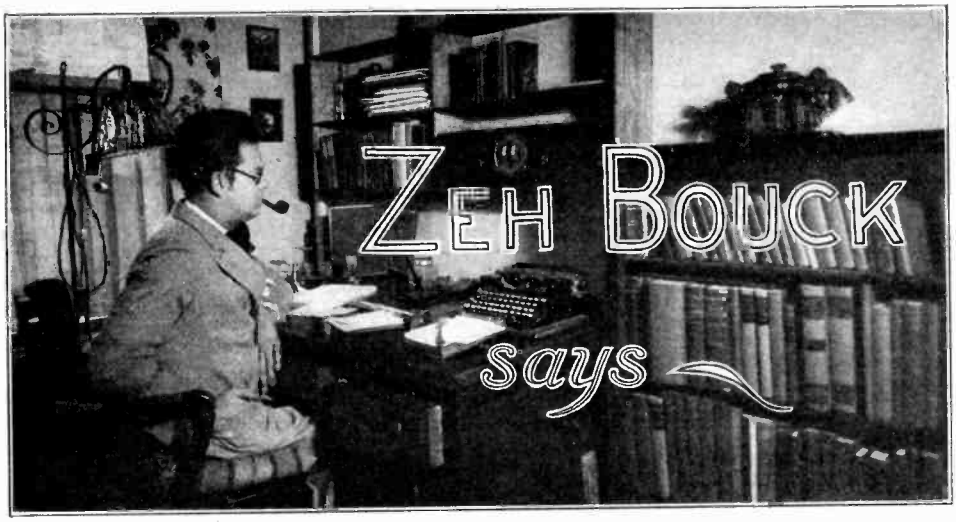
POWER SWITCHES

Three different types of switches are made by Pilot, to satisfy different tastes and requirements. The No. 42 is of the toggle type, and will handle 1½ amperes at 110 volts. It has a bakelite case and requires three mount-

(*Continued on page* 45)



The No. K-113 amplifier in assembled form. The base panel is of aluminum.



THE POWER QUESTION AGAIN

IN our last column we made some pertinent remarks on just how much power was required in the output circuit of a radio receiver to insure adequate home volume. Since that time our old friend, George Lewis, veteran operator, engineer and radio executive, has sent us the following comments, which he labels "Pilgrim's Progress in Power."

"The picture of a radio fan with 'phones clamped tightly to his ears, the phone cords held so that they cannot brush against his clothing, breathing tentatively as he chafes at the distant ticking of a clock, forms a painfully accurate visualization of broadcasting in the early days of the art—the struggle to hear.

"The aching and calloused ears, reminiscent of what W. O. McGeehan refers to as the cauliflower industry, welcomed the advent of the megaphone attached to the telephone receiver, whereby several members of the family, huddled about the 'loud speaker,' might hear, by wiggling ears and imagination, a slightly distant station.

"The next step along this route of progress was an improved speaker. The ordinary telephone receiver was replaced by a specially designed unit, and the megaphone gave way to a weird snakelike horn. At this point, speaker development had passed that of the tube. Sufficient power could not be obtained from a 199 or 201A tube to rattle the speaker—the criterion of loudspeaker reception. Folks who would spend fifty dollars to take a rattle out of their car would spend twice as much to put it in their radio.

"Then came the more artistic cone speaker with the 171 and 210 power tubes, and last year the moving coil or dynamic speakers and the super-giant 250 tube.

"And so the conquest of power continues.

"'You can hear my radio all over the house,' rejoices one ardent Christian. 'You can hear mine in the next block,' returns Pilgrim number two. The louder the noise the better the set. Radio manufacturers, cognizant of this demand for power and still more power, needs must suply it, and so we have 250 tubes in push-pull with large dynamic speakers deliverng a volume sufficient for a concert hall and about as much use in the average home as a carillon.

"Here is a curve showing Pilgrim's Progress in power. What is the limit—if any? Has the inertia of the high power stampede carried us beyond the normal power required for home reception?

"There is really no justification for super-power reception in our parlors. Not only does excessive volume provoke a variety of nervous and legal disorders, but the full amount of excess power is never used. It is like hitching a steam locomotive to your pleasure car. The result is expensive receivers—in first cost and in upkeep.

