SHORT WAVE RADIO

April
1934

Edited by
Robert Hertzberg and Louis Martin

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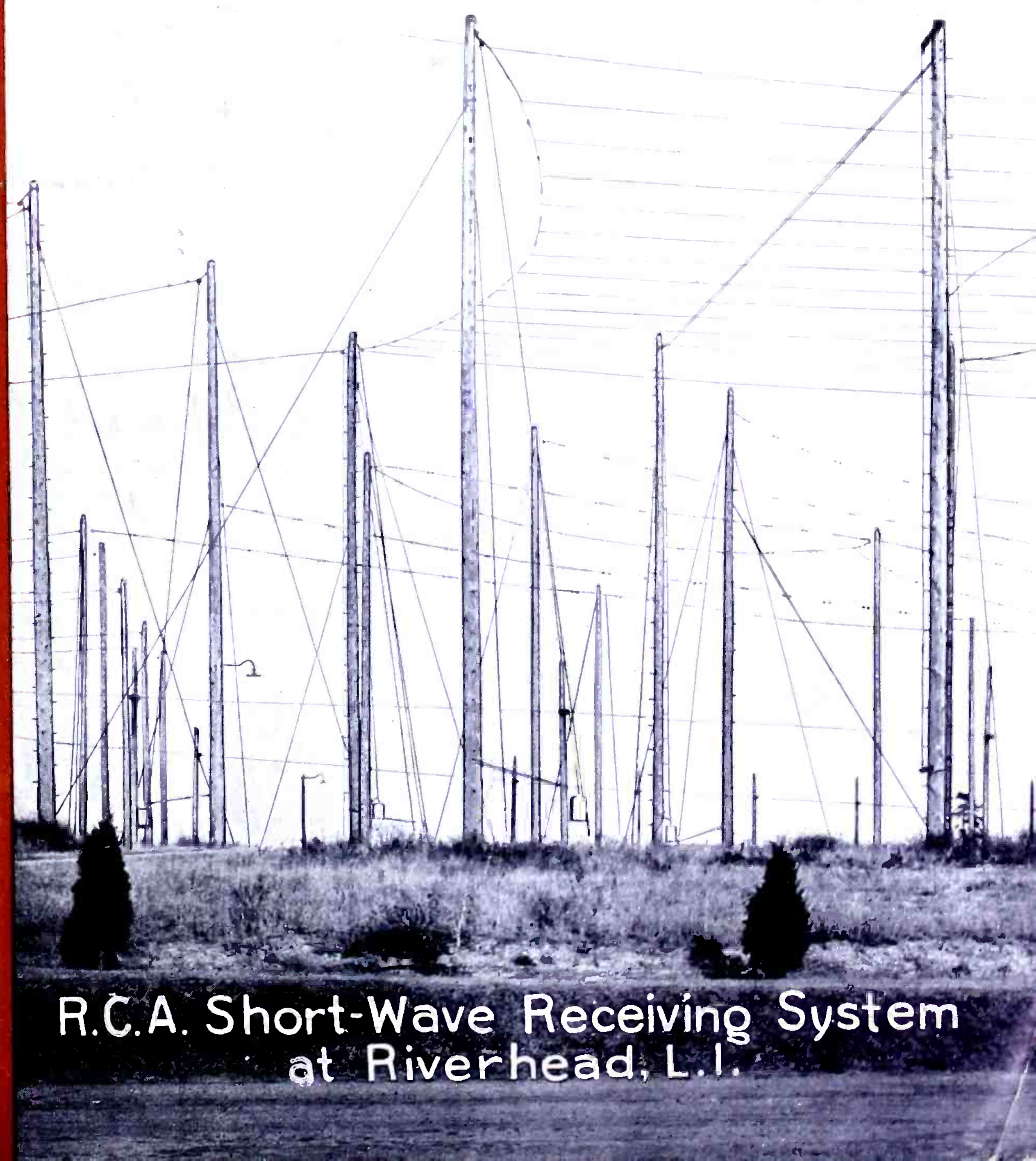
IN THIS ISSUE:

25¢
IN CANADA 30¢

A Forest Of Aerials



R.C.A. Short-Wave Receiving System at Riverhead, L.I.

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THE printing of the first edition of the Short Wave Radio HANDBOOK has been completed, and copies of the book are now available. There is no more waiting for deliveries. The day your order comes in, that same day your copy goes into the mails. We guarantee fast service.

The publication of the HANDBOOK was delayed slightly because Mr. Clifford E. Denton, the author, ran into a puzzling difficulty with one of the oscillators he describes in the book. Rather than release data of which he was not absolutely certain, he spent additional time on the instrument, and found that the trouble was due merely to a defective little part, and not to any fault in the design. We wish to emphasize the fact that the two receivers and the two oscillators designed by Mr. Denton and described in detail in Chapter IV are brand new and have never appeared in print before.

The Short Wave Radio HANDBOOK is full of valuable "dope." It is solid text, from beginning to end, and does not contain a single manufacturer's advertisement. Many purchasers of the book have already remarked that the coil information alone is worth the dollar the book costs.

For a full list of subjects and information on ordering, please refer to the back cover of this issue.

• • •

The

Short Wave Radio

HANDBOOK

I will help You start a Spare Time or Full Time Radio Service Business without capital

J. E. SMITH, *President*
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The man who has directed the Home-Study Training of more men for the Radio industry than any other man in America.

Here are a few examples of the kind of money I train *"my boys"* to make

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"The National Radio Institute put me in a position to make more money than I ever made in good times. I am in the radio service business for myself, where it is possible for me to make from $50 to $75 a week. Service work has increased because people, who in normal times would buy a new Radio, now are contented to have the old one 'pepped up'."—BERNARD COSTA, 150 Franklin St., Brooklyn, N. Y.

NOW OWNS OWN BUSINESS

"If I had not taken your Course I would be digging ditches instead of running my own business. One week I made $75 on repairing alone, and this doesn't count sales. If a fellow wants to get into radio, N.R.I. is the starting point."—R. S. Lewis, Modern Radio Service, Pittsfield, Ill.

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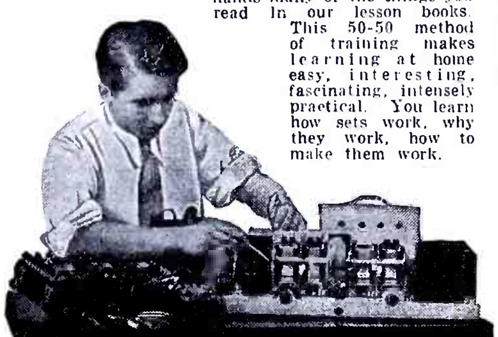
My Course is not all theory. I'll show you how to use my special Radio equipment for conducting experiments and building circuits which illustrate important principles used in such well-known sets as Westinghouse, General Electric, Philco, R. C. A., Victor, Majestic, and others. You work out with your own hands many of the things you read in our lesson books. This 50-50 method of training makes learning at home easy, interesting, fascinating, intensely practical. You learn how sets work, why they work, how to make them work.



Free Book Tells How Mail Coupon

The world-wide use of Radio sets for home entertainment has made many opportunities for you to have a spare time or full time Radio business of your own. I give you instructions early in your Course for doing 28 Radio jobs common in almost every neighborhood. Many N. R. I. men make $5, $10, $15 a week extra in spare time almost at once. I show you how to install and service all types of receiving sets. I give you Radio equipment and instructions for conducting experiments, for building circuits and testing equipment, and for making tests that will give you broad, practical Radio experience. Clip the coupon below and get my free 64-page book, "Rich Rewards in Radio"—it gives you a full story of the success of N. R. I. students and graduates, and tells how to start a spare time or full time Radio business on money made in spare time while learning.

Many N. R. I. Men Make $5, $10, $15 a Week Extra in Spare Time Almost at Once

Many of the seventeen million sets now in use are only 25 per cent to 40 per cent efficient. I will show you how to cash in on this condition. I will show you the plans and ideas that have enabled many others to make $5, $10, $15 a week in spare time while learning. Ford R. Leary, 1633 Davison Road, Flint, Mich., wrote: "My part-time earnings while taking the N. R. I. Course were $651."

Get Ready Now for a Radio Business of Your Own and for Jobs Like These

Broadcasting stations use engineers, operators, station managers, and pay up to $5,000 a year. Radio manufacturers use testers, inspectors, foremen, engineers, servicemen and buyers, and pay up to $7,500 a year. Radio dealers and jobbers employ hundreds of servicemen, salesmen, managers, and pay up to $5,000 a year. Radio operators on ships enjoy life, see the world, with board and lodging free, and get good pay besides. My book tells you of the opportunities in Radio Loud Speaker Apparatus, Set Servicing, Aircraft Radio, Television, Police Radio, Short Wave, and other fields. Get it.

I Will Train You at Home in Your Spare Time

Hold your job until you're ready for another. Give me only part of your spare time. You do not need a high school or college education. Hundreds with only a common school education have won bigger pay through N. R. I. J. A. Vaughn jumped from $35 to $100 a week. J. E. McLaurine increased his earnings 100 per cent. The National Radio Institute is the Pioneer and World's Largest organization devoted exclusively to training men and young men by Home Study for good jobs in the Radio industry.

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I will give you an agreement to refund every penny of your money if you are not satisfied with my Lessons and Instruction Service when you complete my Training. And I'll not only give you thorough training in Radio principles, practical experience in building and servicing sets, but also Advanced Training in any one of five leading branches of Radio opportunities.

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Mail the coupon for "Rich Rewards in Radio." It's free to any ambitious fellow over 15 years old. It tells you about Radio's spare time and full time opportunities; about my training; what others who have taken it are doing and making. Mail coupon now in an envelope or paste it on a 1c post card.

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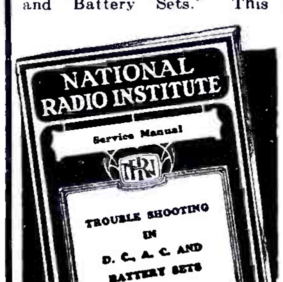

THIS COUPON IS GOOD FOR ONE *FREE* COPY OF MY NEW BOOK — mail it TODAY

J. E. Smith, *President,*
National Radio Institute, Dept. 4DS8
Washington, D. C.

Dear Mr. Smith: I want to take advantage of your Special Offer. Send me your two books, "Trouble Shooting in D.C., A.C. and Battery Sets" and "Rich Rewards in Radio." I understand this request does not obligate me. (Please print plainly.)

Name.................................*Age*.......

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Will Grace
Your LIVING ROOM

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Now supplied in four complete models: Standard; Standard plus A.V.C.; Crystal; and Crystal plus A.V.C—Battery, D.C. or A.C.—all voltages; all frequencies.

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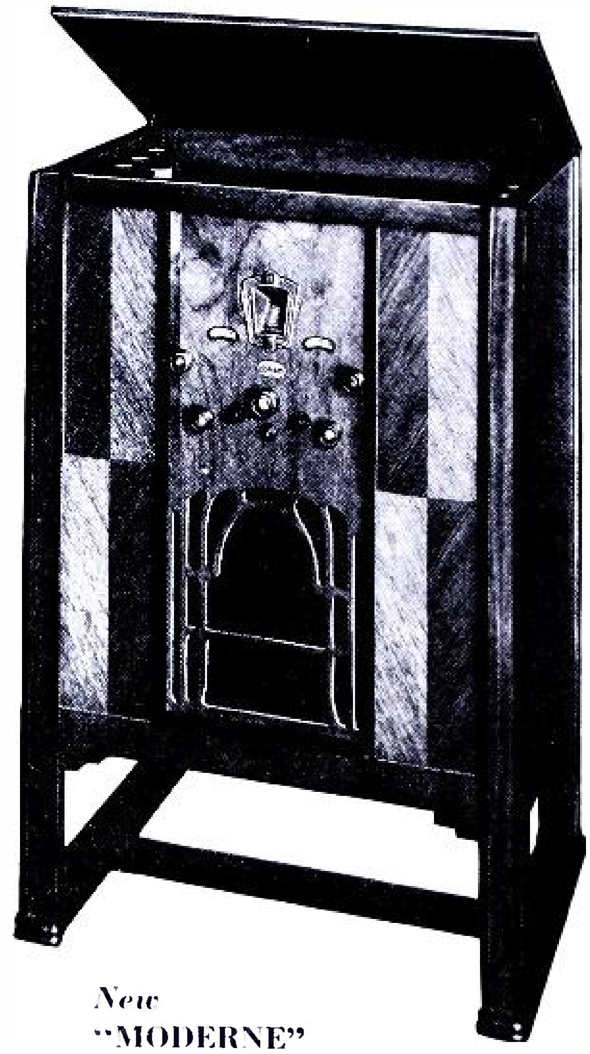

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The modified modern lines of this stately console will harmonize with other room furnishings.

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COMET "PRO"
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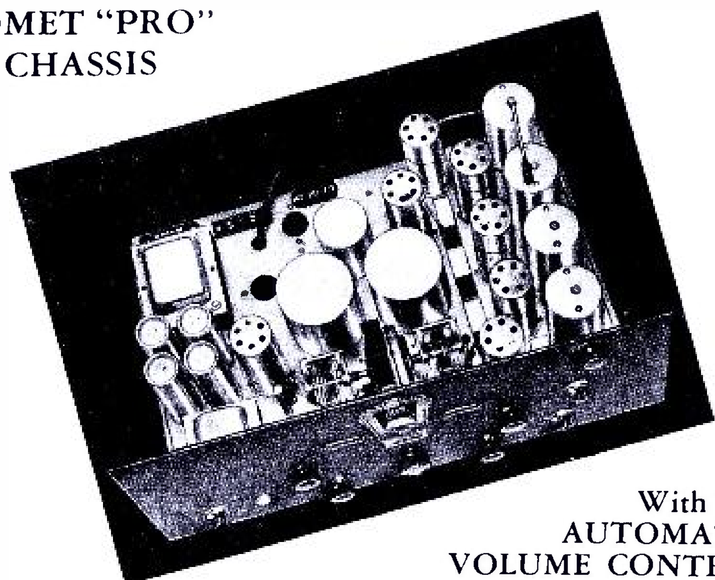

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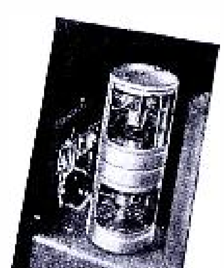

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April, 1934 Vol. 1, No. 6

SHORT WAVE RADIO

devoted to short-wave transmission and reception in all their phases

Robert Hertzberg, *Editor*
Louis Martin, B. S., *Technical Director*

IN FUTURE ISSUES:

AMATEUR RADIO—So many advanced short-wave broadcast listeners have become interested in the subject of transmitting that we have asked a prominent and experienced amateur to give a few pointers on getting started. His advice is of personal rather than technical nature and will answer many questions that our readers have asked.

NOISE ELIMINATION—Noise has become the greatest single limiting factor in short-wave reception. Are we going to sit back and simply accept the noise as an inevitable part of short-wave reception, or are we going to do something aggressive about it? The steps taken by a number of short-wave clubs and manufacturers will be described in a lively article.

REVISED STATION LIST—There have been so many changes among the short-wave broadcasting stations of the world that we are revising the five-page list that has been appearing in the magazine and will present this in the June issue. We also expect to publish photographs of some of the more popular foreign transmitters.

COMMERCIAL SET REVIEW—Two more prominent short-wave receivers have been obtained for test and write-up. The reports are complete and unbiased and undoubtedly will be of considerable value to prospective set purchasers.

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Address all correspondences of editorial or advertising nature to SHORT WAVE RADIO, 1123 Broadway, New York N. Y. Telephone: CHelsea 2—6620 and 6621.

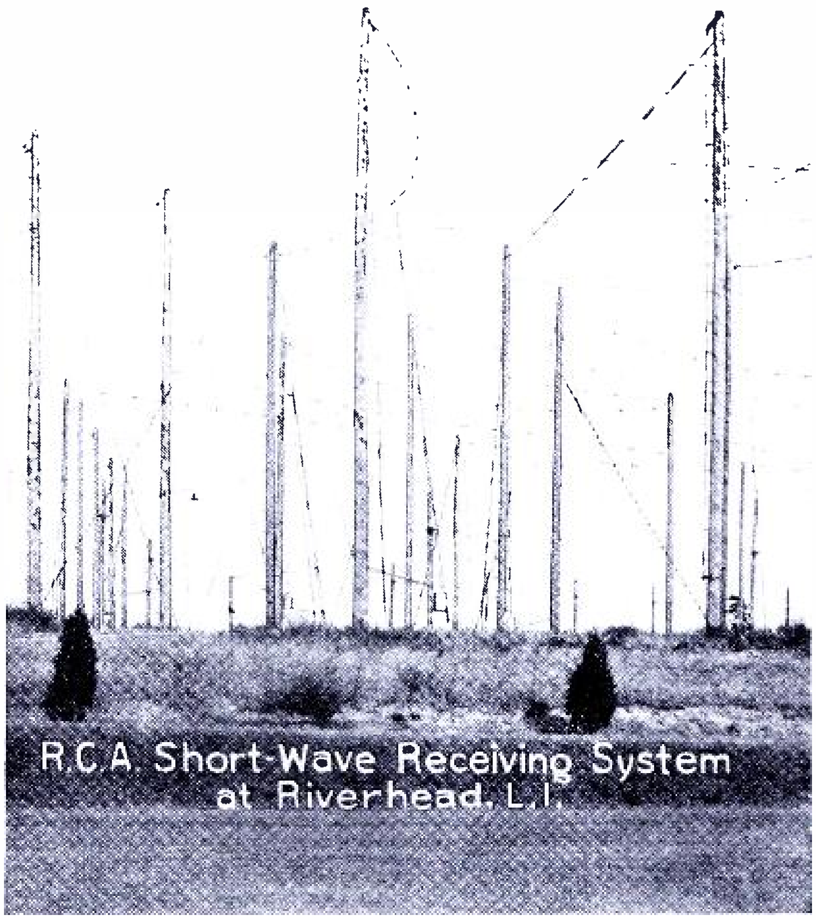
IN THIS ISSUE:

Of General Interest:

Of Explanatory Nature:

For the Constructor:

A Forest Of Aerials



THE repeated success of the National Broadcasting Company in rebroadcasting programs picked up on the short waves from foreign countries has aroused considerable interest among short-wave listeners, who themselves find direct foreign reception a highly interesting pastime. As no explanation is given during the broadcasts as to how they are accomplished, many listeners have written in and inquired for details. In order to enlighten readers of SHORT WAVE RADIO on the matter, the editors made a trip to Riverhead, Long Island, where the East Coast receiving stations of RCA-Communications, Inc., are located.

The Riverhead installation is one of the units of RCA's famous "Radio Central," the transmitting end of which is located a few miles further west, at Rocky Point, L. I. Riverhead itself is about seventy miles from the center of New York City. The country is as flat as a table-top, Long Island Sound is only four miles to the north, and the Atlantic Ocean eight miles to the south; there are no buildings higher than three or four stories for twenty miles in any direction, and therefore the location is naturally very good for radio purposes. More than ten years ago RCA bought up thousands of acres of this barren, sandy country to assure itself of an interference-free spot for its rapidly expanding transoceanic radio services.

There are now three sections of the receiving "station." The first comprises a group of small buildings on the edge of the town of Riverhead itself. In one of these buildings are located several banks of long-wave receivers, which have been in constant use for more than a decade. This is the original receiving station of Radio Central, the whole Radio Central project having been undertaken shortly before the long-distance possibilities of short-wave transmission became known.

A few miles further east is located the short-wave telegraph receiving building, and several miles beyond this is a special short-wave broadcast receiving station used exclusively for foreign broadcast pickup. As the program unit is simply a small edition of the telegraph building, we will describe the latter first.

The Forest of Aerials

In approaching the short-wave telegraph receiving station, the visitor is immediately struck by the veritable forest of aerials that covers many acres of ground space. Hundreds of 60-foot wooden poles stick out of the ground like so many weeds, and from certain angles the sky appears to be honeycombed with wires. The short-wave listener who boasts of a single doublet antenna with a transposed feeder feels rather insignificant as he wanders through this maze of antennas.

At a point several hundred feet from the receiving house proper, a big wooden sign looms in front of the visitor. "No Cars Permitted Beyond This Point," it reads. Ignition noises from unprotected automobiles raise just as much havoc out here as they do any other place, and only cars fitted with suppressors are permitted to draw up in front of the receiver house. The road leading to the station is a private one, so RCA, fortunately, is able to keep out offending machines.

The receiving building itself is a simple two-story brick affair about 75 feet long and 50 feet wide. On the lower floor are huge banks of storage batteries for both filament and plate supply, and in an adjoining room are generators for keeping these charged. All the receivers use battery tubes. This arrangement not only insures permanent quietness of operation, but also makes the station independent of power line failure for many hours.

Separate Aerials Used

On the second floor are found racks upon racks of complicated-looking apparatus. Investigation proves that these are really a whole lot simpler than they appear. The general idea is to use three separate antennas, each connected to a separate receiver, in order to receive a single station operating on a definite frequency channel. The three antennas of a group are known as a diversity array," and are highly directional. The three individual aerials of each array are separated about ten wavelengths and connect to the receivers themselves through radio-frequency transmission lines, some of which are thousands of feet long. In the receiving house, above the receiver racks, the ceiling appears to be covered with two-wire transposed feeder lines, which run all over the place and over each other without mutual interference. Some of these transposed lines may be seen in the upper part of Fig. 2. The spacing between these indoor lines is very close, the blocks being only about three-quarters of an inch square.

The purpose of having three separate aerials and three separate receivers is to compensate for fading effects, which, as every short-wave listener knows, are very annoying. It has been found that the fading experienced on antennas tuned to the same station and separated by only a few hundred feet is not the same on the different antennas. At any instant the signal may be strong in one aerial and weak in another. By using three separate aerials and three separate receivers, all tuned to the same signal, and by feeding the outputs of the three receivers into a common reproducing device, a good deal of the fading effect is overcome and surprisingly steady reception is obtained.

At the present time there are

twenty-eight diversity arrays at Riverhead. This means there is a total of eighty-four antennas and eighty-four separate receivers. In addition, there are six general utility receivers, bringing the total to ninety receivers! What a grand time the members of a short-wave club could have in this place if RCA were ever crazy enough to let them loose in it!

Receivers Are Simple

In spite of their formidable appearance, the receivers used at the telegraph house are really fairly easy to analyze. Each set comprises two stages of tuned radio-frequency amplification, a good old reliable regenerative detector, and a couple of audio-amplifier stages. Familiar looking plug-in coils made of heavy copper wire are used in all stages. Please note that these sets are not superheterodynes. The t.r.f.-regenerative arrangement has been found to be altogether satisfactory for code reception purposes.

At the time of this visit, these receivers were being revamped to use the 6.3 volt series of battery tubes, replacing the older 3.3-volt battery series.

Practically the entire world is on tap in this remarkable station. The signals received here are not transcribed directly, but are "piped" over land lines to the RCA offices at 66 Broad Street, New York, where they are put into printed form and delivered to their destinations. As the telegraph station is a pretty busy place, RCA decided some time ago not to disrupt any of the service here by attempting foreign short-wave broadcast pickups. Instead, it established an altogether separate station for this purpose. It is located on a barren stretch of ground, with no human habitation for miles around. The special program house is shown in Fig 3. This is a cozy little building about sixty by twenty-five feet, with a background of more antenna masts and wires. There are four diversity arrays, aimed at Europe, the West Coast of the United States, Buenos Aires, and Rio de Janeiro, respectively. At the present time only two complete diversity receivers, a total of six sets, are available. This is enough for ordinary purposes, as rebroadcasting is attempted from only one country at a time.

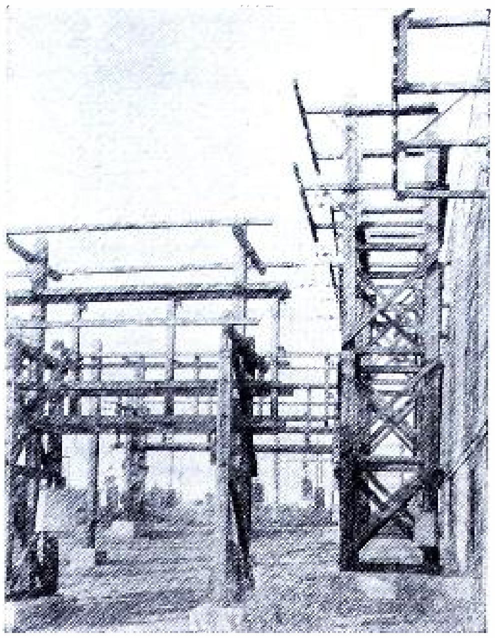


Fig. 1: These wooden structures support the radio-frequency transmission lines from the eighty-four scattered aerials surrounding the short-wave telegraph receiving station at Riverhead, L. I. Most of these transmission lines consist of four wires. The spacing between them is maintained very closely by means of large concrete blocks which hang from the ends of the lines and thus keeps them taut at all times.

Unlike the code receiver, the special short-wave broadcast instruments are superheterodynes. These supers consist of two stages of tuned radio-frequency amplification, detector-oscillator, three stages of intermediate-frequency amplification, second detector, and two stages of audio-frequency amplification. The outputs of the three receivers of a diversity unit are combined, as with the code receivers, to produce a single signal having a minimum of fading. The programs are put on special telephone wires which connect directly to 66 Broad Street, New York. From here the circuits are bridged to the National Broadcasting studios in Radio City, Fifth Avenue and 50th Street, New York. Incidentally, the services of this special program station are not confined exclusively to RCA. The Columbia Broadcasting System has availed itself of them for the Byrd rebroadcasts, as mentioned on page 15 of the March, 1934 issue of SHORT WAVE RADIO.

Plug-in Coils Used

Here, also, all the apparatus is battery-operated. Plug-in coils give the sets a frequency range of 5600 to 25,000 kc., or 12 to 53 meters. Additional coils can easily be made to cover frequencies down to 1500 kc. (200 meters) where this is desired. Automatic volume control is accomplished by applying a varying negative bias to the control grids of the radio-frequency amplifier stages. Special care is taken throughout to insure good shielding. The various r.f. and i.f. units are mounted in independently isolated compartments in heavy metal cabinets. Even the unused plug-in coils are kept in special compartments, which have the same overall temperature as the operating receiver. Thus, when it is necessary to shift the wavelength, the coils are quickly exchanged and the compartments locked up tight with the least possible delay. Frequency drift due to thermal changes is thus minimized.

Comparisons

Comparisons have been made between results obtained with one, two and three short-wave receivers, with and without automatic volume control. Except when general reception conditions are very stable, the use of three separate receivers with automatic volume control and with individual antennas has been found to give results which are sufficiently superior to justify the cost of the

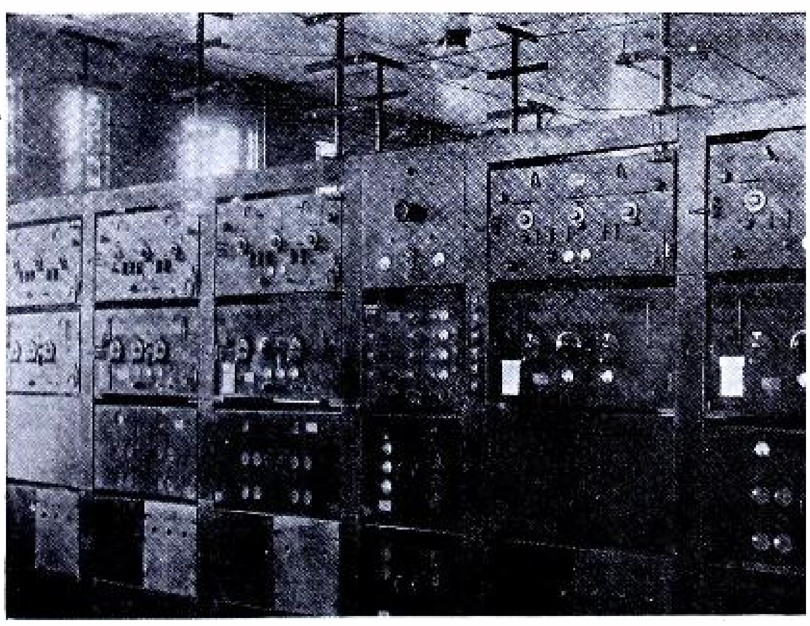


Fig. 2: One of the many short-wave receiver racks at Riverhead, L. I. This particular view shows telegraph receivers, but the short-wave broadcast receivers are almost identical in appearance. Each vertical section represents a single receiver. The top rack holds the radio-frequency amplifier, the second the detector-tuner unit, the third the audio amplifier and the bottom shelf the spare plug-in coils. The central series of panels (the third from the right) is a control section, where the outputs of the various receivers are combined to take advantage of the diversity effect. Each of these receiver sections contains six individual receivers, which work as two diversity systems. The wires mounted on the small cross arms under the ceiling are the transposed r.f. transmission lines from the outside antennas.

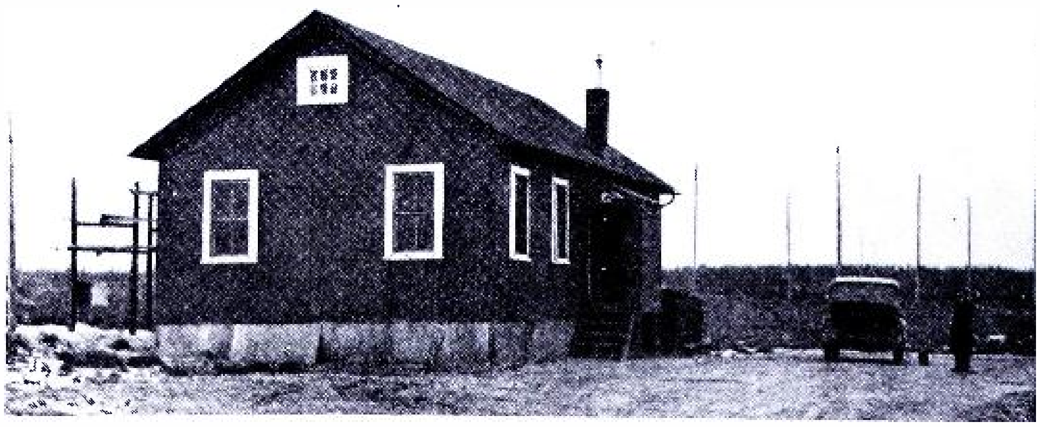


Fig. 3: This plain little building is the special short-wave program receiving house several miles outside the town of Riverhead, L. I. Some of the poles supporting the diversity antennas may be seen in the background. There is nothing for miles around here. The only interference that is experienced is created by passing airplanes.

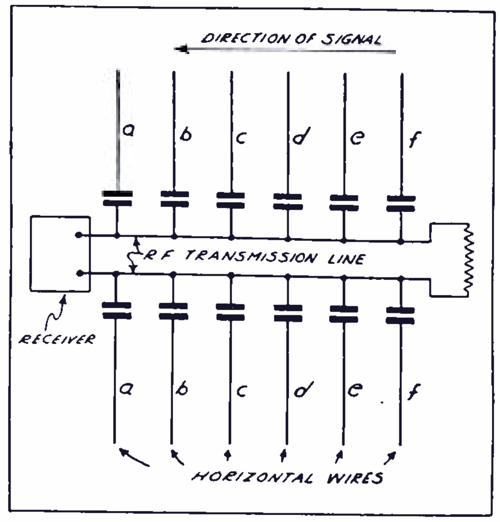


Fig. 5: Fundamental layout of a directional antenna array. The various wires a, b, c, d, etc., are separated by wooden poles in a horizontal position.

additional equipment. As fading becomes either deeper or more rapid, the benefit derived from the diversity system becomes more appreciable. In fact, there are times when the three receivers and their antennas give fair quality and intelligibility on a signal that is altogether unintelligible on a single set.

(It is surprising how much the signal strength can be increased by having a properly directed antenna. On page 70 of the SHORT WAVE RADIO HANDBOOK is described a novel aerial arrangement by which the direction of an antenna can be varied at will *while a signal is being received*. The arrangement referred to will convince the most hardened skeptic of the benefits to be derived from the proper use of ordinary antenna system. Try it and be convinced!)

Figure 4 shows a view of the small line control board for transferring programs from the receivers to New York. The operator of this board truly has the world at his fingertips. Programs are regularly received from all the GS-stations at Daventry, England; the DJ-stations at Zeesen, Germany; EAQ, Madrid, Spain; FYA, Pointoise, France; RNE, Moscow, U.S.S.R., (which, incidentally, is the same station as RV59 and operates on both 6000 and 12,000 kc.), I2RO and IRM, 9830 kc., Rome, Italy; the HB-station, Geneva, Switzerland; LSX and LSY, Buenos Aires, Argentina; PPQ and PPU, Rio de Janeiro, Brazil; and YVQ, Caracas, Venezuela.

Of course, there are times when even the diversity arrays and the big superheterodynes are rendered helpless by terrific fading and other disturbances. Many short-wave listeners at other points have been able to bring in clear signals from certain foreign stations when conditions at Riverhead have been unfavorable. This is no particular reflection on the Riverhead apparatus, but simply indicates how freakish reception conditions can sometimes be.—*R. H.*

Byrd Base Station Established

REAR Admiral Richard E. Byrd has notified Herbert L. Pettey, secretary of the Federal Radio Commission, via radio, that he started broadcasting from Little America on Saturday, February 3, 1934, at 10 p. m. and that he will report weekly on happenings in Little America.

Admiral Byrd's radiogram of February 2, read:

"Mr. Herbert L. Pettey, Secretary,
Federal Radio Commission,
Washington, D. C.
Station KFZ, the Columbia Broadcasting System's newest station and the first broadcasting station on the Antarctic continent, will be formally opened Saturday, February third. It will be temporarily housed in a tent. The snows of Little America and the pressure of unloading operations have not permitted the construction of the special shack assigned to it. This will be done, however, as soon as conditions permit. Charles J. V. Murphy, in charge of radio communications and operations for the expedition, will be in charge of station. John Dyer, radio engineer, will be engineer of station KFZ. Will report weekly on happenings in Antarctica. One thing to be said for it is that it won't suffer from competition.

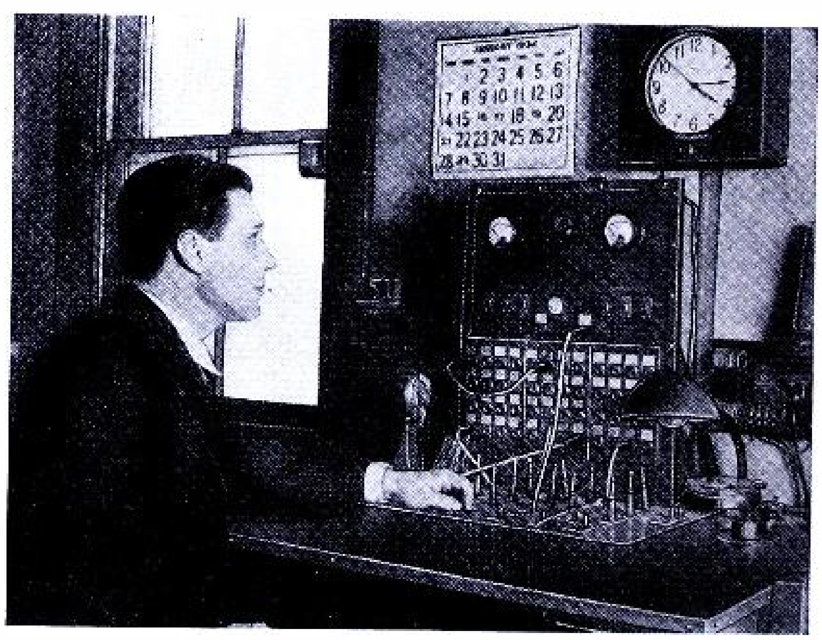
R. E. BYRD."

Mr. Pettey also received a radiogram from Charles J. V. Murphy, who is in charge of radio communication in Little America, outlining in a graphic manner the difficulties encountered, and the resourcefulness necessary, to establish a radio station there. His report tells of one of the dramas of radio and emphasizes the indomitable spirit of the pioneers who are using radio to penetrate and to throw light upon the most inaccessible portions of the earth. Mr. Murphy's message reads:

"Probably no broadcasting station in the world has been founded under more spectacular circumstances than KFZ, the first broadcasting station in the Antarctic. Immediately after last Saturday's broadcast, station KJTY aboard the *Ruppert*, after voyaging fifteen thousand miles, was dismantled. Preparations were made to move

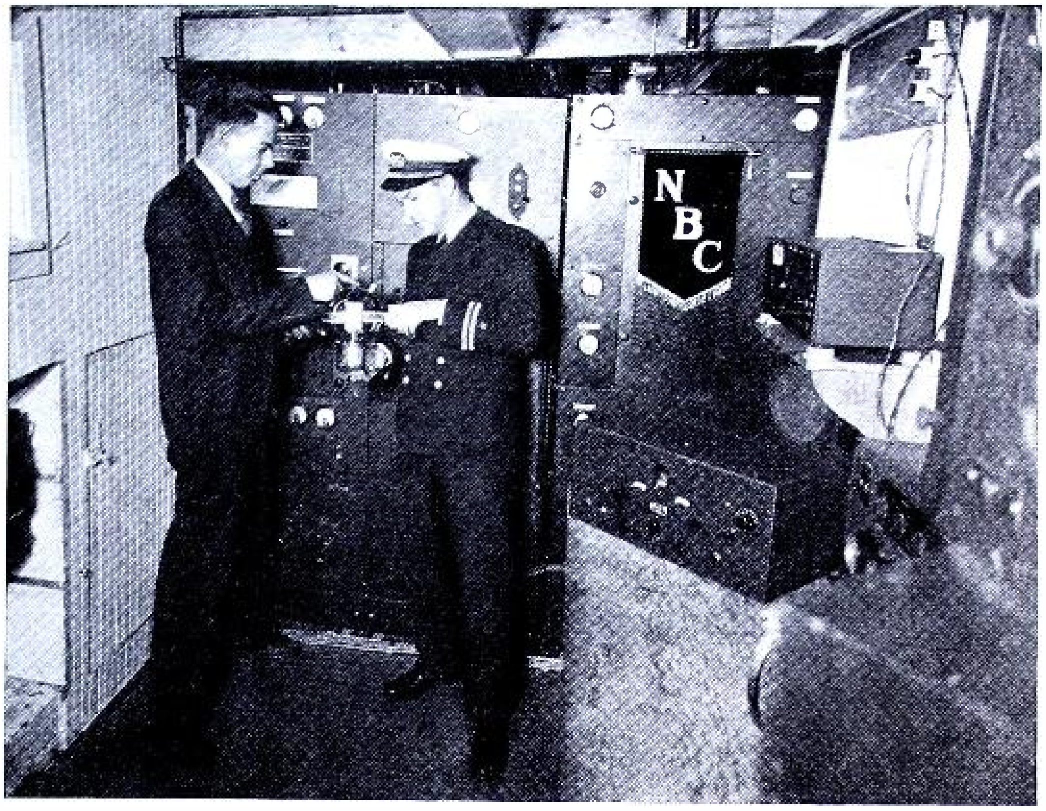
(*Continued on page* 43)

Fig. 4: Through this modest little switchboard pass short-wave programs from most of the world. The outputs of the various diversity receivers are routed through this board to 66 Broad St., New York. A. T. Medsger is at the controls.



Around-the-World S.W. Broadcasts

PHILLIPS H. LORD, known to radio listeners all over North America as "Seth Parker," has set forth on the first leg of a lazy round-the-world pleasure jaunt on his own four-masted windjammer, which he has named after the character rôle that has netted him fame and fortune. Radio will play an important part in this adventure, for the *Seth Parker* is equipped with a powerful short-wave telephone transmitter by means of which Lord plans to broadcast back to the United States from distant and seldom-visited places. Conditions permitting, the programs will be put on the National Broadcasting Company's networks. Of course, owners of short-wave receivers will be able to pick up the transmissions directly and to follow the vessel as it circumnavigates the globe.



The radio room of the Seth Parker. Radio engineer Carey P. Sweeney (left) is explaining one of the tubes to Phillips H. Lord. In the background is the short-wave transmitter, to the right the receivers, and in the foreground the voice amplifier and control equipment.

Call Letters KNRA

In many respects this excursion of Lord will provide listeners with more thrills than the Byrd expedition, as the *Seth Parker* will be on the move continually and Lord himself is a keen radio showman and an extraordinary microphone performer.

The call letters of the *Seth Parker* are KNRA. The combination is purely accidental, and Lord didn't know he was getting it until the license came through from the Federal Radio Commission. The transmitter is a flexible RCA one-kilowatt job, with a frequency range of 5500 to 17,100 kilocycles (17.54 to 54.55 meters). This range is well within the coverage of practically all short-wave receivers. The exact frequencies that will be employed at different times will depend, of course, on the distance between the ship and the United States, the season of the year, the time of transmission and on the several other factors that influence high-frequency radio work and sometimes make it a sporting proposition rather than a scientific certainty.

The receiving equipment on board the *Seth Parker* consists of a regular RCA ship receiver and also a crystal-model Comet "Pro." The latter is going as part of the personal belongings of the operator.

The National Broadcasting Company assigned one of its own engineers to the *Seth Parker.* He is Carey P. Sweeney, who holds a commission as a Lieutenant, junior grade, in the U. S. Naval Reserve. He has complete charge of the installation, and his voice will undoubtedly be heard in many tests between the ship and various RCA shore stations. According to a press release of the Federal Radio Commission, station WEM of RCA Communications, Inc., located at Rocky Point, L. I., has been granted special authority to communicate with KNRA in order to facilitate reception of program material from the schooner for delivery to the studio of NBC.

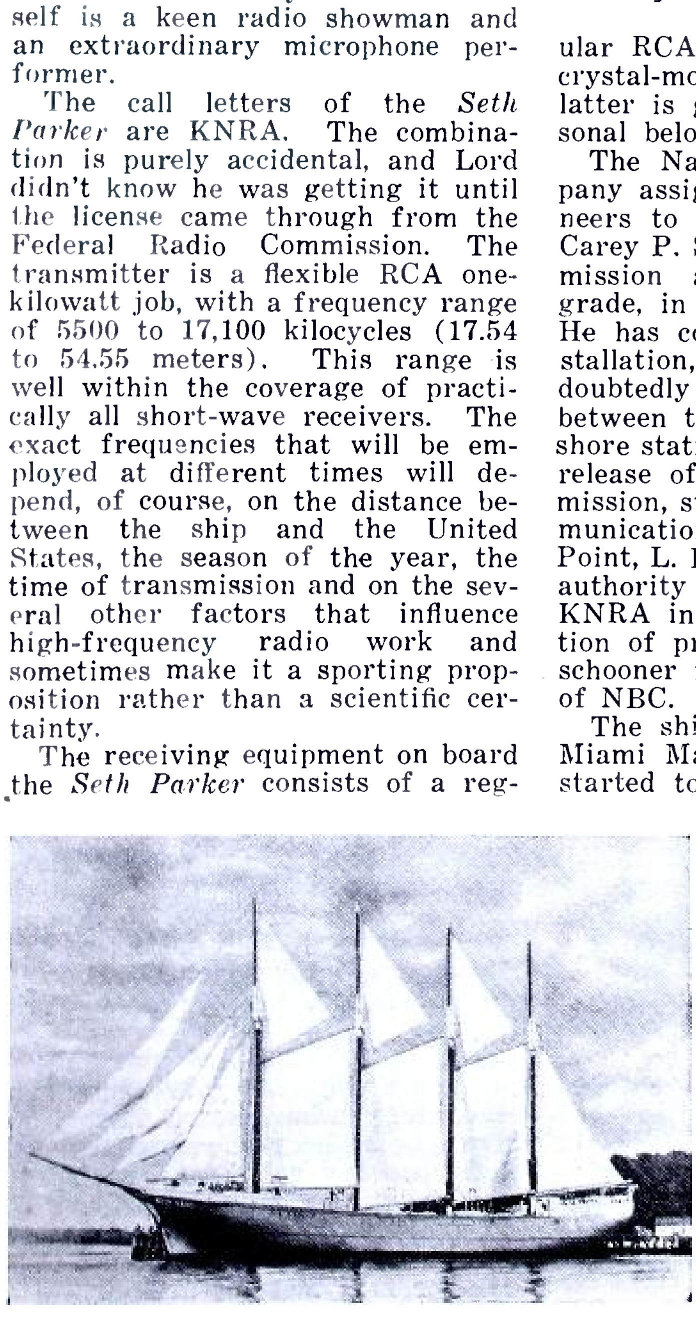
The ship was scheduled to leave Miami March 1st. Many listeners started to hear KNRA before this date, as the transmitter underwent complete checking by RCA engineers during a number of shakedown cruises along the Atlantic seaboard. No definite schedule of programs has been announced. The likelihood is that rebroadcasting by the domestic NBC chains will be attempted as the itinerary and reception conditions permit, while ship-to-shore contacts for communication and testing purposes will be made right along.

