Edited by Robert Hertzberg and Louis Martin

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BARKHAUSEN AND KURZ OSCILLATIONS—The accidental discovery by two German scientists of the phenomenon of internal electron oscillation in vacuum tubes has led directly to the development of practicable ultra-high-frequency oscillators. The effect is simple, but not generally understood. Andrew Alford has written an excellent article telling all about it.

A VISIT TO RADIO CENTRAL—Have you ever wondered how the National Broadcasting Company works its spectacular short-wave rebroadcasts? To find out, the editors made a special trip to Riverhead, L. I., where “Radio Central” is located. The amazing receiving equipment that they saw will be described at length.

THE G. E.’K-80 RECEIVER—One of the most interesting set developments of the current season is the G. E. Model K-80, which contains many unusual circuit features. Robert S. Kruse, who needs no introduction, analyzes this receiver in an article of outstanding merit.

COMMERCIAL SET REVIEW—We receive so many inquiries about factory-built receivers that we have decided to initiate a new monthly department in which representative receivers will be described truthfully and completely from the standpoint of the prospective purchaser. We expect that this series of articles will settle many questions in the minds of our readers.

CHARLES H. FARRELL, Advertising Manager

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TELEVISION—When and How

By The Editors

TELEVISION, the ballyhoo of the radio industry, again seems to be arousing general public interest. With the opening of the new and elaborate Radio City studies of the National Broadcasting Company in New York and the cautiously worded announcement that television has been made in them for television programs, people are again asking the question, "When will television come around the corner?"

Its arrival has been delayed by much extravagant and unfortunate publicity, which has been the work of professional stock promoters rather than of competent engineers. About three years ago, the public was heavily oversold on the whole television idea, but since no provisions had been made for nation-wide broadcasting and no adequate receivers were available, the whole thing died a quick and not particularly mournful death. Radio people with the interests of both the public and their own industry at heart denied the ballyhoo because they knew that no tangible sales—except stock sales—could materialize from it.

The general public impression at the time was that the television receiver would be an accessory to the regular broadcasting receiver, something like the loudspeakers used to be in the early days of broadcasting. This possibility was definitely eliminated when the Federal Radio Commission took experimental television out of the broadcast band and placed it in frequency channels above 1500 kc.

No matter what happens in the television field, one thing is certain: the television receiver of the next year or two, if it materializes that soon, will be distinctly separate from the sound receiver. There will be no problem of synchronization, as there was with talking movies, as the sound and sight programs are transmitted simultaneously and both are represented over the air by instantaneous radio signals of exactly the same speed. Indeed, it would be quite a trick—well nigh an impossible one—to throw the sight and sound sections of the same program out of synchronization!

In order to avoid premature publicity that will do more harm than good, several of the largest firms in the industry have been guarding their television experiments with a secrecy not practiced since the days of the World War. In fact, although it is definitely known that research is going on at a furious pace, not a single satisfactory report of the work has reached the public prints. Extremely private and closely guarded demonstrations for the benefit of patent licensees have been held from time to time, but all the people who attended these must have been warned very strongly about keeping quiet, for not a word could ever be obtained out of them.

Why All the Secrecy?

"Why all the secrecy?" you may ask. Well, it is a long story, friends. The main answer is that the leaders of the radio industry are determined NOT to have television repeat the frenzied history of broadcasting. Broadcasting, like Topsy, "just grew." It started altogether accidentally, without any deliberate effort on anyone's part. The nucleus for the present world-wide audience of radio listeners was a group of several thousand pioneer "wireless" amateurs who built their own receivers and saw nothing particularly significant or startling in the voice and music transmissions of the early amateur and experimental radio stations. The Westinghouse Company through W8XK (KDKA), broadcast the Harding election returns in 1920 and the families and friends of these amateurs suddenly discovered that it was all very interesting. The boom was on, and the people who were least prepared to capitalize on it were the very people already in the radio business. Broadcasting stations by the hundred sprang up overnight, and every shop containing a vise and a drill press became a radio factory. Fortunes were made and lost in quick succession. The thin authority exercised over broadcasting by the Department of Commerce was proved to be illegal and confusion reigned supreme. Only in 1927, six years after the start of the boom, did Congress pass controlling legislation, and even at that the early Federal Radio Commissioners, selected more for their political affiliations than their technical accomplishments, did not cover themselves with any particular glory.

Today broadcasting is a very highly organized industry, representing an investment of millions of dollars and employing thousands of men and women. The Radio City studios of NBC alone take in broadcasting, in their size, equipment and cost, are tangible evidence of the maturity of the business.

Now, no one wants uncontrolled television development to upset the applecart of broadcasting prosperity, which was one of the anomalies of the economic depression. The big moguls of radio have no intention of releasing television to the public until they have something that can be merchandised, just as they now successfully merchandise regular radio receivers through thousands of wholesale and retail channels throughout the country. If television is to be sprung on the public, it probably will be sprung all at once, at such time as television receivers can be produced in quantities and shipped, handled, installed, and operated just like any other piece of household radio equipment. The television receivers shown to date require the services of half a dozen engineers, cost more than a dozen radio sets, and are laboratory instruments rather than devices for home entertainment. The radio industry does not want experimental equipment—it wants outfits that require no more manipulation than a sound.
receiver. Perhaps the images produced by the first commercially available receivers will not be perfect, but simplicity of control will certainly be an important sales feature.

The radio production people, who plan and stage commercial programs, are keeping a wary eye on developments, for the advent of television will certainly involve a change in their technique. The subject has already been given consideration in several books, and some enterprising broadcasters have even thought up the idea of televising sponsors’ trade marks and replicas of their products.