"Poor Pilgrim has met the giant Despair, and wallows in the Sloughs of Despond—for his pocket-book cannot keep up with his pyramiding idea of power POWER—POWER!

"In this age of keen competition between radio engineering laboratories, serious consideration is being given to ideal amplifiers, designed by scientists, uninfluenced by the views of high pressure salesmen and publicists.

"While there is some disagreement as to the maximum undistorted power output justified in the home radio installation, there is a general concensus that it lies somewhere between the output of two 171 type tubes in push-pull and two type 250 tubes in push-pull. A single 250 tube might seem ideal were it not for the excessive plate voltage required for the efficient operation of this tube with the concomitant high cost of power supply apparatus.

"This year a new power tube has made its debut delivering an undistorted power output

of 1.7 watts with a plate potential of 250 volts. This tube, as a group, is known as the 245 type. In an efficient push-pull circuit this tube will deliver 4.8 watts of well nigh perfect signal to a good dynamic speaker. This takes into consideration the fact that tubes in push-pull can be overloaded somewhat without introducing audible distortion.

"This tube will experience a most enthusiastic reception in new receivers this season—as it is by far the most efficient power amplifier yet designed for use in broadcast receivers.

"The success of this tube in the 1929-30 receiver will, in the writer's opinion, put a halt to the wild clamor for super-power and clearly demonstrate that quality reproduction can be had with ample volume in moderately priced amplifiers."

A WARNING—WHICH ONLY THE WISE WILL NEED!

(After Omar)

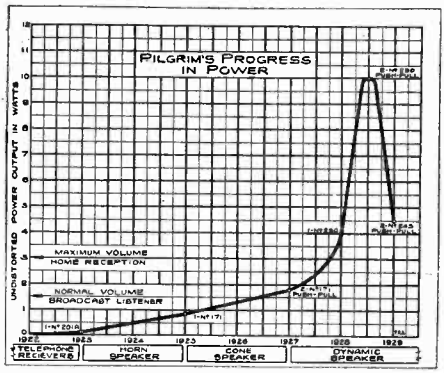
Ah woe unto the man who gives a friend,
Or sells, perchance, with money in the vend,
A radio. That man sure loseth all,
And seeks for peace the the bug-house in the end.

SUMMER RADIO

To my mind, summer is the most logical time of the year for enjoyable radio entertainment. It is *the* radio season, contrary to general ideas on the subject.

Super-power stations have overcome the only physical objections to summer radio—weak signals and static. The super-power station pushes through the absorbent summer atmosphere for several hundreds of miles with a signal that is adequately above the average static background. In appreciation of this fact, the quality of summer programs is quite on a par with the fall and winter offerings.

To my mind the great attraction of summer radio is the purity and appeal of tone of a properly loaded loud speaker operating in the open. Here, for once, we find justification for genuine super power amplifier, using at least two 245 tubes in push-pull, outputting into a good dynamic or electrostatic speaker. It is a simple matter to run leads to the speaker, conveniently located on a veranda or high in a tree with an adequate baffle. This last idea is most effective from an esthetic point of view, but somewhat inconvenient in the case of rain or sparrows.



PORTABLE SETS

You know, almost any receiver can be made into a portable set with the help of a good automobile. To those, not so conveniently equipped, we dedicate the following:

Sad tears were shed when William Samson died
And all the town spoke highly in his praise,
Lamenting on the fate that from their side
Removed their friend to dim uncharted ways.
They sang his saga, and they told the world
How ere his blood excited vessel burst,
With strength of ten he lifted up and hurled
A Ford sedan at Mrs. Bill the First.

They told how once the landlord dared to beg
His rent of Bill, unpaid for half a year,
And where they found that landlord's missing leg,
Just half a mile beyond his missing ear.

And how one day this mighty man now dead
Discolored Mrs. Will the Second's eyes
By tossing grand pianos at her head—
Then pushed a railroad train for exercise.

His friends passed hats about the village green,
To buy for Bill a tombstone paragraph,
That o'er his sweaty brow, at last serene,
They might inscribe a loving epitaph.

Sweet friends they were, but poets not at all—
(Let tears make right their half lambic verse,
Forgive the dactyl and Bill's sins withal),
And thus they wrote in meter wrong but terse:

"Here lies Bill Samson, cruel the death he met
When he tried to lift a portable radio set."