Realization of a Dream

Aside from its radio angle, the cruise of the *Seth Parker* has other interesting aspects. The trip is the realization of a boyhood dream of Lord to sail the seven seas in search of thrills and adventures, to visit and explore places that are little more than dots on a map. Having made a considerable fortune out of his radio programs, Lord is now in the enviable position of being able to satisfy his wanderlust in style, comfort, and even luxury. Only 30 years old, with a sensationally successful career behind him, he is going out to enjoy himself. There are a lot of people who wish they could go with him!

Besides Lord and three close friends, the *Seth Parker* will carry the radio engineer, a physician, a motion-picture man, two cooks and a crew, a total of 25 men. Lord himself has been commissioned a Lieutenant in the U. S. Naval Reserve, so that he can officially claim for the United States any new land that he discovers.

(*Continued on page* 45)



The four-masted schooner Seth Parker with full sail up. The vessel was completely renovated by Lord for his round-the-world cruise, and boasts of everything from auxiliary engines and new canvas to a short-wave transmitter and electrical refrigeration.

Week-End Tuning For the Foreign Short-Wave Stations

By Capt. H. L. Hall

whose reception is the envy of all who know him.

MORE tuning by short-wave fans is accomplished over week-ends than any other time of the week. There may be many reasons for this, but I think the real and most outstanding one is the fact that when you decide to log more than a few stations in a day, you find that their hours for transmission are such that you can sit by idly waiting for the hands of the clock to reach the particular time that the station you want to hear comes on the air. If we decide to start on a Saturday afternoon, let us tour the dials together. There is no reason we should not hear the entire world.

On Saturday from 1 to 3 p.m. E.S.T., EAQ, Madrid, Spain, sends programs to her colonies and although these transmissions are not beamed towards us, we here in the States have no difficulty picking them up. Frequent announcements in both English and Spanish make identification of this station easy. At the close of the program the Spanish National Anthem is played and "Ee-ah-coo" tells you they have shut down, only to return at 5:30 p.m. to 7 p.m., which is their nightly schedule.

Rome and Berlin

Let us say we heard enough of the rhumbas and left EAQ around two o'clock. This is a rather quiet hour, but 2RO, Rome, Italy, on 25.4 meters, should be heard. This station is heard here until 6 p.m. but that does not mean always. There was a time when 2RO could be classed with the "foreign locals," but for the last few months they have been heard with no degree of volume. With the coming of spring this station should be coming over to us again as they did last year at that time.

Germany, which used to be heard when they were on 25.51 meters in the afternoon, seemingly has abandoned that wave and are heard nightly from 8 to 11 p.m. on 49.83 meters. That of course will leave us free to tune for Pontoise, France, on 25.63 meters. Although the programs radiating from this station consist principally of talks, which are rather monotonous, occasionally lively French songs sung in the "Maurice Chevalier" manner are heard.

Due to the fact that the English short-wave stations at Daventry are still experimenting as to the best time for them to be on the air, one cannot safely say whether we would be able to get any of the "G's" or not, but at the time of writing this article GSB on 31.5 meters has been rolling in very well. Their station announcements naturally are in English. It is advisable to listen to these with interest as future special broadcasts and schedules are generally spoken about.

Local or Canadian stations are always there to be heard and who has not heard the baritone voice of the station announcer at VE9GW, 49.22 meters, Bowmanville, Canada, giving his call?

At 5.15 p.m. we will hear the latest in worldly troubles when we tune for the League of Nations station, which broadcasts on *Saturday only* from 5.15 to 6 p.m. Their program is divided into three parts: fifteen minutes of Spanish, English and French with announcements at the end of each period. "Hillo, Hillo," precedes every talk. HBP, 38.47 meters, and HBL, 31.27 meters, are the stations used to transmit these talks.

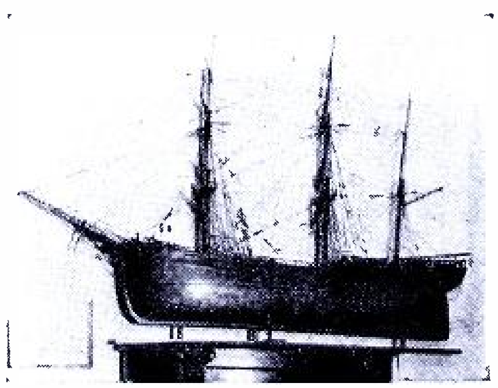


Fig. A: A three-masted barque with single topsails—a four-foot long model built by Capt. Hall that has been exhibited at many museums and admired by collectors from all over the world. Every bit of the complicated rigging actually works, although some of the pulleys are so small that three of them fit on the head of a pin!

Before turning to these stations we have RV59, Moscow, U. S. S. R. (50 meters) to try for. When we say *try* we mean exactly that. Although this station's schedule is 4 to 6 p.m. E.S.T., one rarely hears them until they have been on the air for at least a half an hour. As they are on 50 meters it is not a difficult station to find on your dials. Here is the reason. Every one knows where England and Germany are on the forty-nine meter band. You will find RV59, Moscow, between Germany and the powerful code station on the fifty-meter band.

Two New Stations

Two new stations have joined the "forty-niners" and have "gummed" up this popular band a little more. They are W4XB, 49.67 meters, Miami Beach, Florida, and COC, 50.2 meters, Havana, Cuba. The Florida station has been heard as early as 5 p.m. and at late as midnight, but the Havana station has a daily schedule of 5 to 6 p.m., E.S.T. With a regenerative receiver one may experience some difficulty separating them, but if you get RV59 let us say at 4.30 you will have clear reception without interference until either of the others come on. Superheterodyne owners will be able to tune in these stations even when all three stations are active. Rather a good test for your individual receivers, because if you have a set that can separate the forty-nine meter band, *keep it*. Some receivers are equipped with band spreading for this terribly conjested condition, and well do we need it.

Back we can go to Spain at 5.30 p.m. or listen to a South American that may obligingly be on the air waiting to be "caught." At this hour you may even hear GSA, 49.59 meters, Daventry, as they have been coming over on this wave in the late afternoon until 5.45, when they sign off, only to return at 6 to 8 p.m. "Big Ben" will roll in and strike midnight for the Londoners but it will be 7 p.m. here in New York City.

Taking it for granted one of these programs will suit your individual taste and you have heard a program of maybe an hour or so, one can see that Saturday will have been spent in a thoroughly enjoyable way.

Sunday is even a better day to tour the world but we will leave that day for next month's article.

How I Got Started

MANY people when they first meet me ask how I got started in this short-wave game. Before the depression came I was in a business that demanded absolute quiet. This was building models of ships of the past. Not the gaudy little affairs one sees in the average shop windows, but miniature ships, which, if they had been made on a larger scale, could have sailed the seven seas. I found it impossible to accomplish this fine work unless I started to work on these models after the average person had gone to bed. That meant starting about eleven o'clock or midnight and working until the wee hours of morning. No one could stand the strain of this delicate work without intervals of relaxation and as I was only mortal I used to stop and smoke. At that time I had only a regular wave broadcast receiver. So, I used to DX on it, but finding that by four a.m. nearly all the stations had "shut up shop" I thought, "Europeans are just about waking up." When it was four a.m. here it was 9 a.m. in some of the foreign lands. So I drifted into the short-wave field purely by accident and I far from regret it. Some of my best catches have been gotten when I "knocked off" work and tuned to a distant land just waking up. For months I never missed Australia when they came in, and the Far Eastern stations were my constant visitors.

Some Beautiful Models

It was no "joke" working on that large model shown in Fig. A. The hull was built in the Napoleon era and to have the authentic rigging it meant looking up details, etc., in reference books. This was a tiresome undertaking. All the spars, complete set of rigging and detail are hand made and made by the writer. This model was owned by a noted Frenchman and has been exhibited in museums both here and abroad. It is a three-masted barque with single topsails.

The other picture, Fig. B, shows four models, also museum pieces. These are of American types of the period from 1840 to 1880.

The three-masted vessel to the extreme right is an American barque of the period of 1880. This type was used to carry coffee between South America and ports here in the States. The scale is 1/8 inch to the foot.

The two models to the left, one in a glass case and the other standing on top, are models of whaling barques of the period of 1840 which sailed out of New Bedford, Mass. The one on top with the model whale lashed to the side of the ship gives one an idea of the size of a whale when compared with the size of the vessels that went after them. The whaling ships were only 106 to 110 feet in length and whales average as long as 89 feet. The whale, after being caught, used to be cut up alongside the ship and taken on board the ship in pieces.

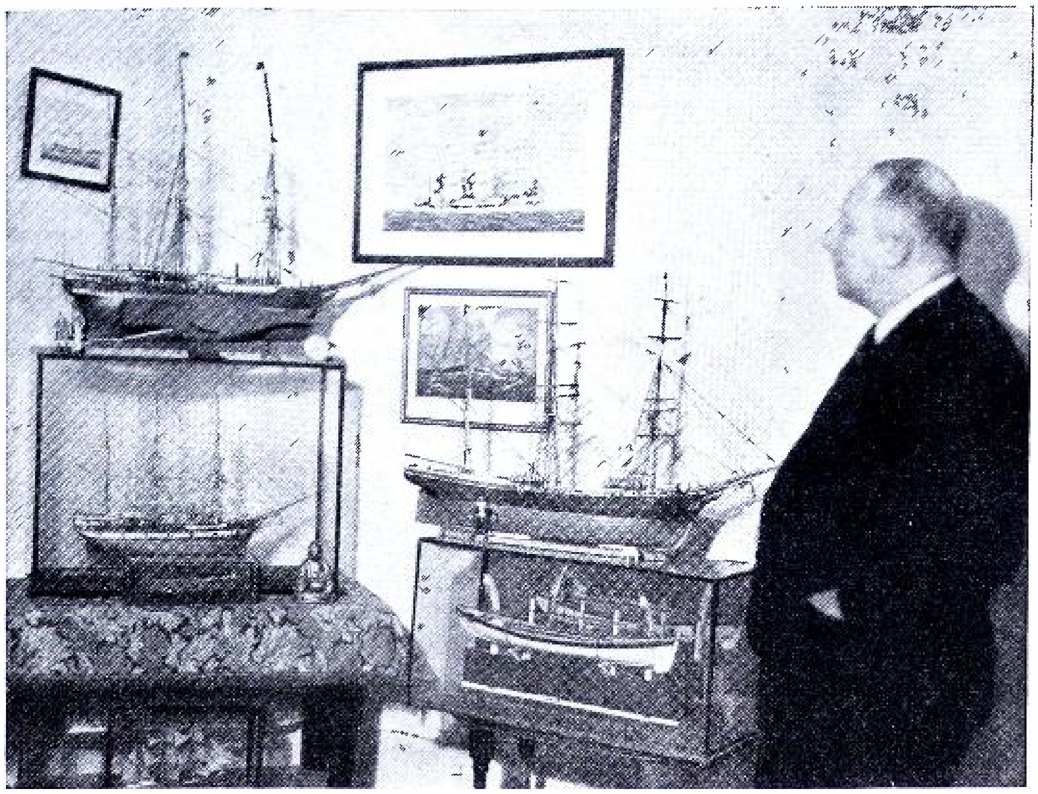


Fig. B: Capt. Hall with four more examples of his craftsmanship. Note particularly the whaling model in the upper left corner, with the model of a whale (in correct proportion) hanging from the side.

Ship model collecting is a hobby of the very rich. Some models built by me are owned by The Old Dartsmouth Museum, New Bedford, Mass., The Museum of Science and Industry, News Building, New York City, The Museum of Science and Industry, Chicago, Ill., The Louvre, Paris, France, and others.

The picture with the three models represent $4,500 in art.

Station Changes

Asia:

49.9 m.—ZHI, Singapore. Mon. Wed. Thurs. 5.30 to 7.45 a.m. Sat. 10.30 p.m. to 1 a.m.

49.5 m.—PRIWK, Bandoeng, Java, 6.45 to 7.30 p.m.

49.2 m.—PRIWK, Bandoeng, Java, 4.15 to 6 a.m.

58.00 m.—Amateur Society at Bandoeng, Java, 7.30 to 10.30 a.m.

16.38 m.—FZS, Saigon, Indo China, (Phone-active) 6 a.m., E.S.T.

Europe:

25.57 m.—PHI, Huizen, Holland. 7.30 to 11 a.m. (Tues. and Wed. no transmission.)

Canada:

49.1 m.—VE9HX, Halifax, N. S. 10.30 a.m. to 2 p.m. and 6 to 12 p.m.

South America:

48.78 m.—YV3BC, Caracas, Venezuela. 5 to 9.30 p.m.

73.00 m.—HCJB, Quito, Ecuador, 7.30 to 9.45 p.m. except Monday.

49.3 m.—CP5, La Paz, Bolivia, 7.45 to 11.30 p.m.

West Indies:

49.4 m.—HIX, Santo Domingo, Tues. 8 to 10 p.m. Sun. 7.40 a.m.

50.2 m.—COC, Havana, Cuba, daily 5 to 6 p.m.

A Report from the Middle West

Dear Capt. Hall:

The March number of SHORT WAVE RADIO at hand, and note therein that reports of reception conditions in Western part of the United States would be appreciated. While I cannot qualify for the west coast, perhaps a middle west report may be accepted.

Was particularly interested in your statement of a month or so ago that you have been receiving foreign stations at night upon the so-called "daylight" waves. Our experience is far different.

Tests here in the south central part of North Dakota have been carried out by three observers, using a variety of receivers. My own receiver is a four-tube t.r.f. regenerative—quite satisfactory for my purposes. The best receiver we have used is a National AGS, which should be comparative, to say the least.

We have found that upon bright days, foreigns from England, France, Germany and the Central Americas may be received with fair regularity, although fading is nearly always present. This condition continues up until about 5 p. m. central time, at which time "business is over." As an even better example, our own stations, like W8XK, on 25.26 meters, will roll in with terrific volume until about 5:45 p. m. at this season of the year, after which it is impossible to even pick up their carriers! This evening, in the 31-meter band, Springfield and Schenectady were rolling in fine business until approximately 6:15 p. m.; and, at 7 p. m., no carrier could be heard, in spite of the fact that I copied TGA, Guatemala, and LQA, Argentina, on code without difficulty. Our only hope here during the evening appears to be XETE, and then only occasionally! I don't know their schedule.

On the 49-meter band, good reception of locals, W8XK, etc., may be had ordinarily until about 7:45 p.m., from that time until about 10 p.m., very little doing after which they will again come in with nice volume. Station KEE, in communication with Koko Head, does not appear to be subject to these restrictions, possibly due to a directional radiator system, if used. As for foreigns—after twilight—apparently impossible with every receiver we have tried!

Quite a tale of woe, I will admit. To be perfectly frank, it apparently takes a pretty good receiver to pick up the foreigns at all in this country, where one might expect reception conditions to be ideal, that is, no hills, no trees, no obstructions, "no nothing"!

Please do not conclude that I'm finding fault with your department of the good publication Short Wave Radio. I have not the slightest doubt that you "write 'em as you hear 'em," and I frankly envy your success along reception lines! I am merely offering the above as an example of what several fellows here are doing, or rather, not doing with a wide range of receivers. I hope that you will continue your department in the above-mentioned magazine in the same vein that you have so far—it gives some of the rest of us hope!

I may write you again if I can find, borrow, steal, or build a 12- or 15-tube superhet that will change my own opinion as regards availability of the foreign broadcasters up here. So far, I've used, among my own and other's receivers, the following: Stewart-Warner, Lincoln, National AGS, converters, and several of my own make, from three-tube what-nots to this and that, to be "specific." Results, same.

Better reception for you—

D. M. Paul,
Edgeley, N. D.

January 29, 1934.

SEND IN REPORTS

As the United States is a big country, and reception conditions vary markedly in different locations, Capt. Hall would like to receive reports from other short-wave listeners, so that he may collate them for the benefit of all readers. Capt. Hall does all his listening in New York, and he is particularly anxious, therefore, to learn what general results are being obtained on the West Coast. Address your letters to Capt. Hall in care of SHORT WAVE RADIO, 1123 Broadway, New York, N. Y.

Please do not ask Capt. Hall to pass opinion on different makes or kinds of radio receivers.

New Russian Station

The station with which RNE, Moscow, U. S. S. R., conducts telephony tests on 50 meters is RSZ, 34,21 meters, which is situated at Irkutsk.

Incidentally, remember when writing to Moscow for verifications to address your letter to the U. S. S. R. (Union of Soviet Socialistic Republics.) Officially there isn't any such place as "Russia" anymore.

From Pittsburgh

Dear Capt. Hall:

I have been reading your articles, since the first issue of S. W. R., with very much interest.

In the March issue you say that RW59 comes in like a local; well, that does not go for Pittsburgh. Some highpower commercial code stations in N. J., about 8 kc. away from RW59, are about 20 kc. broad here and stations on about 50 meters can be heard only when these code stations are not in operation. I have heard Moscow only twice, the first was November 6, 1933, which I have had verified.

About verifications from 2RO. Last spring I wrote them and also included an International Reply Coupon but received no reply, but last August I again wrote and received a card in about three weeks.

HAT2 has been heard testing with code on 43.86 meters but has not been heard broadcasting. My verifications include 24 countries.

My receiver is a home-made, all a.c., r.f. using the following tubes; 58, 57, 56, 2A5; dynamic speaker; doublet antenna with a transposed lead-in.

It might interest you to know that KDKA-W8XK have a special program known as the "DX Club" which is on Monday mornings at 12:30 a.m., E.S.T. (Sunday nights). There are no dues or requirements, it is more or less an information department. Both boadcast band DX and Short Wave DX tips are given. I am the short-wave speaker.

Lots of luck and DX

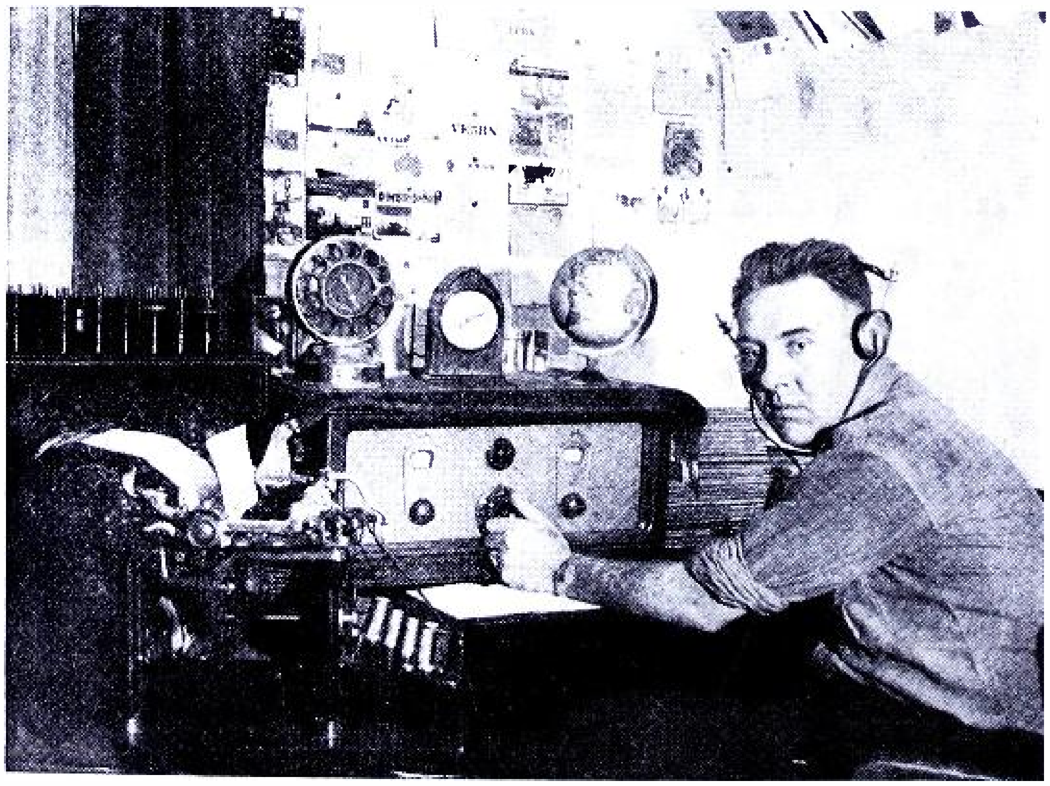
Edward C. Lips,
2237 Fairland Street,
Pittsburgh, Pa.

S. W. Club of New York

The growing interest in short-wave reception in the city of New York is reflected in the formation of a new fraternal organization, the Short Wave Club of New York, which is open to all owners of short-wave and all-wave receivers. The first meeting was held in January at the Y. M. C. A., 63rd Street and Central Park West, and was attended by 55 enthusiasts. It is planned to hold meetings twice a month.

As another meeting place may have been selected by the time this notice appears, interested readers are invited to write to Miss E. Tittel, the club's secretary, 29 East 38th Street, New York, N. Y., for information regarding future meetings. The temporary officers elected at the preliminary meetings were Welcome W. Braden, president, and Capt. H. L. Hall, vice-president.

The editor of Short Wave Radio attended the first several meetings and talked himself hoarse answering questions. He can testify to the fact that the club is a very live organization and that its members are intelligent, active short-wave listeners.



A listener who has found short-wave radio an interesting hobby for more than 20 years—M. Mickelson, of Minneapolis, Minn., who is dispatcher at the Minneapolis Police Station KGPB. This is only one of his numerous receivers.

Best Short Wave Stations

The list of stations below has been compiled directly from the log of Capt. Hall. The column to the left is the wavelength, the letter to the right indicates the type of transmission, and the location and operating time follow. The operating time is liable to change from day to day, so that those listed may only be used as a guide. All times given are E.S.T.

World wide stations that send programs, B, Broadcast; E, Experimental; P, Telephone stations.

Europe

16.30, P, PCK, Kootwijk, Holland, about 6.30 a.m.
16.86, B, GSG, Daventry, England, 7.30 to 8.45 a.m.
16.88, B, PHI, Huizen, Holland, 7 to 9 a.m., irregular.
19.55, B, CTIAA, Lisbon, Portugal, Tuesday and Friday, 4.30 to 7 p.m.
19.68, B, Pontoise, France, 8 to 11 a.m.
19.73, B, DJB, Zeesen, Germany, 7.15 to 11 a.m.
19.82, B, GSF, Daventry, England, 3 to 5 a.m.
19.84, B, HVJ, Vatican City, Italy, 10 to 10.30 a.m.
25.00, B. RNE, Moscow, Sunday, 11 a.m. to 12.
25.20, B, Pontoise, France, 11.15 to 2.15 p.m., 3 to 6 p.m.
25.28, B, GSE, Daventry, England, 7.30 to 8.45 a.m. and 4 to 6 p.m.
25.40, B, 2RO, Rome, Italy, 2 to 6 p.m.
25.51, B, DJD, Zeesen, Germany, 8 to 11 p.m.
25.53, B, GSD, Daventry, England, 3 to 5 a.m., and 1.15 to 2.45 p.m.
25.57, B, PHI, Huizen, Holland.
25.63, B, Pontoise, France, 3 to 6 and 6.15 to Midnight.
29.04, Ruysselede, Belgium, 1 p.m. on.
30.00, B, EAQ, Madrid, Spain, 5.30 to 7 p.m.
31.27, B, HBL, Geneva, Switzerland, Sat. 5 to 5.45 p.m.
31.30, B, GSC, Daventry, England, 6 to 8 p.m.
31.55, B, GSB, Daventry, England, 11 a.m. to 1 p.m., 1.15 to 2.45 p.m., 6 to 8 p.m.
43.86, HAT2, Budapest, Hungary, irregular. No time schedule.
45.38, B, REN, Moscow, Russia, 2 to 6 p.m.
49.50, B, OXY, Skamleback, Denmark, 2 to 6 p.m.
49.59, B, GSA, Daventry, England, 2.45 to 5.45 p.m., 6 to 8 p.m.
49.83, B, DJC, Zeesen, Germany, 8 to 11 p.m.
50.00, B, RV59, Moscow, Russia, 4 to 6 p.m.
50.26, B, HVJ, Vatican City, Italy, very irregular.
60.30, E, G6RX, Rugby, England, 8 to 10 p.m., irregular.
69.44, E, G6RX, Rugby, England, 9 to 11 p.m., irregular.

Asia

16.50, P, PMC, Bandoeng, Java, 3 to 5 p.m., irregular.
19.03, E, JIAA, Kemikawa, Japan, 4.30 a.m., irregular.
20.03, P, KAY, Manila, Phillippine Isl., 5 to 8 a.m.
28.80, P, UIG, Medan, Sumatra, 4 to 5 a.m.
30.40, E, JIAA, Kemikawa, Japan, 5 to 7 a.m.
48.90, B, ZGE, Zula Lumper, Malayan States, Sun., Tues., Fri., 6.30 to 8.30 p.m.
49.10, B, VUC, Calcutta, India, 9 to 12 a.m. and 2 p.m. to 3 a.m.
70.6, B, RV15, Khabarovsk, Russia, 3 to 9 a.m.

Africa

23.38, B, CNR, Rabat, Morocco, Sun., 7.30 to 9 a.m.
29.58, P, OPM, Leopoldville, Belgian Congo, 9 to 10 a.m.
37.33, B, CNR, Rabat, Morocco, Sun., 3 to 5 p.m.
41.60, B, EAR58, Tenerffe, Canary Isl., 5 to 6 p.m.
48.99, B, Johannesburg, South Africa, 4 to 5 a.m., 12 to 3 p.m., and 8 to 10 a.m.
49.50, B, VQ7LO, Nairobi, Kenya, 11 a.m. to 2 p.m.

North America

16.87, B, W3XAL, Bound Brook, N. J., 10 a.m. to 4 p.m., irregular.
19.56, B, W2XAD, Schenectady, N. Y., Mon., Wed., Fri. and Sun., 4 to 5 p.m.
19.64, B, W2XE, Wayne, N. J., 11 a.m. to 1 p.m.
19.67, B, W1XAL, Boston, Mass., 11 a.m. to 3 p.m., Sun.
19.72, B, W8XK, Pittsburgh, Pa., 10 a.m. to 4 p.m., irregular.
25.27, B, W8XK, Pittsburgh, Pa., 4.30 to 10 p.m., irregular.
25.36, B, W2XE, Wayne, N. J., 3 to 5 p.m.
25.45, B, W1XAL, Boston, Mass., Sat., 5 to 11 p.m., and Sun. 6 to 8 p.m.
31.28, B, W3XAU, Philadelphia, Pa., 1 to 6 p.m.
31.36, B, W1XAZ, Springfield, Mass., 7 p.m. to 1 a.m.
31.48, B, W2XAF, Schenectady, N. Y., 8 to 11 p.m.
46.69, B, W3XL, Bound Brook, N. J., irregular.
48.86, B, W8XK, Pittsburgh, Pa., 4.30 p.m. to 1 a.m.
49.02, B, W2XE, Wayne, N. J., 6 to 11 p.m.
49.18, B, W3XAL, Bound Brook, N. J., Sat. 4.30 to 12 p.m.
49.18, B, W9XF, Chicago, Ill., 8 to 9.30 p.m.
49.34, B, W9ZAA, Chicago, Ill., 3 to 6 p.m.
49.50, B, W3XAU, Philadelphia, Pa., 8 to 12 p.m., irregular.
49.50, B, W8XAL, Cincinnati, Ohio, 9 to 10 p.m.

South America

19.19, P, OCJ, Lima, Peru, 2 p.m. irregular.
25.73, E, PPQ, Rio de Janeiro, Brazil, 7 p.m., irregular.
27.35, P, OCI, Lima, Peru, 10 p.m., irregular.
28.98, E, LSX, Buenos Aires, Argentina, 8 to 9.30 p.m., irregular.
30.03, E, LSN, Buenos Aires, Argentina, 9 to 10 p.m., irregular.
32.00, B, Ti4NRH, Costa-Rica, 7 to 8 p.m.
36.65, E, PSK, Rio de Janeiro, Brazil, 8 p.m., irregular.
40.55, E, HJ3ABD, Bogota, Colombia, 9 to 11 p.m.
41.55, B, HKE, Bogota, Colombia, Mon. 6 to 7 p.m. and Tues. 8 to 9 p.m.
41.60, B, HJ4ABB, Manizales, Colombia, 9 to 10 p.m.
45.00, B, HC2RL, Quito, Ecuador, Sun. 5 to 7 and Tues. 9 to 11 p.m.
45.31, B, PRADO, Riobamba, Ecuador, Thurs. 9 to 11 p.m.
45.60, B, HJ1ABB, Barranquilla, Colombia, 6 to 10 p.m.
47.00, B, HJ5ABD, Colombia, Thurs., Sat. and Sun., 7 to 9.30 p.m.
48.00, B, HJ3ABF, Bogota, Colombia, 7 to 10.30 p.m.
48.50, B, TGW Guatemala, 6-12 p.m.
48.78, B, YV3BC, Caracas, Venezuela, Evening, irregular.
48.95, B, YV11BMO, Maracaibo, Venezuela, 8 to 11 p.m.
50.20, B, YV1BC, Caracas, Venezuela, 5 to 10 p.m., irregular.
50.20, B, HJ4ABE, Tunga, Colombia, 9 to 10.30 p.m.
73.00, B, HCJB, Quito, Ecuador, Evening, irregular.

Mexico, West Indies, and Yucatan

25.50, P, XDM, Mexico City, Mexico, 8 to 9 p.m., irregular.
26.00, E, XAM, Merida, Yucatan, 6 to 7 p.m. irregular.
32.09, E, XDC, Mexico City, Mexico, 5 to 7 p.m., irregular.
47.50, B, HIZ, Santo Domimgo, 5 to 6 p.m.
47.80, B, HI1A, Dominican Republic, Mon., Wed. and Fri. 12 to 1.30 p.m. Tues., Thurs. and Sat. 7.30 to 9.30 p.m.
B, HIX, Santo Domingo, Tues. 8 to 10 p.m.
50.2, B, COC, Havana, Cuba, 5 to 6 p.m.

Oceania

31.28, B, VK2ME, Sydney, Australia, Sun. 1 to 3 a.m., 5 to 8.30 a.m., and 9 to 11 a.m.
31.55, B, VK3ME, Melbourne, Australia, Wed. 5 to 6.30, Sat. 5 to 7 a.m.

Canada

25.60, B, VE9JR, Winnipeg, Canada, 6 to 10 p.m., irregular.
49.10, B, VE9HX, Halifax, N.S., Evening, irregular.
49.22, B, VE9GW, Bowmanville, Canada, 3 to 6 p.m. daily.
49.29, B, VE9BJ, St. John, N. B., 5 to 10 p.m.
49.42, B, VE9CS, Vancouver, B.C., Fri. 12 to 1.30 p.m.
49.96, B, VE9DR, Montreal, Canada, 8 to 10 a.m., Sun 1 to 10 p.m.

NOTE: All times given are approximate and subject to change.

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SHORT WAVE RADIO'S

Short-Wave Station List

THE following list, conveniently arranged alphabetically according to call letters, represents practically all the short-wave stations of the world, except amateur, that use voice transmission and are therefore recognizable by listeners who do not know the code. In most cases the frequency in kilocycles, the corresponding wavelength in meters, and the location by city are given; the country of origin, where it is not obvious, may quickly be determined from the preliminary list of international call letter assignments. Amateur and some special experimental calls consist of the assigned prefix, followed by a number and two or three letters.

Stations listed as "experimental" change around a great deal and may use code or voice; definite frequencies cannot be given for them.

No attempt has been made to include operating schedules in this list, as a great majority of the stations are experimental in nature, and have the habit of changing announced programs without warning. Up-to-the-minute information on the best stations of the month is contained in another department in this issue.

For the sake of brevity, a number of abbreviations of operating company names are used. These are RCA, Radio Corporation of America; GPO, General Post Office; BBC, British Broadcasting Corporation; CBS, Columbia Broadcasting System; NBC, National Broadcasting Company; GE, General Electric Company; ATT, American Telegraph & Telephone Co.; MRT, Mackay Radio Telegraph Co; MIT, Mass. Institute of Technology.

This station list will be omitted from the May issue, and will reappear in the June issue after being completely checked over and revised.

List of International Call Assignments

Block of Calls	Country	Amateur Prefix
CAA-CEZ	Chile	CE
CFA-CKZ	Canada	VE
CLA-CMZ	Cuba	CM
CNA-CNZ	Morocco	CN
CPA-CPZ	Bolivia	CP
CQA-CRZ	Portuguese colonies:	
	Cape Verde Ids.	CR4
	Portuguese Guinea	CR5
	Angola	CR6
	Mozambique	CR7
	Portuguese India	CR8
	Macao	CR9
	Timor	CR10
CSA-CUZ	Portugal:	
	Portugal proper	CT1
	Azores	CT2
	Madeira	CT3
CA-CVZ	Rumania	CV
CWA-CXZ	Uruguay	CX
CYA-CZZ	Canada	
CZA-CZZ	Monaco	CZ
D	Germany	D
EAA-EHZ	Spain	EAR
EIA-EIZ	Irish Free State	EI
ELA-ELZ	Liberia	EL
ESA-ESZ	Esthonia	ES
ETA-ETZ	Ethiopia (Abyssinia)	ET
F	France (including colonies):	
	France proper	F
	French Indo-China	F1
	Tunis	FM4
	Algeria	FM8
G	United Kingdom:	
	Great Britain except Ireland	G
	Northern Ireland	GI
HAA-HAZ	Hungary	HA
HBA-HBZ	Switzerland	HB
HCA-HCZ	Ecuador	HC
HHA-HHZ	Haiti	HH
HIA-HIZ	Dominican Republic	HI
HJA-HKZ	Colombia	HJ
HRA-HRZ	Honduras	HR
HSA-HSZ	Siam	HS
I	Italy and colonies	I
J	Japan	J
K	United States of America:	
	Continental United States	W
	Philippine Ids.	KA
	Porto Rico and Virgin Ids.	K4
	Territory of Hawaii	K6
	Territory of Alaska	K7
LAA-LNZ	Norway	LA
LOA-LWZ	Argentine Republic	LU
LZA-LZZ	Bulgaria	LZ
M	Great Britain	G
N	United States of America	W
OAA-OCZ	Peru	OA
OFA-OHZ	Finland	OH
OKA-OKZ	Czechoslovakia	OK
ONA-OTZ	Belgium and colonies	ON
OUA-OZZ	Denmark	OZ
PAA-PIZ	The Netherlands	PA
PJA-PJZ	Curacao	PJ
PKA-POZ	Dutch East Indies	PK
PPA-PYZ	Brazil	PY
PZA-PZZ	Surinam	PZ
RAA-RQZ	U. S. S. R. ("Russia")	RA
RVA-RVZ	Persia	RV
RXA-RXZ	Republic of Panama	RX
RYA-RYZ	Lithuania	RY
SAA-SMZ	Sweden	SM
SPA-SRZ	Poland	SP
STA-SUZ	Egypt:	
	Sudan	ST
	Egypt proper	SU
SVA-SZZ	Greece	SV
TAA-TCZ	Turkey	TA
TFA-TFZ	Iceland	TF
TGA-TGZ	Guatemala	TG
TIA-TIZ	Costa Rica	TI
TKA-TZZ	France	
TSA-TSZ	Territory of the Saar Basin	TS
UHA-UHZ	Hedjaz	UH
UIA-UKZ	Dutch East Indies	PK
ULA-ULZ	Luxemburg	UL
UNA-UNZ	Yugoslavia	UN
UOA-UOZ	Austria	UO
UWA-VGZ	Canada	VE
VHA-VMZ	Australia	VK
VOA-VOZ	Newfoundland	VO
VPA-VSZ	British colonies and protectorates	
	British Guiana	VP
	Fiji, Ellice Ids., Zanzibar	VP1
	Bahamas, Barbados, Jamaica	VP2
	Bermuda	VP9
	Fanning Id.	VQ1
	Northern Rhodesia	VQ2
	Tanganyika	VQ3
	Kenya Colony	VQ4
	Uganda	VQ5
	Malaya (including Straits Settlements)	VS1-2-3
	Hongkong	VS6
	Ceylon	VS7
VTA-VWZ	British India	VU
VXA-VYZ	Canada	
W	United States of America:	
	Continental United States (for others, see under K.)	W
XAA-XFZ	Mexico	X
XGA-XUZ	China	AC
YAA-YAZ	Afghanistan	YA
YBA-YHZ	Dutch East Indies	
YHA-YHZ	New Hebrides	YH
YIA-YIZ	Iraq	YI
YLA-YLZ	Latvia	YL
YMA-YMZ	Danzig	YM
YNA-YNZ	Nicaragua	YN
YSA-YSZ	Republic of El Salvador	YS
YVA-YVZ	Venezuela	YV
ZAA-ZAZ	Albania	ZA
ZBA-ZHZ	British colonies and protectorates	
	Transjordania	ZC1
	Palestine	ZC6
	Nigeria	ZD
	Southern Rhodesia	ZE1
ZKA-ZMZ	New Zealand:	
	Cook Ids.	ZK
	New Zealand proper	ZL
	British Samoa	ZM
ZPA-ZPZ	Paraguay	ZP
ZSA-ZUZ	Union of South Africa	ZS ZT ZU

STATIONS ALPHABETICALLY BY CALL LETTERS

—C—

CEC 10,670 kc., 28.12 m.
15,860 kc., 18.91 m.
19,690 kc., 15.24 m.
Santiago, Chile
CFA 6,840 kc., 43.8 m.
Drummondville, Quebec, Canada
CGA 4,780 kc., 62.7 m.
13,340 kc., 22.55 m.
13,750 kc., 21.82 m.
9,330 kc., 32.15 m.
18,170 kc., 16.5 m.
Quebec, Canada
CM6XJ 15,000 kc., 19.99 m.
Central Tuinucu, Cuba
CMCI 6,060 kc., 49.5 m.
Havana, Cuba
CN8MC 6,250 kc., 48 m.
Casablanca, Morocco
CNR 8,050 kc., 37.33 m.
9,300 kc., 32.26 m.
12,880 kc., 23.38 m.
Rabat, Morocco, Africa
CT1AA 6,990 kc., 42.9 m.
9,600 kc., 31.25 m.
Lisbon, Portugal
CT3AQ 11,181 kc., 26.33 m.
Funchal, Madeira

—D—

DAF 8,470 kc., 35.42 m.
12,400 kc., 24.19 m.
17,270 kc., 17.37 m.
Norden, Germany
DAN 11,340 kc., 26.44 m.
Nordeich, Germany
DFA 4,400 kc., 68.17 m.
19,240 kc., 15.58 m.
DFB 18,520 kc., 17.12 m.
DGK 6,680 kc., 44.91 m.
DGU 9,620 kc., 31.2 m.
DHC 11,435 kc., 26.22 m.
DHO 20,040 kc., 14.97 m.
DHI 19,950 kc., 15.03 m.
DIQ 10,290 kc., 29.15 m.
DIS 10,150 kc., 29.54 m.
Nauen, Germany
DJA 9,560 kc., 31.38 m.
Konigswusterhausen, Germany
DJB 15,200 kc., 19.73 m.
DJC 6,020 kc., 49.83 m.
DJD 11,760 kc., 25.51 m.
Zeesen, Germany
DOA 7,230 kc., 41.46 m.
7,390 kc., 37.8 m.
4,430 kc., 67.5 m.
3,620 kc., 82.9 m.
Doeberitz, Germany

—E—

EAJ25 6,000 kc., 50 m.
Barcelona, Spain
EAR110 6,980 kc., 43.0 m.
Madrid, Spain
EAQ 19,700 kc., 15.23 m.
10,000 kc., 30 m.
Alcalda 43—Madrid, Spain
EHY 10,100 kc., 29.7 m.
Madrid, Spain

—F—

F8KR 3,750 kc., 80 m.
F8KR 6,660 kc., 45 m.
Constantine, Algeria
F8MC 6,875 kc., 43.6 m.
Casablanca, Morocco
FIGA 6,000 kc., 49.97 m.
Tananarive, Madagascar
FL 6,120 kc., 49.02 m.
FLJ 9,230 kc., 32.5 m.
Paris, France
FQE 12,150 kc., 24.68 m.
FQO 12,150 kc., 24.68 m.
FRE 18,240 kc., 16.44 m.
FRE 19,400 kc., 15.45 m.
FRO 18,240 kc., 16.44 m.
St. Assise, France
FSR 20,680 kc., 14.5 m.
Paris, France
FTA 11,950 kc., 25.12 m.
FTD 19,830 kc., 15.12 m.
FTF 7,770 kc., 38.6 m.
FTK 15,690 kc., 19.12 m.
FTK 15,860 kc. 18.9 m.
St. Assise, France
FYA 11,705 kc., 25.6 m.
FYA 11,905 kc., 25.16 m.
FYA 15,240 kc., 19.68 m.
Pontoise (Paris) France
FZG 12,000 kc., 24.98 m.
FZR 16,200 kc., 18.5 m.
FZS 11,900 kc., 25.02 m.
FZS 18,310 kc., 16.38 m.
Saigon, Indo-China

—G—

GAA 20,380 kc., 14.72 m.
GAG 18,970 kc., 15.81 m.
GAS 18,410 kc., 16.38 m.
GAU 18,620 kc., 16.11 m.
GBB 13,580 kc., 22.09 m.
GBC 17,080 kc., 17.55 m.
GBC 12,780 kc., 23.46 m.
GBC 9,310 kc., 32.22 m.
GBC 8,680 kc., 34.56 m.
GBC 4,980 kc., 60.26 m.
Rugby, England
GBJ 18,620 kc., 16.1 m.
GBK 16,100 kc., 16.57 m.
9,250 kc., 32.4 m.
11,490 kc., 26.1 m.
Bodmin, England
GBP 10,770 kc., 28.04 m.
GBS 18,310 kc., 16.38 m
12,250 kc., 24.46 m.
12,150 kc., 24.68 m.
GBU 18,620 kc., 16.11 m.
22,300 kc., 13.45 m.
12,290 kc., 24.41 m.
9,950 kc., 30.15 m.
GBW 14,480 kc., 20.7 m.
9,790 kc., 30.64 m.
GPO, Rugby, Eng.
GBX 16,150 kc., 18.56 m.
10,390 kc., 28.86 m.
GCA 9,710 kc., 30.9 m.
GCB 9,280 kc., 32.33 m.
GCS 9,020 kc., 33.26 m.
GCU 9,950 kc., 30.15 m.
GCW 9,800 kc., 30.60 m.
GDS 6,900 kc., 43.45 m.
GDW 4,840 kc., 62.0 m.
Rugby, England
GSA 6,050 kc., 49.58 m.
GSB 9,510 kc., 31.55 m.
GSC 9,585 kc., 31.29 m.
GSD 11,750 kc., 25.53 m.
GSE 11,865 kc., 25.28 m.
GSF 15,140 kc., 19.81 m.
GSG 17,770 kc., 16.88 m.
GSH 21,470 kc., 13.97 m.
BBC, Daventry, Eng.
G6RX 4,320 kc., 69.44 m.
Rugby, England