Some Predictions

Our belief is that the change in technique will not be as startling as some people think; there being a number of important psychological factors to consider. For instance, a listener can turn on a radio receiver in his home and listen to one program after another, at the same time carrying on normal conversation, dancing, walking, reading, scrubbing floors or washing dishes. Casual attention of this kind to television programs is impossible, as the listener, or rather “looker,” must sit in front of the televiser and concentrate on the screen just as he does at any picture show. If a program depends too strongly on visual appeal, it will suffer considerably. People sitting in the comfort of their own homes are not likely to exercise so much concentration and they will certainly be bored much more readily with a dull television program than with a dull sound program. It is difficult enough to keep some people quiet in a picture theatre!

Bell Telephone’s Work

All the foregoing remarks apply generally to radio television. They do not take into consideration the fact that the Bell Telephone Laboratories have spent a sum of money that runs into millions of dollars on television experiments from the wire transmission standpoint. As a matter of fact, the television demonstrations staged by the Bell Telephone Laboratories from time to time were generally regarded as the most successful of all television efforts.

In October, 1930 the Bell Telephone engineers demonstrated a remarkable two-way television system between 195 Broadway and 463 West Street, New York, N. Y., a distance of a few miles. A person stepped into a small booth quite like an ordinary telephone booth and carried on a conversation with a person at the other end of the line, at the same time seeing his image clearly on a small screen directly in front of him. Likewise, the person at the other end was able to see the first person’s image. The system was positively magical!

Of course, what the Bell Telephone Laboratories and the American Telephone and Telegraph Company undoubtedly are striving for is commercial two-way television as an auxiliary to its regular telephone service, which is universally regarded as the best in the world. Eventually, it may be possible for telephone subscribers to see each other as well as to talk to each other, paying for this privilege just as they now pay for long-distance calls and other special telephone services. Just when this service will be available is just as much a matter of conjecture as the advent of radio television.

What makes this particularly interesting from the short-wave standpoint is that television can be transmitted only on the short waves. From all appearances, the extremely short waves, below 10 meters, will be used, but many problems still remain unsolved.

Technical Considerations

Consider the simple case of a stationary picture consisting of alternate black and white lines on which the scanning beam passes from jet-black lines to white lines, successively. Such an object will require the greatest possible frequency band. If the picture is square, then the total number of elements in the system will be 60 x 60 x 16, or 57,600 elements. This corresponds to a frequency of 28.8 kc.

It is quite clear from this simple calculation that if a still picture is to be transmitted, the band width required for each station is 57.6 kc. Unfortunately, however, very few people will be satisfied with looking at still pictures, and no one believes that, except for experimental work, "still" will be used.

The modern television transmitter produces moving pictures of exactly the same type as ordinarily seen on the screen, and it is with the problems connected with this form of transmission that television engineers must cope.

Consider the frequency band required by motion pictures being transmitted by television with sound accompaniment. The size of a single "frame" on a reel of motion picture film is such as to have a ratio of about 4 to 3, that is it is 33 per cent wider than it is high. Even if a 60-line scanning system were used, the band width required would be 128 kc. Now, a 60-line scanning system gives good picture detail, but in all probability, at least 120 lines will be required for public acceptance. The same picture scanned 120 times requires a picture communication band 512 kc. wide.
television receiver. This tube is the cathode-ray tube, which requires automatic synchronization between the transmitter and the receiver. As stated previously, motion pictures will undoubtedly be transmitted by television stations. In the transmitter itself the scanning system must cover the picture completely for every frame transmitted. Since ordinary motion picture film now in use requires the passage of 24 frames per second for a good image, it is quite clear that the beam in the cathode-ray tube in the receiver must not only follow the individual scanning of the elements of each frame, but at the same time must keep in synchronism with each change of picture frame. In other words, there must be a synchronizing system to provide for the lining up of each horizontal line during the scanning of each frame and another synchronizing system for the lining up of each frame. These synchronizing signals are sent out by the transmitter in the form of impulses which are picked up by the receiver and are utilized so as to give automatic synchronization.

Synchronizing Problems

In a 120-line scanning system, therefore, one impulse is required at the end of each line. Furthermore, if there are 24 frames per second, the frequency of the picture synchronizing signal is 120 x 24, or 2,880 impulses per second. The vertical synchronizing signal, which automatically keeps the picture in frame, requires 24 impulses per second, since each impulse is necessary for each picture frame.

An important point arises here. It might seem that the synchronizing signals would cause distortion of the signal, and this would be so were it not for a very ingenious solution de-

Above: The power and transmitting room of W2XAB, the experimental visual broadcasting station of the Columbia Broadcasting System, located at 485 Madison Avenue, New York. Much interesting work was done by this station during 1931, but it is no longer on the air. Edwin K. Cohen, chief engineer of CBS, is at the supervisor's desk. Right: The artist's position in front of the photoelectric cell frame. Directly behind the square opening, in an adjoining room, is the scanning apparatus. Below, right: A general view of the W2XAB television studio. The large white screen was used as a background for the performers, to give the transmitted images desirable contrast.

Cathode-Ray Tube

It needs but a meagre comparison with ordinary broadcast problems to conclude that, with 120-line scanning systems, no more than two television stations could be included in the entire broadcast band between 550 and 1500 kc. The only possible way in which the required frequency channels may be secured without mutual interference is by utilizing the very short wavelengths in the neighborhood of six meters (50 megacycles). In other words, when television steals around the corner, it is certain to be located right in short-wave fans' own front yard.