A SIMPLE LIGHTNING ARRESTER

One of the best ideas we have run across in the matter of lightning arresters is to fit a spark plug into the end of a four- or five-foot length of iron pipe, and drive the pipe into the ground. Connect the aerial to the usual binding post on top of the spark plug. The gap in the plug takes care of the rest.

This arrangement, by the way, is easily applicable to portable equipment, and the pipe, driven into moist ground, may also be used for the receiving ground.

A NOT DIFFICULT COURSE IN RADIO MATHEMATICS

Many radio experimenters, among whom I am sure we can number the majority of readers of RADIO DESIGN, would like to

delve deeper into the engineering aspects of their hobby (or profession, as it may well be) and are stumped by the barricade of mathematics that seems impregnable to anything short of a college engineering course. As a matter of fact, the average radio experimenter, possessing a public school knowledge of math, and stimulated by a genuine interest in things scientific, can acquire the fundamentals of higher mathematics in one year's time by application to the proper books. We suggest the following library to the serious radio experimenter:

College Algebra by Wentworth—Ginn and Co.

Plane Trigonometry by Wentworth—Ginn and Co.

Analytical Geometry by Wentworth—Ginn and Co.

Mathematics For Home Study by Palmer—McGraw Hill.

Calculus Made Easy by Thompson—MacMillan and Company.

Calculus For Home Study by Palmer—McGraw Hill.

Mathematics For Engineers by Dull—McGraw Hill.

A Test Book of Physics by Duff—Blackiston.

Engineering Mathematics—D. Van Nostrand.

EUROPE ON SPEAKER WITH THE SUPER-WASP

(*Continued from page* 14)

United States of America and Canada. Hello, Mr. Kleiman, of 1640 *Ocean Avenue, Brooklyn, N. Y. We received your letter to-day.*" *He then proceeded to read my letter over the air: "I had the most wonderful thrill of listening to you. The program came in very fine on my Pilot Super-Wasp short-wave receiver, etc.*"

Your set "delivers the goods." Every Tuesday evening I listen to KGO, Oakland, California. On Monday and Wednesday nights I listen to G5SW at Chelmsford, England. WGY, KDKA and one Cleveland station come in as regularly as locals.

Short-wavevically yours,
J. N. Kleiman.

ACKNOWLEDGMENT FROM COSTA RICA

This isn't all. The owner of NRH, which is probably the most unique broadcasting station in the world, took the trouble to verify the editor's reception of his signals, and wrote him the charming letter that follows:

Heredia, Costa Rica,
Central America.

Mr. Robert Hertzberg,
"Radio Design,"
103 *Broadway, Brooklyn, N. Y.*
Dear Sir:

Spring 1929 *of your magazine has swell me up, and I am going to enclose herewith the diploma of verification from the NRH, the smallest radio station on earth, just because you have mentioned that you did hear Costa Rica, in Central America, as goody as Chelmsford, England, Holland, or Manitoba, great stations working with* 30 *thousand or more watts.*

Your page 8 *and your cover ad in "Radio Design" are worth a lot to me. It is simply the acknowledgment of the impossible. I have read also ads in QST, and thanks very much for your mention of the name of my country, a novel means to use patriotism. We are all proud down here to know that an amateur of the NRH, working for fun, without pay, has inscribed on the roll of noted stations of the earth the name of Costa Rica.*

Please accept my congratulations for "Radio Design" last numbers, and believe me, yours most truly,

Amando Cespedes Marin.

Mr. Marin's diploma of verification is certainly the most unusual certificate of its kind we have ever seen. It puts to shame the penny post cards and the mimeographed forms used by far more affluent broadcasters. for whose benefit we are producing it on page 14. Gaze upon it and admire!

NEW PILOT PARTS ANNOUNCED

(*Continued from page* 42)

ing holes. The No. 44 is of the snap type, and will handle 3 amperes at 220 volts. It is supplied with a round bakelite on-off knob, and mounts in a single hole The No. 46 is exactly like the No. 44, except that a little lever is furnished instead of a knob.

NEW DRUM DIAL

For those who like to have the knob centered directly below the plate, Pilot has brought out the Nos. 1285 and 1286 single illuminated drum dials, which are alike in construction but have different panel plates. These plates are of handsomely finished bronze.