—H—

HB9D 7,200 kc., 41.5 m.
Zurich, Switzerland
HBF 18,900 kc., 15.78 m.
HBJ 14,560 kc., 20.6 m.
Pragins, Switzerland
HBL 9,595 kc., 31.27 m.
HBP 7,800 kc., 38.47 m.
Geneva, Switzerland
HC1DR 6,382 kc., 47 m.
Quito, Ecuador
HC2JSB 8,000 kc., 37.5 m.
Guayaquil, Ecuador
HCJB 8,110 kc. 37.0 m.
5,714 kc., 52.5 m.
Quito, Ecuador, S. A.
HJ1ABB 5,800 kc., 51.75 m.
Barranquilla, Colombia
HJ2ABA 5,880 kc., 51.49 m.
Tunja, Colombia
HJ3ABD 7,400 kc., 40.55 m.
HJ3ABF 6,250 kc., 48.0 m.
Bogota, Colombia
HJ4ABB 7,150 kc., 41.6 m.
Manizales, Colombia
HJ4ABE 5,930 kc., 5.06 m.
Medellin, Colombia
HJ5ABD 6,380 kc., 47.0 m.
Cali, Colombia
HJB 7,470 kc., 40.16 m.
HJY 9,930 kc., 30.2 m.
18,460 kc., 16.25 m.
HKC 6,270 kc., 47.81 m.
Bogota, Colombia
HKF 7,612 kc., 39.14 m.
HKM 6,660 kc., 45 m.
Bogota, Colombia
HKO 5,900 kc., 50.8 m.
Medellin, Colombia
HKX 7,140 kc., 42.02 m.
Bogota, Colombia
HSP2 9,640 kc., 31.1 m.
HSP 17,750 kc., 16.92 m.
Bangkok, Siam
HVJ 5,970 kc., 50.26 m.
75,110 kc., 19.84 m.
15,120 kc., 19.83 m.
Vatican City, Rome, Italy

—I—

I2RO 11,810 kc., 25.4 m
Rome, Italy
I3RO 3,750 kc., 80 m
Rome, Italy
IAC 8,380 kc., 35.8 m.
6,650 kc., 45.1 m.
12,800 kc., 23.45 m.
Pisa, Italy
IBDK 11,470 kc., 26.15 m.
S. S. Elettra (Marconi's Yacht)
IRW 19,540 kc., 15.25 m.
Italy

J

JB 6,069 kc., 49.43 m.
Johannesburg, South Africa
J1AA 7,880 kc., 38.07 m.
13,090 kc., 22.93 m
9,870 kc., 30.4 m.
15,490 kc., 19.36 m.
Tokio, Japan

—K—

K6XQ Experimental
S. S. Lake Miraflores
KAZ 9,970 kc., 30.09 m.
Manila, P. I.
KDK 7,520 kc., 39.89 m
KEJ 9,020 kc., 33.27 m
Kauhuku, T. H.
KEL 6,860 kc., 43.7 m.
Bolinas, Cal.
KEQ 7,370 kc., 40.71 m.
Kauhuku, T. H.
KES 10,410 kc., 28.80 m.
KEZ 10,410 kc., 28.80 m.
Bolinas, Cal.
KGHA 2,506 kc., 119.5 m.
Portable on snowplow, Wash.
KGHB 2,506 kc., 119.5 m.
Portable on snowplow, Wash.
KGHC 2,506 kc., 119.5 m.
Police car, Wash.
KGHD 2,506 kc., 119.5 m.
Seattle, Wash.
KGHE 2,506 kc., 119.5 m.
Snoqualmie Pass, Wash.
KGHO 1,534 kc., 191.1 m.
Des Moines, Iowa
KGJX 1,712 kc., 175.15 m.
Pasadena, Cal.
KGOZ 2,470 kc., 121.5 m.
Cedar Rapids, Iowa
KGPA 2,414 kc., 124.2 m.
Seattle, Wash.
KGPB 2430 kc., 123.4 m.
Minneapolis, Minn.
KGPC 1,712 kc., 175.15 m.
St. Louis, Mo.
KGPD 2,470 kc., 121.5 m.
San Francisco, Cal.
KGPE 2,422 kc., 123.8 m.
Kansas City, Mo.
KGPG 2,422 kc., 123.8 m.
Vallejo, Cal.
KGPH 2,450 kc., 122.4 m.
Oklahoma City, Okla.
KGPI 2,470 kc., 121.5 m.
Omaha, Neb.
KGPJ 1,712 kc., 175.15 m.
Beaumont, Tex.
KGPK 2,470 kc., 121.5 m.
Sioux City, Ia.
KGPL 1,712 kc., 175.15 m.
Los Angeles, Cal.
KGPM 2,470 kc., 121.5 m.
San Jose, Cal.
KGPN 2,470 kc., 121.5 m.
Davenport, Iowa
KGPO 2,450 kc., 122.4 m.
Tulsa, Okla.
KGPP 2,442 kc., 122.8 m.
Portland, Ore.
KGPQ 2,450 kc., 122.4 m.
Honolulu, T. H.
KGPS 2,414 kc., 124.2 m.
Bakersfield, Cal.
KGPW 2,470 kc., 121.5 m.
Salt Lake City, Utah
KGPX 2,442 kc., 122.8 m.
Denver, Colo.
KGPY 1,574 kc., 189.5 m.
Shreveport, La.
KGPZ 2,450 kc., 122.4 m.
Wichita, Kans.
KGTP Various aero frequencies
KGZA 2,414 kc., 124.2 m.
Fresno, Cal.
KGZB 1,712 kc., 175.15 m.
Houston, Tex.
KGZC 2,422 kc., 123.8 m.
Topeka, Kan.
KGZD 2,430 kc., 123.4 m.
San Diego, Cal.
KGZE 2,506 kc., 120 m.
San Antonio, Tex.
KGZF 2,450 kc., 122.4 m.
Chanute, Kans.
KGZG 2,470 kc., 121.5 m.
Des Moines, Iowa
KGZH 2,442 kc., 122.8 m.
Klamath Falls, Ore.
KGZI 1,712 kc., 175.15 m
Wichita Falls, Tex
KGZJ 2,430 kc., 123.4 m.
Phoenix, Ariz.
KGZL 1,712 kc., 175.15 m.
Shreveport, La.
KGZM 2,414 kc., 124.2 m.
El Paso, Tex.
KGZN 2,414 kc., 124.2 m.
Tacoma, Wash.
KGZO 2,414 kc., 124.2 m.
Santa Barbara, Cal.
KGZP 2,450 kc., 122.4 m.
Coffeyville, Kans.
KGZQ 1,712 kc., 175.15 m.
Waco, Tex.
KGZR 2,442 kc., 122.8 m.
Salem, Ore.
KGZT 2,470 kc., 121.5 m.
Santa Cruz, Cal.
KGZU 2,470 kc., 121.5 m.
Lincoln, Neb.
KGZV 2,414 kc., 124.2 m.
Aberdeen, Wash.
KGZW 2,458 kc., 122.8 m.
Lubbock, Tex.
KGZX 2,414 kc., 124.2 m.
Albuquerque, N. M.
KGZY 1,712 kc., 175.15 m
San Bernardino, Cal.
KIO 11,670 kc., 25.68 m.
KKH 7,520 kc., 39.89 m.
KKP 16,040 kc., 18.71 m.
Kauhuku, T. H.
KKQ 11,945 kc., 25.1 m.
KKW 13,780 kc., 21.77 m.
KKZ 14,150 kc., 21.17 m.
KQJ 18,050 kc., 16.61 m.
Bolinas, Cal.
KSW 1,658 kc., 180.7 m.
Berkeley, Cal.
KVP 1,712 kc., 175.15 m.
Dallas, Tex.
KWN 21,060 kc., 14.24 m.
KWO 15,420 kc., 19.46 m.
KWU 15,350 kc., 19.54 m.
KWV 10,840 kc., 27.67 m.
KWX 7,610 kc., 39.42 m.
KWY 7,560 kc., 39.65 m.
KWZ 10,400 kc., 28.8 m.
Dixon, Cal.

—L—

LGN 9,600 kc., 31.23 m
Bergen, Norway
LQA 9,600 kc., 31.25 m.
LSA 9,890 kc., 30.3 m.
LSA 14,530 kc., 20.65 m.
LSG 19,950 kc., 15.03 m.
LSG 19,906 kc., 15.07 m.
LSL 10,300 kc., 29.12 m.
LSL 21,160 kc., 14.17 m.
Buenos Aires
LSM 21,130 kc., 14.15 m.
Monte Grande, Argentina
(Buenos Aires)
LSN 14,530 kc., 20.65 m.
LSN 21,020 kc., 14.27 m.
LSN 20,680 kc., 14.5 m.
LSR 18,960 kc., 15.82 m.
LSX 10,350 kc., 28.98 m.
LSY 20,730 kc., 14.47 m.
LSY 10,410 kc., 28.8 m.
LSY 18,130 kc., 16.55 m.
Buenos Aires

—N—

NAA 16,060 kc., 18.68 m.
NAA 12,045 kc., 24.89 m.
NAA 4,105 kc., 74.72 m.
Arlington, Va. (time signals)
NPO 8,872 kc., 33.81 m.
Cavite, P. I. (time signals)
NSS 12,045 kc., 24.89 m.
Annapolis, Md. (time signals)

—O—

OCI 18,680 kc., 16.06 m.
OCJ 15,620 kc., 19.19 m.
Lima, Peru
OKI 21,000 kc., 14.28 m.
Podebrady, Czechoslovakia
OKIMPT 5,145 kc., 58.31 m.
OKIMPT 5,170 kc., 58 m.
Prague, Czechoslovakia
OPL 20,040 kc., 14.97 m
OPM 10,140 kc., 29.58 m.
Leopoldsville, Belgian Congo
ORG 19,210 kc., 15.62 m.
ORK 10,330 kc., 29.04 m.
Brussels, Belgium
OXY 15,300 kc., 19.6 m.
Lyngby, Denmark
OXY 6,075 kc., 49.4 m.
OXY 9,520 kc., 31.51 m.
Skamleback, Denmark
OZ7RL 3,560 kc., 84.24 m.
Copenhagen, Denmark

—P—

PCK 7,770 kc., 38.6 m.
18,400 kc., 16.3 m.
PCL 16,300 kc., 18.4 m.
PCV 17,830 kc., 16.82 m.
PDK 10,410 kc., 28.8 m.
PDU 7,830 kc., 38.3 m.
PDV 12,060 kc., 24.88 m.
Kootwijk, Holland
PHI 17,770 kc., 16.88 m.
11,730 kc., 25.57 m.
Huizen, Holland
PK2AG 3,156 kc., 95 m.
Samarang, Java
PK3AN 6,040 kc., 49.67 m.
Sourabaya, Java
PLE 18,200 kc., 15.94 m.
PLF 17,850 kc., 16.8 m.
PLG 15,950 kc., 18.8 m.
PLM 12,250 kc., 24.46 m.
PLR 10,630 kc., 28.2 m.
PLV 9,420 kc., 31.86 m.
PLW 8,120 kc., 36.92 m.
9,480 kc., 31.63 m.
PMB 20,620 kc., 14.54 m.
5,170 kc., 58 m.
PMC 18,370 kc., 16.33 m.
PMN 10,360 kc., 29.25 m.
PMY 5,170 kc., 58.0 m.
Bandoeng, Java
PPG 11,660 kc., 27.73 m.
PPU 19,270 kc., 15.57 m.
Rio de Janeiro
PRADO 6,620 kc., 45.31 m.
Riobamba, Ecuador
PRAG 8,450 kc., 35.5 m.
Porto Algero, Brazil
PSA 21,080 kc., 14.23 m.
PSH 10,220 kc., 29.35 m.
PSK 8,190 kc., 36.65 m.
Rio de Janeiro

—R—

RABAT 12,830 kc., 23.38 m.
8,035 kc., 37.33 m.
Morocco
RAU 15,100 kc., 19.85 m.
Tachkent, Turkestan
REN 6,610 kc., 45.38 m.
RIM 7,630 kc., 39.34 m.
RKI 7,500 kc., 39.97 m.
U. S. S. R.
RV15 4,273 kc., 70.2 m.
Khabarovsk, Siberia
RV59 6,000 kc., 50 m.
Radio Moscow, U.S.S.R.
RXF 14,500 kc., 20.69 m.
Panama City, Panama

—S—

SAJ 6,065 kc., 49.46 m.
Motola, Sweden
SRI 9,570 kc., 31.35 m.
Poznan, Poland
SUV 10,050 kc., 29.83 m.
Cairo, Egypt

—T—

TI4NRH 9,675 kc., 31 m.
Heredia, Costa Rica, C. A.
TIR 8,790 kc., 34.13 m.
14,500 kc., 20.69 m.
Cartago, Costa Rica
TGA 14,500 kc., 20.69 m.
TGW 6,660 kc., 45 m.
6,180 kc., 48.5 m.
TGX 5,940 kc., 50.5 m.
Guatemala City, C. A.

—U—

UIG 10,400 kc., 28.8 m.
Medan, Sumatra
UOR2 6,072 kc., 49.41 m.
Vienna, Austria

—V—

VE9AP 6,335 kc., 47.35 m.
Drummondville, Canada
VE9BJ 6,090 kc., 49.29 m.
St. John, N. B., Canada
VE9BY 4,795 kc., 62.56 m.
6,425 kc., 46.7 m.
8,650 kc., 34.68 m.
London, Ontario, Canada
VE9CA 6,030 kc., 49.75 m
Calgary, Alta., Canada
VE9CF 6,050 kc., 49.59 m
6,100 kc., 49.15 m
Halifax, N. S., Canada
VE9CG 6,110 kc., 49.1 m.
Calgary, Alta., Canada
VE9CL 5,710 kc., 52.5 m.
6,147 kc., 48.8 m.
Winnipeg, Canada
VE9CS 6,069 kc., 49.43 m.
Vancouver, B. C., Canada
VE9CU 6,005 kc., 49.99 m.
Calgary, Alta., Canada
VE9DR 11,780 kc., 25.47 m.
6,005 kc., 49.96 m.
Drummondville, Quebec, Canada
VE9GW 6,095 kc., 49.17 m.
11,800 kc., 25.42 m.
Bowmanville, Ontario, Canada
VE9HK 6,120 kc., 48.98 m.
VE9HX 6,125 kc., 48.98 m.
Halifax, N. S., Canada
VE9JR 11,720 kc., 25.6 m.
Winnipeg, Canada
VK2ME 9,760 kc., 30.75 m.
10,520 kc., 28.51 m.
Sydney, Australia
VK3LR 9,510 kc., 31.55 m.
5,680 kc., 52.8 m
Melbourne, Australia
VLJ 9,980 kc., 37.59 m.
VLK 9,760 kc., 30.75 m.
10,520 kc., 28.51 m.
Sydney, Australia
VPD 7,890 kc., 38.0 m
Suva, Fiji Islands
VPN 4,510 kc., 66.5 m.
Nassau, Bahamas
VQ7LO 6,000 kc., 49.5 m.
Nairobi, Kenya, Africa
VRT 5,050 kc., 59.42 m.
10,070 kc., 29.8 m.
Hamilton, Bermuda
VSIAB 7,195 kc., 41.67 m.
Singapore, S. S.
VUC 6,110 kc., 49.1 m.
Calcutta, India
VWY 18,540 kc., 17.1 m.
Poona, India

—W—

W1XAB 4,700 kc., 63.79 m.
Portland, Me.
W1XAG Experimental
Police, Providence, R. I.
W1XAI Experimental
Tufts College, Medford, Mass.
W1XAK Experimental
Westinghouse, Chicopee Falls, Mass.
W1XAL 11,790 kc., 25.45 m.
W1XAL 6,040 kc., 49.67 m.
W1XAL 15,250 kc., 19.67 m.
W1XAL 21,460 kc., 13.98 m.
Boston, Mass.
W1XAN Experimental
Round Hills, Mass.
W1XAU 1,560 kc., 199.35 m.
W1XAV 1,600 kc., 187.5 m.
Boston, Mass.
W1XAW Experimental
Tufts College, Medford, Mass.
W1XAZ 9,570 kc., 31.35 m.
Westinghouse, Springfield, Mass.
W1XG 43,000 kc., 6.52 m.
Boston, Mass.
W1XJ Experimental
Harvard U., Cambridge, Mass.
W1XK Experimental
Westinghouse, Port. & Mob.
W1XL 6,040 kc., 49.67 m.
Boston, Mass.
W1XM Experimental
M.I.T.
Cambridge, Mass.
W1XP Experimental
W1XV Experimental
M.I.T.
S. Dartmouth, Mass.
W1XW 41,000 kc., 7.32 m.
W1XW 51,400 kc., 5.83 m.
W1XW 60,000 kc., 5.00 m.
W1XW 400,000 kc., ¾ m.
A. F. Sise, Milton, Mass.
W2XAA Experimental
Bell Labs., Port. & Mob.
W2XAB 2,750 kc., 109.1 m.
CBS, New York, N. Y.
W2XAC 8,690 kc., 34.5 m.
W2XAD 15,330 kc., 19.56 m.
W2XAF 9,530 kc., 31.48 m.
GE, Schenectady, N. Y.
W2XAK 43,000 kc., 6.52 m.
W2XAK 48,500 kc., 6.18 m.
W2XAK 60,000 kc., 5.00 m.
CBS, New York, N. Y.
W2XAO 17,850 kc., 16.8 m.
W2XAR Experimental
Long Island City, N. Y.
W2XAV Experimental
Bell Labs., Port. & Mob.
W2XAW Experimental
GE, Schenectady, N. Y.
W2XBB Experimental
RCA, New York, N. Y.
W2XBC 25,700 kc., 11.67 m.
RCA, New Brunswick, N. J.
W2XBG Experimental
Radio Marine, New York, N. Y.
W2XBI Experimental
RCA, Rocky Point, N. Y.
W2XBJ 14,700 kc., 20.27 m.
Rocky Point, N. Y.
W2XBL Experimental
RCA, Port. & Mob.
W2XBS 2,750 kc., 109.1 m.
NBC, Bellmore, L. I.
W2XBT 43,000 kc., 6.52 m.
W2XBT 48,500 kc., 6.18 m.
W2XBT 60,000 kc., 5.00 m.
NBC, Portable
W2XBW Experimental
Globe Wireless, Garden City, N. Y.
W2XBX Plane, Experimental
Bell Labs.
W2XC Experimental
Federal Tel. Co., Port. & Mobile.
W2XCJ Experimental
Police, Bayonne, N. J.
W2XCS Experimental
W2XCT Experimental
Police, Eastchester, N. Y.
W2XCU 12,850 kc., 23.35 m.
W2XCU 8,650 kc., 34.68 m.
Rocky Point, N. Y.
W2XDC Experimental
RCA, Portable & Mobile
W2XDJ 21,420 kc., 14. m.
ATT, Deal, N. J.
W2XDK Experimental
Polin, Inc., Port. & Mob.
W2XDO 17,110 kc., 17.52 m.
W2XDO 8,630 kc., 34.74 m.
ATT, Ocean Gate, N. J.
W2XDT Experimental
Press Wireless, Port. & Mob.
W2XDV Experimental
CBS, New York, N. Y.
W2XDY Experimental
W2XDZ Experimental
Central Hudson Gas & Electric Co.
Portable
W2XE 15,270 kc., 19.65 m.
W2XE 11,830 kc., 25.36 m.
W2XE 6,120 kc., 49.02 m.
CBS, Wayne, N. J.
W2XEA Experimental
W2XEB Experimental
W2XEC Experimental
W2XED Experimental
W2XEE Experimental
W2XEF Experimental
W2XEG Experimental
W2XEH Experimental
Police, Bayonne, N. J.
W2XEI Experimental
P. J Golihofer, Port. & Mob.
W2XEJ Experimental
D. B. Whittemore, Yonkers, N. Y.
W2XEK Experimental
Knickerbocker Broad. Co., Port. & Mob.
W2XEL Experimental
Police, Eastchester, N. Y.
W2XER Experimental
D. B. Whittemore, Yonkers, N. Y.
W2XES 34,600 kc., 8.67 m.
Englewood, N. J.
W2XF 43,000 kc., 6.52 m.
W2XF 48,500 kc., 6.18 m.
W2XF 60,000 kc., 5.00 m.
NBC, New York
W2XG Experimental
Bell Labs., Ocean Township, N. J.
W2XGG Experimental
Police, Bayonne, N. J.
W2XJ Experimental
Bell Labs., Ocean Township, N. J.
W2XK Experimental
NBC, New York, N. Y.
W2XL Experimental
Bell Labs., Port & Mobile
W2XM Experimental
W2XN Experimental
Bell Labs., Holmdel, N. J.
W2XO 12,850 kc., 23.35 m.
GE, Schenectady, N. Y.
W2XP Experimental
RCA, Riverhead, N. Y.
W2XR 1,600 kc., 176.5 m.
W2XR 43,000 kc., 6.97 m.
W2XR 48,500 kc., 6.18 m.
W2XR 60,000 kc., 5.00 m.
W2XS Experimental
W2XT Experimental
RCA, Rocky Point, N. Y.
W2XU Experimental
Bell Labs., Portable
W2XV 30,100 kc., 9.97 m.
W2XV 31,100 kc., 9.65 m.
W2XV 31,600 kc., 9.49 m.
W2XV 33,100 kc., 9.06 m.
W2XV 34,600 kc., 8.67 m.
W2XV 35,600 kc., 8.43 m.
W2XV 37,100 kc., 8.09 m.
W2XV 37,600 kc., 7.98 m.
W2XV 38,600 kc., 7.77 m.
W2XV 40,100 kc., 7.48 m.
W2XV 40,600 kc., 7.38 m.
W2XV 41,000 kc., 7.31 m.
D. E. Replogle, Mobile in Auto.
Clifton, N. J.
W2XW Experimental
W2XY Experimental
Bell Labs., Portable
W3XAB Experimental
RCA, Camden, N. J.
W3XAD 43,000 kc., 6.97 m.
W3XAD 48,500 kc., 6.18 m.
W3XAD 60,000 kc., 5.00 m.
RCA, Camden, N. J.
W3XAJ Experimental
RCA, Camden, N. J.
W3XAK 2,100 kc., 136.4 m.
NBC, Portable
W3XAL 17,780 kc., 16.87 m.
W3XAL 6,100 kc., 49.15 m.
NBC, Bound Brook, N. J.
W3XAM Experimental
RCA, Port. & Mob.
W3XAN Experimental
Harrisburg, Pa.
W3XAR 34,600 kc., 8.67 m.
Haverford (Brookline), Pa.
W3XAU 9,580 kc., 31.32 m.
W3XAU 9,590 kc., 31.28 m.
W3XAU 6,060 kc., 49.5 m.
CBS, Philadelphia, Pa.
W3XAW Experimental
W3XAX Experimental
M. & H. Sporting Goods Co., Port.
W3XAY 30,200 kc., 9.93 m.
W3XAY 35,800 kc., 8.38 m.
W3XAY 41,800 kc., 7.17 m.
W3XAY 42,200 kc., 7.10 m.
W3XAY 47,800 kc., 6.27 m.
W3XAY 48,200 kc., 6.22 m.
W3XAY 53,800 kc., 5.57 m.
W3XAY 54,200 kc., 5.53 m.
W3XAY 60,200 kc., 4.98 m.
Atlantic Refining Co., Phila., Pa.
Experimental
W3XB Experimental
College Park, Md.
W3XE 9,580 kc., 31.32 m.
W3XE 43,000 kc., 6.52 m.
W3XE 48,500 kc., 6.00 m.
W3XE 60,000 kc., 3.75 m.
Philco, Philadelphia, Pa.
W3XE 8,650 kc., 34.68 m.
Baltimore, Md.

W3XL Experimental
NBC, Bound Brook, N. J.
W3XN Experimental
Bell Labs., Whippany, N. J.
W3XR Experimental
Bell Labs., Mendham Township, N. J.
W3XV Experimental
RCA, Arneys-Mount, N. J.
W3XW Experimental
Boonton, N. J.
W3XX 8,650 kc., 34.68 m.
W3XZ 4,795 kc., 62.56 m.
Washington, D. C.
W4XB 6,040 kc., 49.67 m.
Miami Beach, Fla.
W4XC Experimental
Portable
W4XD Experimental
Port. & Mob.
W4XG 8,650 kc. 34.68 m.
Miami, Fla.
W5XC Experimental
Shreveport, La.
W6XAC Experimental
Fred W. Christian, Jr., Portable
W6XAD Experimental
San Francisco, Calif.
W6XAH 2,000 kc., 150 m.
Bakersfield, Cal.
W6XAJ Experimental
W6XAK Experimental
Globe Wireless, Portable
W6XAO 43,000 kc., 6.97 m.
W6XAO 48,500 kc., 6.18 m.
W6XAO 60,000 kc., 5.00 m.
Los Angeles, Cal.
W6XAQ 51,400 kc., 5.83 m.
W6XAQ 60,000 kc., 5.00 m.
W6XAQ 400,000 kc., 0.75 m.
Police, Phoenix, Ariz.
W6XAR Experimental
W6XAS Experimental
Julius Brunton & Sons Co., Port. & Mob.
W6XBB Experimental
R. M. Heintz, Port. in Cal.
W6XC 41,000 kc., 7.32 m.
W6XC 51,400 kc., 5.83 m.
Remler Co., San Francisco, Cal.
W6XD 27,800 kc., 10.79 m.
MRT, Palo Alto, Cal.
W6XF Experimental
Heintz & Kaufman, Port. in Cal.
W6XJ Experimental
Heintz & Kaufman, Port. in Cal.
W6XP Experimental
Press Wireless, Portable and Mobile
W6XQ 24,000 kc., 12.48 m.
San Mateo, Cal.
W6XR Experimental
San Francisco, Calif.
W6XS 2,100 kc., 136.4 m.
Los Angeles, Calif.
W7XA Experimental
Globe Wireless, Ltd., Portable
W7XAW 2,342 kc., 128.09 m.
Seattle, Wash.
W7XC Experimental
Edmonds, Wash.
W7XK Experimental
Seattle, Wash.
W7XL Experimental
Northern Radio Co., Portable
W8XAC 34,600 kc., 8.67 m.
W8XAC 41,000 kc., 7.31 m.
W8XAC 51,400 kc., 5.83 m.
Police, Lincoln Park, Mich.
W8XAG 8,650 kc., 34.68 m.
Dayton, Ohio
W8XAL 6,060 kc., 49.5 m.
Crosley, Cincinnati, O.
W8XAN 43,000 kc., 6.97 m.
W8XAN 48,500 kc., 6.18 m.
W8XAN 60,000 kc., 5.00 m.
W8XAN 1,600 kc., 176.5 m.
Jackson, Mich.
W8XAS Experimental
W8XAT Experimental
V. G. Martin, Rochester, N. Y.
W8XAY Experimental
W8XAZ Experimental
Buffalo Broad. Corp., Buffalo, N. Y.
W8XD Portable
WBEN, Inc.
W8XF 43,000 kc., 6.97 m.
W8XF 48,500 kc., 6.18 m.
W8XF 60,000 kc., 5.00 m.
Pontiac, Mich.
W8XH Portable
WBEN, Inc.
W8XI Experimental
W8XK 21,540 kc., 13.93 m.
W8XK 17,780 kc., 16.87 m.
W8XK 15,210 kc., 19.72 m.
W8XK 11,870 kc., 25.26 m.
W8XK 9,570 kc., 31.35 m.
W8XK 6,140 kc., 48.86 m.
Westinghouse, E. Pittsburgh, Pa.
W8XL 17,300 kc., 17.34 m.
Dayton, O.
W8XL 43,000 kc., 6.97 m.
W8XL 48,500 kc., 6.18 m.
W8XL 60,000 kc., 5.00 m.
Cuyahoga Hts., Ohio
W8XN 1,600 kc., 176.5 m.
Jackson, Mich.
W8XP Portable
W8XS Experimental
Westinghouse, E. Pittsburgh, Pa.
W8XW Experimental
V. G. Martin, Rochester, N. Y.
W9XAA 6,080 kc., 49.31 m.
W9XAA 11,830 kc., 25.36 m.
W9XAA 17,780 kc., 16.87 m.
Chicago, Ill.
W9XAI Experimental
W9XAJ Experimental
Milwaukee, Wis., Portable
W9XAK 2,100 kc., 142.9 m.
Manhattan, Kans.
W9XAL 2,200 kc., 136.4 m.
Kansas City, Mo.
W9XAM 4,795 kc., 62.56 m.
Elgin, Ill.
W9XAO 11,840 kc., 25.34 m.
W9XAO 2,000 kc., 150 m.
W9XAP 2,100 kc., 142.9 m.
Chicago, Ill.
W9XAR Experimental
Portable & Mobile
W9XAT 43,000 kc., 6.97 m.
W9XAT 48,500 kc., 6.18 m.
W9XAT 60,000 kc., 5.00 m.
Dr. G. W. Young, Portable
W9XAV Experimental
Press Wireless, Port. & Mob.
W9XD 43,000 kc., 6.97 m.
W9XD 48,500 kc., 6.18 m.
W9XD 60,000 kc., 5.00 m.
Milwaukee, Wis.
W9XE 43,000 kc., 6.97 m.
W9XE 48,500 kc., 6.18 m.
W9XE 60,000 kc., 5.00 m.
Marion, Ind.
W9XF 17,780 kc., 16.87 m.
W9XF 11,880 kc., 25.24 m.
W9XF 6,100 kc., 49.18 m.
NBC, Chicago, Ill.
W9XG 2,750 kc., 109.1 m.
W. Lafayette, Ind.
W9XJ Experimental
State Univ., Grand Forks, N. D.
W9XK 2,000 kc., 150 m.
Iowa City, Iowa
W9XL 17,300 kc., 17.34 m.
W9XL 12,850 kc., 23.35 m.
W9XL 6,425 kc., 46.70 m.
Anoka, Minn.
W10XAA Plane, Experimental
Bell Labs.
W10XAC Experimental
Milwaukee, Wis., Port. & Mobile
W10XAF Experimental
Larry L. Smith, Portable
W10XAG Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XAH Experimental
W10XAI Experimental
NBC, Portable and Mobile
W10XAJ Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XAK Experimental
NBC, Portable and Mobile
W10XAL Experimental
CBS, Portable and Mobile
W10XAM Experimental
W10XAN Experimental
W10XAP Experimental
NBC, Portable and Mobile
W10XAQ Experimental
Westinghouse, Portable & Mobile
W10XAY Experimental
Polin, Inc., Portable and Mobile
W10XBA Plane, Experimental
W10XBB Plane, Experimental
W10XBC Plane, Experimental
Aeronautical Radio Inc.
W10XBE Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XBF Experimental
W10XBG Experimental
W. G. H. Finch, Portable & Mob.
W10XBI Plane, Experimental
Roland Reed
W10XBK Experimental
W. G. H. Finch, Portable & Mob.
W10XE Experimental
RCA, Portable and Mobile
W10XI Plane, Experimental
Aircraft Radio Corp.
W10XJ Experimental
Bell Labs., Portable
W10XN Experimental
NBC, Portable and Mobile
W10XT Experimental
RCA, Portable and Mobile
W10XX 43,000 kc., 6.97 m.
W10XX 48,500 kc., 6.18 m.
W10XX 60,000 kc., 5.00 m.
RCA, Portable
W10XY Experimental
NBC, Portable and Mobile
W10XZ Experimental
CBS, Portable and Mobile
WAEQ Various aero frequencies
Elmira, N. Y.
WAJ 13,480 kc., 22.26 m.
Rocky Point, N. Y.
WBA 190 kc., 1.579 m.
Harrisburg, Pa.
WBR 190 kc., 1.579 m.
Butler, Pa.
WCK 2,414 kc., 124.2 m.
Belle Island, Mich.
WCN 5,070 kc., 59.08 m.
Lawrenceville, N. J.
WDX 190 kc., 1.579 m.
Wyoming, Pa.
WEA 10,610 kc., 28.28 m.
WEB 6,940 kc., 43.23 m.
WEC 8,930 kc., 33.59 m.
WEF 9,590 kc., 31.6 m.
WEL 8,950 kc., 33.52 m.
WEM 7,400 kc., 40.54 m.
WES 9,450 kc., 31.74 m.
WGN 5,260 kc., 57.03 m.
WIY 13,870 kc., 21.63 m.
Rocky Point, N. Y.
WJL 190 kc., 1.579 m
Greensburg, Pa.
WKA 21,060 kc., 14.25 m.
Lawrenceville, N. J.
WKDU 1,712 kc., 175.15 m.
Cincinnati, Ohio
WKF 19,220 kc., 15.61 m.
WKF 4,750 kc., 63.21 m.
Lawrenceville, N. J.
WKJ 9,590 kc., 31.6 m.
Rocky Point, N. Y.
WKK 21,410 kc., 14.01 m.
WKN 19,830 kc., 15.13 m.
Lawrenceville, N. J.
WKU 14,700 kc., 20.27 m.
WKW 19,020 kc., 15.77 m.
Rocky Point, N. Y.
WLA 18,350 kc., 16.35 m.
WLK 16,330 kc., 18.44 m.
WLO 21,400 kc., 14.01 m.
WLO 16,300 kc., 18.4 m.
WLO 10,540 kc., 28.44 m.
ATT, Lawrence, N. J.
WMA 13,390 kc., 22.4 m.
Lawrenceville, N. J.
WMB 190 kc., 1,579 m.
West Reading, Pa.
WMDZ 2,442 kc., 122.8 m.
Indianapolis, Ind.
WMF 14,470 kc., 20.73 m.
Lawrenceville, N. J.
WMI 19,850 kc., 15.1 m.
WMI 9,700 kc., 30.9 m.
ATT, Deal, N. J.
WMJ 2,422 kc., 123.8 m.
Buffalo, N. J.
WMN 14,590 kc., 20.56 m
Lawrenceville, N. J.
WMO 2,414 kc., 124.2 m.
Highland Park, Mich.
WMP 1,574 kc., 189.5 m.
Framingham, Mass.
WNA 9,170 kc., 32.72 m.
WNB 10,680 kc., 28.09 m.
Lawrenceville, N. J.
WNC 19,200 kc., 15.6 m.
WNC 14,480 kc., 20.7 m.
WNC 9,750 kc., 30.75 m.
WND 18,350 kc., 16.35 m.
WND 13,400 kc., 22.38 m.
WND 6,753 kc., 44.4 m.
ATT, Deal, N. J.
WOA 6,750 kc., 44.41 m.
WOB 5,850 kc., 51.26 m.
WOF 9,750 kc., 30.77 m.
WOK 10,550 kc., 28.44 m.
WON 9,870 kc., 30.40 m.
Lawrenceville, N. J.
WOO 17,110 kc., 17.52 m.
WOO 8,550 kc., 35.09 m.
WOO 6,515 kc., 46.05 m.
WOO 8,630 kc., 34.74 m.
WOO 4,750 kc., 63.13 m.
WOO 4,116 kc., 72.87 m.
WOO 3,124 kc., 96.03 m.
WOP 19,380 kc., 15.48 m.
Ocean Gate, N. J.
WOU 2,590 kc., 115.8 m.
Green Harbor, Mass.
WOX 2,540 kc., 118.06 m.
New York, N. Y.
WPDA 2,414 kc., 124.2 m.
Tulare, Cal.
WPDB 1,712 kc., 175.15 m.
WPDC 1,712 kc., 175.15 m.
WPDD 1,712 kc., 175.15 m.
Chicago, Ill.
WPDE 2,442 kc., 122.8 m.
Louisville, Ky.
WPDF 2,442 kc., 122.8 m.
Flint, Mich.
WPDG 2,458 kc., 122.8 m.
Youngstown, O.
WPDH 2,442 kc., 122.8 m.
Richmond, Ind.
WPDI 2,430 kc., 123.4 m.
Columbus, Ohio
WPDK 2,450 kc., 122.4 m.
Milwaukee, Wis.
WPDL 2,442 kc., 122.8 m.
Lansing, Mich.
WPDM 2,430 kc., 123.4 m.
Dayton, Ohio
WPDN 2,458 kc., 122. m.
Auburn, N. Y.
WPDO 2,458 kc., 122. m.
Akron, Ohio
WPDP 2,470 kc., 121.5 m.
Philadelphia, Pa.
WPDR 2,458 kc., 122. m.
Rochester, N. Y.
WPDS 2,430 kc., 123.4 m.
St. Paul, Minn.
WPDT 2,470 kc., 121.5 m.
Kokomo, Ind.
WPDU 1,712 kc., 175.15 m.
Pittsburgh, Pa.
WPDV 2,458 kc., 122. m.
Charlotte, N. C.
WPDW 2,422 kc., 123.8 m.
Washington, D. C.
WPDX 2,414 kc., 124.2 m.
Detroit, Mich.
WPDY 2,414 kc., 124.2 m.
Atlanta, Ga.
WPDZ 2,470 kc., 121.5 m.
Fort Wayne, Ind.
WPEA 2,458 kc., 122.8 m.
Syracuse, N. Y.
WPEB 2,442 kc., 122.8 m.
Grand Rapids, Mich.
WPEC 2,470 kc., 121.5 m.
Memphis, Tenn.
WPED 1,712 kc., 175.15 m.
Arlington, Mass.
WPEE 2,450 kc., 122.4 m.
WPEF 2,450 kc., 122.4 m.
WPEG 2,450 kc., 122.4 m.
New York, N. Y.
WPEH 1,712 kc., 175.15 m.
Somerville, Mass.
WPEI 1,712 kc., 175.15 m.
E. Providence, R. I.
WPEK 2,422 kc., 123.8 m.
New Orleans, La.
WPEL 1,574 kc., 189.5 m.
W. Bridgewater, Mass.
WPEM 2,470 kc., 121.5 m.
Woonsocket, R. I.
WPEP 1,712 kc., 175.15 m
Arlington, Mass.
WPES 2,442 kc., 122.8 m.
Saginaw, Mich.
WPET 1,712 kc., 175.15 m.
Lexington, Ky.
WPEV 1,574 kc., 189.5 m
Portable, Mass.
WPEW 1,574 kc., 189.5 m
Northampton, Mass.
WPEZ
Miami, Fla.
WPFA 1,712 kc., 175.15 m
Newton, Mass.
WPFC 2,442 kc., 122.8 m.
Muskegon, Mich.
WPFD 2,430 kc., 123.4 m.
Highland Park, Ill.
WPFE 2,442 kc., 122.8 m.
Reading, Pa.
WPFG 2,442 kc., 122.8 m.
Jacksonville, Fla.
WPFH 2,414 kc., 124.2 m.
Baltimore, Md.

WPFI 2,414 kc., 124.2 m.
Columbus, Ga.
WPFJ 1,712 kc., 175.15 m.
Hammond, Ind.
WPFK 2,430 kc., 123.4 m.
Hackensack, N. J.
WPFL 2,470 kc., 121.5 m.
Gary, Ind.
WPFM 2,414 kc., 124.2 m.
Birmingham, Ala.
WPFN 1,712 kc., 175.15 m.
Fairhaven, Mass.
WPFO 2,470 kc., 121.5 m.
Knoxville, Tenn.
WPFP 2,414 kc., 124.2 m.
Clarksburg, W. Va.
WPFQ 2,470 kc., 121.5 m.
Swarthmore, Pa.
WPFR 2,470 kc., 121.5 m.
Johnson City, Tenn.
WPFT 2,442 kc., 122.8 m.
Lakeland, Fla.
WPFU 2,422 kc., 123.8 m.
Portland, Me.
WPFV 2,470 kc., 121.5 m.
Pawtucket, R. I.
WPFX 2,442 kc., 122.8 m.
Palm Beach, Fla.

WPFZ 2,442 kc., 122.8 m.
Miami Beach, Fla.
WPGA 2,442 kc., 122.8 m.
Bay City, Mich.
WPGB 2,414 kc., 124.2 m.
Port Huron, Mich.
WPGC 1,534 kc., 1.96 m.
So. Schenectady, N. Y.
WPGD 2,458 kc., 122.8 m.
Rockford, Ill.
WPGE 2,430 kc., 123.4 m.
Sheveport, La.
WPGF 1,712 kc., 175.15 m.
Providence, R. I.
WPGG 2,414 kc., 124.2 m.
Albany, N. Y.
WPGI 2,430 kc., 123.4 m.
Portsmouth, O.
WPGJ 2,414 kc., 124.2 m.
Utica, N. Y.
WPGK 2,470 kc., 121.5 m.
Cranston, R. I.
WPGL 2,442 kc., 122.8 m.
Binghamton, N. Y.
WPGS 2,414 kc., 124.2 m.
Mineola, N. Y.

WPPC 1712 kc., 175.15 m.
Providence R. I.
WRBH 2,458 kc., 122 m.
Cleveland, Ohio
WRDR 2,414 kc., 124.2 m.
Grosse Pt. Village, Mich.
WRDS 1,574 kc., 189.5 m.
E. Lansing, Mich.
WRDQ 2,470 kc., 121.5 m.
Toledo, Ohio.

—X—

X2GA 7,612 kc., 39.4 m.
Nuevo Laredo, Mexico
XAM 11,540 kc., 26.0 m.
Merida, Yucatan
XDA 5,857 kc., 51.22 m.
11,760 kc., 25.5 m.
14,620 kc., 20.5 m.
XDC 9,400 kc., 31.9 m.
XETE 9,600 kc., 31.25 m.
XEW 6,023 kc., 49.8 m.
XIF 6,167 kc., 48.65 m.
Mexico City, Mex.

—Y—

YNA 14,500 kc., 20.69 m.
Managua, Nicaragua
YV1BC 6,110 kc., 49.1 m.
YV11BMO 6,130 kc., 48.95 m.
YV1BC 6,120 kc., 49.02 m.
Caracas, Venezuela
YV2AM 14,110 kc., 21.26 m.
Maracaibo, Venezuela
YV3BC 6,130 kc., 48.9 m.
9,510 kc., 31.56 m.
Caracas, Venezuela
YVQ 11,690 kc., 25.65 m.
13,500 kc., 22.48 m.
YVR 18,300 kc., 16.39 m.
Maracay, Venezuela

—Z—

ZGE 6,000 kc., 50 m.
Kuala, Lumpur, Malay States
ZL2ZX 6,060 kc., 49.5 m.
ZLT 7,390 kc., 40.6 m.
10,990 kc., 27.3 m.
ZLW 12,300 kc., 24.4 m.
18,340 kc., 16.35 m.
10,980 kc., 27.3 m.

Police Stations Alphabetically by Names of Cities

WHILE the regular alphabetical list of stations is the most convenient for general reference purposes, many readers have asked for a special list of the police radio stations alone, arranged alphabetically according to names of cities. This is very useful when a listener wants to hunt for a particular city and does not know either the call letters or the operating frequency in advance. The list below is the official list issued by the Federal Radio Commission, and is therefore accurate and dependable.

In addition to the frequency in kilocycles, the power of each station in watts is included. It is sometimes desirable to have this information as a means of comparing the range, signal strength, etc., of different stations. To find the wavelength in meters of any station, look in the regular list for the call letters, which are followed by both the frequency in kilocycles (kc.) and the wavelength in meters (m.).