The sound systems which must accompany these television transmissions also require a definite channel, and they are distinct and separate from the picture channels. A typical case outlined by Beers states that the tuning range of the picture receiver was limited to 35-to-55 mc, and the sound receiver from 55-to-75 mc. Aside from the frequency differences in each channel, the main point is that two complete channels are required for the picture and the sound.

There seems to be little doubt that the cathode-ray tube will play an important rôle in the commercial television receiver. This tube not only obviates the necessity for a
vised by engineers of the RCA Victor Co. This solution makes use of the fact that although the beam at the transmitter can return to its starting position after each line in almost zero time, the cathode-ray beam at the receiver actually requires time. In fact, 10 per cent of the picture to be transmitted must be added to the time of scanning at the transmitter in order to allow sufficient time for the cathode-ray beam at the receiver to return to its starting position. In other words, during 10 per cent of the time that the transmitter is in operation, no picture is being scanned. It is during this small interval of time that the synchronizing signals are “sneaked” in.

Although many of these technical considerations are of importance only to the design engineer, nevertheless they do point out very definitely that many of the old difficulties which hampered commercial television have been solved very satisfactorily.

RCA’s Work

In the December, 1933, issue of the PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS a comprehensive description of experimental television receivers is given. In this description, G. L. Beers points out that the superheterodyne circuit was selected for the receiver. The design of this circuit is such as to provide flat-top response in both the r.f. and i.f. circuits. An important point is noted in connection with the design of the i.f. transformers which is well worthy of consideration. These i.f. transformers have a response curve which is much wider than ordinarily required, in order to provide ample response when the oscillator changes frequency. Temperature changes, variations in tube capacity, etc. The entire receiver is completely shielded in every respect and it would be extremely difficult for the layman to tell the difference between it and the own broadcast set. The audio amplifiers used in these receivers are practically flat from 20 cycles to about 400,000 cycles per second. This amplifier, of course, is used in the picture receiver; the one used for the reception of the musical accompaniment has the usual flat characteristic between about 100 and 4,000 cycles.

In many of the tests conducted by the RCA Victor Co. atop the Empire State Building in New York, it was found that the only form of interference originated from ignition systems of airplanes and automobiles; otherwise, reception was practically perfect. A very peculiar effect was noted in connection with this interference. It was found that if it was strong enough, it actually threw the system out of synchronism. The effect, therefore, was somewhat similar to the early days of sound pictures when the voice either preceded or followed the picture slightly.

Of course, much work must yet be accomplished. For instance, at the present time there is no adequate standardization by which television receiver performance can be measured. As pointed out by E. W. Engstrom, “Expression of the degree of satisfaction provided by a television image has been bounded on the one hand by the only claim of the conservation of the observer, and on the other hand by the practical limitations which prevent, for the moment, an increase of picture details, picture steadiness, picture illumination, picture contrast.”

The purpose of this article is not to emphasize the fact that television receivers are ready for distribution to impatient customers, but rather to point out in a general way the advantages that have been made and to show that it is not unreasonable to suppose that we can really expect television in the near future. How near that “near” is, is something we cannot venture to guess.

Need for Standardization

There is need for standardization of performance of television receivers, just as there are standards by which broadcast receivers are measured. In the broadcast receiver, sensitivity, selectivity, and fidelity are definitely measurable by standard tests, so that an intelligent comparison between competitive sets may be made. However, these tests have a significance only to engineers versed in radio terminology, and serve a highly useful purpose.

The problem in television is a bit different. The same three characteristics may be used, but there is need for additional standards to take care of the scanning system. There seems to be little doubt that the various previously-mentioned characteristics will be measured under static conditions—without the scanning system, so that for real, overall performance the scanning system must be included as part of the test, regardless of whether this system uses a cathode-ray tube or a disc.

But here is where the trouble arises. The “goodness” of a television system may be arbitrarily defined as the quantity of information contained per unit area of the picture; so that if the scanning system is to be included in the test, some measure of the quantity of information contained in the image must be devised. This, it seems to us, is one of the first problems to be tackled by television standardization committees.

Merely saying that the detail looks good or looks bad is qualitative and depends to a large extent upon the training of the observer and the acuteness of his vision. A comparison between a standard image and the image obtained from the receiver must be interpreted quantitatively.

Until such standardization is realized—and it may be long after television is accepted by the public—radio stores selling different television receiver would do well to use the same image for all the sets, so that a prospective purchaser may choose a receiver giving detail suitable to him.

What Price Television

Every time a layman talks about television, he mentions price. What he means is the first major concern he asks. The answer is usually a shrug of the shoulders and a sly attempt to change the topic. From the standpoint of economics, the price must be what the public is willing to pay. Between fifty and one-hundred dollars is our guess, for a medium quality receiver. Remember, television receiver manufacturers are—or, rather, will be—in business to make money.

Photograph of a completed experimental television receiver built by the RCA Victor Co. for experimental purposes. This receiver contains a power unit, a cathode-ray television tube unit, two receivers—one for pictures and one for sound signals—and a loudspeaker.

Arrangement of the television receiver built for special tests by the RCA Victor Co. One of the most encouraging things about this receiver is its resemblance to a modern broadcast receiver. How far off is commercial television?
With Bob Bartlett in the Uncharted Arctic Regions

This article describes for the first time the radio aspects of the latest Arctic adventure of the famous captain of the "S. S. Morrisey" and his party of scientific specialists, who made many interesting discoveries.