In these two dials, the bakelite drum carrying the condensers is driven by a specially treated cord which is wound around the drum and connects with a small pulley on the adjusting knob. There is absolutely no backlash, any slight wear in the cord being taken up by an automatic spring compensator. Brackets on both sides of the drum permit any combination of condensers to be mounted. The dial is equipped with a mounting foot which allows it to be screwed to the subpanel or baseboard, in addition to the front panel itself. The scale, which is removable, is illuminated by a small flashlight bulb fitting in a suitable socket. The whole dial is extremely strong and will easily handle the largest and heaviest "bath-tub" condensers.

Get a Big Pay Radio Job

$400 A Month

"I was making good money before, but I'm making more than ever now—more than $400 a month. The Radio field hasn't been scratched yet and it is getting bigger and better every day."

J. G. Dahlstead,
1484 So. 15th St.,
Salt Lake City.

Seldom under $100 a wk

"My earnings seldom fall under $100 a week. My profits for the past three months were $577, $645, $465. You give a man more for his money than anybody else."

E. E. Winborne,
1414 W. 48th St.,
Norfolk, Va.

$10,000 more in *Radio*

"I work 38 hours a week and make more than three times the weekly salary I did before I enrolled. I can safely say that I have made $10,000 more in Radio than I would have in my old job."

Victor L. Osgood,
7101 Bay Parkway,
Brooklyn, N. Y.

LIKE THESE

I Have Trained Hundreds of Men to make *much more money* in Radio than they *could make* in other fields

Let me show you, too, how, in a short time, you can be making $5 to $20 a week more. How, in a year or less you can be ready for a big-pay Radio job. Others are winning big success through this training—why not you? Men and young men from practically every trade and profession are getting into Radio. Why?

Because it is today's fastest growing business. Because there are so many opportunities for quick success. Look at the salaries above. What field other than Radio offers the chance to make that kind of money after about one year's training? None that I know of.

Big growth making many big pay jobs

Don't slave your life away for $25, $35 or $40 a week in a no-future job. You can't enjoy yourself—get the good things of life—an automobile, a home, money in the bank, on that salary. Begin now to get ready for Radio where $50 to $75 a week is only the beginning.

Many jobs lead to as high as $200 a week. In the short space of a few years Radio has grown to rank among the world's greatest industries. Every year there are hundreds of new jobs among the 30,000 Radio dealers, 600 broadcasting stations, 900 manufacturers, over 1,000 ships and other branches. My book gives the facts.

Many make $5 to $25 extra a week almost at once

The day you enroll I will show you how to do 10 Radio jobs most common in every neighborhood in connection with installing, repairing and maintaining sets. G. W. Page, 1807 21st Ave., S., Nashville, Tenn., says, "I picked up $935 in my spare time while studying." F. J. Margraf, Lapeer, Mich., writes, "After one month with you I started earning extra money."

I give you the Radio Parts for a home experimental laboratory. Six Big Outfits. With them you can build practically all receiving set circuits. Two you build are shown here.

I will train you at home. Give you practical Radio experience

Hold your job. My 50-50 method of training—one-half from lesson books and one-half from practical experiments using Six Big Outfits of Radio Parts, given without extra charge, makes learning at home easy, fascinating. It is unequaled. You don't have to be a high school or college graduate.

Many of my most successful graduates didn't even finish the grades. My training includes Television, Talking Movies, Radio Prospecting, Radio in Aviation, Screen-Grid Tubes, A.C. Sets—all the latest developments. Every penny of your money will be refunded, if upon completion, you are not satisfied with the lessons and instruction service.

Act NOW. Get "Rich Rewards in Radio"

It gives you the facts about Radio, where the jobs are, what they pay, what your prospects are for future advancement. Clip the coupon. Send it at once for a copy. You won't be obligated in the least.

J. E. Smith, President,
Dept. 9T52,
National Radio Institute,
Washington, D. C.

N.R.I. trained Men are Recognized *Radio Experts*

FIND OUT QUICK WHAT RADIO OFFERS YOU — MAIL THIS

J. E. Smith, Pres.,
National Radio Institute, Dept. 9T52
Washington, D. C.

Dear Mr. Smith: Without obligating me, send "Rich Rewards in Radio" explaining your training and Radio's opportunities for bigger success.