LICENSED MUNICIPAL POLICE RADIO STATIONS

Location	Call Letters	Frequency (kc.)	Power (watts)
Akron, Ohio	WPDO	2458	100
Albuquerque, N. M.	KGZX	2414	50
Arlington, Mass.	WPED	1712	100
Atlanta, Ga.	WPDY	2414	150
Auburn, N. Y.	WPDN	2458	50
Bakersfield, Cal.	KGPS	2414	50
Baltimore, Md.	WPFH	2414	500
Bay City, Mich.	WPGA	2442	50
Beaumont, Tex.	KGPJ	1712	100
Hackensack, N. J.	WPFK	2430	200
Berkeley, Cal.	KSW	1658	400
Birmingham, Ala.	WPFM	2414	150
Buffalo, N. Y.	WMJ	2422	500
Cedar Rapids, Iowa	KGOZ	2470	50
Chanute, Kans.	KGZF	2450	5
Charlotte, N. C.	WPDV	2458	50
Chicago, Ill.	WPDB	1712	500
Chicago, Ill.	WPDC	1712	500
Chicago, Ill.	WPDD	1712	500
Cincinnati, O.	WKDU	1712	500
Clarksburg, W. Va.	WPFP	2414	30
Cleveland, O.	WRBH	2458	500
Coffeyville, Kans.	KGZP	2450	50
Columbus, Ga.	WPFI	2414	50
Columbus, O.	WPDI	2430	200
Dallas, Tex.	KVP	1712	150
Davenport, Iowa	KGPN	2470	50
Dayton, O.	WPDM	2430	400
Denver, Colo.	KGPX	2442	150
Des Moines, Ia.	KGZG	2470	100
Detroit, Mich.	WCK	2414	500
Detroit, Mich.	WPDX	2414	500
Washington, D. C.	WPDW	2422	400
E. Providence, R. I.	WPEI	1712	50
El Paso, Tex.	KGZM	2414	100
Flint, Mich.	WPDF	2442	100
Ft. Wayne, Ind.	WPDZ	2470	200
Fresno, Cal.	KGZA	2414	100
Grand Rapids, Mich	WPEB	2442	100
Grosse Point Village, Mich.	WRDR	2414	50
Highland Park, Mich.	WMO	2414	50
Honolulu, T. H.	KGPQ	2450	100
Indianapolis, Ind.	WMDZ	2442	400
Jacksonville, Fla.	WPFG	2442	100
Kansas City, Mo.	KGPE	2422	400
Klamath Falls, Oreg.	KGZH	2442	25
Knoxville, Tenn.	WPFO	2470	400
Kokomo, Ind.	WPDT	2470	50
Lansing, Mich.	WPDL	2442	50
Lexington, Ky.	WPET	1712	500
Lincoln, Nebr.	KGZU	2470	50
Los Angeles, Cal.	KGPL	1712	500
Louisville, Ky.	WPDE	2442	200
Memphis, Tenn.	WPEC	2470	400
Milwaukee, Wis.	WPDK	2450	500
Minneapolis, Minn.	KGPB	2430	400
Muskegon, Mich.	WPFC	2442	50
Mineola, N. Y.	WPGS	2414	200
New Bedford, Mass. (Fairhaven)	WPFN	1712	100
New Orleans, La.	WPEK	2430	100
Newton, Mass.	WPFA	1712	50
New York, N. Y.	WPEE	2450	400
New York, N. Y.	WPEF	2450	400
New York, N. Y.	WPEG	2450	500
Oklahoma City, Okl.	KGPH	2450	250
Omaha, Nebr.	KGPI	2470	400
Pasadena, Calif.	KGJX	1712	400
Pawtucket, R. I.	WPFV	2470	50
Philadelphia, Pa.	WPDP	2470	500
Phoenix, Ariz.	KGZJ	2430	100
Pittsburg, Pa.	WPDU	1712	400
Port Huron, Mich.	WPGB	2414	50
Portland, Me.	WPFU	2422	100
Portland, Oreg.	KGPP	2442	500
Reading, Pa.	WPFE	2442	100
Richmond, Ind.	WPDH	2442	50
Rochester, N. Y.	WPDR	2458	200
Rockford, Ill.	WPGD	2458	50
Saginaw, Mich.	WPES	2442	50
St. Louis, Mo.	KGPC	1712	500
St. Paul, Minn.	WPDS	2430	500
Salem, Oreg.	KGZR	2442	25
Salt Lake City, Utah	KGPW	2470	100
San Diego, Cal.	KGZD	2430	100
San Francisco, Cal.	KGPD	2470	400
San Jose, Cal.	KGPM	2470	50
Santa Barbara, Cal.	KGZO	2414	100
Santa Cruz, Cal.	KGZT	2470	50
Seattle, Wash.	KGPA	2414	250
Sioux City, Ia.	KGPK	2470	100
Somerville, Mass.	WPEH	1712	100
Swarthmore, Pa.	WPFQ	2470	50
Syracuse, N. Y.	WPEA	2458	400
Tacoma, Wash.	KGZN	2414	100
Toledo, Ohio	WRDQ	2470	200
Topeka, Kans.	KGZC	2422	50
Tulare, Cal.	WPDA	2414	150
Tulsa, Okla.	KGPO	2450	100
Vallejo, Cal.	KGPG	2422	7.5
Waco, Tex.	KGZQ	1712	50
Wichita, Kans.	KGPZ	2450	250
Wichita Falls, Tex.	KGZI	1712	50
Woonsocket, R. I.	WPEM	2470	50
Youngstown, O.	WPDG	2458	150

CONSTRUCTION PERMITS ISSUED FOR MUNICIPAL POLICE STATIONS

Location	Call Letters	Frequency (kc.)	Power (watts)
Aberdeen, Wash.	KGZV	2414	50
Albany, N. Y.	WPGG	2414	100
Binghamton, N. Y.	WPGL	2442	150
Cranston, R. I.	WPGK	2470	50
Hammond, Ind.	WPFJ	1712	100
Lakeland, Fla.	WPFT	2442	50
Lubbock, Tex.	KGZW	2458	50
Miami, Fla.	WPFZ	2442	100
Palm Beach, Fla.	WPFX	2442	50
Portsmouth, O.	WPGI	2430	50
Providence, R. I.	WPGF	1712	150
San Bernardino, Cal.	KGZY	1712	50
Shreveport, La.	WPGE	2430	50
Utica, N. Y.	WPGJ	2414	100

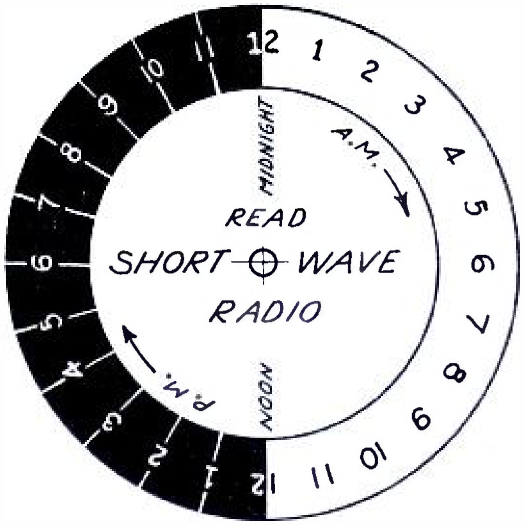
LICENSED STATE POLICE STATIONS

Location	Call Letters	Frequency (kc.)	Power (watts)
Iowa			
Des Moines	KGHO	1534	400
Massachusetts			
Northampton	WPEW	1574	Night–500, Day 1100
W. Bridgewater	WPEL	1574	Night–500, Day 1100
Framingham	WMP	1574	Night–500, Day 1100
Michigan			
E. Lansing	WRDS	1574	Night–1000, Day 5000
New York			
So. Schenectady	WPGC	1534	Night –500, Day 1000
Pennsylvania			
Butler	WBR	190	300
Greensburg	WJL	190	500
Harrisburg	WBA	190	300
W. Reading	WMB	190	300
Wyoming	WDX	190	300
Texas			
San Antonio	KGZE	2506	500

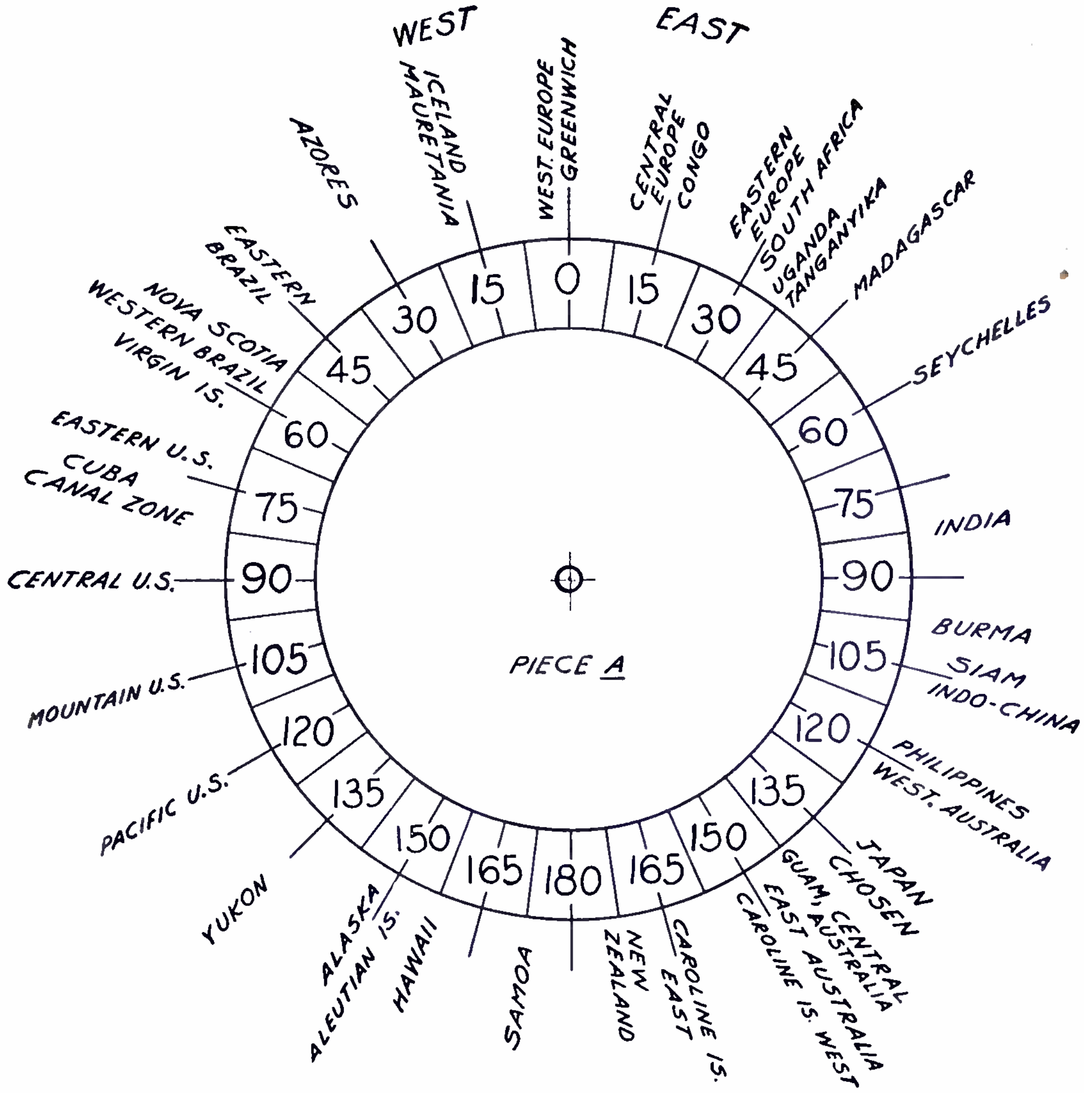
CONSTRUCTION PERMITS FOR STATE POLICE STATIONS

Location	Call Letters	Frequency (kc.)	Power (watts)
Washington			
Portable & Mobile Snowplow No. A232	KGHA	2506	10
Portable & Mobile Snowplow No. A227	KGHB	2506	10
Portable & Mobile State police car	KGHC	2506	10
Seattle	KGHD	2506	50
Snoqualmie Pass	KGHE	2506	50

Home-Made Time Conversion Chart



PIECE B



To make this time conversion chart, simply cut out pieces A and B, taking care to trim piece B closely to form a perfect circle. Paste both sections on separate pieces of stiff cardboard, using a piece about 5 x 6 inches for section A and trimming around for section B exactly 2¼ inches in diameter. Push through the center holes with a scriber or similar tool, and fasten the two pieces with a short machine screw, a couple of washers, and a nut. Adjust the nut so that the inner piece B turns without catching.

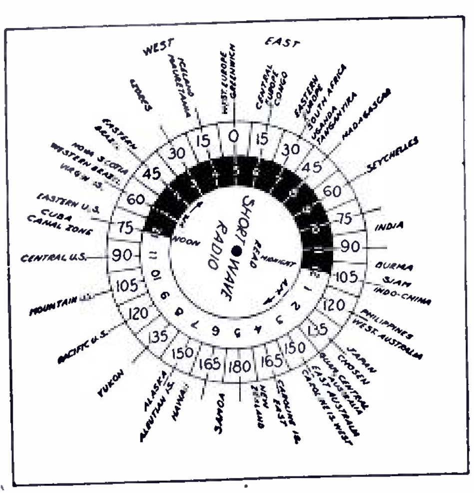
KNOWING the standard time and longitude at any place on the earth, the corresponding standard time at any other place can be read directly from the chart. The inner circle is marked with the hours of the day, the white half for forenoon (a.m.) and black half for afternoon (p.m.) while the outer circle is marked off in degrees east and west of Greenwich. By comparing the two scales, it will be seen that the time changes one hour for every fifteen degrees change of longitude. To obtain the time at any place, in relation to the time at any other place, it is necessary only to set the time on the inner circle to the longitude of the place where the time is known and to read the time indicated at the longitude of other place.

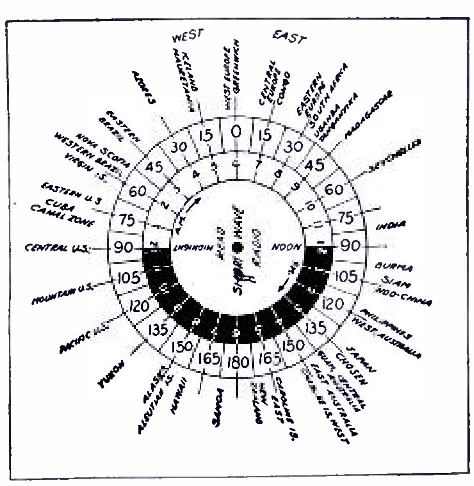
It should be noted that the 180° meridian corresponds to the international date line. In going across this line from east longitude to west longitude, a day is lost; in the other direction, a day is gained. That is, a place just east of this date line is one day later than is a place just west of this line.

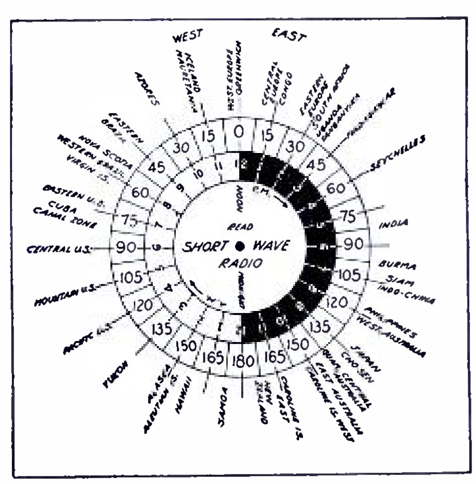
There is also a change in date in passing the midnight line of the inner circle of the chart, it being a day later as one passes from before 12 midnight to after 12. In going around the chart in a counter clockwise direction, there is one date from the 180° line around to the midnight line, and another date, which is one day earlier, for the remainder of the way around the chart.

Below are shown three examples of the use of the completed time conversion chart. The device is exceedingly simple, requires no calculation or knowledge of mathematics, and gives instant, direct readings. Every short-wave listener will find it both useful and educational.

To obtain the time in Chicago when it is 3 a.m. in India, set the inner circle so that the numeral 3 on the white half is aligned with India; central U.S. then reads about 3:45 p.m. Since Central U.S. is on the opposite side of the date line, it is 3:45 p.m. of the previous day.



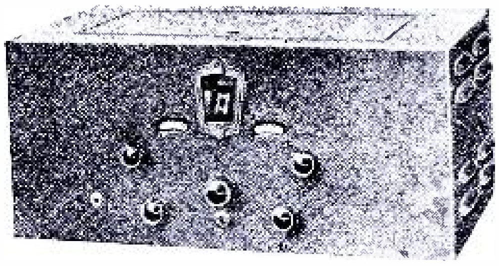




S. W. Receiver Review

To assist prospective purchasers of short-wave receivers in selecting equipment most suitable for their own needs, we have established this regular monthly department, in which factory-built sets will be described honestly, accurately, and completely after having been tested thoroughly by us. Readers are invited to suggest particular sets in which they are interested, and we will endeavor to obtain stock samples for test and write-up. Please do not ask us to make comparisons between different receivers.

No. 1
The Comet "Pro"



Panel view of the "Pro" showing the tuning dials and control switches. This model has no a.v.c or crystal.

MAKE: *Comet "Pro"*; manufacturer, Hammarlund Manufacturing Co.

MECHANICAL DETAILS: overall length, 21½"; height, 9½"; depth, 12½"; panel, 20½" x 9¼". Weight of chassis alone, 30 pounds; weight of a.c. receiver in metal cabinet, 45 pounds. Cabinet and panel of sheet steel; finish, speckled black.

REQUIRED ACCESSORIES: loudspeaker and tubes; in the case of the battery models, a complete set of batteries is needed in addition.

PRICE: a.c. model, less tubes, metal cabinet and speaker, $81.00; same receiver in metal cabinet (see photograph on this page), less tubes and speaker, $90.00. Battery model, less metal cabinet, tubes, and speaker, $69.00. These represent base prices; other models are higher (see "Type of Set").

TYPE OF SET: an eight-tube superheterodyne (with rectifier) intended specifically for short-wave use. Covers the band from 1200 to 20,000 kc. (15 to 250 meters). Coils may be obtained to cover the regular broadcast band if so desired. Four sets of plug-in coils are used to shift from one band to another. Models may be obtained which have automatic volume control and/or crystal. Also, any of these models may be had in console form rather than in metal cabinets.

GENERAL DESCRIPTION: The "Pro" utilizes its eight tubes in the following manner: 58 electron-coupled oscillator, 57 first detector, two 58's in the i.f. amplifier, a 57 second detector, a 2A5 output tube, and a 58 in the electron-coupled beat oscillator. The rectifier is an 80.

Two plug-in coils, shielded by means of cylindrical cans, are required for each band. Looking at the chassis, from the front of the set toward the rear, the two large cans directly behind the tuning condensers are for the coils: the left one for the oscillators and the right-hand one for the antenna. The long handle protruding from the i.f. transformer in the rear right-hand corner is for varying the beat note of the beat oscillator. The location of the power transformer and the tubes may be gleaned from the photograph.

The tuning facilities are very complete. As may be seen from the schematic, the coils are tuned by two "tank" condensers and a number of band-spread condensers. On the two lowest-frequency (highest wavelength) coils, band-spreading is obtained by means of two 29-mmf. band-spread condensers; on the remaining two short-wave bands, band-spreading is obtained by two 12.5 mmf. condensers. It should be noted that no switch is necessary to throw from one set to the other—the operation is completed automatically when the proper coils are inserted.

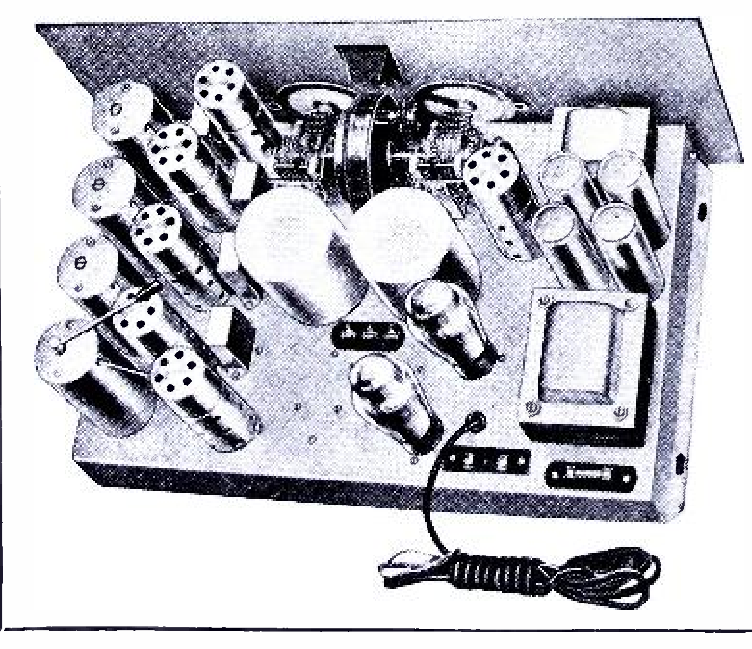
The remaining features of the receiver are more or less standard, although the parts used in the construction are of excellent quality and the mechanical work is exceptionally fine.

The arrangement of the parts on the front panel (see photograph) is as follows: jack at left is for phones; upper-left knob, setting for oscillator tank condenser; lower left-hand knob, off-on switch and tone control; center knob, band-spread tuning unit; toggle switch under band-spread knob, on-off switch for beat oscillator; lower right-hand knob, volume control; upper right-hand knob, tank condenser for first detector.

OPERATION AND PRECAUTIONS: To place the set in operation, insert the proper coils, the speaker (dynamic with external field cannot be used), and connect the antenna (provision is made for doublet types of aerials) to the proper posts.

The oscillator and first-detector tank condensers are set to the approximate frequency corresponding to the station to be heard with the band-spread dial (the main dial) set at 50. It is then rotated slowly until the station is tuned in. An important point should be mentioned here. The tuning curves which come with the set should be consulted at *all* times; furthermore, the dial settings corresponding to the curves are for the oscillator tank condenser, *not* the first-detector tank condenser. The reason for this is that, although the two dials track very well, the oscillator dial is the sharper of the two, and its settings, therefore, are more true.

This relative broadness of the detector tuning unit is probably the one weak spot in the entire receiver. Unless the operator is very careful, image interference is liable to occur. For instance, during the tuning of the set, the oscillator dial may be set at one spot and the detector dial rotated until maximum signal is heard. It will be found, sometimes, when this procedure is used, that the dial



Deck view of the "Pro" receiver. The main tuning dial and band-spread condensers are shown clearly. Directly behind the tuning condensers are the shield cans for the oscillator and first-detector tuning coils. The various strips for speaker and aerial connections are also shown.

readings of the two tank condensers do not nearly correspond. What has happened is that the detector tank condenser has been tuned to resonance, but the oscillator has been tuned to a frequency 465 kc. *below* the i.f. instead of above it (465 kc. is the intermediate frequency).

The only solution to this problem lies in following the instructions given with the receiver to the letter. Use no short-cuts on your own and make no attempt to use noise (which is usually as "broad as a house") as a signal. This difficulty can only be appreciated after you have operated the set for a while. But when you have become accustomed to tuning the receiver as it should be tuned, then all this image-frequency (double tuning) business goes by the wayside.

Additional Features

In the a.v.c. models a switch is available on the panel for throwing the a.v.c. system in and out. In short-wave broadcast reception it is recommended that this feature be used, but for general "ham" use it may or may not be recommended. The models with crystals are especially valuable for amateur communication use. Your reviewer, however, tried it on phone signals, and the response was pretty good. There was a decided lack of high notes, of course, but the selectivity was amazing and interference was nil.

The band-spreading action of the receiver is its oustanding feature. First, the band-spread is *continuous* throughout the entire range of the receiver. The type of band-spreading used, however, results in a non-uniform spread at various frequencies, and this fact should be taken into consideration by the operator. At 20 megacycles (15 meters) the band-spread is approximately 1500 kc. wide and narrows to 300 kc. wide at 10 megacycles (30 meters), the range of the "AA" set of coils. With the "BB" coils, which cover the range from 10 to 5 megacycles (30 to 60 meters), the band-spread is 1000 kc. at 10 megacycles and 150 kc. wide at 5 megacycles.

With the "CC" and "DD" coils, larger band-spread condensers are automatically inserted in the circuit. The band-spread width varies from approximately 1200 kc. at 4.5 megacycles (67 meters) to 225 kc. at 1.5 megacycles (200 meters). This receiver is one of the few designed for continuous band-spreading over the entire range of the set.

Another feature worth mentioning is that the power unit is built in the same chassis as the receiver proper. Heretofore it has been the general opinion that power packs should be separated from the receiver by several feet in order to reduce hum. In the two weeks that this receiver was operated by your reviewer, not once was he bothered by hum. The combination of the power pack and the set in one chassis is becoming more and more standard practice, and should be taken into consideration by prospective purchasers.

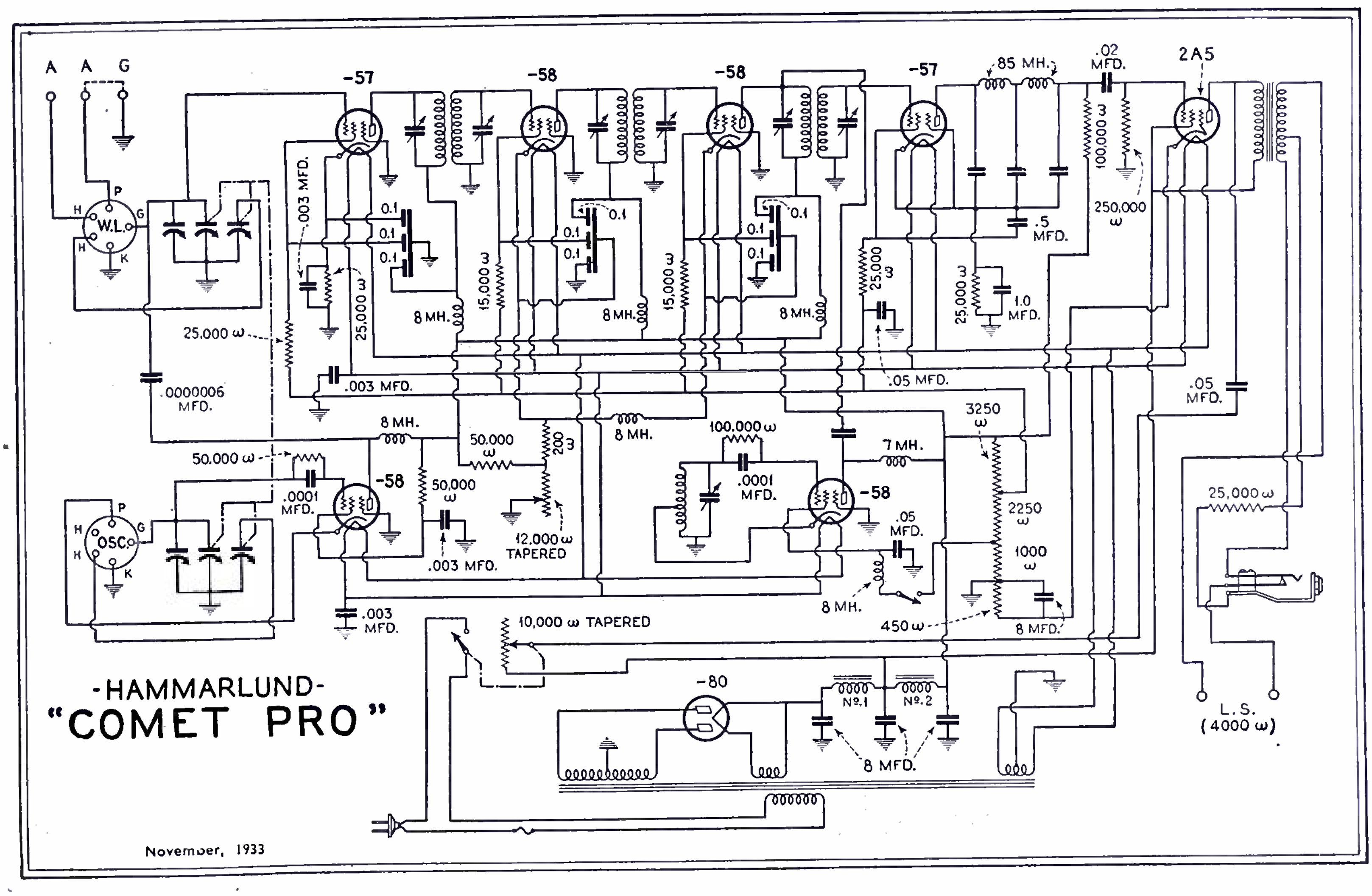
The widespread use of doublet antennas for short-wave reception purposes makes the doublet connections available with the "Pro" a special feature. Heretofore, if one wanted to use a doublet, it was necessary to rewire the antenna circuit to facilitate its use.

Yearly models is becoming as important in the radio business as it is in the automotive industry. Notwithstanding, the "Pro" does not become obsolete yearly. Such features as the crystal and a.v.c. may be installed in earlier models to bring them up to date at a nominal fee.

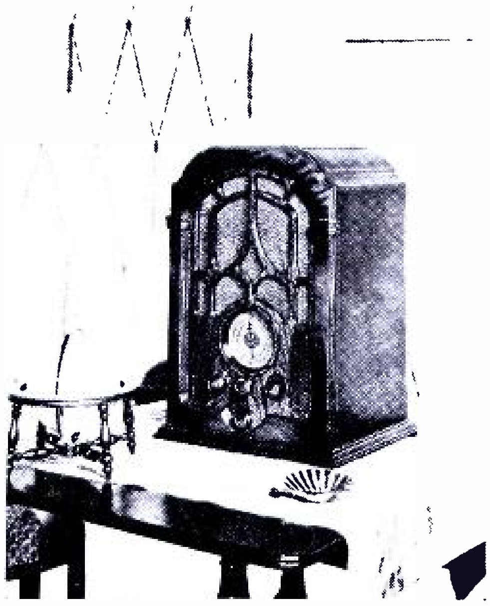
The phone jack is a valuable asset. When hunting for distant stations, it is very desirable to first tune them in on headphones and then switch over to the loudspeaker. No change in tuning is required.

APPLICATION: The Comet "Pro" is not intended for use by people who have never before operated short-wave receivers. Every possible control has been placed on the panel or made generally available so that maximum signal strength can be obtained. In the hands of an experienced operator, this receiver gives very excellent results, but when manipulated by an inexperienced tuner, results may be erratic.

For short-wave broadcast purposes the "Pro" with a.v.c., but without crystal, is recommended; in cases where extreme interference is encountered the crystal may prove helpful. For amateur use, the crystal model is pretty essential, while the a.v.c. feature may not be required.—*L. M.*



-HAMMARLUND-
"COMET PRO"



The table model K-80 receiver. The tuning dial has a 60/1 ratio-driving mechanism, which makes tuning on the short waves comfortable.

A New Departure in S. W. Broadcast Sets

The extent to which short-wave receiver design has advanced since the days of wooden-baseboard construction is well exemplified in the new instrument analyzed by Mr. Kruse in the following article. Features of mechanical construction and electrical operation that were considered impossible of attainment only a few years ago are used here effectively and successfully.

By Robert S. Kruse*

IN the standard-wave broadcast receiver field one gets approximately what one pays for; all sets have been pretty well classified through the cold and impersonal verdict of the laboratory. The performance is definitely known.

Very oddly, the same statement does not yet apply to short-wave broadcast receivers; too often their advertising seems to indicate a complete lack of faith in measurements, and a medieval trust in the primitive "listening test."

We are, however, passing out of that stage, and it should be of interest to examine the performance data on a good 1934 multi-range receiver. Without prejudice, we shall therefore consider the meaning of the data on General Electric's K-80 and similar receivers, which data are available.

When one speaks of improvements, it is well to know what came before. Reviewing briefly, then, the usual short-wave superheterodyne has been dodging problems instead of facing them. Although broadcast-wave experience clearly indicated the need of adequate pre-amplification, most short-wave sets lacked it and attempted to compensate with high i.f. gain or else just got along somehow. The result was a noisy set in one case, a dead one in the other. Inadequate pre-selection, to save parts, has produced a myriad of sets with bad image interference.

Finally, the vast range of fading found on the short-waves urgently demands an automatic volume control of extremely long range, which, in turn, is possible only with plenty of non-regenerative gain. That need also has, in the main, been dodged.

To wring out of this a household receiver, operable by anyone, seemed like a rather tough problem—and *is* a tough problem. One requires at least four sets of tuning coils, yet they and their switchgear must go into the space ordinarily allotted to a single radio equipment without any ill consequences. The job is one of those that must be defeated in detail, and the story told in the same way. That the story is told about a General Electric receiver is no adverse comment on other receivers—it merely indicates that the G.E. data were available and illustrated the 1934 tendencies.

One of the most notable tendencies is that of using enough tuned circuits. The oscillator requires one for each tuning range, the detector input requires another for each range, the r.f. amplifier requires one for each stage for each range. In the broadcast band we can proceed very nicely with one stage of r.f. amplification, as is well known. As the wavelength is made shorter (frequency raised), both the selectivity and the amplification of this stage decrease (as is only too well known to many users of short-wave sets), until, below 30 meters, one stage *is not enough from the standpoint of either selectivity or signal-noise ratio.* Here, then, should be available an additional r.f. stage, and it may be noted in passing that this is exactly opposite to the queer practice of some sets of dropping out r.f. stages as the wavelength goes down!

Three Tuned Circuits

From this line of reasoning, we see that in the broadcast range we shall have three tuned circuits at least, and at wavelengths below 30 meters (frequencies about 10,000 kc.) we shall have at least four tuned circuits.

There now arises the much-argued question of the number of tuning ranges necessary. If a receiver were to use plug-in coils, we could show improved performance by using a great many narrow tuning ranges—requiring five bushels of coils. However, in a switching system it is by no means true that more ranges improve sensitivity. Quite to the contrary, additional ranges cause higher stray capacity, more "dead coil" resonance points, and more severe headaches for the serviceman.

Accordingly, it is wisdom to use a large enough tuning condenser so that the broadcast band is covered in one range (as usual), and then to split the remaining territory down to 15 meters (20,000 kc.) into not more than three or four ranges. This is easily done by proper padding and tapping.

Another question now arises—that of the switching method. In earlier short-wave sets we minimized the number of switch sections by using "tuned impedance" couplings between tubes. The defect of this is that one has 100 per cent coupling in all the ranges, and it is hard for the designer to emerge with decent selectivity curves. Furthermore, a grid-leak is then unavoidable unless someone can invent a really good grid choke to work at all frequencies between 20,000 kc. and 500 kc.—a 40/1 range! Grid-leaks are not only high impedances for r.f.—they are also high impedances for audio, and noise ensues in too many cases.

For these reasons, and with recent good switches to fall back on, it now seems better to use regular r.f. transformers between stages (also at the antenna input), and to switch both primary and secondary.

Similarly, for the oscillator, there have been found too many distressing irregularities in dynatrons (which require but one tuned coil), and gradually we have receded to the old standby, a tuned grid with a "tickler" plate coil. Here, also, there are, accordingly, two switches and two coils per range.

At this point it may be of interest to examine the K-80 schematic shown herewith as Fig. 1. It will be

*Consulting Engineer.

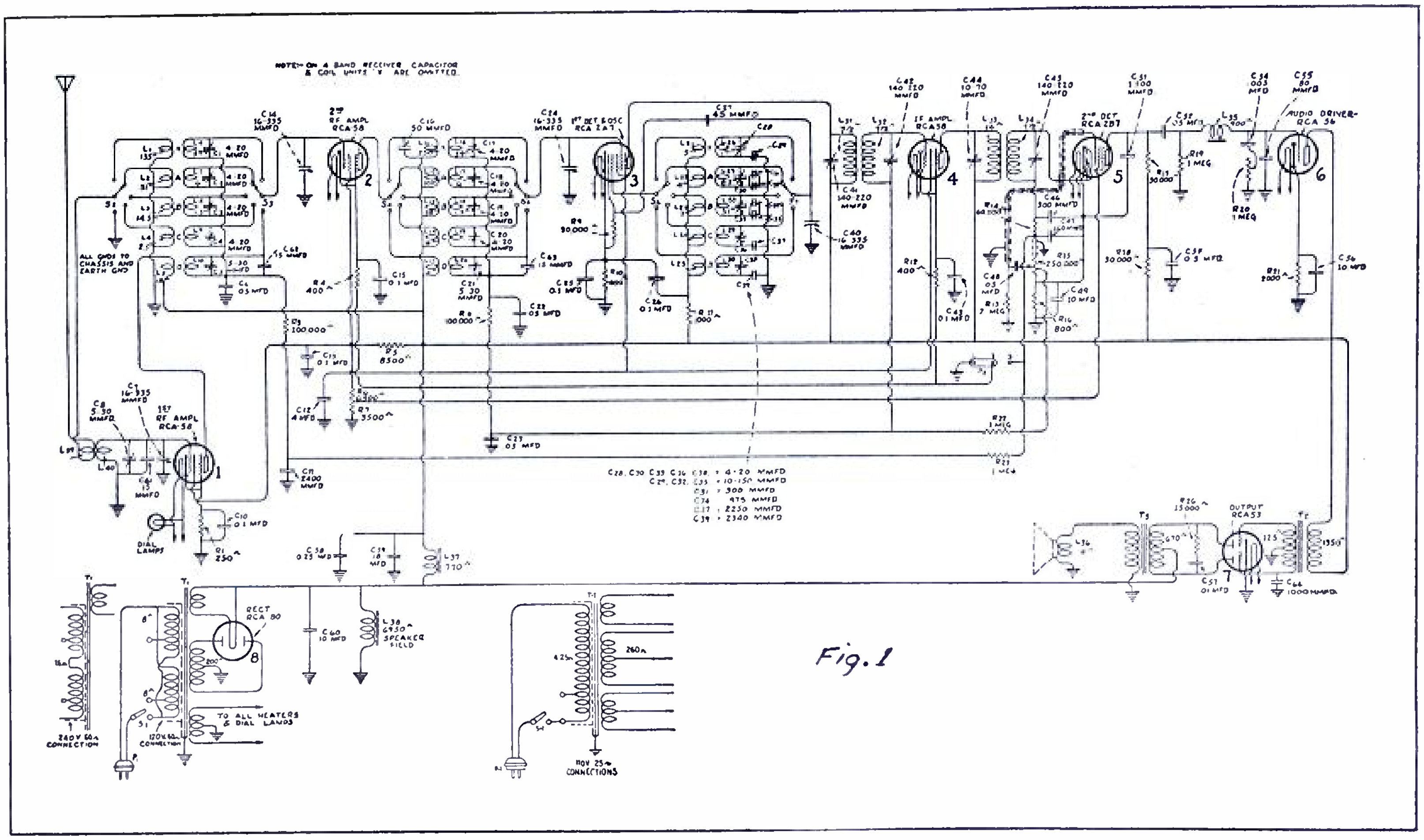


Fig. 1: The general schematic diagram of a 1934 multi-range entertainment receiver, General Electric type K-80. Such receivers introduce a new special service field. Proper adjustment requires 23 alignment adjustments, instead of 4 for the corresponding single-range receiver.

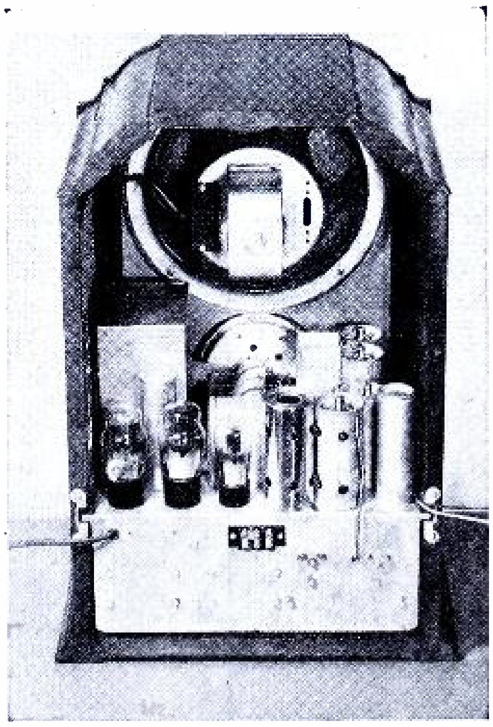
seen that the switch has six sections with five points each; also, that the tuning condenser has four sections, one of which is not switched, but is at all times associated with the extra r.f. stage used to bump up the sensitivity and selectivity in the shortest-wave range (10,000 kc. to 18,000 kc.).

Coil Placement

The coil placement in a really short-wave receiver is a serious problem. We could avoid the most serious aspect of this problem by using removable coils, but these will not be tolerated in an entertainment receiver. We must therefore make the coils live together. If each be separately shielded we may (possibly) escape absorptions caused by unused coils—but at the same time we have built a painfully complex sheet-metal mess, and have raised the stray capacities. Both from the performance and the manufacturing angle this is bad, while for the serviceman it is sinful.

Accordingly, it is becoming common practice to place the coil-group on a steel sheet or frame, which can then be treated as an assembly, test and replacement unit. This becomes one floor-level of the final set, or one apartment along a wiring corridor. In the General Electric sets the "flat" construction has been adopted. The coils are at one level, the resistors and condensers (fixed) at another, and so on. The units are separately assembled, tested, and stacked into a finished set, manifestly with repeated tests during the process.

With such grouping of coils there is necessarily interaction; in fact a degree of it would be found anyway, even with complete shielding of coils, since the circuits are capacity-coupled through the switch-parts. A very tedious and serious design job must then be undertaken to minimize the tendency toward "dead spots," so well known in the older "switching" receivers.



Back view of the K-80 receiver. Note the unusual height of the chassis—necessary to accommodate the multi-coil assembly.

Tremendous aid is here lent by a really competent automatic volume control system—of which more later. That the thing can be done is illustrated by the sensitivity curves herewith, Fig. 2. In no instance does a dead-coil resonance change the sensitivity more than 2/1, and even these points have been placed where nothing of importance is damaged even to that extent.

Selectivity

Possibly the most significant change in 1934 short-wave b.c. reception is shown in Fig 3. Selectivity curves so uniform over a huge tuning range are a vast improvement. They are, of course, possible only because the added tuned circuit has been provided in the Band D range, otherwise we should see that curve looking rather like a saucer, with the well-known noise, bad image ratio and generally poor reception.

The 300 kc. curve is for range X, which means "export," and is aimed at Europe, where there are stations in the 150-450 kilocycle region, which is to say at wavelengths up to 2000 meters.

It is unfortunate that one of the most important improvements of the 1934 receiver cannot be readily shown from data now at hand. This is the very large improvement in image ratio, or, as it was formerly called, "reduction of two-spot tuning." In broadcast receivers for standard waves this is eliminated by one tuned r.f. stage, variable-mu tubes, and the use of proper intermediate frequency, an important item.

Unfortunately, there *is no proper intermediate frequency* meeting all needs for signals from 15 meters to 2000 meters, nor even from 15 meters to 500 meters, which latter is the U.S.A. problem. One must choose a compromise frequency and then *use enough pre-selection.* This pre-selection cannot be supplied without tuned r.f. circuits, and the number shown in our illustrative schematic seems necessary for 1934 conditions. In this particular set experimental replacement of one of the tuned r.f. circuits by other devices at once threw the receiver into that region of noise and interference whose miseries are not fully appreciated until such a test is made. Measured "image ratio" figures on typical short-wave broadcast receivers should be presented later if the present type of information is found interesting by readers of Short Wave Radio. They will be found a bit startling, but no more so than the performance of 1934 receivers.