By Lewis Winner

On June eighteenth, 1933, at 8 a.m., the S.S. Morrisey, historic 100-foot exploration schooner, was sent out by R. A. (Bob) Bartlett of Peary fame, slipped her moorings in the MacWilliams Shipyards, Port Richmond, Staten Island, and set sail on a three-month trek to an Arctic region, unvisited by man since 1823. It is of interest to review this area and engage in other scientific research. The multitude of discoveries made by Captain Bartlett and his scientific specialists is stirring, especially those concerning radio.

To acquaint you with the type of persons engaged in this expedition, I have noted hereewith a brief explanation as to their work. Professor Jack Angel of McGill University, Montreal, topographical genius, mapped out a section of the Arctic region heretofore uncharted. Strange and rare birds were brought back by Dr. Robert Dove of the Dalhousie University at Halifax. Ethnological discoveries were made by Junius Bird of Rye, New York, assisted by Bob Moe of Brooklyn, New York, who also acted as radio operator and correspondingly made some unusual findings with which we shall concern ourselves shortly. A. D. Norcross, New York, sportsman, who has gone along with Captain Bartlett for years on these Arctic trips, also made major discoveries. A photographic study of the entire voyage was made by Pyrman Smith of Pathé News.

Call Letters VOQH

As stated, Bob Moe, who operates station W2UN in New York, operated the Morrisey radio station, which had the call letters VOQH. A veteran operator assisted by precision equipment, Mr. Moe was able to collate the most comprehensive and interesting data I have ever studied on reception in the Arctic regions, especially during the summer months. So that you may have as accurate a picture as possible of the conditions which existed during this trip, I will take you, graphically, of course, along the route of the Morrisey.

From New York the Morrisey went to Brigus, New Foundland, where she spent about a week, held up by bad weather. A few miles each day were covered until Hope Dale, Labrador, was reached. The Morrisey then went south-west to Turnavick, a fishing station on the old Bartlett family island. She continued north, still making slow progress because of the long nights, which necessitated the ship being tied to ice pans. These pans consisted of solid ice in combination with large chunks of broken-up ice. The Morrisey continued through the Hudson Straits, where the ice again held up the party. Bad currents also delayed the voyage. After breaking out of the ice, she proceeded to South Hampton Island, through Sir Thomas Rowes Welcome into the Fox Channel. She then made her way to the Fox Basin, where the ship was frozen in for three weeks. After the ice loosened up, the Morrisey proceeded northwest to White Island, and finally up to Fury and Hecla Straits, the point of destination. Fury and Hecla represent the names of two boats which went up to this region during 1821 to 1823 looking for the Northwest passage. These ships were commanded by Parry and Lyon, who spent the winter in these parts. The anchoring of the Morrisey in this part represented the first time this had been done since 1823. This is the area...
that Captain Bartlett went up to re-charter.

The _Morrissey_ was again iced in here for three more weeks. After the ice broke up she retraced her steps back home, making only one exception and that being that she went about in the opposite direction around South Hampton Island.

We shall now concern ourselves with the equipment used in the radio room. The transmitter used consisted of two 204A tubes in push-pull, self excited with a tuned grid, tuned plate circuit. Power was supplied by a bank of 110-volt Exide batteries which turned a generator and fed a step-up transformer to supply 3000 volts to the tubes. The 7500-kc. and 14,128-kc. channels were used. The antenna used was the Zeppelin feed type, seventy-five feet long outside.

The receiver used was a Hammarlund battery type high-frequency model known as the “Pro.” There are seven tubes in this model. Two type 78 tubes are used in “air-tuned” i.f. channels, and two 78 tubes are used as electron coupled oscillators. (one is a standard oscillator in the input, and the other is a high-frequency oscillator for c.w. work and also for locating phone stations).

Two 77 tubes are used as detectors and a 42 is used in the audio side. The precision design of this receiver provided consistent reception regardless of the conditions which were met, providing world-wide contact at all times, which certainly was important.

Through the efforts of the _New York Times_ and W2KJ, an amateur station owned by J. and S. A. Ross of Brooklyn, New York, the contacts were accomplished.

The 40-meter channel was used for receiving and transmitting approximately as far up as Fox Channel. This frequency provided excellent results.

The following, told to me by Mr. Moe and taken from his log book, will indicate more accurately what results were obtained.

“July 20th to August 14th. The West Coast stations came in best from midnight on. New York was poor. In the earlier part of the evening, however, New York started to come in satisfactorily.

“When Fox Channel was reached, the 40-meter channel became useless. I then had to shift to the 20-meter band, which provided excellent results.

“Incidentally, while in Labrador W8XK, the Pittsburgh relay broadcasting station on 17 meters, was heard consistently supplying us with very interesting news bulletins.

“On the 20-meter band, in Fox Channel, I contacted 4’s, 5’s and 6’s with ease. As we went further north off White Island, I was able to contact 2’s, 3’s, 5’s 7’s and 9’s, but no 6’s. The Canadian stations came in exceedingly well.

“As we proceeded to a northerly area, (August 26th), only the 1’s, 2’s, 8’s and 9’s were contacted. Beginning September 7th, the 2’s and 1’s died out completely. I could only hear the North and Middle West—Cleveland to Minneapolis and Kentucky on the south. At this time the _Morrissey_ was at the entrance to the most northern point, or at Fury and Hecla Straits.”

The expedition started on the return voyage on September 8th. All but the 2’s began coming back on 20 meters. In fact, in order to get messages to New York they had to be relayed through Ann Arbor, Michigan. Mr. Moe kept to the 20-meter schedule until September 20th, when he reached Labrador again.