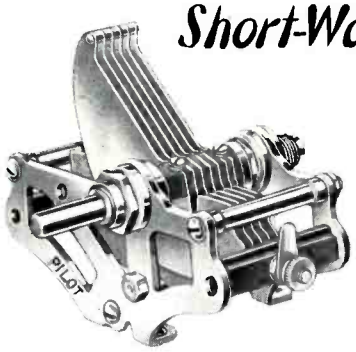
Name..... Age.....

Address .....

City..... State.....

Newest PILOT Items/

Short-Wave Condenser



Short Wave Condenser No. 1611

Featuring a 50% greater condenser plate air-space than is customary, to meet the peculiar requirements of short-wave work. The special pigtail entirely eliminates scraping noises. For mounting either directly on front panel or on sub-panel. Can be used with clock-wise or counter-clockwise dial.

Made in World's Largest Radio Parts Plant

Steel-Jacketed Transformer

Steel Jacketed Transformer No. 412

This little giant contains twice the amount of steel and copper used in any other transformer at similar prices. Ratios, 3½ to 1 and 2 to 1. Its correctly designed, compact construction permits mounting on top or underneath sub-panel. Being absolutely moisture proof, all electrolytic action between terminals and windings is avoided, thus preventing open circuits. The New Pilot "B" Eliminator choke and Output Impedance (Nos. 414 & 415) are also housed in the same type of steel case.

TRADE MARK

PILOT RADIO & TUBE CORP.

323 BERRY ST. BROOKLYN N.Y. U.S.A.

Announcing – a NEW Radio Thrill!

PILOT DOUBLE-DUTY SUPER WASP

SHORT-WAVE BAND — BROADCAST BAND

TUNED SCREEN GRID — 14 TO 500 METERS

Designed and Developed by Robert S. Kruse

Note These FEATURES:

Covers 14 to 500 meters, making it a splendid broadcast receiver as well as the most efficient short-wave set.

The only Short-Wave receiver having a stage of Tuned R.F. with Screen-Grid Tube.

Condenser Controlled Regenerative Detector.

Four Tubes including Super-Sensitive Screen Grid.

Also works efficiently on dry-cell tubes.

Two sets of plug-in coils furnished.

All-metal chassis.

No A.C. Hum pick up. Completely shielded R.F. and Detector Stages.

Low losses—ingenious design reduces all R.F. connections to 1½" or less!

Splendid loud-speaker results.

Vernier dials for both tuning condensers.

Absolutely eliminates hand de-tuning effect.

Greatest Sensitivity and Selectivity.

Simplicity of assembly due to "sectional cans" and minimum wiring. Assemble and operate it same evening!

On very first test received loud and clear broadcast programs from Chelmsford, England; Costa Rica, Central America; PCJ Eindhoven, Holland; Manitoba, Canada, etc.

Smooth operation, consistent results, easy to tune!

Priced low because produced complete in World's Largest Radio Parts Plant. Complete Kit includes 2 sets of 5 coils each, full-sized blueprint, and all necessary parts except tubes and batteries.

Custom Set Builder's Price, **$29.50**

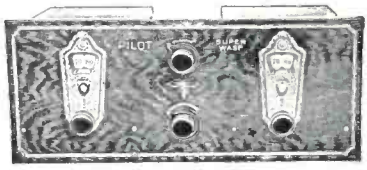
If there is no Pilot dealer in your neighborhood, write us direct.

South African Fan Hears U. S. A. with "Purity and Volume"

"I have just constructed a new all-wave receiver using only Pilot parts and am more than pleased with the result. The set gives remarkable purity and volume, which proves out the transformers. Any wave length from 15 metres to 525 can be had, the Pilot coils being easily interchangeable. I tried it out on Sunday evening for the first time and heard Cape Town, JB, 7LO, Nairobi, 3LO, Melbourne, 2XO, New York; and KDKA, Pittsburgh!"

The above item appeared January 19, 1929, in C. R. Slingsby's radio column in the "Cape Argus," a newspaper published at Claremont, South Africa. This achievement was made with the Pilot Wasp. We await with interest Mr. Slingsby's results with the Super-Wasp, which is even more efficient than its "little brother!"

Assemble it and hear it the same evening!



Front panel view of assembled Super-Wasp.

PILOT RADIO & TUBE CORP.

323 BERRY ST. BROOKLYN, N.Y. INC.

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