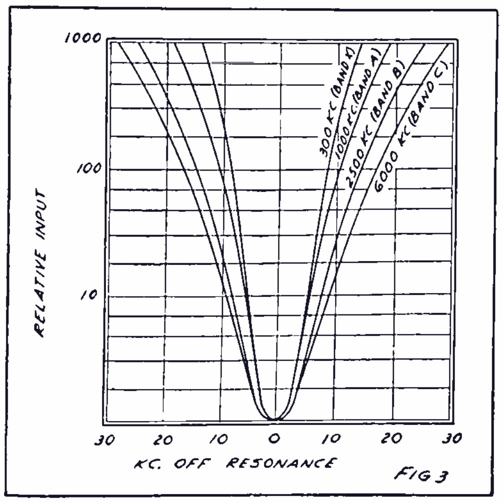


Fig. 3: The sort of selectivity to be demanded from 1934 multi-range entertainment receivers. This requires some explaining. The 1000 kc. curve is for the usual broadcast range. The 300 kc. shows the sharpening tendency for longer waves. This is the X range supplied only for European users. Curves B and C show the broadening effect of a shorter wave. Range D would be very broad—also the sensitivity would be down, but for that cause an extra r.f. stage is cut in and curve D (not shown) hardly differs from the last two. Thee curves are for a General Electric K-80-X receiver.

Nearly anyone can rig up an automatic volume control that is more or less satisfactory in controlling the limited fading found in the standard broadcast band used inside the United States. It is quite another job to compensate for the swift and violent fadings of short waves. The extremely long a.v.c. range required can best be illustrated by Fig. 4, which shows what has actually been put into our illustration-set. If this set is run with the volume control wide open, we find that a 1000 kc. modulated carrier which produced 2 audio watts at the loudspeaker when but 2 microvolts of the carrier are arriving can increase *fifty thousand fold* without increasing the audio output more than 4/1. It should be noted that this action goes on without reference to the setting of the volume control, as that is a pure audio gain control, having no effect whatever on the a.v.c. system. Thus, if one chooses to reduce the audio output to 1/5 watt with the same incoming carrier at 2 microvolts, then the same 50,000 fold increase would still raise the level only 4 times—to 4/5 of a watt.

A.V.C. System

Frequency, of course, *does* have an effect on the a.v.c. system, especially when using the extra r.f. stage, which is not under the hand of the a.v.c. system. Thus, in general, the a.v.c. range is reduced somewhat on the shorter waves—and that is exactly why such a vast excess of control-range is necessary. However, there is no harm in a too-good a.v.c. system.

The method of the control may be of interest. The 2B7 second detector has its connections so made that it acts as a diode rectifier-detector. The rectifier output flows through a 60,000- and a 250,000-ohm resistor in series to get back to the cathode. Across these resistors there accordingly appear both audio and d.c. voltages—the i.f. voltage having been bypassed through condensers. A portion of the audio voltage across the 250,000-ohm resistor is picked off by a sliding contact and is fed through a .05-mf. condenser to the input grid of the pentode section of the 2B7, which, thereupon, acts as a first audio amplifier. The sliding contact is the volume control. Two more audio stages provide a high overall audio gain.

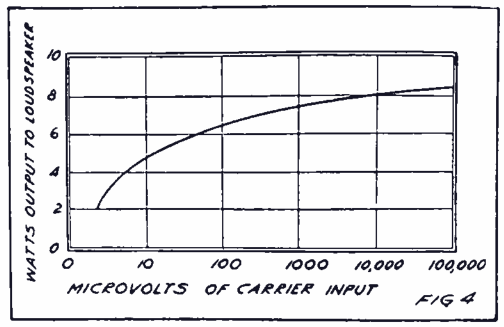


Fig. 4: Action of a modern long-range automatic volume control. The curve is for the circuit shown in the schematic diagram of Fig. 1.

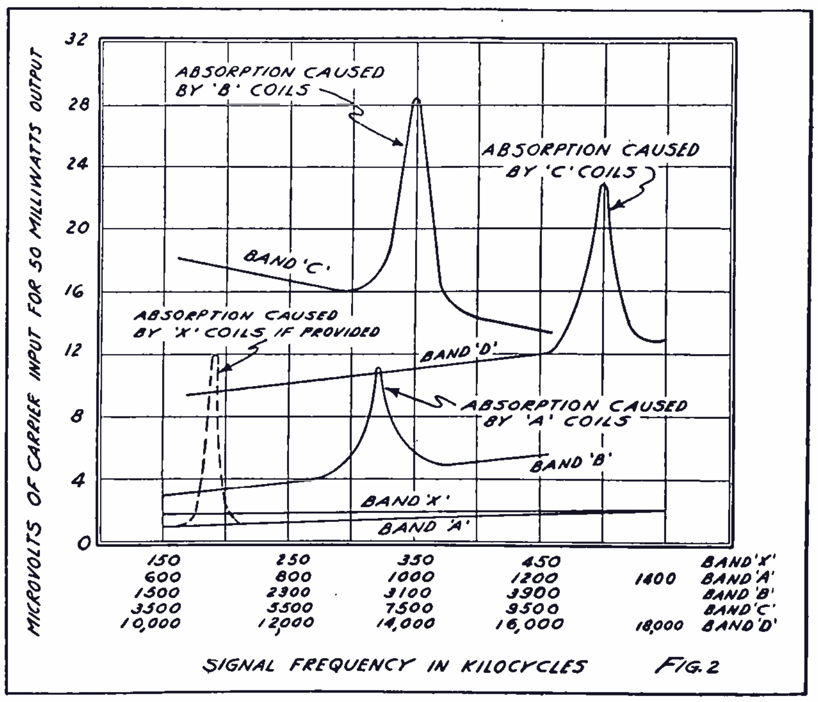
Meanwhile, we are neglecting the d.c. voltage which also appeared across the 250,000-ohm resistor. This voltage is taken to the grid of the first r.f. amplifier through an audio filter (1 megohm resistor and .05-mf. condenser followed by another resistor of 100,000 ohms). As the incoming signal becomes stronger, the rectified current through the 250,-000-ohm resistor becomes larger, the voltage across that resistor rises, hence more bias voltage is fed back to the r.f. 58, and the amplification drops. To control one stage is not enough, hence the i.f. stage and the mixer tube are also controlled in a similar manner. However, they cannot be biased as heavily as the first tube, since they must carry more signal. Accordingly, their variable bias is not taken from the entire 250,000-ohm resistor, but from a tap part way down.

The satisfactory operation of an

Fig. 2: Some thoroughly honest sensitivity curves for a 5-range receiver. (General Electric K-80-X). In the American version of the set (K-80) the X coil is omitted, hence the bump on the A curve disappears, and the line resembles that shown for range X. The other absorption bumps will be seen to have been so located as to do little damage—and in the worst instance they change the sensitivity only about 45%—less change than is commonly found between the 550 kc. and 1500 kc. response of ordinary broadcast receivers. As ordinarily stated these curves would indicate the following sensitivity; for 50 milliwatts output.

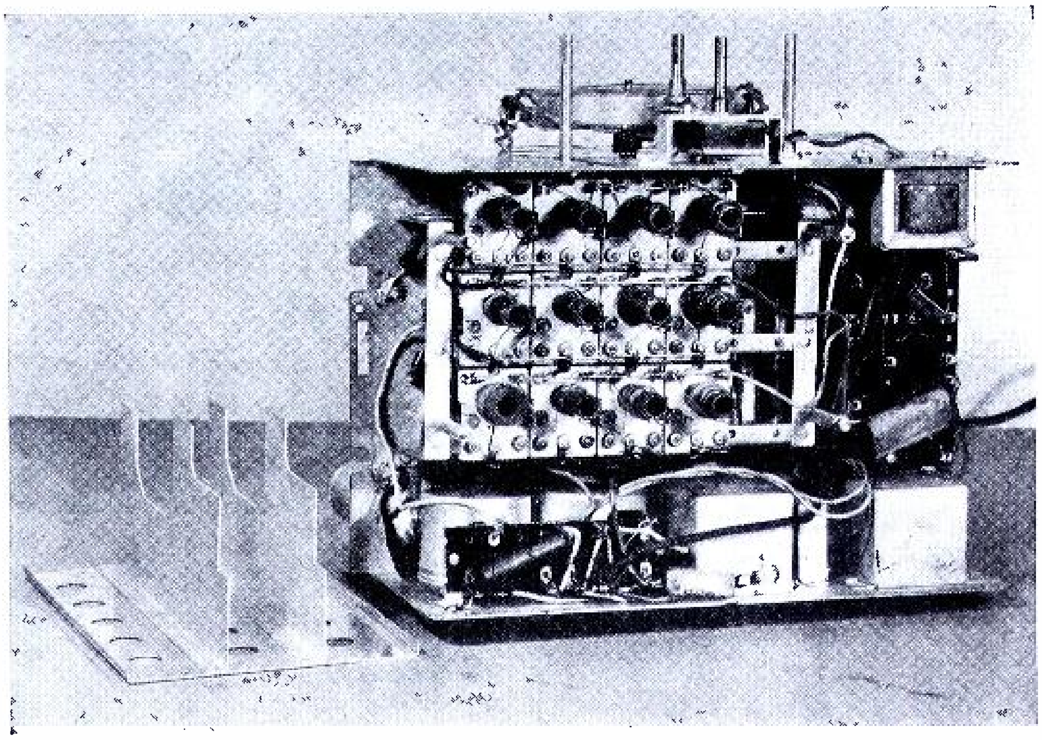
Band	Range in frequency	Range in meters	Microvolts input
X (Export)	150-410	732-200	1.5
A (American)	540-1500	200-555	1 to 2
B	1500-3900	77-200	3 to 5
C	3900-10,000	30-77	13 to 18
D	8000 to 1800	16.7 to 37.5	10 to 12*

(*Note effect of extra r.f. stage at this point.)
These figures can be used as good 1934 standards of performance.



oscillator all the way from 2000 meters to 15 meters without basic circuit change is something of a problem where the same tuning condenser is to be used. For such service the pentagrid converters are being widely used. They are, in effect, an oscillator of the triode type, electron-coupled to a bias-detector of the tetrode type, this detector having its output at intermediate frequency, since the input grid (of the tetrode section) is fed at signal frequency from the t.r.f. circuit, while the triode portion is being oscillated at a frequency equal to signal frequency plus intermediate frequency. The electron coupling between the triode and tetrode is due to their use of a common cathode, and the fact that the triode has a plate which is in the form of a screen, so that some electrons pass through and into the tetrode section, where they eventually terminate on the tetrode plate.

The data-sheet information on these tubes will not always be found to pan out in short-wave use, and if the reader is able to make out the constants on the schematic he will see that they do not quite check those given on the usual tube data sheets.

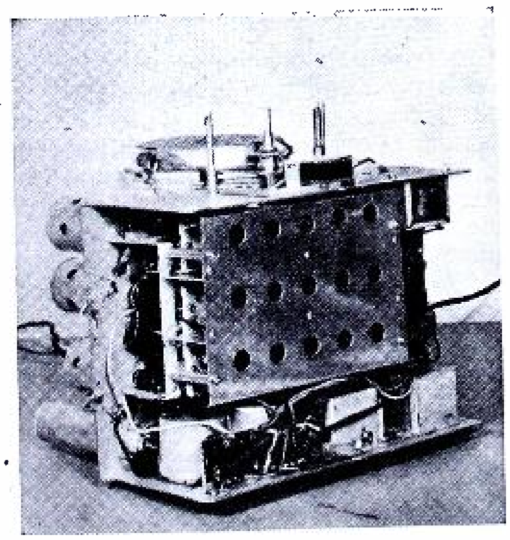


The K-80 chassis resting on its back. The coil shield has been removed to show the bank of individual coils, which are thrown in and out of the circuit by means of a multi-pole rotary switch.

The Public

So far, we have been digging around inside the set—but John Public seldom does this. He sits in, twists the knobs, and listens to the noises. In past years he has too often had to learn how to tune a short-wave receiver, and he didn't always like that. In the present case the learning has been much simplified, and that, too, will be found a 1934 tendency—and a mighty fine and proper tendency it is. I have no patience whatever with that sort of engineering which regards complexity as a virtue.

Accordingly, we are seeing extremely high-ratio dials that *run smoothly*. After the abominably rough dingbats that have appeared in the name of tuning controls on most of the broadcast receivers during the last five years, this is something to make the heart sing. I solemnly believe that General Electric will sell many of its K-80 sets purely because of that frictionless 60-to-1 tuning control—plus the smart idea of putting a tiny crank on the knob for spinning it quickly to another part of the scale. This control is one which even the makers of communication receivers might look at with some attention, although most of them have used good tuning controls for years and years, because they dealt with hard-boiled professionals who refused to endure rough tuning controls that would make a good receiver semi-useless.



Under view of the K-80 chassis, showing the perforated coil shield in place.

The electrolytic condenser, and the consequent ability to use many microfarads cheaply, has removed one of the biggest problems from a short-wave entertainment receiver. Except for this, the present schematic, and most others, shows nothing unusual. In our particular example the output stage works class B, hence draws a varying plate current, and it thus becomes undesirable to take that plate current through the field winding of the loudspeaker. This field winding is accordingly of the high-resistance type and is shunted across the B supply. The stabilizers on the class B output stage will also interest the reader, especially if he has attempted to operate high-power class B stages. The rectifier, by the way, is a high-vacuum type (80), not a mercury-vapor tube. The latter make noises at short waves, especially when they are becoming old and fretful.

New Characteristics of Type 48 Tube

THE 48 is a tetrode designed for use as a power amplifier in receivers operated from d.c. power lines. New ratings for this tube are given on the basis of control-grid-voltage values of –19 and –20 volts for plate-supply voltages of 96 and 125 volts, respectively. The characteristics for these conditions are:

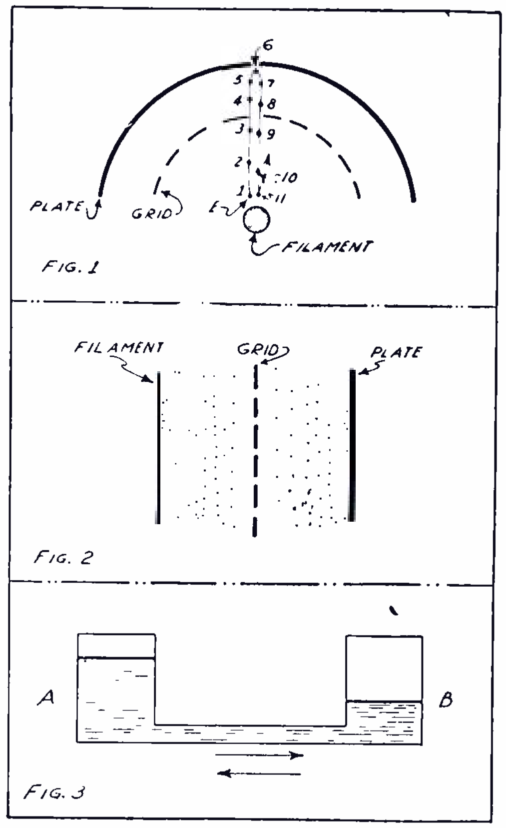
Heater voltage	30		volts
Heater current	0.4		ampere
Plate voltage	96	125 max.	volts
Screen voltage	96	100 max.	volts
Control grid voltage	–19	–20	volts
Plate current	52	56	milliamperes
Screen current	9	9.5	milliamperes
Mutual conductance	3800	3900	micromhos
Power output	2.0	2.5	watts
Harmonic distortion	9.0	9.0	per cent
Load resistance	1500	1500	ohms

From the above tabulation, it will be noted, in comparison with the former values, that the mutual conductance has been increased to 3800 and 3900 micromhos, that there has been a slight increase in plate current, and that the power output has been increased to two watts. The new recommended value of load resistance is 1500 ohms. Type 48's with the new ratings are interchangeable with those having the former ratings.

In addition to its use as a tetrode, the 48 offers advantages as a triode in push-pull circuits. The advantages of one type of operation over

(*Continued on page* 45)

The Odd Story of Barkhausen-Kurz Oscillations



SUMMARY: *Oscillation in ordinary radio circuits is produced by means of continuous feed back of energy from the plate circuit to the grid circuit, through the medium of a "tickler" coil or some other device common to both circuits. In the highly interesting Barkhausen-Kurz system, however, oscillations of extremely high frequency are generated by a peculiar movement of electrons within the tube itself. The frequency is controlled by the applied electrode voltages, not by the values of external inductance and capacity! The theory of B-K operation is clearly explained in this article.*

By Andrew Alford

THE phenomenon which we are about to describe was discovered more or less by accident by two German scientists, Barkhausen and Kurz, in 1919, as they were measuring the amount of residual gas in a transmitting tube. As usual, they put a large positive potential of the grid and a smaller negative potential on the plate, and were observing the plate current with a very sensitive instrument. It was a routine measurement. The electrons fly toward the grid and on their way ionize the residual gas. The positive ions are drawn to the negatively charged plate. The microammeter in the plate circuit measures this positive ion current to the plate. The greater this current, the more gas there is in the tube.

Patience Rewarded

This method had been used by many people day in and day out without anyone stumbling on anything unusual. But Barkhausen and Kurz did; one day their plate meter read *backwards!* Unlike most of us, they did not swear, but checked their connections, and found that the meter had a perfect right to read backwards because the current was really flowing against the plate battery. Suspecting oscillations, they placed a wavemeter near the circuit. It had no effect and registered nothing. They did not stop. They strung two Lecher wires across the room, bringing one end of the pair close to their misbehaving circuit. By sliding a bridge consisting of a crystal in parallel with a galvanometer along the two wires, they found standing waves one meter long. No wonder their wavemeter refused to read! Still the two scientists were not satisfied. Indeed, what makes the circuit oscillate? they asked. Can such short waves be modulated? Can they be received? So they continued. Before they got through they not only succeeded in modulating 50 centimeter waves with voice and also receiving intelligible signals 1000 feet away, but they also explained why their circuit misbehaved. This was in 1919, remember.

Once a thing is explained it usually seems simple enough. So it is with Barkauser-Kurz oscillations. The electrons which are attracted by the positive grid need not all immediately land on it; some of them may, and do, fly through toward the plate. The negatively charged plate repels them, so that they are forced back toward the grid. They can once more fly through it and keep on toward the filament. Here they are again chased back by the attraction of the grid as well as the space charge gathered next to the filament. They can keep on flying back and forth through the grid somewhat like a pendulum can oscillate about a point of equilibrium. If the conditions are just right, a great number of electrons can get in step, so that a whole cloud of them proceeds to dance about the grid. It is the oscillation of this electronic cloud which produces a rapidly oscillating current in the tube circuit.

What Actually Happens

In order to get a better mental picture of what actually takes place within the tube, let us consider Figs. 1 and 2. The path of an electron E is shown in Fig. 1. At point 1 electron E is leaving the filament. At point 2 it is strongly attracted by the grid and consequently is gaining speed. At point 3 it is traveling very fast and heading for one of the spaces between the grid wires. (Some electrons will, of course, hit a grid wire and go on through the wires toward the grid battery.) At point 4 electron E has just emerged from the opening in the grid and is continuing, by virtue of its inertia, toward the plate; it is going against the attraction of the grid and the repulsion of the plate. At 5 electron E is traveling quite slowly and will come to a complete standstill at point 6 any instant. At 7 the inertia of the electron has been completely overpowered and it has been forced back toward the grid; it is again gathering speed. At 8 it is going very fast. At 9 it has just emerged from an opening in the grid and is again flying against the attraction of the grid, which is working to stop it. At 10 the attraction of the grid materially helped by the repulsion due to a crowd of electrons which are idling around the filament (space charge). At 11 electron E is once more turned back toward the grid and on its way to repeat its last journey.

An Analogy

Figure 2 shows what happens when a great number of electrons are dancing in step. At any given time there are comparatively few electrons near the grid for the simple reason that they fly by it very fast. There is a great congestion of electrons now near the plate, then near the filament. This is because the electrons travel comparatively slowly near the ends of their paths.

In Fig. 3 is shown a fairly good analogy of an electron tube. Water is taking the place of the electrons. The two large vessels represent the spaces near the filament and the plate of the tube. The thin tube represents the space near the grid. Water is flowing from one large vessel A into the other large vessel B, then back again through the thin tube. Water flows at a high rate of speed through the thin connecting tube, yet there is not much of it there at any given time. On the other hand, there is a great deal of water in the large containers and there it moves slowly.

From this picture it is fairly easy to see what will happen if the various voltages are increased or decreased. Suppose that the positive grid voltage is increased. The electrons must go faster, consequently the frequency of oscillations is increased. Suppose now that the negative plate voltage is increased. This tends to move stopping point 6 (Fig. 1) toward the grid. The electron path is thus shortened and the frequency of oscillations is again increased. Suppose now that the filament current is increased. This naturally results in greater emission from the filament. More idle electrons gather around the filament. The repelling force of the bigger cloud is greater, so the stopping point 11 is moved toward the grid. The electron path is again shortened and the frequency is increased. The smaller is spacing between the electrodes, the shorter is the electron path and the higher is the frequency. (With very small tubes, wavelengths of the order of 13 centimeters have been obtained recently.) All of these deductions from this simple theory were experimentally established by Barkhausen and Kurz.

Resonance Necessary

Complete as this theory seemed to be, it did not enable Barkhausen and Kurz to obtain strong, stable, and readily reproducable oscillations. The intensity of their oscillations varied for no apparent reason and was not very great at any time. Later investigators found it sometimes difficult to reproduce their results. Apparently there was some very important factor which possessed the power of veto over these oscillations and which had not been recognized by the two German scientists. This factor was discovered later. It was found that the circuit outside the tube must be tuned to the frequency at which the electrons wished to oscillate. This circuit had to be tuned only approximately, but it had to be tuned for oscillations would not start or else would be very weak. If the tuning of the outside circuit is varied, the electrons in the tube begin to oscillate at the frequency to which the circuit is tuned unless this is made very different from the one they themselves prefer. When the frequency of tuning is too far off, they either quit in disgust or else oscillate so meekly that it is difficult to observe the r.f. current. It is the frequency which the electrons prefer that varies with the voltages and the electrode spacing in the manner which we described above. This discovery enabled later investigators to obtain stable and fairly strong oscillations.

Electrons in Step

One important question remained unanswered for a long time: What is it that makes the electrons get in step and dance together? Certainly, the emission from the filament is continuous. Why should not the numbers of electrons traveling in both directions average up? In 1930 Moeller ventured an explanation. His theory is being gradually verified. The bulk of it is very probably correct. It is too complicated to be explained here in detail, so we shall have to limit ourselves to the main ideas. To begin with, it is admitted that the electrons are furnished by the filament continuously. The outside circuit is assumed to be already oscillating. The grid voltage is supposed to be fixed while the voltages of the plate and the filament are fluctuating because of the oscillations in the outside circuit. It is further assumed, for simplicity, that the plate voltage is normally zero with respect to the filament. Under these conditions, a d.c. voltmeter would read, let us say, 100 volts between either the grid and the filament or between the grid and the plate. Actual voltages, however, would differ from the average because of the assumed oscillations in the outside circuit. It may be further assumed that the alternating voltages impressed on the plate and the filament are 180 degrees out of phase. Suppose, for example, that the amplitude of the superimposed alternating voltage is 50 volts. Then the plate and filament voltages fluctuate as shown in the following table:

Filament Voltage	Grid Voltage	Plate Voltage
-100	0	-100
-120	0	- 80
-150	0	- 50
-120	0	- 80
-100	0	-100
- 80	0	-120
- 50	0	-150
- 80	0	-120
-100	0	-100

These fluctuations are, of course, repeated during every cycle. Let us consider two electrons, electron A and electron B. Electron A leaves the filament during the first part of the cycle, while electron B leaves it during the second part of the cycle. In the first place, it is quite clear that electron A can gain more speed than electron B. Moreover, if the time of electron travel is such that electron A will be on its way back during the second part of the cycle while electron B will have to return during the first part of the next cycle, the first electron will gain even more speed while the second will fly still slower. After several cycles electron A will have acquired so much speed that it will be thrown out either into the plate or back into the filament. Electron B, on the other hand, will be still oscillating and getting closer and closer to the grid. Of course what happened to electron A happens to all electrons which come out of the filament during the first part of the cycle. Only the electrons which come out of the filament during the second part of the cycle, and which therefore are already approximately in step, can keep oscillating about the grid. The plate current consists of electrons which are thrown out. The energy which keeps the outside circuit going is supplied by the electrons of class B through a rather complicated process of induction. The energy which is used to accelerate electrons of class A is wasted when they strike the plate, for there it is promptly converted into heat.

Another Factor

In addition to this process, which works to get electrons in step, there is still another which also tends to do the same thing. Let us again consider electrons A and B. As we have already said, electron A travels faster than electron B. Therefore A tends to catch up with B. After several cycles the two electrons are not nearly as much out of step as they were at the beginning. On the average there will be more electrons in step than out of step even if electrons of type A are not thrown out. Indeed, oscillations have been observed with such high negative plate potentials that at least while the oscillations were building up no electrons could have reached the plate and the filament used was so small that only few lucky electrons could have landed on it.

Once one has gained a fairly good picture of what goes on in the tube,

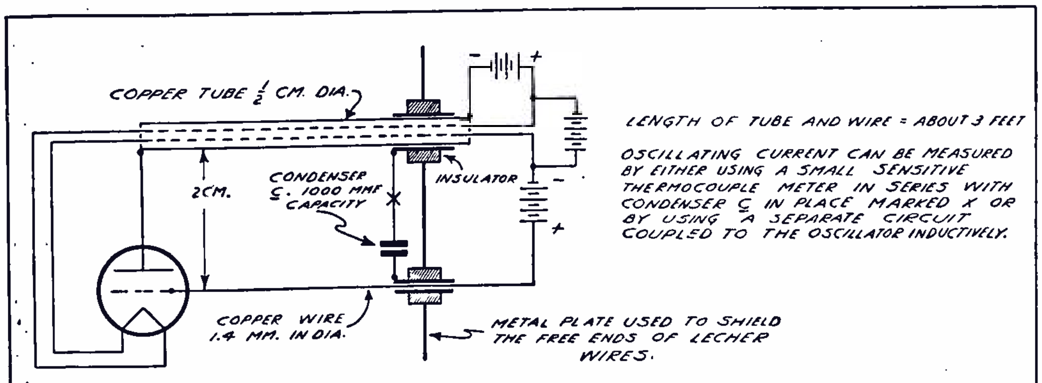


FIG. 4

it is comparatively easy to follow the experiments made by other people and to plan his own. In order that one may have some guidance in the design of the appropriate oscillating circuits and other details, we show two circuits which have been used with success to produce Barkhausen-Kurz oscillations. See Figs. 4 and 5, which are complete in all details.

Conclusion

Many other circuits have been used to produce these oscillations. It is not yet time to judge which of these circuits is the best. Many good circuits, no doubt, are still to be invented. In conclusion, we may add that when one is experimenting with B-K oscillations, patience is a very valuable asset. Some tubes refuse to oscillate altogether. Slight modifications in a circuit sometimes make a 100% difference. Large positive voltages heat up the grid and make one feel very uneasy. The oscillating current is only too often too weak to be measured. Sudden changes in the plate current produced by change in the tuning of the circuit usually mark the beginning of oscillations, but the amount of the plate current is no accurate measure of the intensity of the oscillations. If a tube refuses to oscillate it often can be made to do so by lowering or raising the filament voltage or grid voltage or plate voltages or the circuit may be. In general, the more regular and symmetrical the structure of the tube, the less capricious it is. Like in all other high-frequency work, removal of the base, of course, reduces the unwanted capacity and helps considerably.

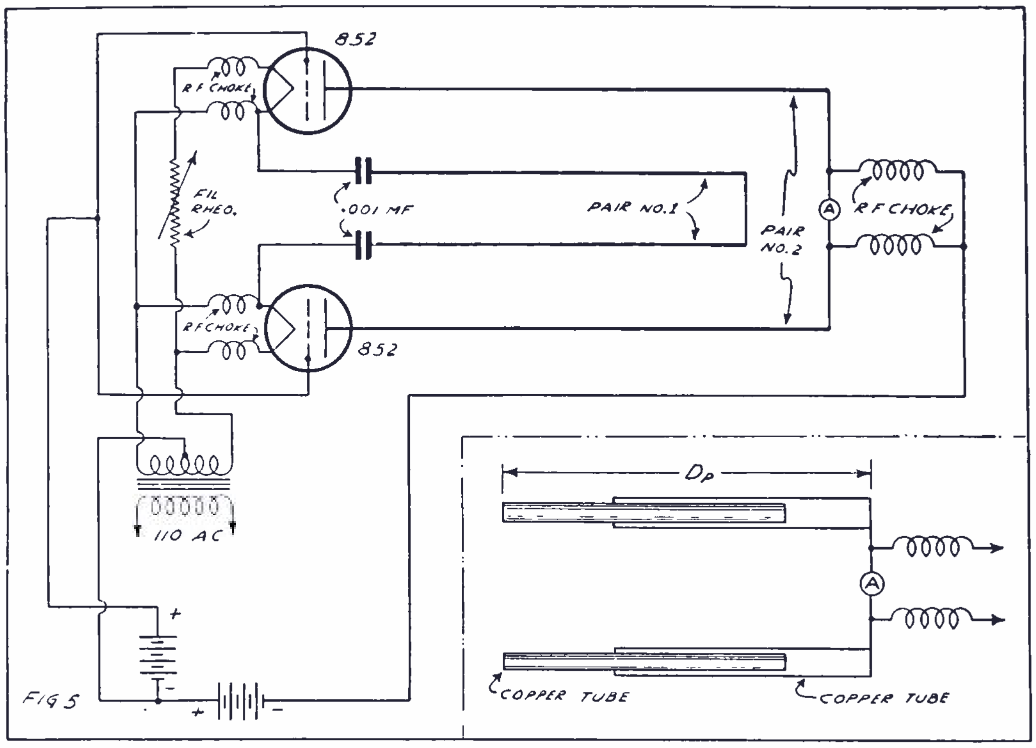


FIG 5

A TABLE OF VOLTAGES, CURRENTS, WAVELENGTH AND DISTANCE

Eg	*Ep*	*Ig*	*Ip*	*Wave-length*	*Dp*	*Df*	*Iosc*
300	—109	650 ma.	1.4 ma.	67.5 cm.	67 cm.	54 cm.	1.1 A
400	—109	625 ma.	4.5 ma.	67.5 cm.	67 cm.	54 cm.	2.0 A
500	—109	500 ma.	6.5 ma.	67.5 cm.	67 cm.	54 cm.	2.4 A

Filament current is adjusted so that Ig is limited to the values shown above. Greater Ig would heat the grids more. The output of oscillator is about 2.5 watts.

Book Review

COMMUNICATION ENGINEERING, by William Littell Everitt, published by McGraw-Hill Book Company, New York, N. Y., 6 by 9 inches, 567 pages, over 350 illustrations, cloth covers. Price, $5.00.

This is one of the few radio books that has appeared during the last few years which treats the subject of communication engineering with the attempt to acquaint the student with the broader principles of communication engineering, rather than with specific details. A very valuable feature of this book is the inclusion of practical problems at the end of each chapter which should be worked out by the student. Although the problems are by no means complete, nevertheless, their solutions entail quite a bit of the information discussed in the accompanying chapter.

The book starts off with a general discussion of networks and continues through a discussion of complex quantities; network theorems, which include the resolution of networks into equivalent T and Pi systems; resonance, which is very comprehensive; and up-to-date transmission lines, a very essential treatment for the transmitting amateur. The chapter in inductive interference is especially welcome, specialized treatment of electromagnetic induction and electrostatic induction are also complete and of vital importance to the modern engineer. The treatment of coupled circuits and impedance matching is very illuminating, and the usual bewildering mathematical treatments have been reduced considerably, rendering their solution relatively easy.

The last half of the book is a discussion of audio and radio frequency amplifiers for both reception and transmission, modulation and demodulation, and vacuum-tube detectors. They can hardly be improved upon in a textbook of this type.

This book is essentially a textbook for electrical engineers who intend to specialize in communication work. Although a great many, if not all, of the principles discussed in this book are especially suitable for telephone work, nevertheless, the close alliance between this field and radio should make this book of vital interest to every radio engineer. The treatment of oscillators, for instance, while not new, is discussed in detail.

Although it is strongly recommended that a knowledge of at least calculus be required for a thorough understanding of the book, its clean-cut statements and unambiguous definitions should prove exceedingly helpful to anyone with a knowledge of radio who wishes to clarify the technical points in his own mind.

—*L. M.*

RICH REWARDS IN RADIO, published by the National Radio Institute, Washington, D. C., 7¾ by 10¾ inches, 64 pages, printed throughout in two colors, two-color paper cover, numerous photographic illustrations.

This highly interesting booklet is available free of charge to men interested in learning the opportunities for spare time and full time employment that radio offers. It tells how they can quickly fit themselves for these opportunities at home in their spare time, by means of a course of home instruction that has proved its effectiveness over a period of many years.

The booklet emphasizes the fact that while radio is a giant industry, it is still growing, and that developments along various lines are creating new jobs right along. People interested in reading this very well prepared piece of literature can obtain copies free by writing to the publishers and mentioning SHORT WAVE RADIO.

(*Continued on page* 47)

Aluminum vs. Steel for Receiver Chassis

SUMMARY: *Since the advent of the metal chassis as a foundation for radio receivers, there has been some doubt as to the relative advantages of aluminum and steel. In the article below, some of these advantages and disadvantages are discussed, and a general conclusion reached.*

If you can spare the price of aluminum, use it; if you desire a somewhat more commercially finished product, plate the aluminum and then have a coat of paint baked on. The result is comparable to any high-grade commercial chassis or panel.

THE breadboard type of receiver construction has disappeared, and in its stead we have the metal chassis as the foundation of the modern radio receivers. The old breadboard had many advantages, but its susceptibility to dust and its generally untidy appearance have more or less cast it into discard, except for special types of transmitting sets. The use of metal for chassis came somewhat as a surprise to those old-timers who grew up with the idea that any metal in or near a radio receiver reduces the efficiency; but their claims notwithstanding, the metal chassis is here to stay.

Aluminum, of course, was one of the first materials selected to fill the important job of supporting the receiver. This metal can be worked easily, has an attractively natural color, and has sufficient strength to withstand the normal usage imposed upon it. It has, however, several disadvantages which have caused many people to turn to the use of steel as the chassis material. First, the cost of aluminum is relatively high compared to that of steel; second, it cannot be soldered easily; and third, it is extremely difficult for the average home constructor to make holes in aluminum that are really round.

Cost a Factor

The high cost of aluminum is, perhaps, the dominating factor contributing to its gradual disuse. Until the manufacturers of this metal make substantial price reductions, the use of aluminum in radio receivers will decrease. The fact that it cannot be soldered easily is not an important one. Modern receiver construction has been so developed that the practice of soldering to the actual chassis is strictly "taboo."

The third item contributing to the decline in the use of aluminum is probably the second in the order of importance—the inability of the home constructor to make round holes. After a man spends three or four dollars for a piece of aluminum, he at least expects the holes he makes to be reasonably round. If he must go to the trouble of reaming out the holes after they are drilled, the likelihood is that he will begin to look around for some material other than aluminum when he constructs another receiver.

But wait! Don't rush out and buy a piece of sheet steel. There are a few points about steel that are not so "hot." First, the resistivity of steel is greater than that of aluminum, so the shielding action is not as good, and shielding action is one of the most important features of the use of metal chassis. Second, the losses in steel are greater than in aluminum, not so much the eddy-current losses, because of the higher resistivity, but the hysteresis loss. Third, steel rusts, so it can hardly be considered for a permanent receiver.

The fact that steel is cheap and produces clean-cut holes when properly drilled is sufficient reason to devise means of counteracting some of its disadvantages. The usual procedure is to cadmium- or copper-plate the steel, which costs very little, and then, for a commercial appearance, having a coat of paint baked on. This may seem like a costly proposition, but the truth of the matter is that a cadmium-plated chassis 12 by 15 by 3 inches costs about two dollars; a baked paint finish on top of the plating costs but a few cents extra.

The reason for the copper or cadmium plating is obvious when the question of skin effects is considered. Since current travels on the surface of the wire at high frequencies, the center of the wire does little aside from adding to mechanical strength. At the very short wavelengths (high frequencies) used in present-day short-wave receivers, practically all the current travels on the plating, so the high resistivity of the steel matters very little. There may be a little hysteresis loss, but the amount need not worry anybody.

The importance of plating a steel chassis has been recognized by practically every manufacturer of short-wave receivers. Many i.f. transformers, for instance, are completely shielded except for their bottoms, so when they are mounted on an unplated steel chassis, coupling between i.f. stages results, and the receiver oscillates like a fool. No matter how much fussing around you do, the oscillation cannot be eliminated—until the chassis is plated in order to increase its shielding action.

An additional consequence of plating is, of course, the prevention of rust, which reason alone is sufficient to warrant its use. Then again, a steel chassis may be spot welded on the inside, and gives a finished appearance comparable only to the highest grade of commercial work—*L. M.*

A Question and An Answer

Jan. 3, 1934.

Chief Engineer
Philco Radio & Television Corp.
Philadelphia, Pa.
Dear Sir:

We understand that Philco has been licensed under the Farnsworth patents to manufacture television receiving equipment employing a form of cathode ray tube. We are also informed that Heintz & Kaufman of San Francisco have been licensed to manufacture transmitting equipment.

Are you ready to release any data on your television activities at the present time? As television undoubtedly will be accomplished on the high frequencies, we naturally are very much interested in all developments along this line.

Very truly yours,
SHORT WAVE RADIO,
Robert Hertzberg,
Editor.

Jan. 18, 1934.

SHORT WAVE RADIO
1123 Broadway
New York City.
Attention: *Mr. Robert Hertzberg, Editor,*
Gentlemen:

We have your letter of January 3rd. We are not ready to release any information on our television developments at this time.

A great deal of work remains to be done in connection with television broadcasting, before television receivers can be put on the market. We see little possibility of work on transmitter equipment and broadcasting programs being completed this year.

Yours very truly,
PHILCO RADIO & TELEVISION CORPORATION
Walter E. Holland,
Vice-President in charge of Engineering.

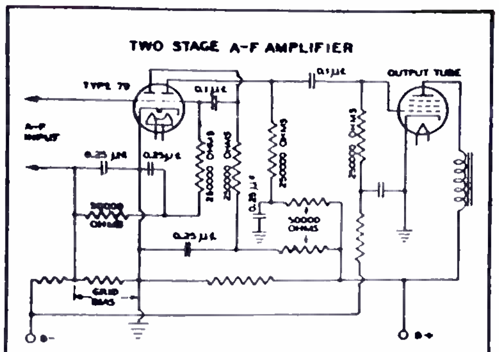


FIG. 1

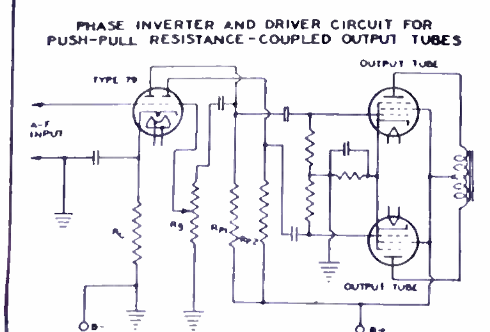


FIG. 2

How To Use The Type 79 Double Triode

SUMMARY: *The type 79 is a versatile tube that should receive more attention from short-wave experimenters and constructors. It permits many interesting, novel and effective amplifier arrangements that require simple, inexpensive parts and accessories. This article gives practical "dope" on its applications.*

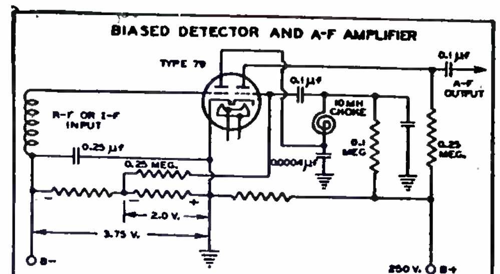


FIG. 4

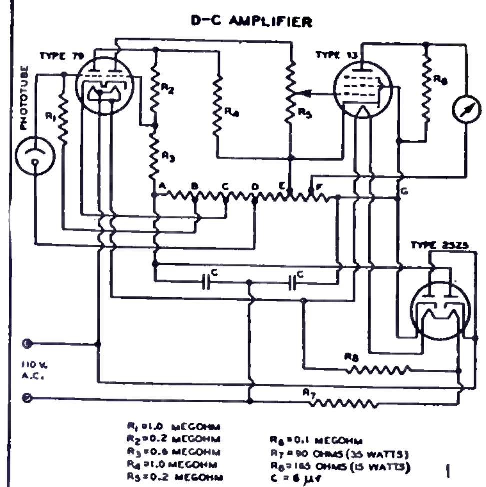


FIG. 5

THE type 79 vacuum tube, consisting of two high-mu triodes in a single bulb, although designed to be used as a Class B audio amplifier, has many other applications.

The two triode units are identical and except for a common cathode are independent each from the other. This tube may be put to all the usual triode uses limited only by the common cathode. It may be used with both triodes in parallel, in push-pull arrangement, and in combinations where each triode unit performs a different function.

The ratings and characteristics for each triode unit are as shown:

Heater Voltage		6.3	Volts
Heater Current		0.6	Ampere
Plate Voltage	180	250	Volts
Grid Voltage	−1.5	−2.0	Volts
Plate Current	1.25	1.75	Milliamperes
Amplification Factor	80	80	
Plate Resistance	50500	51500	Ohms
Power Output	30	57	Milliwatts

Resistance-Coupled A.F. Amplifier

As a resistance-coupled amplifier having its two units operating in cascade, the 79 provides exceptionally high voltage amplification. The circuit of Fig. 1 is quite satisfactory for a resistance-coupled amplifier arrangement when plate-supply voltages of low-ripple content are available. Because of the high gain of the 79, it is imperative that little or no hum voltage affect the grids. An inadequately-filtered supply voltage may be used, however, if a resistor of 50,000 to 100,000 ohms is connected in the grid return of the first unit and the capacity shown as 0.25 mf. in Fig. 1 is changed to 10 or 15 mf.

Measurement of the gain at 420 cycles with plate volts of 250 and grid volts of —2 showed a voltage amplification of over 2000. The input voltage was limited to a value which just caused grid current in the second unit. With an input signal of 24 millivolts, the RMS voltage measured across the 0.25-megohm plate load of the second unit is 50 volts. This is a gain of approximately 2100. A curve of output voltage vs. input voltage shows the gain to be constant up to and including 24 millivolts input.

Fig. 3 shows a plate family of curves for a single unit with a 250,000-ohm load line for the 250-volt supply condition.

The question may arise as to whether the 79 or the 53 is more desirable for special applications such as the above, since both are similar in having two triodes with a common cathode. A tabulation of their operating characteristics in a resistance-coupled amplifier (Fig. 1) follows:

	Type 79	*Type 53*	
Filament Voltage	6.3	2.5	Volts
Filament Current	0.6	2.0	Amperes
Plate Supply Voltage	250	250	Volts
Grid Voltage	−2.0	−3.0	Volts
Plate Current (per unit)	0.32	0.5	Milliampere
Voltage Amplification (per unit)	46.0	26.8	
Overall Voltage Amplification	2100	720	
Max. A.F. Input Voltage (RMS)	0.024	0.08	Volts
Max. A.F. Output Voltage (RMS)	50.0	57.5	Volts
Plate Load	0.25	0.25	Megohm
Distortion	negligible	negligible	

The deciding factors in choosing between the two tubes are the available filament supply, the gain required, the available input for the stage, and the hum characteristic of the power supply.