The 40-meter channel was then again put into use. Even at this (Continued on page 42)
Short Wave Short Cuts

PRIZE WINNER

Drilling Tube Bases
By Donald Bottolson

E VERY short-wave experimenter who attempts to wind coils on burned-out tube bases has had the experience of the molded composition breaking in the vise. This trouble can be overcome by using the scheme shown in the diagram. Simply insert a common spool in the tube base to be drilled and fasten it tightly with a small clamp. Then insert the clamp in the vise and you have a very solid base for drilling.

Reducing Insulator Capacity

The capacity effect between the ends of small aerial insulators, while not important at low broadcast frequencies, becomes appreciable on the very high frequencies (short waves). Since a number of small insulators is usually cheaper than a single long one, it is a good idea to use two or three in a row, joined by short pieces of wire. The overall capacity effect is thus lowered considerably.

Grid Leak Clips

By Geo. Donald Hendricks

TWO Fahnestock spring binding posts salvaged from old "B" batteries may be made into an excellent grid leak holder, as shown in the sketch. Bend down the part of the spring marked "A", then bend up the body of the post to form an "L" shaped support. Mount the two clips the desired distance apart by means of wood or machine screws. This same mounting is also very convenient for supporting small radio frequency chokes which are wound on forms resembling grid leaks.

Temporary Coil Connections

By Bob Hunteman

I T is very irritating to have wound a short-wave coil on a standard form and have all leads nicely soldered to the prongs only to find you could have put on one more turn or one less turn on the tickler coil. By merely bringing the leads through a hole (already in some forms) punched or drilled in the bottom of the coil forms, the leads can be twisted tightly and compactly around the outside of the prongs, a few turns forming a good connection, and the coils may be used in a conventional tube socket and tried in the set. When the coil has proven correctly wound, the leads may then be soldered in the conventional way.

Using Old Cartridge Fuses

By Robert A. Binkey

BURNED out fuses of the cartridge type make excellent forms for short-wave radio-frequency choke coils. The tubing is usually of fibre or some other composition and is a good insulator.

Of course, the inside of the fuse should be cleaned out, and the metal end caps removed. The ends of the tubing may be drilled to take terminal and mounting bolts, or one of the metal end caps may be drilled to accommodate a single mounting screw. The choke may thus be mounted in a vertical position.

Automatic Antenna Adjustment

By Arthur Darling

I T has become quite common practice to employ one series antenna condenser which, in some cases, necessitates adjustment every time a coil is changed. It is not necessary to tolerate these adjustments if five-pin coils are used.

A short piece of bell wire is soldered to the unused coil pin. Another piece of bell wire is soldered to the grid end of the grid coil. The antenna wire then connects to the fifth or extra pin. A few twists are made in the bell wire. After the coil is placed in circuit, the twists are varied until dead spots are removed from the dial.

If one such condenser is used with each coil, it is evident that condenser adjustment becomes automatic with the insertion of each coil.

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Tracing Noise

Before condemning a receiver for being noisy, make sure that the noise is in the set, and is not due to outside disturbances. Disconnect the aerial and ground, turn up the volume control to maximum, and listen. The set may be surprisingly quiet. If it is, the noise obviously is external and you can do nothing about it, except to try an isolated antenna with a good transposed feeder lead-in.

Indoor Aerials

It is just as important to insulate an indoor aerial as an outdoor one. However, the insulators need not be as heavy, as they carry comparatively little strain and are not subject to rain and snow. Long pieces of bakelite or isolantite, taken from old variable condensers, make good insulators for the purpose, as they are light and thin and have excellent dielectric properties.

Incidently, it makes no difference whether the wire is insulated or not. Any size between No. 20 and No. 14 is OK.
The Worcester "Forty-Niner"

**Summary:** Here is a description of a novel receiver designed exclusively for broadcast reception in the 49-meter band. It has no switches, plug-in coils, or interchangeable drawers, since it covers only the one band. You merely flip the switch and tune, exactly as in a conventional broadcast receiver.

By J. A. Worcester, Jr.

There are undoubtedly many readers of this magazine who find no appreciable entertainment value in the various amateur, airport, police and commercial phone bands and are interested only in short-wave broadcast reception. For these readers the receiver described in this article, designed for exclusive reception in the 49-meter broadcast band, is presented. This band embraces many of the most important U. S. and Canadian stations, as well as important stations in South America, Europe and Africa, and for all-around results is considered superior to the 26- and 19-meter bands.

Choosing a Circuit

The choice of a suitable circuit for this purpose presented something of a problem. The superhet-erodyne was soon dismissed because of its high cost and complicated construction. The conventional radio frequency, regenerative detector circuit was finally adopted as combining most satisfactorily the requirements of ease of construction, low cost and low noise level.

Since the frequency band covered by this receiver extends only from 5.5 to 6.5 megacycles (46.15-54.55 meters), it is entirely feasible to employ untuned r.f. transformers in the form of closely coupled tuned circuits with a coefficient of coupling just sufficient to provide satisfactory amplification of the above band. Two stages of this type of amplification are included with an individual gain control so that the overall amplification can be advanced to the maximum value consistent with satisfactory "apparent selectivity" and noise level.

There are numerous advantages which result from covering a comparatively narrow band of frequencies to the exclusion of others. For one thing, it is possible to design an antenna system of the correct dimensions to give maximum results at the band employed. This procedure also eliminates any possibility of "dead spots." There is also an economic consideration, since for any given receiver sensitivity, it is cheaper to build a receiver to cover a narrow band of frequencies than one to cover the whole short-wave range. Finally, tuning is much simpler than with the usual short-wave receiver; in fact, it is no more difficult than an ordinary broadcast set.

The appearance of the completed receiver as well as the location of the various parts can be noted from the photographs. As can be seen, the receiver looks more like a modern broadcast receiver than the customary short-wave set.

The circuit, as shown in Fig. 1, consists of a tuned input, followed by two untuned radio frequency stages feeding into a third tuned detector stage. The detector is regenerative and is followed by two stages of resistance coupled a.f. amplification. The tubes employed are 58's in the r.f. amplifier stages, V1, V2, V3, a 57 detector, V4, and a 56, V5, and a 2A3, V6, in the audio frequency amplifier.

Unusual Features

The following features may be worthy of comment. The antenna input is designed for use with a doublet antenna. The two tuned circuits, which are ganged together, are lined up by means of the 20-mm. Hammarlund condenser C3 in parallel with the winding L1. The bias on the first r.f. tube is fixed so that the first r.f. stage gives maximum amplification at all times. This results in a higher signal-to-noise ratio than would be obtained if the bias of this tube varied with the two succeeding stages. The amplification of the two untuned stages is varied by means of a variable resistor, R2, in the cathode circuit.

In order to prevent possible oscillation in the r.f. amplifier, the screen grid and plate circuit returns should be made exactly as indicated in the diagram. For instance, the three screen leads are brought to a common junction which is bypassed to ground by the condenser C5. In order to prevent common coupling, the condenser should be connected directly to the junction point of these three leads. The same procedure should be followed when bypassing the plate and cathode returns. Regeneration is controlled in the usual manner by varying the screen grid voltage by means of the potentiometer, R5. In order to prevent "motor boating" in the a.f.
amplifier, decoupling resistors R7 and R11 in conjunction with condensers C11 and C12 are employed.

When building the set it is first necessary to procure the panel and chassis, which can be bought ready made if desired. The panel is made from 1/16" aluminum sheet 7" x 9"; the subpanel, also of aluminum, has dimensions of 11" x 14" x 1 1/4". The location of the various parts can easily be noted from the photographs. The drum dial, potentiometers, and phone jacks are mounted on the front panel. On top of the subpanel are mounted the tuning condenser C1, C2, the Hammarlund trimmer C8 and the coils. The tuning condensers are mounted by aluminum brackets 3 1/2" high and 1 1/4" wide. The trimmer is also mounted on an aluminum bracket 1 3/4" high by 1 1/4" wide.

At the rear of the subpanel are mounted the five-prong Connectorad socket, the triple binding post assembly and the twin speaker jack. Underneath the chassis are mounted the sockets, chokes, condensers, and resistors. The condensers and resistors are mounted directly by their pigtails, as is also the National choke.

**Coil Data**

The coils are, of course, the heart of this set and should be constructed carefully. Unless facilities are available for spacing turns accurately, it would probably be preferable to buy these coils ready made.

The tuned input and detector coils, T1, T4, are identical, as are also the two untuned transformers, T2, T3. Since the latter are the simplest to make, their construction will be discussed first. All the coils are wound on 1" diameter bakelite forms 3" long. Windings L4 and L5 each consist of 43 turns of No. 24 D.S.C. wire wound without spacing. The windings are separated by 1/16" and are in the same direction. The outside lead of L4 goes to the plate and of L5 to the grid. The finished coil is mounted in the National coil shield by means of a 3/4" double angle. Coil T3 is identical in construction.

The input coil, T1, consists of three windings L1, L2 and L3. Winding L2 consists of 40 turns of No. 26 D.S.C. wound 30 pitch. The outside lead of this winding goes to the grid. Interwound with this winding, starting from the grounded end, is L1, which consists of 26 turns of No. 35 D.S.C. Winding L3 consists of 8 turns of No. 35 D.S.C. close wound. This winding is wound in the same direction as L2 and is separated about 3/4" from the grounded end of same. The outside lead of this winding goes to the plate. Coils L8, L9, L10 are identical in construction, except that a grid leak and grid condenser are contained in the shield can. In order to prevent possible grounds, the inner container of the shield is lined with light cardboard.

For best results on the 49-meter band a doublet 78 feet in length should be used. The writer employed the Lych short-wave kit with entire satisfaction. As shown it is possible to use an ordinary antenna by grounding one of the extra terminals, it is almost foolish not to take advantage of the benefits to be derived from the use of a doublet having the correct dimensions.

The only adjustment necessary is the lining up of the two tuned stages by means of the trimmer C3. This is adjusted until the background hiss or the volume of a weak signal is a maximum.

**Results Obtained**

As to results obtained, the writer during a month of testing has received GSA, DJC, RV59 and OXY in Europe, as well as nearly all the American, Canadian, and South American stations listed in this band. All these stations were received with satisfactory loudspeaker volume. RV59 in Moscow is a particularly interesting station in that it is possible to get the schedule from week to week from a rather extensive talk in English given during each broadcast. By following the schedule it is possible to receive this station consistently.

At the low frequency (high wavelength) end of the dial it is possible to receive 54-meter airport stations. Harmonics of broadcast stations are quite plentiful in this band also, as are third harmonics of 160-meter phone amateurs.

**Parts Required**

T1, T4—Tuned r.f. transformers. See text.
T2, T3—Untuned r.f. transformers. See text.
C1, C2—National SEU—25 variable condensers, 25 mm., one clockwise rotation; one counter-clockwise rotation.
C3—Hammarlund 20-mm. variable condenser, MC-20-5.
C4, C5—Polyem 6/16-mf. molded mica condenser.