Biased Detector and R.C. Amplifier

As a biased detector, the 79 may be used as shown in Fig. 4. In comparison with the 53 in a similar circuit, the 79 will give approximately the same output with approximately one-half the input-signal voltage and approximately one-half the grid bias.

If it is desired to operate an output stage in a resistance-coupled push-pull arrangement, the 79 may be used as a pre-amplifier and phase inverter. The a.f. voltage developed across the plate load of the second triode R_{p2} in Fig. 2 is 180 degrees out of phase with the voltage developed across R_{p1}. The grids of the two output tubes can therefore be resistance coupled to R_{p1} and R_{p2}, respectively. The variable tap on R_g is for the purpose of equalizing the voltages on R_{p1} and R_{p2}. These two voltages must be equal for the proper operation of this amplifier.

Application as Phototube Amplifier

The 79, due to its high gain, makes an excellent amplifier to build up phototube impulses for the operation of various devices. When it is desired that slowly-varying-voltage pulses be magnified, the use of a d.c. resistance-coupled amplifier is advantageous. Such devices respond to low frequencies, in contradistinction to usual audio amplifiers. The latter are ordinarily not effective below 25 or 30 cycles.

A suitable d.c. resistance-coupled circuit is given in Fig. 5. With no signal voltage applied to the input terminals, each triode unit should operate at a suitable point on the linear portion of its grid-voltage plate-current characteristic. A voltage applied to the grid of the first unit causes a change in its plate current which in turn produces a change in the voltage drop across its plate resistor and alters the grid bias of the second unit. If the change on the grid of the first unit is in a positive direction, that on the second grid is in a negative direction. This fact may be an essential consideration in designing a d.c. amplifier, i.e., as to whether it should consist of an even or an odd number of stages.

In the amplifier of Fig. 5 consisting of a phototube, the two units of a 79 operating as voltage amplifiers and a 43 operating as a current amplifier, it will be observed that a positive voltage change on the first grid causes a current increase in the plate circuit of the 43. A positive voltage change on the first grid due to light on the phototube is obtained when the phototube is connected as shown.

A 25Z5 operating as a voltage doubler supplies plate voltage for the amplifier. A filter for smoothing the rectified voltage was found to be unnecessary, although in some applications it would be required.

The series-heater arrangement of this circuit requires shunt resistors across the 43 and 25Z5, since the heater of the 79 takes 0.6 ampere. The bleeder resistor should not take over 20 ma. This is desirable to insure suitable output voltages from the rectifier.

Under the condition of average load, the following d.c. voltages are applied to the amplifier:

Total Rectified Voltage (A to G)	220 Volts
Grid Voltage on No. 1 Unit (C to B)	—1.5 Volts
Phototube Supply Voltage (B to D)	60 Volts
Plate-Supply Voltage for No. 1 Unit (C to E) ..	100 Volts
Plate-Supply Voltage for No. 2 Unit (C to E) ..	100 Volts
Plate-Supply Voltage for 43 (E to G)	80 Volts
Voltage to Balance out Plate Current of 43 (G to F)	12 Volts

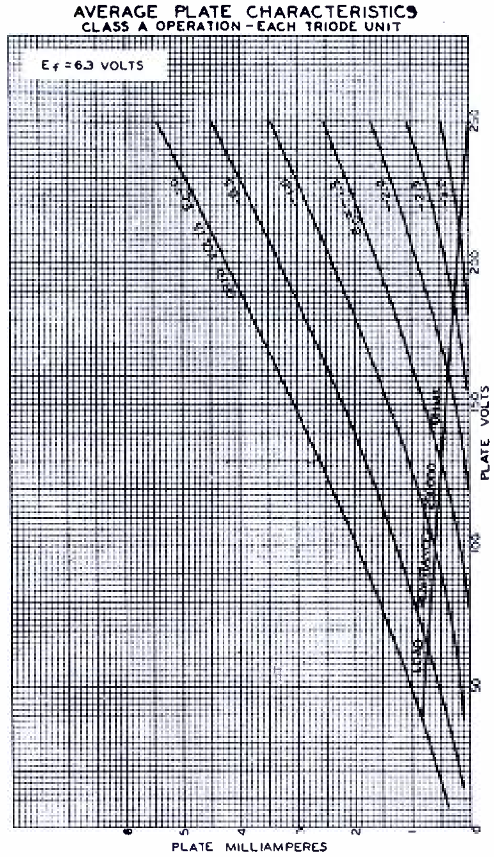


FIG.3

A fairly critical adjustment of voltage was found necessary for good operation. The tabulated voltages represent values found by experiment to be suitable.

Under the influence of light, the phototube resistance drops to a finite value so that current flows through R_1, thereby making the grid of the No. 1 unit less negative. The amplifier phase relations are such that the negative bias on the 43, caused by the drop in R_3 due to a change in No. 2 triode plate current, decreases and the 43 plate current increases. It is easily possible to reduce the 43 bias to zero so that the 43 plate current is limited only by cathode emission and plate voltage. Should it be desired to have no current through the indicating or recording device in the plate circuit of the 43 with no input signal, the diagram shows how the plate current can be balanced out. This is accomplished by returning the low-potential lead of the indicating device, in this case shown as a meter, through a suitable resistor to a point (F) on the bleeder. Thus, the voltage required to balance out the 43 plate current is equal in this instance to 12 volts and is obtained across G-F.

The high-current drain from the rectifier will effect the voltage regulation to some extent, but with the circuit of Fig. 5, no instability was apparent.

The voltages used on the test amplifier were sufficient to allow reasonably good performance. The approximate sensitivity of the amplifier was found to be such that a light flux of less than 0.02 lumen would cause a plate-current change for the 43 of 25 ma.—*RCA Radiotron Co., Inc.*

Schedules of W3XAL-W3XL and Other Stations

The National Broadcasting Company operates two experimental high-frequency relay broadcasting stations at Bound Brook, N. J., in connection with station WJZ. These are W3XAL and W3XL. W3XAL operates on 17,780 kc., Sunday to Friday inclusive from 10 a.m. to 4 p.m. E.S.T.; and on 6,100 kc., on Saturday from 5 p.m. to 1 a.m. E.S.T. W3XL is a general experimental station and has no fixed frequency or schedule, but is usually on 6,425 kc. The accompanying illustration shows some of the equipment used.

Incidentally, the new address of the headquarters of the National Broadcasting Company is 30 Rockefeller Plaza, New York, N. Y.

* * *

Station HC2RL

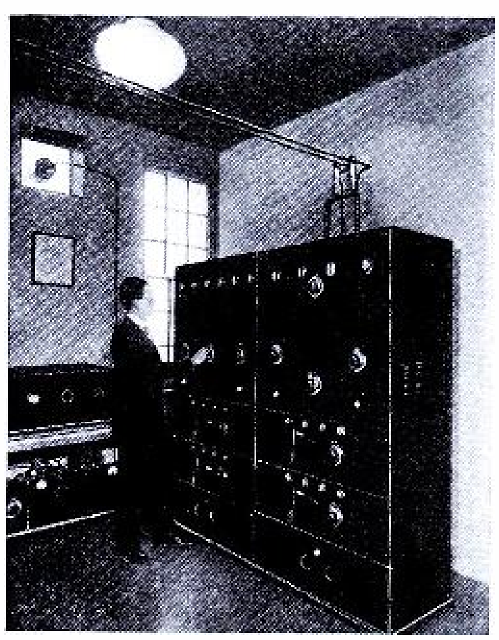
"Have thoroughly enjoyed the first two issues of your magazine and think Captain Hall's Department is going to be a help to many 'listening fans,' such as myself.

"For his list of addresses I have heard on the air and verification written for but not yet received:

Station HC2RL
P. O. Box 759
Guayaquil, Ecuador"

"Incidentally, I have been unable to find this station listed in any logs or magazines as yet. It has been working somewhere around 45.5 meters and comes in with very good volume, one night as late as midnight.

"Another South American apparently has changed frequency—HJ1ABB, Barranquilla, Colombia. This is listed on 51.75 meters but is operating on about 46 meters (I have heard it there several times in the last couple of weeks), just below W3XL, Bound Brook, on 46.67 meters.


Radio frequency exciter equipment recently remodeled for W3XL-W3XAL. Carl Dietsch at controls.

"Station PSK, at Rio Janeiro, which is listed as a commercial telephone station, has been coming in fine with some very good programs, usually signing off about 7:30 p.m.

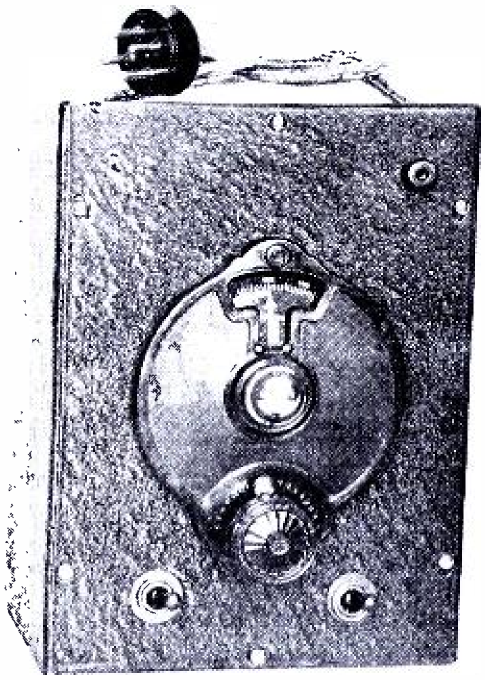
Very truly yours,
H. A. TURNER,
Route 2,
Glen Allen, Va."

* * *

Station HIZ

"Here is another station to add to your list. Station HIZ; Santo Domingo, Dominican Republic. They operate on 47.5 meters and have 20 watts power. They are on daily from 4:40 to 5:40 p.m., E.S.T.; and 10 to 12 p.m., E.S.T. on Saturdays. Their address is Estacion Radiodifusora HIZ; Calle Duarte No. 68; Santo Domingo, Dominican Rep. I received a QSL from them.

FRANCIS FEKEL,
Garden Rr. & Blvd.,
Vineland, N. J."



PANEL VIEW OF THE TESTER

Building, Calibrating, and Operating

An S.W. Station Finder

SUMMARY: *Short-wave reception is not a hit and miss proposition by any means. The better the receiver you have, the greater are your requirements for precision tuning; and, unless your receiver is accurately calibrated, you receive only a small fraction of the stations you are capable of hearing.*

The article here describes what the author prefers to call an S. W. Station Finder. It is merely a modulated oscillator, a.c. operated, that is capable of being calibrated by means of broadcast stations and of adjusting your receiver to almost any desired point.

By D. A. Griffin*

BREATHES there a short-wave fan who would not like to know the proper receiver dial setting for that elusive foreign station he has been hunting for? Those enthusiasts who are constantly on the lookout for stations that come through only on rare occasions have been asking in increasing numbers for a "gadget" that will solve this problem. The "station locater" is well known to the transmitting amateur under the name "frequency meter."

The meter used by the "ham" is not satisfactory for our purpose, however. This is true because the amateur meter is a specialized instrument covering only the amateur bands. Because the short-wave broadcast stations are far removed from these bands, a special type of meter is necessary.

Requirements

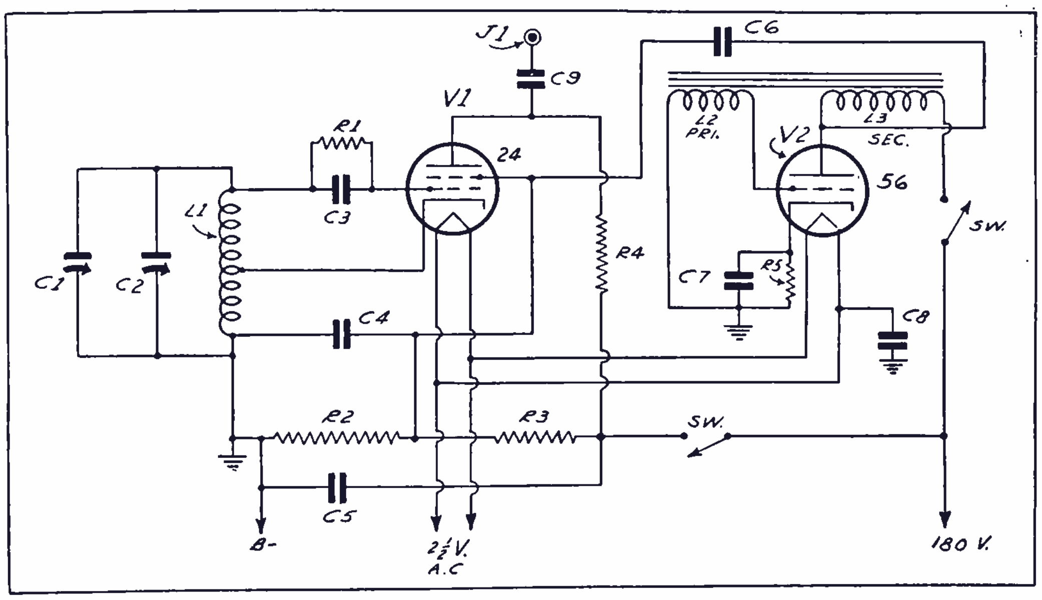
The purpose of this article is to outline the requirements for such a meter, and to describe its construction, calibration and operation. To properly appreciate and use the frequency meter, we must, for the moment, disregard wavelength and think in terms of frequency. To those fans who find this difficult, it might be well to explain that the frequency in kilocycles can be found by dividing the wavelength in meters into 300,000. Conversely, of course, we can take frequency in kilocycles and divide it into this same constant and get wavelength.

The first idea that comes to mind for a frequency meter is a calibrated oscillator with plug-in coils similar to those used in many short-wave sets; or, possibly, a set-up employing coil switches as found in many modern "all-wave" receivers. The trouble with these systems is that it is practically impossible to make plug-in coils or switching arrangements that will "stay put." Some minor change will occur and throw off the calibration. The second difficulty is the actual calibration. Very few short-wave stations hold their frequency to the exactness required for good calibration. It is easy to see that the calibration curve will be poor if we have inaccurate marker points.

Fortunately, we can take advantage of the fact that every oscillator generates harmonics. There is nothing at all mysterious about an harmonic. If we have a tube oscillating at 750 kc., for example, this frequency is called its fundamental, or first harmonic. The oscillator will also generate a second harmonic at twice the fundamental frequency, *i.e.*, 1500 kc.; a third harmonic at 2250 kc., and we can keep right on going higher in frequency in 750 kc. steps, but never *lower* than the fundamental.

About two years ago, our good friend Uncle Sam, via the Federal Radio Commission, decided that all stations in the regular broadcast band should really be tied down to their assigned frequencies. There was considerable burning of midnight oil by engineers and wailing by the station owners, who had to pay for the necessary equipment.

About eighteen months ago the dust settled down, and we find all stations extremely close to their assigned waves. The commission allows them fifty cycles leeway, but the monitoring equipment so closely approaches perfection that in most



SCHEMATIC CIRCUIT AND LIST OF PARTS FOR THE STATION FINDER

PARTS FOR FREQUENCY METER

C1—100 mmf. variable condenser, National type SE-100.
C2—75 mmf. trimmer condenser, National type ADT 75.
C3—.0001 mf. mica condenser.
C4, C8—.01 mf. mica condensers.
C5, C7—.1 mf. tubular condensers, Sprague.
C6—.001 mf. tubular condenser, Sprague.
C9—.00004 mf. mica condenser.
R1, R4—100,000-ohm resistors, Lynch.
R2—3000-ohm, 2-watt resistor, Lynch.
R3—50,000-ohm, 2-watt resistor, Lynch.
R5—2000-ohm, 1-watt resistor, Lynch.
L1—115 turns, on a 1" diameter form, of No. 30 d.s.c. wire tapped at the 30th turn.
L2, L3—midget audio transformer, Leeds.
J1—pin jack.
Steel panel and chassis, complete with box, as described in article, Leeds.

* Leeds Radio

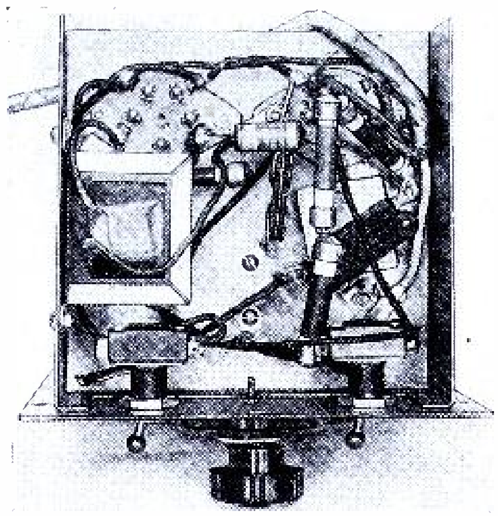
cases the frequency is held within ten cycles. WABC, to the writer's knowledge, rarely varies more than two cycles out of a total of 860,000. The reader with a mathematical turn of mind can figure out the percentage of error for himself.

It is safe to assume the short-wave fan has a broadcast receiver around the house that can be used if the short-wave set does not have the broadcast range. With the trusty broadcast receiver hooked up, you can tune in and pick up all of these extremely accurate frequencies which the broadcasters are keeping so beautifully constant. Furthermore, they do not cost us a penny—all we have to do is to utilize them. They are always accurate, and some are always on the air, so that getting a calibration of a frequency meter is easy, and, what is more important, checking it for accuracy takes but a moment.

Using the Oscillator

Suppose we construct an oscillator that tunes over a portion of the broadcast band. Then let us tune in a broadcast station on our receiver, say, WABC. Now, if we put the oscillator alongside the receiver and turn the oscillator tuning dial slowly, we will hear a high-pitched whistle on WABC when the oscillator approaches the frequency of that station. This will first be heard at about 10 kc. on either side of the station's frequency, 860 kc. As we approach this frequency, the note becomes lower and lower until no audible tone can be heard. The oscillator is then "zero beating" against the station frequency, and is, of course, exactly on 860 kc. If we continue to tune the oscillator condenser in the same direction, the note will start to rise in pitch and then go to zero beat again on the next channel, where the same procedure is used to check 870 kc. Naturally, no zero beat can be obtained if the stations are not operating on either of these frequencies.

If we hunt for a broadcast station on each of the channels, we can zero beat the oscillator against each

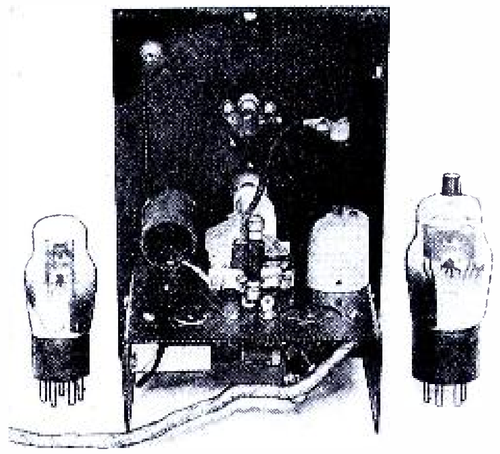


Under-view of the oscillator showing the location of the switches and the a.f.t.

station and draw a calibration curve of the oscillator frequency against its dial readings as shown in Fig. 1.

The curve is broken up into three sections to secure greater length, which in turn gives greater readability. Curve 1 is read against the dial settings on the bottom border; the frequency scale is on the left. Curve 2 corresponds to the dial readings on the top and the frequency scale on the left. Curve 3 corresponds to the dial readings on the top and the frequency scale on the right. The precision dial used has a vernier scale, making it possible to read to one-tenth of one dial division. Inasmuch as there are one hundred and fifty divisons on the dial, you can actually set it to any one of fifteen hundred points.

Too much stress cannot be put on the fact that the job of "zero beating" against station frequency and the notation of the exact dial setting must be made with great accuracy, otherwise the calibration will be poor and the results will be progressively worse as we go to the higher frequencies with our short-wave set. For example, if we want 12,000 kc. on our short-wave set, we can get this point by setting our oscillator on 1000 kc. and listening to its twelfth harmonic. If there was an error of +5 kc. on the calibration curve, the oscillator would be operating on 1005 kc. although the chart read 1000 kc. The twelfth harmonic



Deck view. The coil is on the left, the tuning condenser in the center, and the aluminum can at the right is the trimmer.

would actually be 12,060 kc. instead of the desired 12,000 kc. To cover the entire short-wave band from 1500 kc. up to 23,000 kc., the meter must cover a frequency range of 750 to 1140 kc., as shown on the curve.

Table I gives the frequency ranges covered by the harmonics of the oscillator from its first, or fundamental range, to the twentieth. It will be noted that the overlap becomes greater as the frequency is increased. This can be used to advantage, as many sets do not have good dial spread on the higher frequencies. This fact makes it hard to figure out which harmonic is being picked up, as the calibration of the receiver may be rough or completely missing. Fortunately we can take advantage of the many harmonics in order to make absolutely sure which harmonic we are listening to.

An Example

Suppose we want to pick up a station on 15,000 kc., for example. We can set the oscillator on 750 kc. and listen to its 20th harmonic. It must be kept in mind, however, that we may, for the reasons just mentioned, be listening to the 19th harmonic on 14,250 kc., the 18th on 13,500 kc., or possibly the 21st on 15,750 kc. All we have to do is to tune the oscillator higher in frequency until we hear another beat note in the receiver which is still set at the point assumed to be 15,000 kc. We can predetermine the oscillator dial setting by dividing 19 into 15,000 kc., giving us 789.4 kc. as the next oscillator frequency that will give a beat note of exactly 15,000 kc. That is, 789.4 multiplied by 19 equals 15,000 kc. For that matter, we can divide the 18th or any suitable harmonic into 15,000 kc., securing additional check points. It is obvious that these points will become fewer in number as we go lower in frequency. This is compensated for by the fact that the receiver dial is much easier to read on the lower frequencies, so that the chances of error in the selection of the proper harmonic are remote.

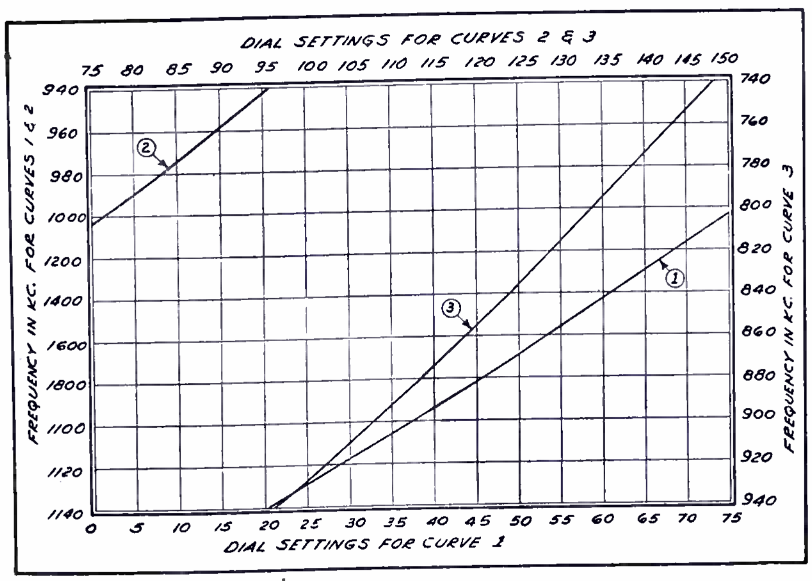


FIG. 1—Calibration curve of the oscillator. The dial divisions are divided into three sections to facilitate reading, as the new type National dial has 150 divisions on it. See the text for additional details.

Conversely, when we are receiving a station whose frequency is unknown, we can turn on the oscillator and tune it until a beat note is picked up against the station carrier. Suppose the oscillator dial reads 1000 kc. and we believe we are listening to its tenth harmonic beating against a station on 10,000 kc. Dividing 10,000 by 9 we obtain 1111.1 kc. as the ninth harmonic point with which we should also obtain a beat note. Dividing 10,000 by 11 we find that 909 kc. is the eleventh harmonic point which should also give an audible beat note at the same receiver setting. A little practice will enable the user to multiply and divide with speed and, gradually, become expert with the meter. Frequency checking then becomes a fascinating hobby in itself, and provides the means for being right on the exact spot with the receiver when looking for that DX station.

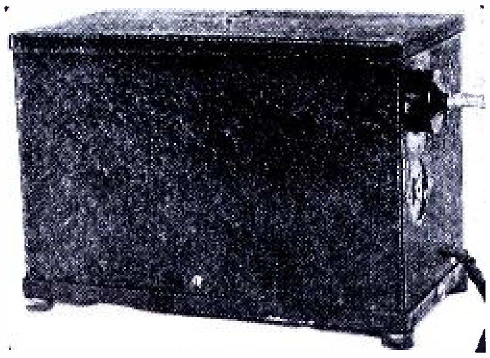
Construction

The construction of the oscillator will undoubtedly be of interest to those who "roll their own." Experience has shown that the most stable oscillator, except for the crystal oscillator which operates on a fixed frequency, is the electron-coupled type. With any type of oscillator the operating temperature, tube ageing and mechanical instability tend to make the oscillator drift around to some extent. As pointed out before, only the best parts are good enough in frequency meter work, or one's efforts will be wasted. The circuit constants shown are the result of a great deal of experiment and should be strictly adhered to. Even so, some drift will occur over fairly long periods, and for this reason the meter should be checked frequently. The applied voltages should be kept constant and it is necessary for the tube heaters to be lit for at least a half hour before use. The frequency shift is quite severe during this period and, of course, no attempt should be made to calibrate or use an instrument during this "warm-up period."

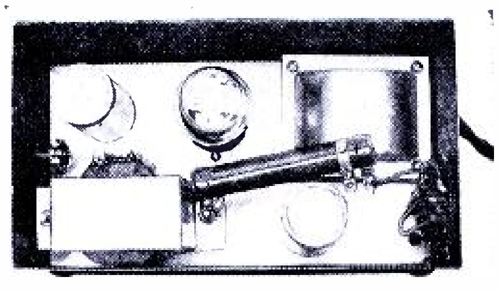
Referring to the circuit, we find the electron-coupled oscillator at the left, which generates the radio-frequency signals. A switch is provided in the B-supply lead so that the unit can be shut off, leaving the tubes lit. At the right is an audio oscillator tube which generates an audio-frequency note. This tube modulates the r.f. oscillator in the same manner a broadcast station's carrier is modulated by a program. Indeed, the unit is a miniature transmitter.

The reason why the modulation is included is because many short-wave sets are not supplied with heterodyne oscillators with which to pick up the "carrier whistle" as a station of the frequency meter is tuned in. Because the harmonics of the electron oscillator are relatively weak, the tone supplied by the audio tube makes it possible to pick them up easily. The frequency meter requires an antenna just as the broadcast station does, because it is completely shielded. A short wire is connected to the pin jack shown, and should be loosely coupled to the receiving antenna of the short-wave set in order to insure loud signals.

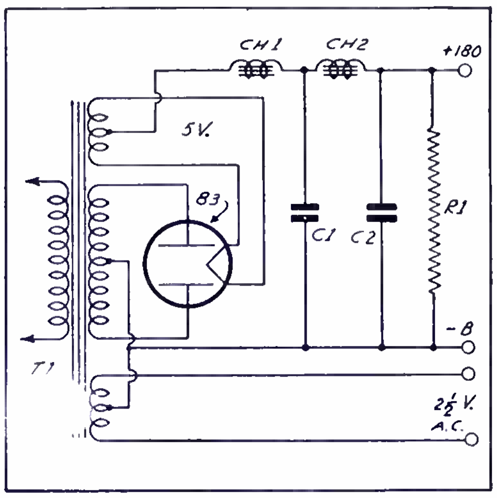
The mechanical construction of such a frequency meter must be extremely rigid. A heavy steel or aluminum box and sub-panel should be employed. If a flimsy box is used, pressure on the front or sides will cause a frequency shift. All apparatus should be mounted as solidly as possible. The dial should be firmly fixed on the tuning condenser shaft, as a slight slip of the dial will throw the entire calibration off. All wiring should be heavy, with short, direct leads that are shakeproof.



The power unit used with the meter.



Under view of the power unit.



Schematic circuit of the power unit.

PARTS FOR POWER PACK

T1—Kenyon replacement type power transformer 300-0-300 volts; 5 volts, 3 amperes; 2½ volts, 6 amperes.

C1, C2—8 mf. electrolytics, Sprague.

CH1, CH2—30 henry, 500-ohm chokes, Kenyon.

R1—15,000-ohm, 50-watt resistor.

The care used in the construction and calibration of the frequency meter are obviously directly related to the accuracy of the instrument. Good workmanship and good results will go hand in hand.

HARMONIC TABLE I

Harmonic	Frequency Range
1	750-1140
2	1500-2280
3	2250-3420
4	3000-4560
5	3750-6700
6	4500-6840
7	5250-7980
8	6000-9120
9	6750-10,260
10	7500-11,400
11	8250-12,540
12	9000-13,680
13	9750-14,820
14	10,500-15,960
15	11,250-17,100
16	12,000-18,240
17	12,750-19,380
18	13,500-20,520
19	14,250-21,160
20	15,000-23,800

This frequency meter uses a type 24A tube as an oscillator and a 56 for the audio modulator. Therefore, it must be supplied with 2.5 volts a.c. for the heaters and about 180 volts for the plates. This power may be obtained from the short-wave receiver itself, if the existing power pack has sufficient spare capacity, or it may be supplied by a separate little power pack, such as the one constructed by the author and shown in the accompanying illustrations. This is a perfectly ordinary unit using a standard rectifier circuit.

The frequency meter shown is fitted with a shielded four-wire cable about three feet long, terminating in a four-prong plug that fits into a four-prong socket on one end of the power pack. The constructor can readily modify this part of the outfit to suit any power pack that he happens to have available.

Mechanical Details

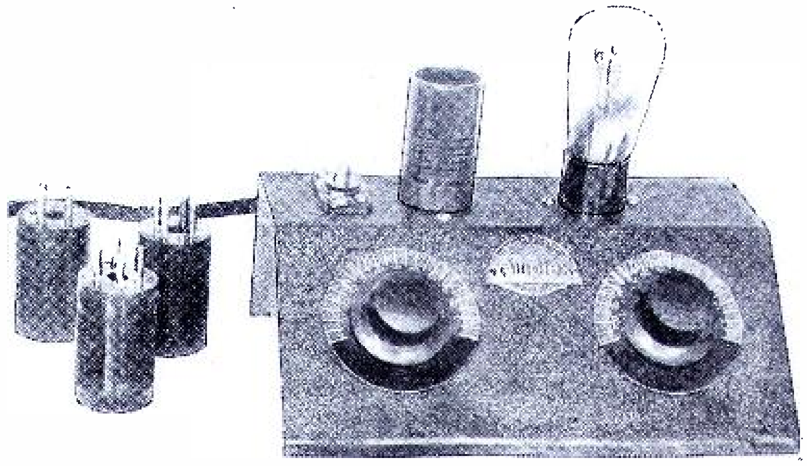
The mechanical construction of the frequency meter is very simple. The front panel is of No. 14 gauge steel, 8¼ by 5⅞ inches. The rear sub-panel is also of steel, bent U-shaped and spot-welded to the front panel. It is cut out of a sheet 9 inches long and 5⅜ inches wide. This whole unit slips into a spot-welded little cabinet measuring 8½ by 6⅛ by 5¼ inches. The cabinet is essential to prevent radiation from the oscillator coil.

Constructors with adequate tool facilities can easily make the chassis and cabinet themselves. However, prepared boxes are available at low cost; these are recommended because they save a lot of work and are finished in speckled black enamel. The finished instrument presents a very neat appearance and will enhance any short-wave receiver installation.

The AMPLEX K-1

a simple one-tube set

Summary: *Mr. Landres, author of the article below, explains the construction and adjustment of a novel little one-tube receiver designed especially for the beginner in short-wave work. Although the circuit is perfectly standard, the unique arrangement of the panel-cabinet combination, the simplicity of adjustment, and the excellent results obtained should make this receiver a very popular one.*



Panel view of the one-tube receiver, showing the arrangement of the controls, tube, and coil.

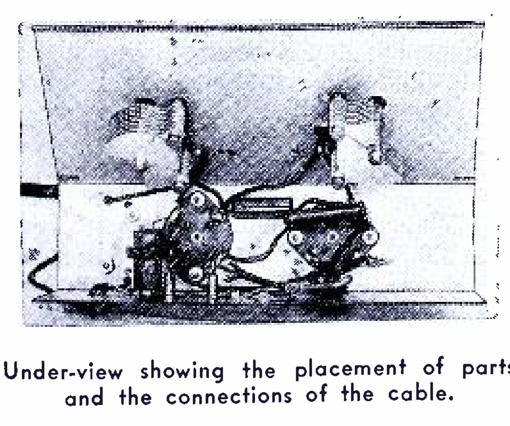
By Arnold Landres

IF we were to claim that this little "one tuber" *will* bring in Australia by way of New Zealand in any location, at any time, regardless of whether or not the station was on the air, we would be depriving the nation's army of crystal gazers of their livelihood. Furthermore, if we were to say that this tiny receiver hears all and tells all, we would be branded as a prevaricator. All of this hokum is another way of saying that we are presenting to the readers of this magazine a simple, one-tube receiver that can do anything any single-tube set can do. It possesses the distinct advantage of employing a unique arrangement of parts in a very cleverly designed panel-cabinet combination that is simple and rugged.

A glance at the photographs tells the mechanical story; and two glances at the diagram should satisfy the technical boys. There is nothing radically new about the whole circuit—it has been used for years in millions of receivers—and for that reason should give no trouble to the new crop of experimenters.

The Circuit

Examine the schematic circuit. The antenna connects through a small variable condenser C1 to the grid of the tube. The ground connects directly to the plus filament. The plate connects through the tickler winding, radio-frequency choke, to the phones. A conventional grid-leak and grid-condenser complete the set. Simple! Economical! Convenient!



Under-view showing the placement of parts and the connections of the cable.

Now look at the front of the receiver. The left-hand dial adjusts the regeneration control; the right-hand dial, the main tuning condenser. On the deck to the left is located the antenna adjusting condenser. The left-hand socket houses the tube; and the right-hand socket, the coil. The under-view of the set shows the regeneration and tuning condensers. The grid condenser and grid-leak are also clearly visible. The radio-frequency choke is just alongside the two phone tips. A battery cable connects the external batteries to the receiver.

Construction

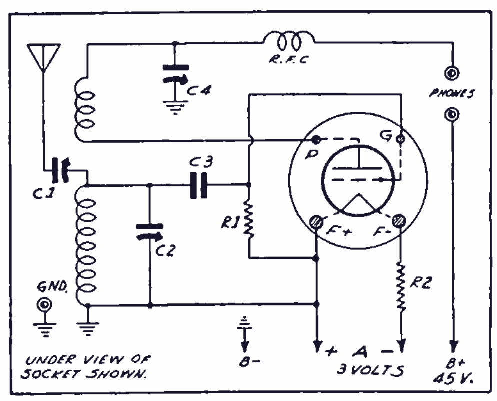
The construction and wiring of the receiver itself are very simple. Mount all the parts (incidentally, the entire receiver including chassis, coils, etc., may be purchased in kit form) in their respective positions, which may easily be determined from the photographs. Then wire the set with the exception of the battery cable; finally, the cable, which is a four-wire affair, is wired directly to the terminals of the apparatus to which they go—no terminal strip is required, or even necessary. Plug the tube into the right-hand socket and the coil into the left-hand socket. Connect the aerial and ground to two leads which come out from the rear, and the set is ready for adjustment.

The adjustment of the receiver is about as simple as its construction. Suppose you place the 40- or 80-meter band coil in the socket. Turn the left-hand dial to zero and rotate it slowly toward 100 until a distinct "plop" is heard. This "plop" signifies that the tube is oscillating. If no "plop" can be heard, check over all the connections to the tickler coil, reversing them if necessary, in order that they be correctly poled. Our "plop" should then be heard.

The next step in the adjustment requires a signal. Tune one in (note the ease with which this can be done!). If the receiver is oscillating the signal will take the form of a squeal. To remove the squeal—but *not* the signal—simply retard the regeneration control toward zero, retuning the signal after each slight readjustment of the regeneration control. Finally, the signal will be clear—and, very often, more than comfortably loud.

The final adjustment must be done carefully. With an insulated socket wrench (which is a standard tool in the radio business), adjust the antenna condenser, C1, for maximum response. Now, during this process, it may be found that the signal goes into oscillation as this condenser is adjusted. As soon as it does, stop the adjustment and retune the regeneration and tuning condensers exactly as was explained in the previous paragraph. After the signal is cleared up again, go back to the

(*Continued on page 43*)



Schematic circuit of the AMPLEX K-1. The socket connections are shown directly.

LIST OF PARTS

C1—25 mmf. (about) fixed variable condenser, Amplex.
C2—100 mmf. variable condenser, Hammarlund.
C3—.001 mf. fixed grid condenser, Pilot.
C4—.0001 mf. regeneration-control condenser, Hammarlund.
R1—3 megohm grid leak.
R2—15-ohm fixed resistor.
Two four-prong sockets, wafer type.
R.F.C.—2 millihenry r.f. choke on wooden dowel.
One four-wire cable.
Two phone tip jacks.
Two knobs with special bakelite dials.
One piece of cadmium-plated steel or aluminum 8½ x 9¼", bent so as to be 3" high and 2¼" wide at the top. The angle of the front panel will then adjust itself automatically.

How to Get Started on an Amateur Phone Set

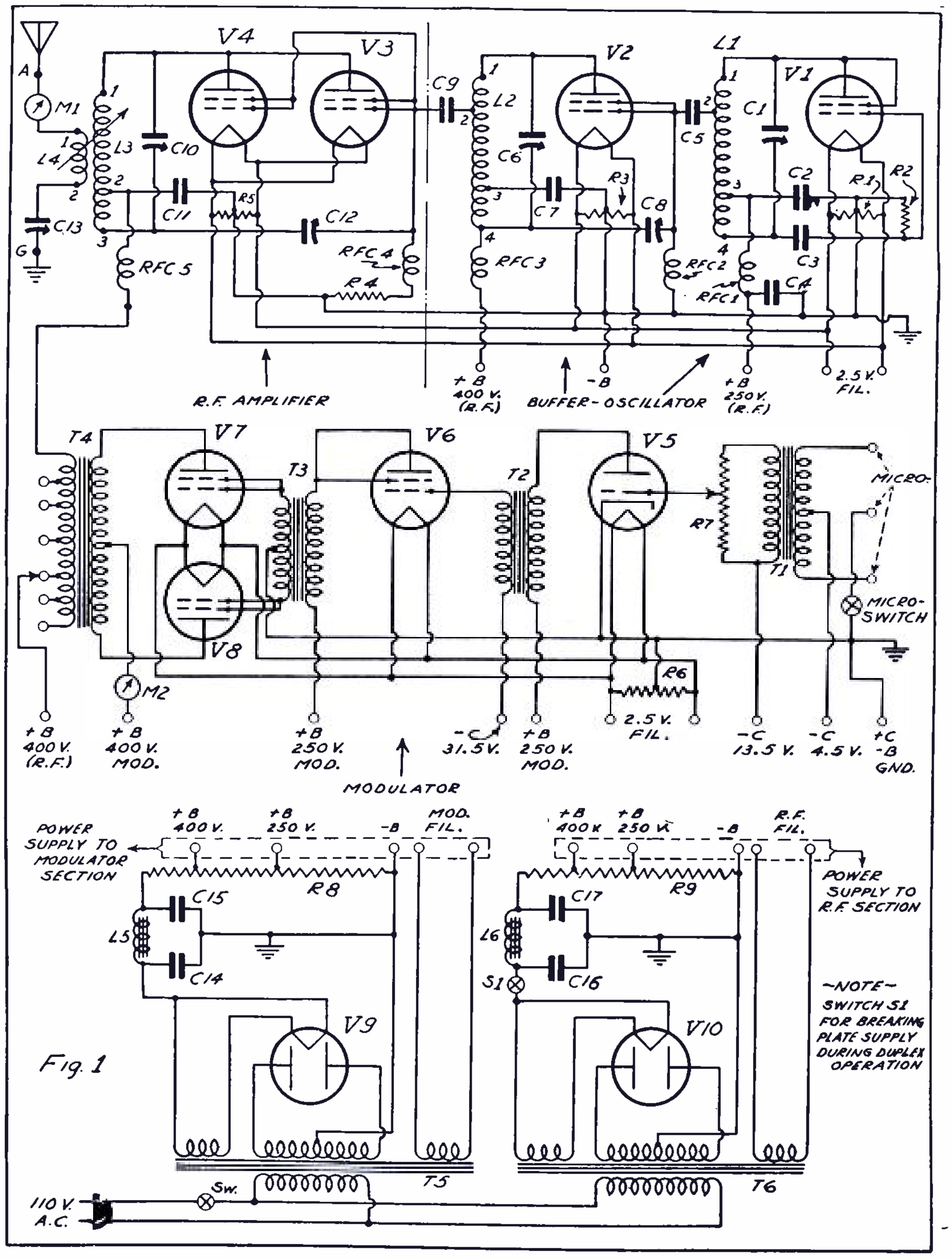
By John B. Brennan, Jr. **Part II**

IN last month's SHORT WAVE RADIO were completely described the design and constructional features of a rack and panel 160-meter short-wave amateur phone transmitter. In this month's installment is described the procedure to be employed in making the necessary adjustments on the transmitter incidental to its operation, together with complete directions for the erection of satisfactory types of transmitting antennas.

Let's suppose that all the units of the transmitter have been built, individually tested for correctness of circuit, and then hooked together as shown in the main circuit diagram, which for the sake of reference, is again shown here, in Fig. 1.

Now, insert one of the type 46 tubes in the oscillator stage socket, V1. With a high resistance voltmeter, measure the voltage applied to the plate of this tube. By means of the sliding clip on the voltage divider resistor, R9, the voltage should be adjusted, while the power to the tube is turned on, to 250 volts. That is to say, don't measure the "no-load" voltage of this tap, but be sure that the tube is connected to this part of the power supply so as to furnish a load. A small neon bulb with either one of its contacts held against any part of the oscillator tube's plate circuit will glow brightly, indicating that the tube is oscillating. Rotate the tuning condenser so as to determine that oscillation takes place over the entire range of the scale.

Now, with a frequency meter, wavemeter, or other accurately calibrated frequency indicating device, which has been previously adjusted to the frequency within the 1800 to 2000 kc. band at which it is desired to operate the transmitter, the oscillator condenser is tuned until, by holding the frequency meter near the oscillator coil, an indication of resonance is obtained.



Complete schematic diagram of the Brennan transmitter. For the values of all parts, see page 20 of the March, 1934, issue.

The R.F. Amplifier

Next, insert a 46 tube in the intermediate r.f. amplifier stage socket, V2, and then remove the plate-supply lead which furnishes plate voltage to this tube. To function properly as an intermediate-amplifier stage, there must be not the slightest trace of r.f. in this stage, and so, in neutralizing it, we again use the neon bulb. Hold it against any part of the buffer's plate circuit. Usually it will glow, indicating that there is r.f. present. Slowly rotate the neutralizing condenser, C8, until the glow vanishes. Then, by slightly returning the tuning condenser, C6, the glow will usually appear. Again adjust the neutralizing condenser until the glow disappears. Repeat this procedure until the neon bulb does not glow regardless of the setting of the tuning condenser. Remember, this operation is carried on with the plate supply to this tube removed.

After you are certain that this stage has been completely neutralized, replace the plate supply connection, with a 0-200 ma milliammeter in series with it. The tuning condenser C6 is then slowly rotated until a sharp deflection, denoting minimum plate current, indicates that this stage is in resonance with the oscillator.