View showing the construction of the coils and shield cans.
Some Unique Tube Characteristics

UNTIL the advent of the graphite anode, the distinguishing mark of a thoroughly evacuated transmitting tube was a glass envelope with silver deposits over more or less of its inside surface. The latest graphite anode tubes, however, are crystal clear. No deposits are in evidence. An explanation in order, and it is forthcoming from Victor O. Allen, Assistant Chief Engineer of the Electronics Division of Hygrade Sylvania Corporation, under whose guidance the graphite anode was recently perfected.

"Gas, the arch enemy of tube operation and life, now has a keeper as well as a getter," states Mr. Allen. "For years past plenty has been said regarding getters which, during the pumping out of a tube, act as a chemical broom in sweeping up the gases driven out of metal pores by the bombardment heat. Were it not for the use of some sort of getter, the pumping time would have to be increased many times, and in the case of the large transmitting tubes, this operation might prove entirely impractical, especially from the economic standpoint. Hence the use of getters. Also the fact that we have been taught to look for that silver lining as a badge of good tube housekeeping.

"It is usually the practice to leave some of the getter material, usually magnesium, barium or the like, in the tube to absorb further amounts of gases which are released from the tube elements during their operation, particularly during heavy overloads. The getter then becomes a keeper, as it were, being charged with absorbing further gases and maintaining the high vacuum essential for proper operation."

"In our own transmitting tube activities we have found that by treating the graphite anode properly during exhaust, it becomes a sponge for those gases released during the life of the tube. This sponge or keeper action of graphite is most pronounced, so that we find it no longer necessary to employ a deposit material on the glass envelope of our tubes to serve as keeper. Our graphite anode tube envelopes are crystal clear, without deposit of any kind. This feature is advantageous, as there is no possibility of the getter-keeper material—in this case the solid, one-piece graphite anode, free from impurities and amorphous carbon or surface carbon dust—getting on insulation between tube elements to cause disasterous leakage effects and reducing heat radiation through the glass envelope."

(See the Jan. '34 issue—Tech. Div.)

MANY inquiries are received relative to the blue glow which is present in a number of tubes. Most of these inquiries are based on the misunderstanding of the different types of glow that may be present in a tube. There are three different types of blue haze that may appear while tubes are in operation: Fluorescent glow; mercury-vapor haze and gas.

The fluorescent glow is usually of violet color, and is noticeable around the inside surface of the glass bulb. This glow is a phenomenon caused by electronic bombardment taking place within the tube. This glow changes with the intensity of the signal and may at times become quite brilliant. Fluorescent glow has absolutely no effect on the operation of a receiver. In fact, tubes with this characteristic are particularly good as regards gas content.

Mercury-vapor haze is a blue glow which is noticeable between the plate and filament in types 82 and 85 rectifier tubes. These are the only types of receiving tubes in which this type of haze appears. The perfect operation of the types 82 and 85 is dependent upon a mercury vapor which comes from free mercury that has been placed in the bulb during (Continued on page 43)
How Radio Receiver Sensitivity Is Rated

SUMMARY: One of the most confusing things radio fans have had to contend with is the matter of receiver sensitivity. To say a set has an amplification of so-many "times" is pretty meaningless, because the theoretical amplification of some circuits is supposed to precede a purely achieved in actual practice. To simplify things, engineers are said on a standard means of determining overall receiver performance, and this is described in the article below.

THE invasion of all-wave receivers into the short-wave field has been accompanied by a host of technical terms which although old to the broadcast radio man, are relatively new to the short-wave fan. Many of the new-fangled ideas incorporated in the past as short-wave sets are already familiar to short-wave listeners; but many technical terms of extreme importance are little understood by the average listener, who is forced to wade through them when attempting to justify the purchase of a new receiver. It is the purpose of this discussion to explain accurately the technical meaning of several important terms used to compare radio receiver performance.

Microvolts Per Meter

The first, and probably the most confusing, term used in the comparison of radio-set performance is microvolts per meter. Furthermore, this term has a significance that is slightly different from what one would ordinarily think: the higher the rating in microvolts per meter, the less sensitive the receiver! Let us start from scratch and see what this business is all about.

The one thing we all know is that radio waves are sent out by transmitters, and that these waves travel in all directions until they strike metal, or a conducting object, like an aerial; when this occurs, the aerial absorbs a bit of the energy from the wave, and the latter is converted into usable sound by the radio set and loudspeaker. This radio wave may be thought of as being energy, and, furthermore, this energy may be thought of as continually changing, the rate of change being equal to the frequency of the wave. (Parenthetically, it may be mentioned that the radio wave may not only be thought of as energy, but as heat is energy.) Now, electrical energy may exist in only two forms: electrostatic and magnetic, the former existing between the plates of a condenser when it is charged, and the latter surrounding a wire carrying current. A radio wave is composed of both types.

An important point arises here: per unit volume of the medium through which the antenna are at any instant, the amount of energy in magnetic form is exactly equal to the amount of energy in electrostatic form, so that the total energy of the radio wave at any instant is equal to the energy in either component. Furthermore, the amount of energy in either form varies continuously, at the frequency of the currents generated at the transmitter. The picture to be formed, therefore, is that of a wave of two components, both equal in magnitude at any instant, and both varying in magnitude from zero to a maximum. When this wave strikes an antenna, a voltage is induced in the antenna, and it is this voltage which is amplified, rectified, and converted into sound by the loudspeaker. A good measure of the sensitivity of a receiver, therefore, is to determine what voltage is required to deliver a fixed output. The greater the voltage required to deliver this fixed output, the less sensitive the receiver; conversely, the lower the voltage required for the fixed output, the more sensitive the receiver.