The Final Amplifier

Attention is then given to the final r.f. amplifier, V3, V4, the same procedure as described for the buffer stage being followed here. Remember that during the process of neutralization the plate supply to the final amplifier stage should be removed. Then, when neutralization is complete, the plate supply is again applied with the milliammeter connected in series with this supply lead.

During this operation the antenna and ground or counterpoise are disconnected. The plate current for this stage, when resonance is obtained, is about 10 milliamperes, while for the buffer stage, the plate current, at resonance, is in the neighborhood of 5 to 10 milliamperes; this minimum will rise to

SUMMARY: *This, the second and concluding article by Mr. Brennan on his excellent amateur phone outfit, deals with operating adjustments and the erection of a suitable antenna. The first article appeared in the March, 1934, issue, and described the construction of the transmitter in detail. This outfit is highly recommended to prospective amateurs who want to "get on the air" with an effective, reliable, and inexpensive station.*

about 15 milliamperes when the final amplifier tubes V3, V4 are placed in ther sockets.

For the moment, let's assume that we have already erected a suitable antenna, whether it be of the Marconi, voltage fed Zepp or doublet type. Details for the erection of these types of antennas are given in a following paragraph.

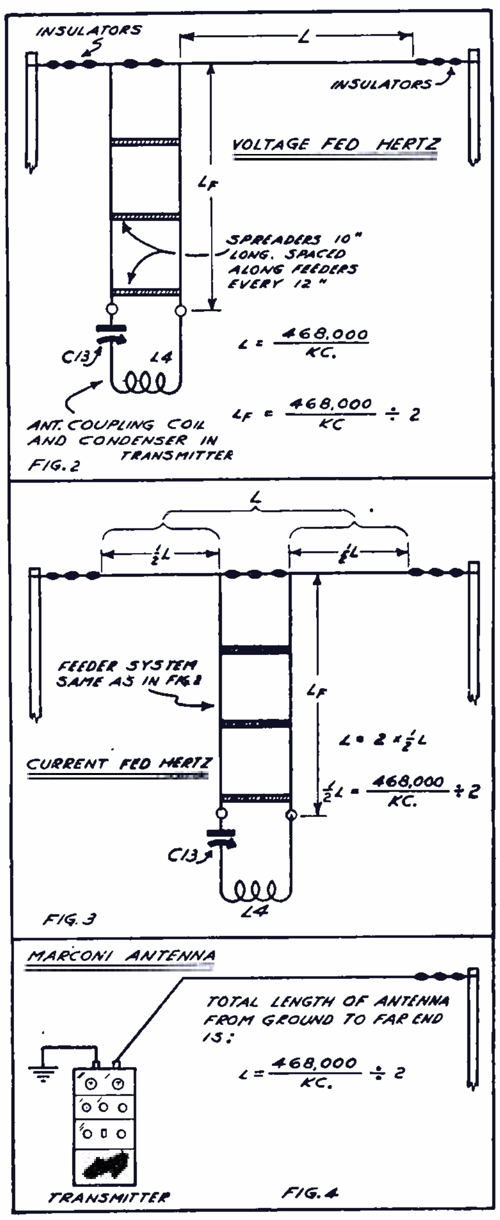
With the antenna system connected to the coupling coil, L4, and its associated tuning condenser, C13, we start out with fairly loose coupling between L3 and L4. Some sort of resonance indicating device should be connected in the antenna circuit, such as a flashlight bulb or hot wire ammeter. Now, slowly rotate the antenna tuning condenser until a point is reached where resonance is indicated either on the meter or by the bulb lighting up—if a bulb is used. It will be noted that the plate current of the final amplifier stage has increased. It is then necessary to retune the amplifier tank condenser, C10, until minimum plate current is again obtained. This new minimum (with antenna load) will be higher than the previous minimum (without the antenna system). The coupling between the coils L3 and L4 is now periodically tightened and successively the tuning and minimum plate current process repeated until the plate current of the final amplifier stage is in the neighborhood of 100 milliamperes. As this minimum plate current increases, the antenna current will correspondingly increase.

Combining R.F.-A.F.

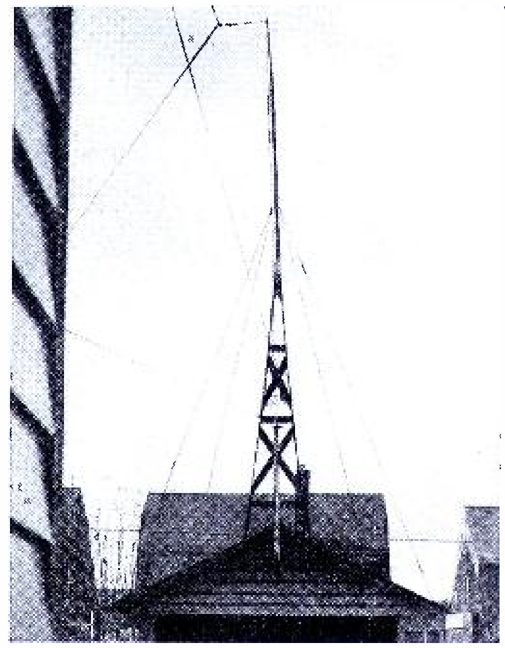
Provided circuit wiring and constructural details have been followed for the audio channel, as described last month, there is nothing more difficult to putting it into operation and combining it with the r.f. portion of the transmitter than to be sure that the correct plate and grid bias voltages are applied. In making adjustments on the transmitter, it is necessary that they be done at the specified operating voltages. It will be noted from the diagram that the oscillator and first audio or speech amplifier stages operate at 250 volts plate potential while the class A 46, the class B 46's, the r.f. buffer, and final r.f. amplifier stages operate at 400 volts plate potential. These voltages are obtained by sliding the contact clips along their voltage divider resistors, R8, R9, while the tubes are in operation. Before any attempt is made to neutralize the r.f. portion of the transmitter, the plate voltages should be adjusted to the correct values as indicated.

Size of Antenna

The physical dimensions of an antenna suitable for operation in the 1800 to 2000 kc. band is such that not always is it possible to employ the voltage or current fed Hertz antennas. Both these antennas require a flat top wire length of some 250 feet, with feeders half that length. Considering these great spans, it is not surprising, then, that a large number of amateurs are forced to resort to the erection of the Marconi type of antenna, whose total length, from transmitter to far end, including the lead-in wire and ground connection, is in the neighborhood of 250 feet. The disadvantage of the Marconi type of antenna is two-fold: first, it is not as good a radiator as the Hertz; secondly, duplex or even rapid two-way communication is somewhat difficult, due to the fact that a radiating portion of the antenna is brought right into the shack, in close proximity to the receiver. In the Hertz antenna, the feeders do not radiate.



Three different antenna layouts suggested by the author.



How Mr. Brennan supports the antenna used with his 160-meter phone outfit. The mast shown has only two legs, made of two-inch boards, and rests on the roof of a one-car garage. It is 20 feet high and is guyed by four wires.

The length in feet of a Hertz antenna system can be computed easily by employing the following formula.

$$L = \frac{468{,}000}{F}$$

where L is the length in feet; F, the operating frequency in kilocycles. Thus, an antenna for operation at 2000 kc. would be

$$L = \frac{468{,}000}{2000} = 234 \text{ ft.}$$

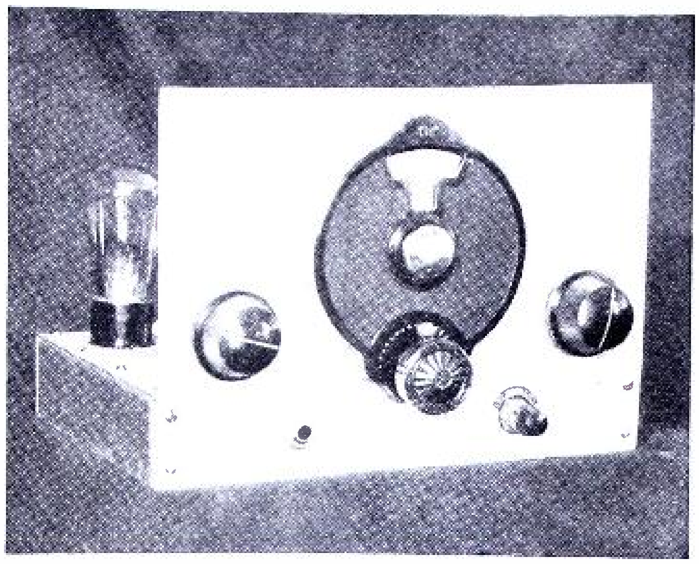
In the case of a voltage fed Hertz antenna, the feeders (half the length of the radiator), 117 feet long, are connected at one end of the radiator portion as shown in Fig. 2. For a current fed Hertz, these feeders are connected at the middle of the radiator. See Fig. 3.

Marconi Antenna

When erecting a Marconi antenna a piece of wire only half the length of the Hertz flat top is cut from a roll and then from it is cut a piece just long enough to connect the transmitter to the nearest good ground connection. Then the remainder is run from the antenna post on the transmitter out to some elevated support such as a mast or pole, as is shown in Fig. 4.

Since both antenna and transmitter have to be adjusted to the same frequency in order to obtain satisfactory operation, it is usual to determine first the physical limitations of your particular location, select

(*Continued on page* 38)



A Unique 3-Tube Super-regenerator

SUMMARY: *The February, 1934, issue of* SHORT WAVE RADIO *contained an excellent article on super-regeneration by the present author. In this article several important points were stressed and several solutions to problems were suggested. This article utilizes the excellent suggestions given; the result is a simple set that should go far toward the realization of an ideal.*

By J. A. Worcester, Jr.

THIS article supplements the one which appeared in the February issue, which dealt with the subject of super-regeneration from a theoretical standpoint. It will be remembered that the main point brought out in this discussion was that it is essential that the detector oscillations entirely die out during the inactive period if satisfactory operation is to be obtained. Otherwise, it is necessary to reduce the feedback until this condition obtains, with a consequent decrease in amplification. It was also pointed out that at the ultra high frequencies corresponding to five and ten meters the damping of the tuned circuits employed was more than enough to provide sufficient damping with the value of quenching frequency commonly employed. There remained, then, only those circuits which were coupled to the tuned circuit as possible sources of insufficient damping. The antenna circuit, which is generally directly coupled to the tuned circuit and offers a low resistance to oscillations flowing in same, was considered as the circuit most likely to be insufficiently damped.

Two general methods of isolating the antenna circuit from the tuned circuit were suggested. One involved a bridge arrangement whereby it was impossble for oscillations flowing in the tuned circuit to get into the antenna circuit, although oscillations induced in the antenna circuit from external transmitters were transferred to the tuned circuit. The other method indicated a coupling method, used by the Bell Telephone Laboratories, whereby the antenna was connected to a coil in the plate circuit.

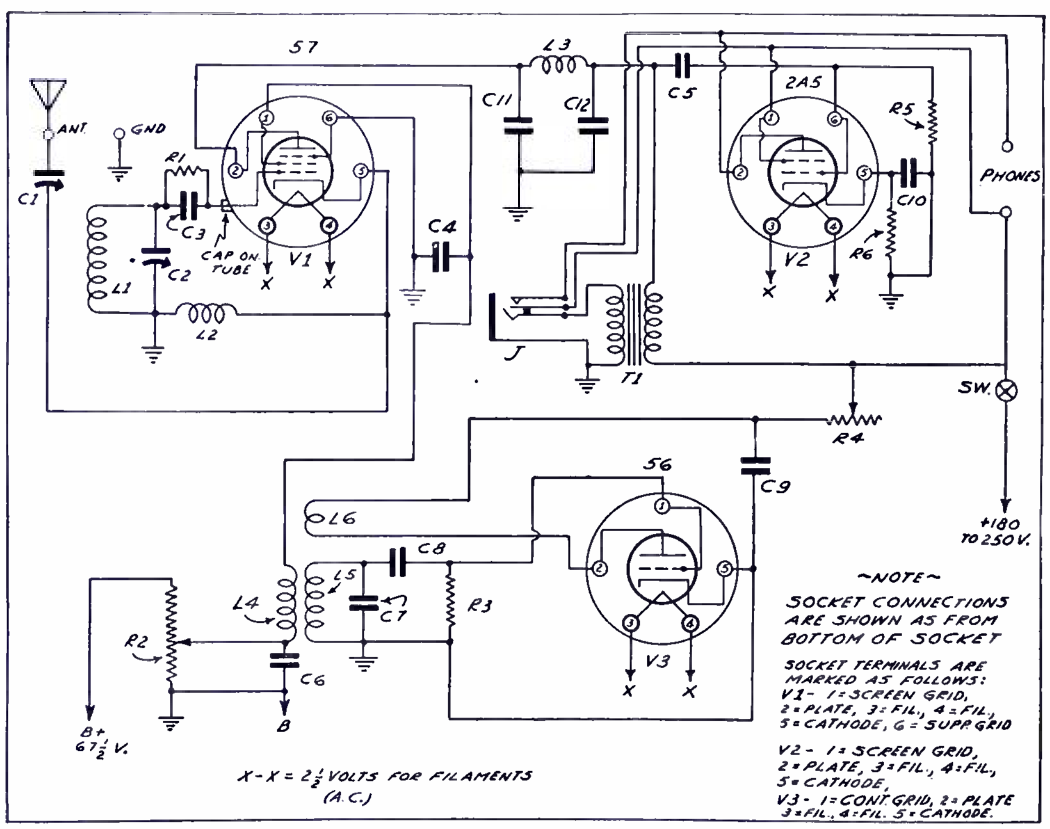
The New Circuit

In the receiver to be described, a variation of this latter method is employed, whereby the antenna is connected to the cathode through the usual coupling condenser.

Oscillations are obtained by the choke L2 in the cathode circuit which is of sufficient size to produce a capacitive reactance common to the plate and grid circuits. This method of obtaining feedback is very effective at wavelengths ranging from five to twenty meters, and undoubtedly is also effective at fre-

PARTS REQUIRED

C1—Hammarlund 35 mmf. variable mica condenser, EC-35.
C2—Hammarlund midget condenser, 20 mmf. max. capacity, MC-20-S.
C3—Solar .0001 mf. moulded mica condenser.
C4, C8, C11—Solar .0005 mf. moulded mica condensers.
C5—Cornell-Dubilier .01 mf. tubular paper condenser, DT 40100.
C6, C9—Cornell-Dubilier .5 mf. "Cub" tubular paper condenser, BB-4050.
C7—Solar .0025 mf. mica condenser.
C10—Polymet 25 mf., 25-volt dry electrolytic condenser.
C12—Aerovox .004 mf. moulded mica condenser.
L1—See text for winding details—forms are Hammarlund Ultra Short Wave Isolantite coil forms, type CF-5-M.
L2—National 2.5 mh, r.f. choke, type 100.
L3—50 turns No. 35 DSC wound on 3/8" bakelite tubing spaced to occupy 3/4".
L4, L5, L6—Quenching frequency transformer. See text for details.
R1—Lynch 3-megohm metallized resistor.
R2, R4—Centralab "Elf" 50,000 ohm potentiometers.
R3—Lynch 100,000-ohm metallized resistor.
R5—Aerovox .5 megohm resistor.
R6—Lynch 400-ohm metallized resistor.
T1—Thordarson Audio frequency transformer, T-5736.
1—Aluminum panel, 14 gauge, 6 1/2" x 9 1/16".
1—Aluminum subpanel, 14 gauge, 9 1/16" x 6 3/4" x 1 1/2".
1—National type "B" dial, 0-100-0.
1—Hammarlund 5-prong Isolantite socket, type S-5.
1—Eby 5-prong laminated socket.



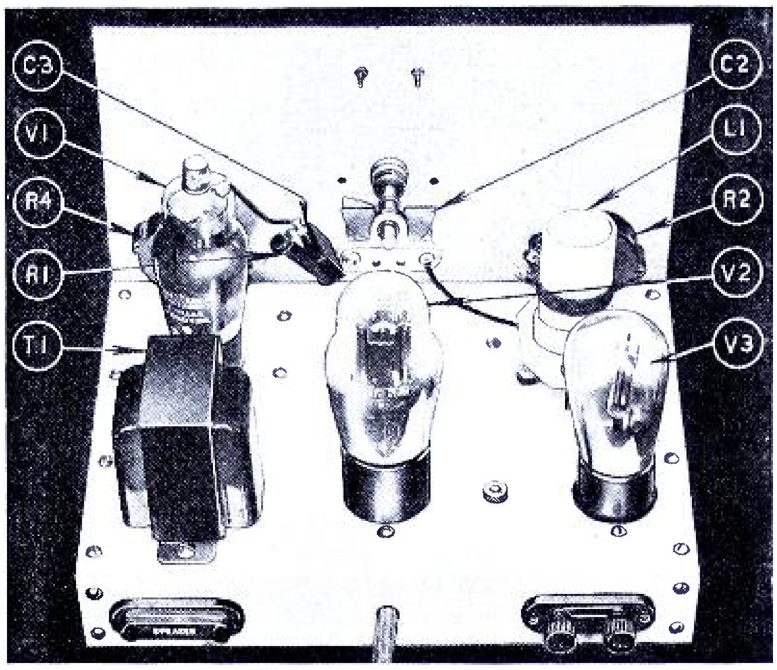
ABOVE: SCHEMATIC DIAGRAM OF THE WORCESTER IMPROVED SUPER-REGENERATOR. BELOW: PARTS LIST

2—Eby 6-prong laminated sockets.
J—Carter type 103. 3-spring jack.
SW—Yaxley single pole, single throw switch.
1—Twin binding post strip, Eby.
1—Twin speaker jack, Eby.
1—3-ft., 5-conductor cable.
1—National screen grid clip type 24.
1—Type 56 tube, V3.
1—Type 57 tube, V1.
1—Type 2A5, V2.

quencies considerably outside this range. The choke employed has an inductance of 2.5 millihenries.

Another unusual feature of this receiver is the three-winding quenching-frequency coil employed. The quenching frequency is applied to the detector by means of the winding L4 in the detector screen-grid circuit. The three-winding construction makes it possible to vary the strength of the quenching-frequency oscillations independent of the detector feedback. The detector feedback is controlled by the potentiometer R2, while the strength of the quenching-frequency oscillations is controlled by the variable resistor, R4.

Plug-in coils are employed, and winding data are furnished for coils to cover the 5-, 10- and 20-meter amateur bands. With the 20-meter coil, it is also possible to hear 19-meter broadcast stations and commercial phones.



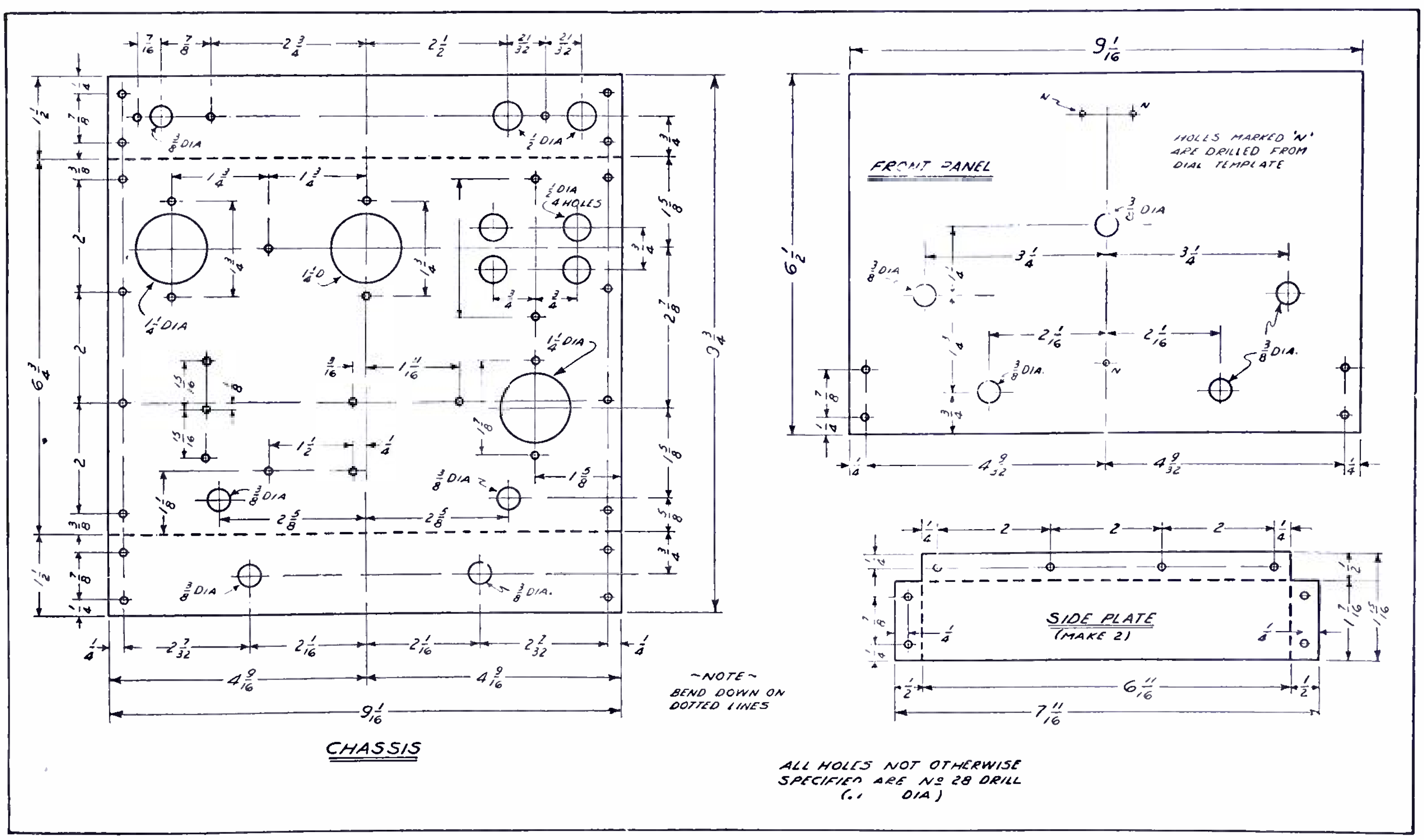
Deck view of the completed receiver. Note the excellent placement of the parts and the ease with which the parts may be assembled. The lettering, of course, refers to the schematic diagram. Of particular interest is the method of connecting the antenna—it connects directly to the cathode of the tube V1. This connection prevents the antenna circuit from interfering with the action of the set.

The tubes employed are a 56 oscillator, a 57 detector and 2A5 amplifier. As is well known, these tubes require a heater voltage of 2½ volts a.c. A plate voltage of 180 to 250 volts is satisfactory, and may be obtained from batteries or a well-filtered power pack. If desired, it is possible to use the 6.3-volt equivalents of the above tubes, allowing the use of a storage battery for heater supply. These tubes would be a 37 oscillator, 77 detector, and 42 amplifier.

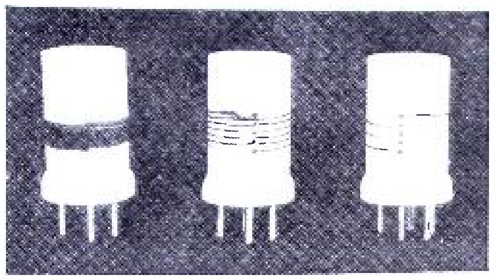
It will be noted from an inspection of the wiring diagram that impedance coupled audio-frequency amplification is employed. The impedance in this case is the secondary of an ordinary audio-frequency transformer. The primary winding is connected to a jack so that headphones can be inserted in the detector output. The use of this connection makes it possible to obtain a fairly good match between the impedance of the phones and that of the r.f. pentode plate. As a precautionary measure, the a.f. pentode output is short circuited when the plug is inserted in the jack. This reduces the possibility of the 2A5 plate voltage being cut off, which results in overheating.

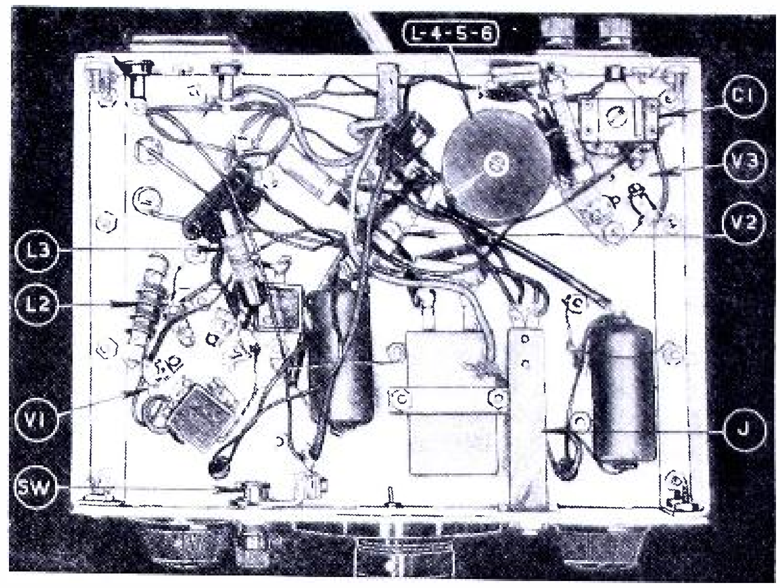
When constructing the receiver, the location of the various parts can be noted from the photographs. The first step is the construction of the chassis, which consists of a 14 gauge aluminum panel 6½" x 9$\frac{1}{16}$" and a subpanel, also of aluminum, 9$\frac{1}{16}$" x 6¾" x 1½".

On the front panel are mounted the variable tuning condenser, C2, the potentiometer R2 and the rheostat R4, the jack, and the B supply switch. On top of the subpanel are mounted the coil socket and the a.f. transformer, while at the rear are mounted the twin binding post and speaker jack assemblies. The remaining apparatus is mounted beneath the chassis and includes the quench-frequency coil as well as the various fixed condenser, resistors, chokes and tube sockets. The plug-in coils are wound on forms having an outside diameter of 1⅛". The winding specifications for the 5-, 10- and 20-meter coils are as follows:



Complete mechanical details of the chassis, side plates, and front panel. All dimensions are in inches.





Left: Unretouched photograph of the coils used. They are wound on forms 1⅛" in diameter. Note that no primary coil is used—only one winding per coil.

Right: Under view of the receiver showing the placement of all the small parts. Only the major items are marked, since the smaller units are placed where most convenient.

5 meters—3 turns No. 24 enamelled wire spaced to occupy one-half inch.

10-meters—6 turns No. 24 enamelled wire spaced to occupy one-half inch.

20 meters—12 turns No. 22 d.s.c. wire close wound.

The quench-frequency coil form is made up of four bakelite discs 1⅝" in diameter by ⅛" thick and three fibre washers ¾" in diameter and ¼" thick. These are assembled on a 1¾", 6/32 machine screw. The winding L6 is wound in one of the end slots and consists of 750 turns of No. 35 d.s.c. wire. The winding L5 is wound in the center slot and consists of 1200 turns of 35 d.s.c. wire. The remaining winding, L4, also contains 1200 turns No. 35 d.s.c. wire. When wiring the quench-frequency oscillator, the outside lead of L5 should go the grid condenser C8 and the inside lead of L6 should go to the plate. No particular polarity has to be observed when wiring L4. The ultra high-frequency choke, L3, contains 50 turns of No. 35 d.s.c. wire spaced to occupy ¾" on a ⅜" bakelite form.

It might be advisable to point out that when wiring the dry electrolytic condenser, C10, it is necessary to observe the polarity. The proper procedure is to ground the negative terminal.

The only adjustment necessary before putting the set into operation is that of the antenna condenser, C1. For the 10- and 20-meter bands this can generally be left "all in" while for the 5-meter band, it will probably have to be turned nearly all out. If it is desired to use the set as a straight regenerative receiver on the 20-meter or other bands, this can be readily accomplished by removing the oscillator tube.

It will generally be found advisable to experiment with various antenna systems and employ the one giving best results in any particular location. Generally, a single vertical wire eight feet in length will be found satisfactory. The lead-in should be connected 13½" from the center of the wire and should be run at right angles to the antenna for the first few feet. The exact length of the lead-in is not important with this type of antenna system.

How to Get Started on an Amateur Phone Set

(*Continued from page 35*)

the type of antenna which this location permits and then tune your oscillator and the remainder of the transmitter to the fundamental frequency of the antenna.

Providing a space of approximately 250 feet is available for the erection of the flat top, there is one type of antenna which is growing fast in popularity. It is the doublet

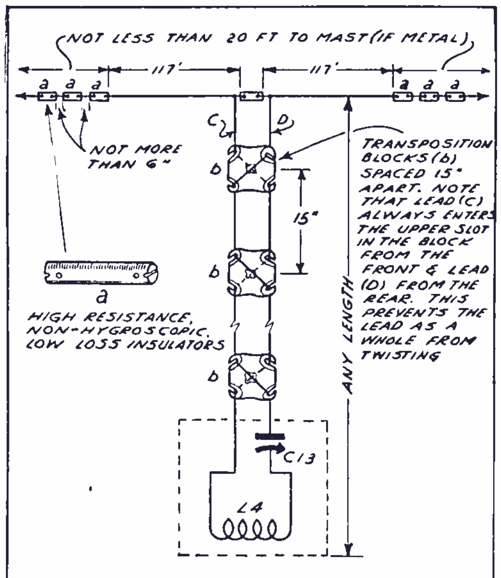


FIG. 5

When a transposed-wire feeder is used, the feeder may be of almost any length without affecting the operation of the flat-top "doublet."

type of antenna, differing from the accepted version of such antennas in that a transposed feeder system is used whose length is independent of the length of the flat top or the operating frequency. In Fig. 5 this type of antenna is shown. An incidental advantage to the use of this type of antenna is that by the use of a suitable switching arrangement it is possible to use the one antenna for both transmitting and receiving.

The author has erected such an antenna for use with the transmitter described. In its construction it is important to keep in mind that the transposition blocks should be spaced along the feeders at distances not greater than 15 inches, measuring from center to center. The feeder line itself should be held taut and rigid to prevent swinging. Note carefully the constructional details as shown in Figs. 5 and 6. Fig 5 shows the dimensions for a 2000 kc. antenna. If another operating frequency (between 1800 and 2000 kc.) is used, then the flat top sections are figured as is the current fed Hertz shown in Fig. 3.

(This second, and final, of the series completes Mr. Brennan's treatment of the phone transmitter. If any readers who wish to build this excellent transmitter have any questions regarding it, do not hesitate to write him care of the editorial office of SHORT WAVE RADIO.

The operating notes given here, while they specifically apply to this transmitter, may also be used as a guide to any other transmitter of similar design. For further details on amateur phone sets, see the article by Robert S. Kruse in the November 1933 issue.—*Tech. Dir.*)

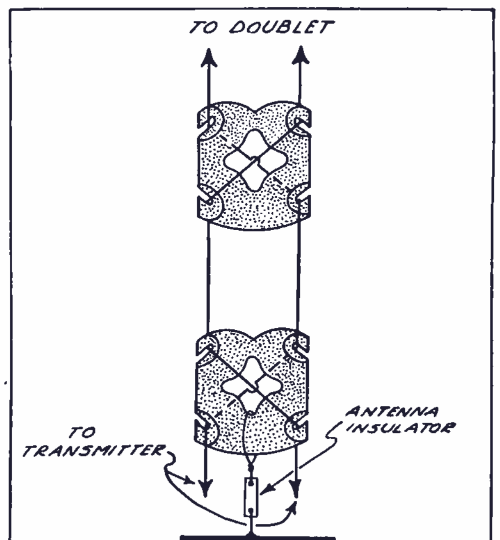


FIG. 6

How the down leads shown in Fig. 5 are fitted into the slots of the transposition insulators and how a single insulator is used at the low end of the feeder to anchor the whole assembly.

Automatic Volume Controls — — Why and How they Work

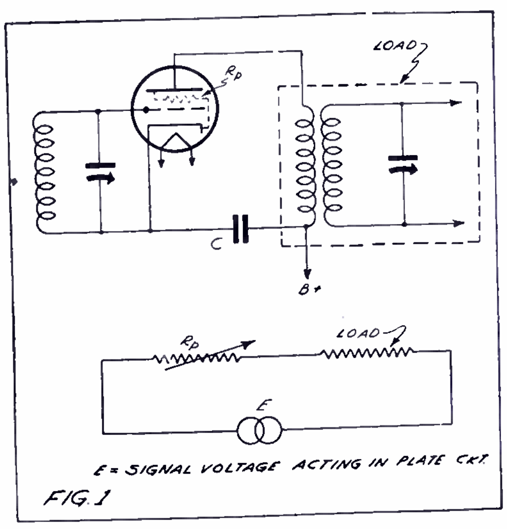
By Louis Martin

SUMMARY: *Complicated tubes and circuits are puzzling the average radio man, and we are attempting, by means of this article to fit the pieces of the puzzle into a unified whole. First, the general subject of volume controls is discussed, then their general theory of operation, and, finally, how automatic volume controls may be made to work hand in hand with manual volume controls. The article is complete and clearly written, and should answer many of the questions that come into the editorial office every day.*

THE hectic attempts to explain some new advance in an art immediately after its inception nearly always gives rise to confusion and inaccurate statements. When automatic volume control—hereafter abbreviated a.v.c.—first made its appearance, there were so many theories and explanations that the uninitiated radio man was more confused than enlightened. And when the variable-mu tube was announced, the number of misconceptions rose by leaps and bounds. One of the most prevalent of these misconceptions, which still exists to some extent today, is that the signal automatically raises or lowers the sensitivity of the receiver directly, without any regard to special circuits designed to vary the sensitivity. In other words, the mere fact that a variable-mu tube was used implied that a.v.c. was taking place. It was indeed unfortunate that the announcement of a.v.c. and variable-mu tubes should have been made at about the same time. Each caused plenty of confusion, and when the two were put together, well—

The automatic control of volume serves a very useful purpose in the regular broadcast channel; it is in the short-wave bands, however, where the real benefits of a.v.c. may be enjoyed. No a.v.c. system can compensate for large changes in frequency; but when its *strength* changes, the a.v.c. system can take it up remarkably well, as those who have listened to receivers properly controlled can attest.

It is the purpose of this article to attempt to clear up some of the mysteries that surround a.v.c. action. Furthermore, I will attempt to accomplish this purpose in as non-technical a manner as is consistent with good accuracy. A distinction should here be made: no *description* of what takes place will be given; but an attempt will be made to show *why* things are done. But enough of the preliminary ballyhoo; let's get down to brass tacks.



Fundamental circuit showing how variation of the plate resistance of a tube causes a change in volume. It is the signal voltage across the load that is applied to the succeeding tube.

Receivers are—or, rather, should be—designed with more sensitivity than is ordinarily required, just as automobiles are capable of more speed and have more reserve power than is ordinarily required. This precaution insures good, quiet reception on stations somewhat beyond the immediate vicinity of the receiver. As a consequence, nearby stations come in very loud and distant stations are comparatively weak; the loud stations are too loud for comfortable reception and the distant ones are usually too weak. To enable the operator to adjust the output at will, volume controls are placed on receivers; these controls enable the volume of a station to be adjusted within definite limits, which are different for nearly every make of receiver.

Why A.V.C.?

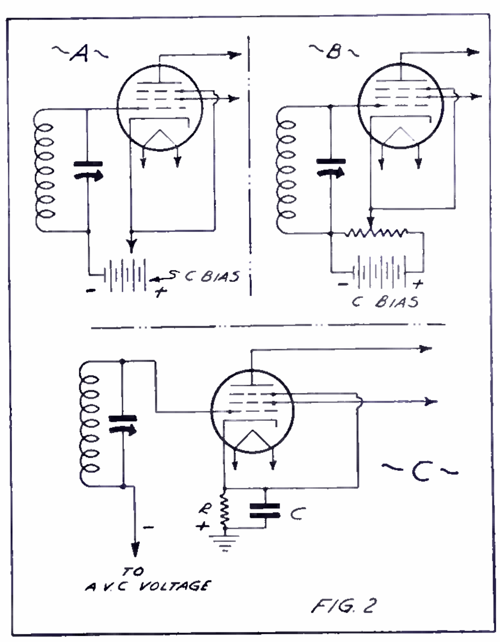
Now, once a station is tuned in and the volume adjusted for optimum loudness, everything is fine; but as soon as another station is tuned in, the volume control must again be adjusted. This continual readjustment of the volume control for different stations gave rise to a need for some device that would automatically adjust the volume to some predetermined point, so that no matter what station was tuned in, within limits, the volume would remain nearly the same.

In other words, all one had to do was to set the volume control once, and every reasonably loud station tuned in would have the same volume. Thus, we have the purpose of the automatic volume control, at least in theory. In short-wave reception it is not so much the fact that different stations come in with different degrees of volume that makes a.v.c. so desirable, but the fact that the amplitude (strength) of stations fades in and out, of their own accord. Here, then, is an urgent need for well-designed a.v.c. systems.

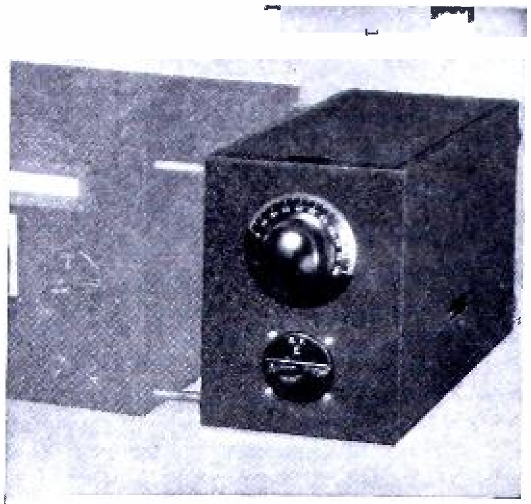
The fundamental principle upon which all a.v.c. systems work is based upon Ohm's law. Consider Fig. 1. Here is a diagram of a single stage amplifier; and underneath, the diagram of what is known as the equivalent circuit. The variable resistor Rp represents the actual a.c. resistance from plate to filament of the tube; the load represents the equivalent resistance in the plate circuit. In other words, the equivalent circuit acts, on paper, exactly as would the actual circuit, only that it is simpler to visualize. The little fictitious generator is the amplified signal acting in the plate circuit. The equivalent circuit, then, only concerns itself with what happens to the signal after it is amplified—that is, it only considers the signal in the plate circuit.

The important thing to notice is that the signal voltage in the plate circuit (equal to uEg, you technical men) is constant, *but that the actual voltage delivered* to the load, which is the really useful part of the total plate signal voltage, E, depends for its value upon the magnitude of Rp, the plate resistance of the tube. If Rp is made very large, then nearly all the voltage would appear across it, and only the small remainder would be available for amplification across the load.

This simple analysis leads to a re-



Some methods of controlling volume.



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markable conclusion: one good way of controlling volume is to vary the plate resistance of the tube, and the amount of variation in plate resistance determines the extent that the volume can be controlled.

There are three ways to vary the plate resistance of a tube: (1) by varying the plate voltage; (2) by varying the screen-grid voltage; (3) by varying the control-grid voltage.

Variation of the plate voltage to secure a variation in plate resistance is not desirable for several reasons. First, changes in plate voltage invariably alter the voltage distribution throughout the circuit, making the action of the receiver erratic. Second, there is some doubt as to whether the plate voltage can be varied sufficiently and conveniently to secure a good range of volume control. Third, the addition of impedance in a plate circuit which is not adequately filtered may cause the amplifier to oscillate violently.

Control of volume by varying the screen-grid voltage is far superior to the plate variation method. No doubt, the voltage distribution changes with changes in the setting of the volume control, but the changes in distribution are usually negligible. The plate resistance can be varied over quite a range with changes in screen voltage, although when the voltage becomes small, distortion sets in. This condition has been alleviated to some extent in some sets by having a dual volume control—one in the antenna circuit and another in the screen circuit. The result is that the screen voltage need not be varied as much to obtain the same change in volume.

Variation of the cathode voltage, as mentioned previously, also changes the plate resistance sufficiently for satisfactory control of volume. In view of the widespread use of the variable-mu type of tubes (the 58, 78, 6A7, etc.) this method is used almost to the exclusion of all others. Hence, all our attention will be concentrated on this method.

The simplest circuit used to vary the bias on a tube in order to secure a change in plate resistance is indicated in A of Fig. 2. An ordinary battery is connected between cathode and grid return, which supplies the bias. The variation in bias is secured simply by varying the tap on the battery. This method is undesirable because it does not permit fine variations in voltage to be secured. To correct this difficulty, a potentiometer may be shunted across the battery, as shown in B of Fig. 2. This method is perfectly convenient, provided that a large enough battery is on hand to secure a good change of volume from one extreme to the other.

The circuit of C is nothing but an adaptation of A. The small resistor R and the condenser C merely serve to supply the minimum bias to the tube—usually about 1.5 or 3 volts. The grid return, it will be noticed, connects to some *negative* voltage, *the positive side of which is grounded.*

This external voltage, which should vary in proportion to the signal strength, is called the a.v.c. voltage, and is labeled as such in the diagram.

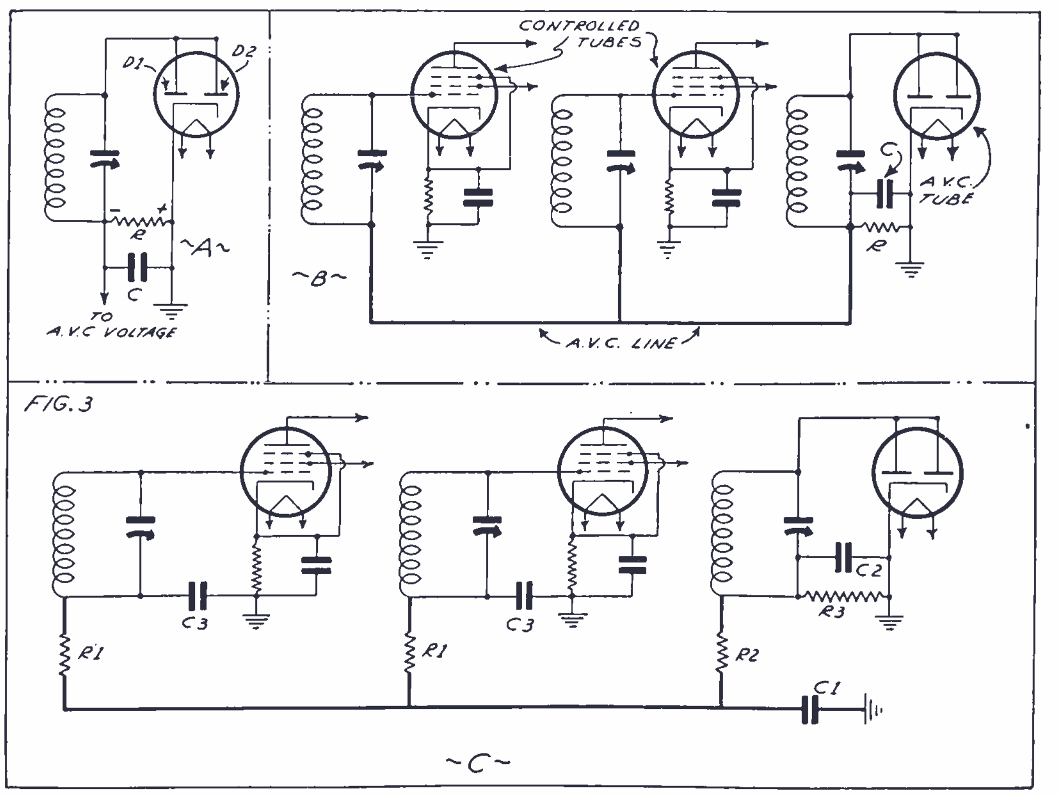
Our next problem is to obtain an a.v.c. voltage that has the following characteristics:

(1) it should be d.c.;

(2) it must vary in accordance with the signal strength—become greater as the signal strength increases;

(3) it should be of such polarity that its positive side is grounded and its negative side is free.

The first requirement can be satisfied in only one place—the detector



Circuits showing how the diode detector generates a.v.c. voltage.

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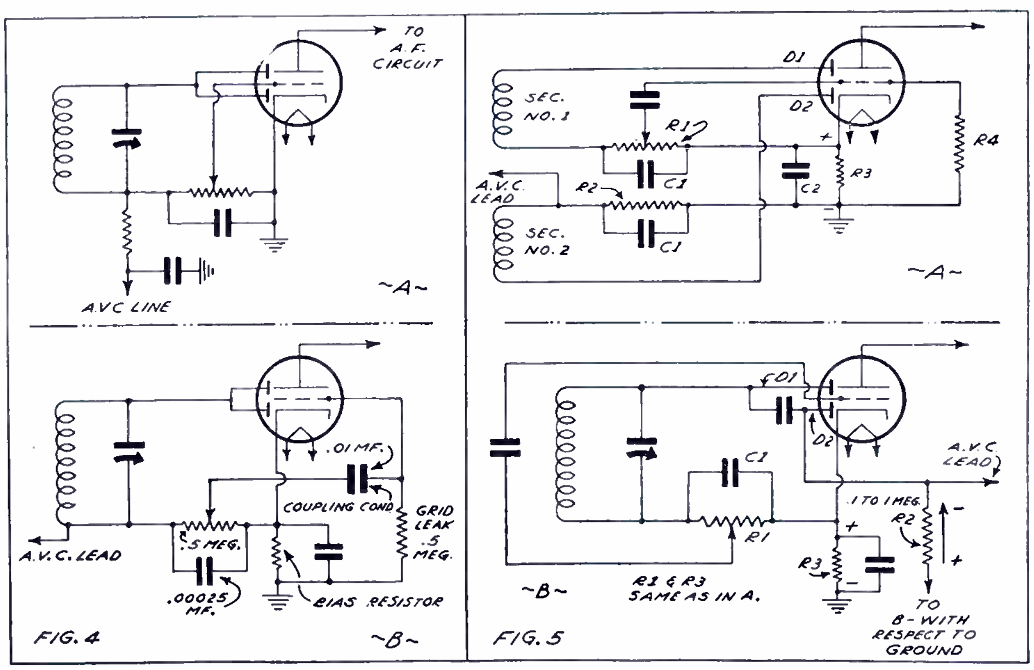
circuit. (The first detector in superheterodynes cannot be considered because the signal strength there is too low and the constant voltage from the oscillator imposes a large steady bias.)

The "audio detector," therefore, must be modified in such a manner as to supply the requisite d.c. voltage. Now, there are almost as many different types of a.v.c. systems as there are bees in a hive; but, fortunately, they have simmered down to a few, and most of the few make use of the diode type of tube, such as the 55, 75, 85, 2B7, etc. Therefore, we will concentrate all of our attention on the diode type of detection and a.v.c. systems.

The simplest form of diode detector which is capable of supplying a d.c. voltage for a.v.c. is shown in A of Fig. 3. Note that the secondary of the tuned circuit connects to the diode plates D1 and D2 through the resistance and capacitance combination R and C. Note that current only flows when the diode plates are positive, so that the direction of the current is from right to left. All our three requisites for a.v.c. voltage are satisfied: the voltage is d.c.; its value depends upon the strength of the signal; and its positive side is grounded and its negative side is "free."

The value of resistor R is about .5 megohm. Variations in the tube's resistance cause distortion, so that if R is made much larger than the tube resistance (from diodes to cathode), any variations due to different signal strengths will be negligible compared to the total circuit resistance. Condenser C is used for the purpose of bypassing the high-frequency signal so as to obtain maximum signal voltage at the tube.

As the signal strength increases, the current increases almost in direct proportion, the voltage across R increases, and the a.v.c. voltage increases. A circuit showing how this a.v.c. voltage is applied to two tubes controlled by a.v.c. is shown in B of Fig. 3 Note that when no signal is received, the grid returns of all the controlled tubes connect to one end of resistor R and condenser C, and that the cathodes are all grounded, which connects them to the positive terminal of R and C. And, since C is large enough to do considerable bypassing (at r.f.), the grid returns of the controlled tubes are effectively connected to their respective cathodes. No voltage is lost



Some additional a.v.c. circuits. Those in Fig. 5 are for delayed a.v.c.

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in this roundabout method since the grid almost never draws current.

The system shown has several disadvantages: (1) because the circuits are interconnected, oscillation is more than likely to take place; (2) the bias applied to the controlled tubes would vary at an audio-frequency rate; and (3) the a.v.c. starts to work just as soon as a signal is received. (This latter difficulty will be explained under delayed a.v.c.)

The first two difficulties may be minimized by means of the filters inserted as shown in Fig. 3C. The two resistors R1 and their associated condensers C3 are used to keep the energy of each circuit within their respective circuits. Thus, interstage coupling via a common a.v.c. lead no longer exists. The resistor R2 and condenser C1 serve to prevent the a.v.c. voltage generated across R3 from varying the bias on the controlled tubes at an audio rate. In short-wave receivers R1 may have a value of .1 megohm and C3 a value of .001 to .01 mf., *mica;* R2 may be about 1 or 2 megohms and C1 about .01 mf.

The triode portion of the detector tube, of course, has a grid which must receive a signal. One of the best connections for this grid is shown in A of Fig. 4. The resistor designated R3 in Fig. 3C is replaced by a .5 megohm potentiometer, and serves to act as a volume control. Thus, by setting the control at any point, all signals will be amplified to the same extent, the variation in sensitivity of the receiver compensating for any differences in signal strength.

How Distortion Sets In

A glance at A of Fig. 4 will show that the bias on the triode portion of the tube is not fixed, being zero with no signal, and increasing with signal strength. Thus, a signal with a carrier of 10 volts modulated 20% will produce a peak audio signal of 2 volts, while the average d.c. voltage due to the carrier will be about 6.4 volts. If the same carrier were modulated 80%, the peak audio signal would be 8 volts, while the d.c. bias due to the carrier would remain the same! Would distortion set in? And how!

The system shown in Fig. 4A is only good, therefore, when the percentage modulation of the signal is small enough so that the audio voltage does not overload the triode. For this reason, circuits are usually designed so that the triode portion receives a fixed bias, regardless of the strength of the carrier. Such circuits, one of which is shown in B of Fig. 4, are known as "fixed bias" amplifiers.

There are also variations in the diode rectifier circuit itself. Instead of half-wave rectification as shown (the two diode plates are tied together), the circuit is split so that full-wave rectification takes place. Since the secondary of the tuning coil is split, only half the total voltage is available for a.v.c. use.

A point I wish to emphasize here is that regardless of what means are available for preventing distortion in the triode (or pentode in the 2B7) portion of the tube, the method of obtaining a.v.c. remains substantially the same.

The one outstanding disadvantage of the method of obtaining a.v.c. as described is that the a.v.c. starts to act just as soon as a signal reaches the detector tube. Hence, a signal which is very weak cannot be amplified further because the a.v.c. stops it. *Some means, therefore, must be found whereby the a.v.c. does not start to act until the signal is amplified sufficiently to have comfortable volume.* Such an action is called *delayed a.v.c.,* simply because the a.v.c. action is delayed until the signal is amplified to a predetermined level.

The simplest circuit suitable for explaining delayed a.v.c. is shown in A of Fig. 5. Resistor R1 is the .5-megohm potentiometer; R2, a resistor of about the same size; R3, a bias resistor, the voltage across which is determined by the normal plate current of the triode portion of the tube in the usual manner; R4 is the triode grid leak of about .5 megohm; C1 are the usual .0001 mf. bypass condensers; and C2 is the bias-resistor bypass condenser.

Note that the detector coil is split into two sections: the first goes to one diode plate in the usual manner, and the other connects to the second diode plate in a somewhat similar manner. Also note that the triode is fixed biased and that the return of the second diode plate is made to *ground,* the *negative* end of R3. This connection places the second diode at a negative potential with respect to the cathode by an amount equal to the bias voltage across R3.

Signal Voltage Equal

Since the two secondaries have the same number of turns and are coupled to the primary to the same extent, the signal voltages induced in each half are equal. Secondary No. 1 rectifies it and applies the audio to the triode grid in the usual manner; secondary No. 2 cannot rectify the signal *until its peak value is greater than the bias* voltage R3; for, at any lower value of signal, diode plate D2 is still negative, and we all know that a tube cannot normally function while its plate is negative. In other words, the second diode plate produces no a.v.c. action until the signal strength reaches a value sufficiently positive to make it draw current.

It is important to notice that both secondaries work in exactly the same manner. The diode plate currents flow through R1 and R2 respectively; that across R1 is the audio signal applied to the control grid; that across R2 is used for a.v.c. The only difference between the two is that the signal secondary starts to work with any size signal, while No. 2 must have a signal whose peak value is greater than that fixed by the voltage across R3. In some cases R3 is made a potentiometer, with its arm going to R2. With this connection, the amount of fixed voltage which the No. 2 secondary must overcome may be made variable; such an adjustment is sometimes called a *sensitivity control.*

Tearing apart the secondary is not a thing to be desired, so a system in common use is that shown in B of Fig. 5. Here the two diode plates are connected through a small condenser of about .0001 mf. Any signal in the secondary is applied to the second diode plate through this condenser, just like in any resistance-coupled amplifier. A *negative* voltage is applied through resistor R2, which serves the same purpose as the negative voltage referred to in A.

Now, if the bias voltage across R3 were 9 volts and D2 were connected to a negative voltage with respect to ground of 6 volts, then D2 would be 15 volts negative with respect to cathode. Therefore, a signal would have to have a peak value of 15 volts before a.v.c. action started. Suppose a 20-volt signal came in. Then D2 would be 5 volts positive with respect to cathode, and a current would begin to flow from D2 to the cathode in the tube in the usual manner. The current flowing through R2 would be in the direction shown by the arrow, so the upper end of R2 would be negative with respect to the lower end. The a.v.c. lead is taken from this negative end.

The amount of voltage from the a.v.c. lead to ground would then equal that across R2 due to the signal plus the fixed voltage applied to the lower end of R2. This is the total voltage applied to the tubes under a.v.c. control. With no signal—or with a signal less than 15 volts peak—the bias applied to the controlled tubes equals only that applied to the lower end of R2—6 volts in our case. It should be made clear, however, that the voltage across R3 and that applied to R2 may be varied at will, depending upon the design of the receiver.

In the leads marked a.v.c. in Figs. 4B, 5A, and 5B the filter resistors have not been shown; they were omitted simply to make the diagram easier to read.

The Amplex K-1

(*Continued from page* 33)

antenna condenser and continue the adjustment. This process must be continued until any adjustment of the antenna condenser does not bring the receiver into oscillation. When this point has been reached, tune it for maximum signal strength. Once this condenser has been adjusted, it need not be touched unless the location or length of the aerial is changed.

Coil Data

15-30 METER BAND—secondary, 4¾ turns No. 28 enamel wire; tickler, 6 turns spaced 3/16″ from bottom of secondary.

30-60 METER BAND—secondary, 10¾ turns No. 28 enamel wire; tickler, 8 turns spaced 3/16″ from bottom of secondary.

60-100 METER BAND—secondary, 22¾ turns No. 28 enamel wire; tickler, 10 turns spaced ⅛″ from bottom of secondary.

100-200 METER BAND—secondary, 51¾ turns No. 28 enamel wire; tickler, 18 turns spaces ⅛″ from bottom of secondary.

All ticklers are closely wound with No. 28 enamel wire; all winding forms are on 1¼″ in diameter. The winding length of the secondary of the 15-30 meter band coil is 9/16″; that on the 30-60 meter band coils, ⅞″; that on the 60-100 meter band coil, 1½″; and that on the 100-200 meter band coil, 1⅜″. Also note that the top end of the secondaries connect to the grid of the tube and that the top end of the tickler goes to B+. Both windings are in the same direction.

The K-1 uses only a single tube, of the 30 series. This works on 2 volts and draws only 60 milliamperes, and therefore can be operated economically on a pair of ordinary No. 4 or No. 6 dry cells. A single small 45-volt B battery is needed and will last months. The final accessory is a pair of earphones. The aerial may be a signal wire between 50 and 150 feet long, in the clear.

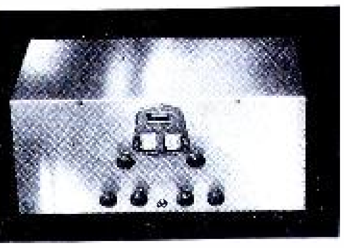
This little set makes an ideal gift for boys interested in the short waves—and also for their fathers. It serves as an admirable introductory receiver for people who want to see what the short waves are all about. If carefully tuned, it will bring in hundreds of police, amateur, airplane, commercial phone and relay broadcasting stations and will provide many hours of amusement. It's volume can easily be increased at a later date by the addition of a simple audio amplifier.

Byrd Base Station

(*Continued from page* 6)

into Little America directly. The breaking up of the ice front near the *Jacob Ruppert's* berth forced the ship to move and it was Monday before the equipment could be landed."

SHORT WAVE RADIO has published considerable information on the radio aspects of the Byrd Antarctic Expedition. New readers are referred to page 4 of the January, 1934 issue, page 12 of February, 1934, and page 15 of March, 1934.


McMurdo Silver
MASTERPIECE II
10-570 METERS

proclaimed greatest all-wave receiver by engineering universities, broadcast executives and explorers.

Admiral Byrd is using Masterpiece II in the Antarctic . . . the Engineer of a Great Eastern University writes, "Masterpiece II is my ideal come true" . . . Broadcast Executives prefer Masterpiece II for their own use, because of its lower noise level and consequent better reception of far distant stations. Many unique features such as band spread tuning, built in beat note oscillator. Write for complete details and particulars of 10-day trial, money-back guarantee offer.

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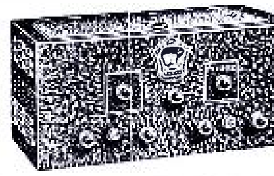
Circle the Globe

You can now circle the Globe with the same set as used by Captain H. L. Hall. The POSTAL INTERNATIONAL is a 9 tube genuine superheterodyne. Custom built for the better Short Wave Fan and Amateur. In the first three weeks, Capt. Hall logged stations in every continent on his Postal International.

TUNED RF PRE-SELECTOR

The POSTAL employs a genuine Tuned RF Preselector—the new triple Drawer coils including band spread—electron coupled oscillator—audio beat oscillator and many other features too numerous to mention.

Sold directly to the Short Wave Fan and Amateur with a money back guarantee. You will be amazed at our special low price for a custom built receiver.

Send a 3c stamp immediately for our complete illustrated booklet and free circuit diagram.

POSTAL RADIO
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NRA

SERVICE MEN!
Increase Your Earnings
Up to $30-$50 Weekly
Our Proven, Tested Plan Tells How. Write for Complete Details TODAY!
INSULINE CORP. OF AMERICA,
23-25 Park Place, Dept. S-41, New York, N.Y.


I'm the Pretzel Bender
... I'll see you on
PAGE 41

HEY!

MUST WE LISTEN TO THAT SHAM-BATTLE?

"Whaddayn mean 'sham-battle'? That's one of London's best orchestras."

Ed retorted, with snap! "Sounds like a boiler factory to me. Where'd you get the noise-maker, anyway—five and dime?"

"Go 'way, dope, that 11 tube all-wave radio set cost a couple o' centuries and it's guaranteed to bring in all the 'foreigners' the way you get locals on your outfit."

Followed a Bronx cheer. "It'll be thrown out, pronto, if you don't choke it off. It's lousy, now, but it could be made to work."

"Okay, wise guy, I'll ask the question—How can it be fixed up?"

"The gink who stuck you with it probably didn't tell you, but no radio, even if you pay a grand for it, is better than the aerial you hook it to. Even yours would be oke if you gave it a chance . . . now, do we play cards or what—?"

"No Radio Can Be Better than its Aerial"

Lynch All-Wave Antenna System Complete Kit (with instructions). $6.50 List

At Radio and Department Stores; or by mail, C.O.D., or postpaid upon receipt of price. Write TODAY for amazing FREE Booklet that explains how you can cut out radio noises.

LYNCH MANUFACTURING CO., Inc.
51 VESEY STREET NEW YORK, N. Y.
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All models guaranteed: long and short wave; all-wave supers; AC-DC; battery; 6 and 32 volt; all-electric car radio, etc. Month's trial FREE. *See remarkable values in new catalog.* Write today. Prices . . . . $9.45 UP

Any Set 30-Day Trial

FORDSON RADIO MFG. CO.
Dept. 4, 1184 Oakman Blvd., Detroit, Mich.

Foreign Long-Wave Stations

MANY short-wave listeners are expressing a surprising amount of interest in European long-wave broadcasting stations. The fact that a number of American all-wave receivers now on the market will tune as low as 9 meters and as high as 2000 meters is evidently the cause of this interest.

As a matter of information, we are listing herewith the European stations that transmit above 550 meters. The frequency in kilocycles, the wavelength in meters and the power in kilowatts are given.

The possibilities of picking up European long-wave stations are rather remote, although radio is always full of surprises and the most unexpected things happen. Of course, it is definitely known that signals between 500 and 2000 meters are pretty badly attenuated during daylight, and are capable of long jumps only during darkness. The time difference between Europe and the United States gums up the situation as far as American listeners are concerned. When it is only 6:00 o'clock in the evening along the Atlantic coast, for instance, it is 11:00 p.m. in Europe and most of the regular broadcasting stations have already closed down for the night. If listening on the long waves is attempted early in the afternoon, the path of transmission between Europe and the United States is partly dark and partly daylight, a combination not particularly conducive to good reception on the long waves. However, we must again remark, "You can never tell." We would like very much to hear from all-wave set owners who are able to explore the regions between 500 and 2000 meters.

kc.	*m.*	*kw.*	
160	1875	1	Brasov (Romania)
167	1796	75	Radio-Paris (France)
			Syria (Syria)
175	1714	500	Moscow I (U.S.S.R.)
183	1639	7	Ankara (Turkey)
		7	Kaunas (Lithuania)
			Madrid I (Spain)
		16	Reykjavik (Iceland)
191	1571	60	Königs Wusterhausen (Germany)
200	1500	30	Daventry National Gt. Britain
208	1442	100	Minsk (U.S.S.R.)
216	1389	30	Motala (Sweden)
223	1345	7	Huizen (Holland)
		20	Kharkov (U.S.S.R.)
230	1304	120	Warsaw (Poland)
238	1261	75	Kalundborg (Denmark)
			Portugal (North) (Portugal)
245	1224	100	Leningrad (U.S.S.R.)
253	1186	60	Oslo (Norway)
262	1145	40	Lahti (Finland)
271	1107	100	Moscow II (U.S.S.R.)
355	845	1	Finmark (Norway)
		20	Rostov-on-Don (U.S.S.R.)
364	824	10	Smolensk (U.S.S.R.)
392	765	0.6	Ostersund (Sweden)
			Slovakia (Czechoslovakia)
401	748	1.3	Geneva (Switzerland)
		100	Moscow III (U.S.S.R.)
413.5	726	0.6	Boden (Sweden)
		10	Voroneje (U.S.S.R.)
431	696	2	Oulu (Uleaborg) (Finland)
519	578.0	0.7	Hamar (Norway)
			Innsbruck (Austria)
527	569.3	5	Ljubljana (Yugoslavia)
		1.2	Tampere (Finland)
		0.5	Finnish Common Wave (Finland)
536	559.7	1	Bolzano (Italy)
		16	Wilno (Poland)

VK2ME

on the speaker! writes Donald O'Sullivan of Rutherford, N. J. John F. Coleman, 158 W. 81 St., New York City, phones our office and lets us listen to GSB coming in on his set. M. Hausner in Indianapolis writes: "I wired up your excellent kit and had it working in no time. In less than a week I have 'pulled-in' 112 stations, 43 of which are distant foreign stations! All were received with remarkable volume and clarity!"

These are only a few of the hundreds of unsolicited letters from delighted purchasers we constantly receive. RESULTS COUNT! that's one of the reasons why we've been actually swamped with orders for our sensational

DOERLE 12,500 MILE TWO TUBE RECEIVER!

Results that make the novice tingle with delight and which thrill even the hard-boiled "old-timer"! Results that make the editors of leading magazines and newspapers write articles glowing with praise!

The other reason is VALUE!

Don't let the low price fool you! It does not mean that we have sacrificed quality! On the contrary, these kits are composed of the finest materials available—HAMMARLUND Condensers—Polymet—SAMSON Audio Unit—CRL—Allen-Bradley—etc. The four coils (15 to 200 meters) are wound on polished Bakelite forms. The heavy crystal finished metal chassis has all holes drilled and this, together with the clear, plain instruction sheets and diagrams makes construction a simple matter, even for the most inexperienced!

HAMMARLUND COMET
"PRO" Standard Chassis $79.38
Cabinet $8.82. RCA Tubes $7.17
A.V.C. Model add $17.64
Special Offer! Free Delivery in U. S. A.

DRY CELL OR AC MODEL COMPLETE KIT $4.75
THE IDEAL BEGINNER'S SET

HARRISON RADIO CO.
142 LIBERTY ST. Dept. D-4, N. Y. C.

Around the World

(Continued from page 7)

The trip is scheduled to last a year and a half. When the schooner leaves Miami, it will skirt the east coast of South America to Buenos Aires and from there cross the South Atlantic to Capetown, South Africa. It will proceed up the west coast of Africa and across to Ceylon, then to Rangoon, India, to Mandalay, to Singapore, Straits Settlement, and then to Indo-China. A big-game hunt in Indo-China, to the inevitable accompaniment of clicking movie cameras, is on the program.

The next stop will be the Dutch East Indies, then Java and some of the mysterious little islands of Oceania. Then Borneo, the northern coast of Australia, south to the Islands of New Zealand, the Solomon Islands, the South Sea Islands group to the Galapagos, through the Panama Canal and up the Atlantic coast to New York. Short-wave set owners who expect to follow the schooner had better equip themselves with a globe and an atlas!

The *Seth Parker* is plentifully stocked with provisions, including the following: eight tons of baked beans, 17 miles of fishing line and 36,000 fish hooks (one guess as to what the main dish of the menu will be!), 51 tons of canned goods and 9 tons of apple sauce, 3,000 jack-knives and 2 tons of novelty jewelry (probably for distribution among camera-shy natives), 75 firearms and 88,000 rounds of ammunition, diving equipment, enough pharmaceuticals to fill a regular drug-store, two Diesel engines for generating power, electrical refrigerators, and, last but not least, an air-conditioning outfit to keep the skipper's cabin cool in the tropics.—*R. H.*

TYPE 48 Tube

(Continued from page 23)

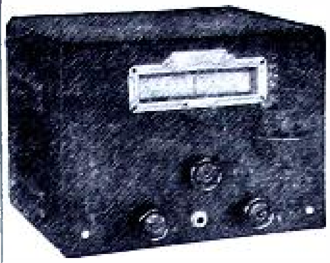
the other depend on requirements for power output and distortion. To illustrate this, values for each method of operation using two 48's in a push-pull Class A amplifier follow:

Operated As	Plate Volts	Control Grid Volts
Triodes	125	-32.5
Tetrodes ...	125	-20.0

Power Output Watts	Maximum Distortion Per Cent
3	3
5	9

When it is desired to use the maximum available line-supply voltage on the plate of the 48, grid-bias voltage may be supplied by means of a "C-bias" battery. A battery for this purpose need be replaced only at very infrequent intervals. Its use makes available considerably larger audio output. When the use of a bias battery is not feasible, a self-bias or fixed-bias method may be utilized. *RCA-Radiotron Co.*

SHORT WAVE SETS The Best Values.. Dollar for Dollar.. on the Market



ALAN ACE

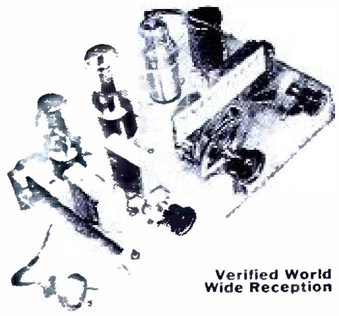
110v. A.C.-D.C. S.W. (15 to 200 Meters)

3 Tubes—6F7—43—25Z5

Absolutely quiet Built-in Power Supply

Front panel plug-in coils; speaker outlet and field supply; phone jack on front panel; completely shielded in black crackle, hinged cover metal cabinet.

Complete, incl. 4 coils (15-200 m.), less tubes....... $16.95
Set Arcturus tubes....... 3.95
Kit with blueprints......... 13.95
Broadcast coil............... 1.49



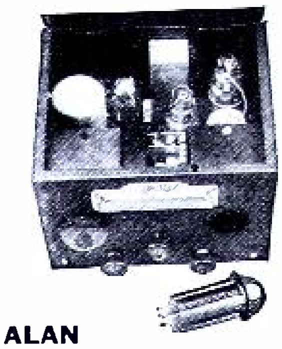
Verified World Wide Reception

ALAN PRIZE WINNER

A.C.-D.C. S.W. (15 to 200 Meters)

Completely self powered latest type 77-43 and 25Z5 tubes. Provision for head phones and speaker.

Complete, less tubes, in rich crackle-finish cabinet. Assembled, wired, tested, ready to plug in............... $12.95
Kit of RCA or Arcturus tubes to match............... 3.75
Complete kit of parts, including 4 coils............ 10.55
Broadcast coil for covering 200 to 500 meters.......... .90
220 V. A.C. or D.C. Adaptor 1.75



ALAN INTERNATIONAL T.R.F.

110v. A.C.-D.C. S.W. (15-200 Meters)

4 tubes: 2-78's, 1-43 and 1-25Z5. Built-in power supply: additional plug-in coil. Other specifications same as Alan Ace. Complete including:

4 coils, 15-200 m.......... $24.95
Set Arcturus tubes........ 4.95
Complete kit with blueprints 21.25
Pair broadcast coils...... 2.75

New! THE BYRD ★ 2-Tube Kit, complete parts, nothing to buy. 34 Detector, 33 Pentode Output. Micro-Vernier dial, black crackled finish, hinged top cabinet. Set 4 coils, 15-200 m. Complete specifications, blueprints, hardware, wire.......... $5.75
Set of matched and guaranteed tubes.......... $1.95

ACE and INTERNATIONAL also available for straight A. C. 110 and 200 D. C. 2 and 6 V. battery operation.
WRITE TODAY FOR FULL PARTICULARS

ALAN RADIO CORP. *Specialists in Short Wave Receivers*
83 CORTLANDT ST., Dept. 3S.W.R., NEW YORK CITY

The Strange Test of a 6A7

THE 6A7 is probably one of the most versatile tubes available and for this reason is receiving widespread use. Some time ago, we made a continuity test between the various elements and cathode of a 6A7 with the tube cold. It tested okay. The same test was conducted with the tube warm—with the heater connected to a source of A supply—and a reading was obtained. It was thought that this tube was defective, so a similar test was made on another 6A7. The result was the same.

It was finally concluded that the small voltage in the tester was applied to the elements with the plus side to the grid, so that we had a beautiful diode tube and were merely measuring the d.c. resistance.

The moral is test the 6A7 with the cathode cold, without any voltages applied other than that contained in the continuity tester.

I'm the Pretzel Bender ... I'll see you on **PAGE 41**

the

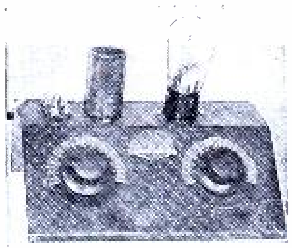
"M. J."

a revelation in ALL-WAVE reception will be announced SHORTLY

Write for preliminary technical details and price of this FINE 13-tube receiver.

PIONEER SOUND LABORATORIES
137 Liberty St.
New York, N. Y.

Learn the Thrill of the SHORT WAVES with an AMPLEX K-1



Verified World-Wide Reception $4.95

Mr. Kramer, N. Y., reports European Stations daily. L. Gigante, Brooklyn, logged 53 stations first day. It's powerful. Gets 'em all—police calls, amateur calls, foreign stations, code and transatlantic phone conversations. BUILD IT yourself. It's easy. Special circuit arrangement uses only 6 wires. Metal Chassis already drilled. All quality parts. Uses inexpensive batteries.

Complete Kit with ALL 4 coils (15-200 meters) less tube and batteries **$4.95**

Wired, tested and ready to use, $5.95

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Consider RCA Institutes . . . 24 years old . . . an institution recognized as an important factor in the radio industry.

The beginner who seeks instruction in any branch of radio will find courses designed for him . . . either at the Resident Schools in New York and Chicago or the RCA Institutes Home Study courses.

Resident Schools are fully equipped—conveniently located—low weekly tuition rates.

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Extension courses for home study on convenient "no obligation" plan. Examination and technical advisory services. Free post-graduate practical training at resident school with modern equipment under instructing engineers.

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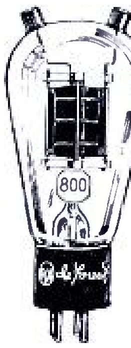
The NEW 800 Tubes



Use the RCA 800 for improved results

As A-F Amplifier and Modulator—Class "B"; as R-F Amplifier — Class "B" (Telephony); as Plate-Modulated R.F. Amplifier —Class "C" (Telephony); as R-F Amplifier and Oscillator—Class "C" (Telegraphy). RCA-800: Filament, 7.5 v., 3.25 amps. Max. Plate Voltage, 1250.

Price each, net, ... $10

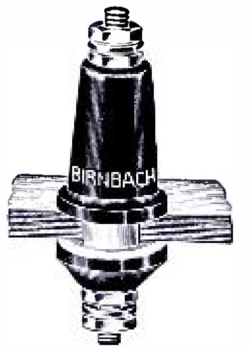
We carry the full line of RCA-de Forest Transmitting Tubes

H. JAPPE COMPANY

46 CORNHILL BOSTON, MASS.

Handy Insulators

THE simultaneous advent of metal chassis, high voltage tubes, and power packs has been responsible for an insulation problem not experienced with previous types of radio set construction. Running ordinary insulated wire through slightly jagged holes in aluminum or steel is not very safe practice, and set builders have been forced to resort to undependable friction tape to forestall short circuits.



A complete remedy for this trouble has made its appearance in the form of a series of cleverly designed little porcelain feed-through stand-off insulators. These are made in both white and brown finish in a variety of sizes, the smallest being a cute little feller only 7/8 inch long overall; this is suitable for receivers, power packs, public address amplifiers and small transmitters. A jack-type stand-off, intended especially for plug-in inductors, is also available.

All these insulators require only a single round mounting hole, as shown in the accompanying illustration, and they center and adjust themselves automatically. The only things needed to make them really perfect are some fibre washers of the correct size to fit the central bushings and to take up the tightening strain. Otherwise the porcelain cracks just when you think you have tightened the nuts enough. The manufacturer of these new items is the Birnbach Radio Co., Inc., of New York.

European short-wave listeners are reporting stations not generally heard in the United States. Among these are RW72, or RV72, Moscow, U. S. S. R., on 45.38 meters; LCL, Jelöy, Norway on 42.9 meters; and EAR, Madrid, Spain on 43 meters.

SHORT WAVE EXCHANGE

Have you some apparatus to sell or swap, or some special service to offer to other short-wave fans? Take advantage of the low rates of this department to reach other "hams". Only 5 cents per word for amateurs, 8 cents per word for manufacturers or dealers. Name, initial and address each count as one word. Not less than 10 words accepted. Cash, money order or U. S. postage stamps must accompany all advertisements. Please write clearly.

5 COILS, DOLLAR. Andraud, 42 Morton Street, New York, N. Y.

THE ANSWER FACTORY has unsnarled many puzzles of amateur and commercial operators. Prompt quotations, reasonable prices. Robert S. Kruse, RFD No. 2, Guilford, Connecticut.

FOR SALE: 30-henry, 100 ma. AmerTran filter choke, type 854, $1.50 plus mailing. AmerTran deluxe second stage audio transformer, $1.50. National type VKCC full vision dial, never used, $1.50. Baldwin loud speaker unit only, no horn, new condition, ideal for small short-wave receiver, $1.00. Jewell 0-15 volt. A.C. voltmeter, small type, flush mounting, brand new, $1.50. Weston type 267 milliammeter, 0-100 mils. Completely encased, panel mounting. Highly accurate needle indicator, with mirror reflector, a bargain at $3.50. A. A. Dolid, 5101—39th Avenue, Long Island City, N. Y.

CONDENSERS: Cardwell-Variable-types; 3 model 164 B, each $2.50; 2 model 503, each $3.25; 1 type 512 B with mycalex supports for 5 meter at $6.50; 2 type 123 B, each $2.25; 2 type 412 B, mycalex supports for 5 meter, each $2.50; 3 type 402 B, $1.15; 3 type 408 B, $1.40. R. H. Odwak, 250 E. 7th Street, Brooklyn, N. Y.

FOR SALE: the original model of the 5-meter receiver described on page 38, November, 1933, issue of Short Wave Radio. Perfect condition. Completely wired, ready for operation. Less tubes and batteries, a bargain at $5.00, postpaid. W2BJU, 989 Tinton Avenue, Bronx, N. Y.

FOR SALE: Phono pick-up to tube matching transformer, $1.00. Assortment of 4, 5, 6, 7 prong wafer type sockets, about a gross altogether, $3.00 for the lot. Special Yaxley 4 section shorting type short-wave switch, $1.00. One set Lynch antenna impedance matching transformers, $.75. Taurex meter rectifier, $1.00. Two-gang Hammarlund tuning condenser, 140 mmf. $1.00. Flechtheim 4 mf., 1000 volt filter condenser, $1.00. Uncased Amertran power transformer 2.5 and 5 volt filament secondaries, 640 volt center-tapped high voltage secondary. Ideal for receiver or small transmitter. Postage extra on all items. Albert Goldring, 121 Howard Avenue, Brooklyn, N. Y.

SUPER-REGENERATOR parts for receiver described in this issue. Three-winding oscillator coil, $1.75. U.H.F. choke, 30 cents. 5, 10 and 20 meter coils, 75 cents each. J. A. Worcester, Jr., 159 South Street, Middletown, N. Y.

ATTENTION: Photo and target shooting fans! Have a collection of target rifles and pistols, used but in perfect condition, including Winchester model 52 with 5A scope, Colt .22 Woodsman, and Colt Officers Model 22/32 revolver, adjustable sights. For sale or exchange for good model D. Graflex, 3¼ x 4¼", 6" lens, film magazine, or telephoto lens for Leica. Box 125, c/o Short Wave Radio, 1123 Bway, N. Y.

ALL-WAVE AIR SCOUT

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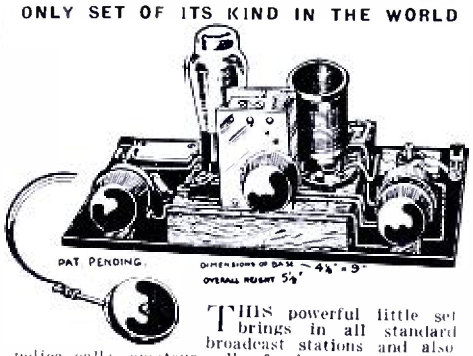

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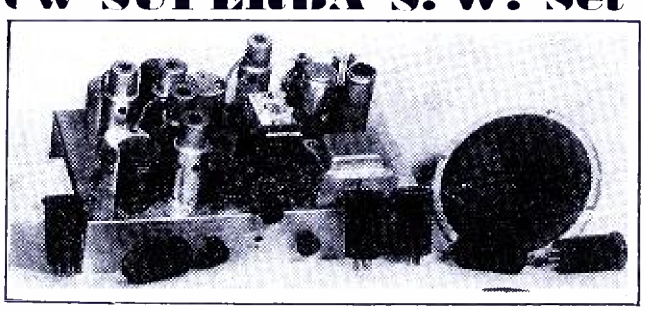

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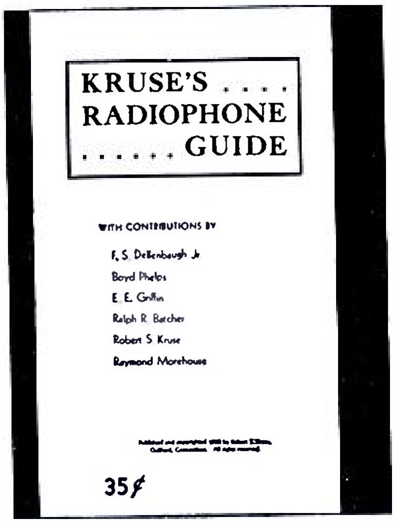

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THE RADIO AMATEUR'S HANDBOOK, 11th edition, by the Headquarter Staff of the American Radio Relay League, West Hartford Conn., 6½ by 9½ inches, 248 pages, heavy paper covers, numerous diagrams and photographs. Price $1.00.

The A. R. R. L. Handbook is universally regarded as the standard reference manual of amateur high-frequency radio communication. There is nothing like it in print any place. This book is absolutely indispensable to the amateur who wants to keep up with the rather dizzy pace of high-frequency developments.

The new 11th edition, which has a blue cover, contains the latest "dope" on single signal receivers and ultra-high and medium-frequency telegraph and telephone transmitters. Particular consideration is given to the use of many of the new tubes that flooded the radio market during 1933.

We heartily recommend the A. R. R. L. Handbook to advanced short-wave broadcast listeners who have any intention at all of getting into the "ham" game.

WHO'S WHO IN AMATEUR RADIO, published by Radio Amateur Publishers, 1107 Broadway, New York, N. Y., 6½ by 9½ inches, 160 pages, paper covers. Price, $1.00.

The first edition of *Who's Who in Amateur Radio* will prove interesting to active transmitting amateurs who may want to know something about the equipment and personal history of operators they contact over the air. About 3000 amateurs are listed. Photographs of some of them are included in the write-ups, which are brief, but to the point.

The back of the book contains a list of the outstanding radio clubs of the United States, the United States radio inspection districts by states and counties, the International abbreviations and a condensed schedule of press, weather, and time transmissions by commercial stations.

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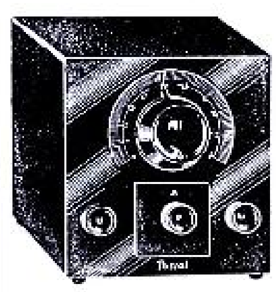

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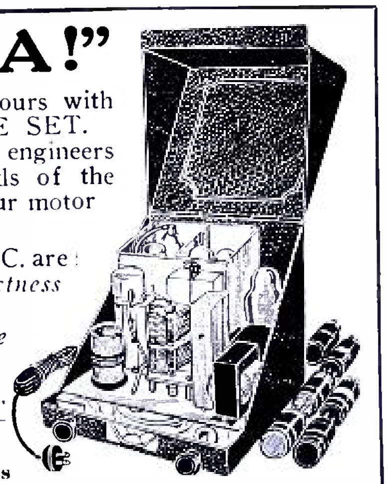

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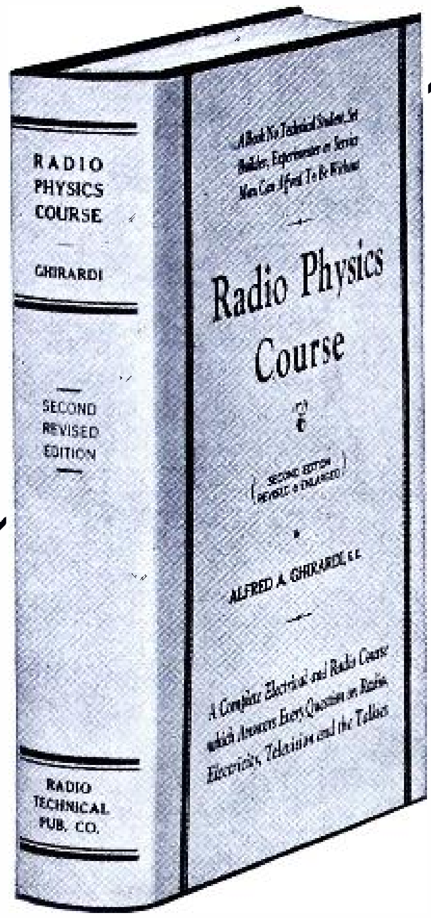

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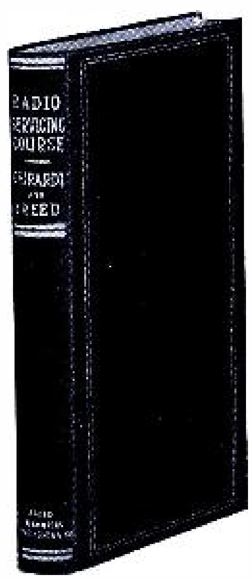

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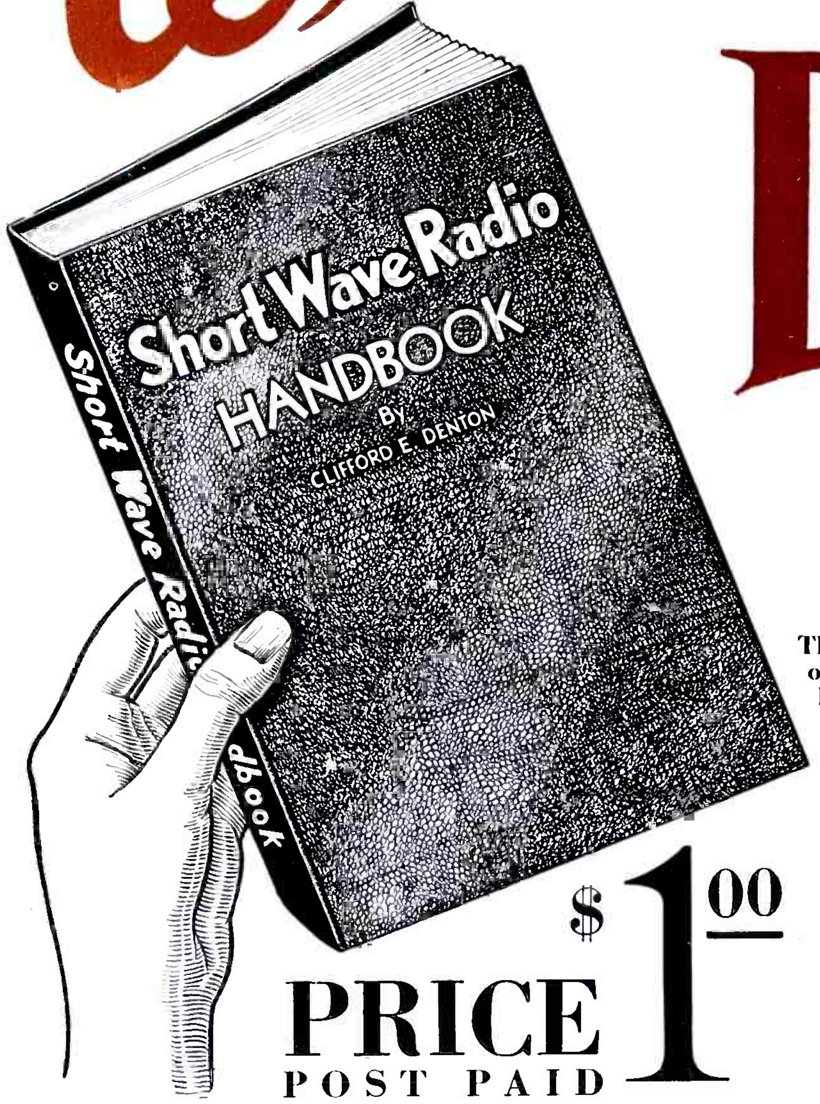

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