Measured At Antenna

The measurement of the sensitivity of a radio set, therefore, requires the measurement of the strength of the wave at the receiving antenna, and in order that everyone make the measurement in the same manner, a standardized procedure has been adopted. Since, as pointed out previously, the amounts of energy in the magnetic and electric fields are identical, it makes no difference which is chosen for the measurement. However, because the electrostatic component lends itself to measurement and standardization more readily than the magnetic component, it was picked for the job. Although it is realized that the total energy of the wave is twice that of the electric component alone, we need not worry, for the simple reason that we are not interested in the energy in the wave per se, but in the sensitivity of the receiver.

Now, the "fly in the ointment" regarding the measurement of the wave at the receiver is that the voltage induced in the receiving antenna is a function of the height of the antenna; the higher the antenna, the greater the voltage induced. In order to make the measurements standard for all types of antenna installations, the voltage induced in the antenna is measured in microvolts (the one-millionth part of the volt), the sensitivity of the receiver is specified in microvolts per meter, which means the number of microvolts per meter of height of the antenna.

The Electrostatic Component of the Wave

If a battery be connected across the terminals of a condenser, a current flows until the condenser is fully charged, at which time the voltage across the condenser is equal to that of the battery. Every condenser has a dielectric which is substantially homogeneous, so that the voltage drop in the dielectric from one plate to the other (a two-plate condenser) is uniform, as shown in Fig. 1. Here the thickness of the dielectric has been exaggerated for simplicity; but the straight line shows that the voltage at any point in the dielectric, measured from the positive plate, depends directly upon the distance of that point from the positive plate. With a given dielectric, the potential is greater as the distance from the positive plate increases.

Few practical radio men realize that a receiving aerial is a condenser, the air between the wire or wires and the ground being the dielectric. Since the wave front of the radio wave is very high—much higher than the aerial—the potential of that place in space in which the aerial is located with respect to ground, is greater the greater the height of the aerial, just as in the case of the condenser cited in Fig. 1. Hence, the electrostatic component of the wave affords a direct means...
of determining the voltage induced in an antenna system.

Microvolts Absolute

We have seen that the actual voltage induced in an aerial is dependent upon the strength of the wave and the height of the antenna in meters. When receivers are tested in the laboratory, where engineers have little or no knowledge of the type of antenna which will be used with the receiver in practice, some sort of a standard antenna must be devised so that no matter in what locality the engineering work is done, there will be a common basis for receiver rating. For this reason, the antenna circuit of the receiver under test in the laboratory is connected to a standard dummy antenna consisting of a 25-ohm resistor, a 20 microhenry inductor, and a 200 mF capacitor in series.

The voltage from the standard oscillator, modulated 30 per cent at a frequency of 400 cycles, is coupled to this dummy antenna, and the voltage required to maintain an output power of .05 watt (50 milliwatts) is measured. This power is to be consumed by a resistor of the same value as will be used by the output transformer and loudspeaker in practice. It is clear, then, that the greater the input voltage required to maintain the 50 milliwatts output, the less sensitive the receiver, and vice versa.

When the 50 milliwatts are obtained, the voltage in the dummy antenna (Fig. 2) is measured, and since it is usually in microvolts, it represents the sensitivity of the receiver in microvolts absolute.

Mechanical vs. Electrical Antenna Height

A man may erect an antenna 100 feet in the air, but because of surrounding objects and because of the presence of the masts, etc., the effective height—that height actually contributing to signal strength—may be only 25 feet. The actual physical height, therefore, is by no means the effective height. Engineers have made a very complete survey of the effective height of the average listener's antenna and have found it to be but 4 meters—about 13 feet!

The result, therefore, is interesting. If a manufacturer states the sensitivity of his receiver is microvolts absolute, then merely divide by 4 to obtain the sensitivity in microvolts per meter.

The absolute measurement is that actual voltage in the antenna circuit required for 50 milliwatts output, and is an excellent basis for receiver comparison because of the standardization of the dummy antenna; but microvolts per meter is useful when the real effective height is known from measurement.

Louis Martin

for March, 1934

Byrd Expedition Notes

At 10 p.m., EST, on Saturday nights, the Columbia Broadcasting System has been rebroadcasting special programs originating on the S. S. Jospeh I. Byrd's main supply vessel, while the latter has been on the high seas bound for Little America. These programs have been transmitted through KJTY, the shore-wave transmitter of the vessel. This same transmitter will be set up at the Expedition's permanent base, where it will again be used for regular relay broadcasting purposes. A complete description of this project appears on pages 4, 5, and 6 of the January, 1934 issue of Short Wave Radio.

In addition to the scheduled 10 o'clock rebroadcasts over the Columbia Broadcasting System's regular chain, KJTY has been running numerous tests, some of hours' duration, with New York. Edwin K. Cohan, Technical Director of CBS, has on occasion talked directly to John Dyer, KJTY engineer, merely by addressing a microphone in his office at 485 Madison Avenue, New York. His voice was transmitted through W2XBJ, one of the short-wave experimental telephone stations of RCA Communications, located at Rocky Point, L. I.

On board the ship, Dyer picked up this station directly. However, the signals from KJTY were relayed to New York by way of either Buenos Aires, San Francisco, or Koko Head, Hawaii, again over the experimental radiophone facilities of RCA. Mr. Cohan has been able to hear KJTY directly, but for short-wave rebroadcast purposes the relay system has been used.

Reception of KJTY's signals has invariably been accompanied by peculiar fading, swinging, and pulsating sounds such as might be made by ocean waves. Many listeners have gotten the impression that the microphone is out on deck, and that KJTY is deliberately broadcasting the noise of the ocean. This, however, is not at all the case, as all the programs from KJTY originate in a sound-proof studio on board the ship. The irregularities in transmission are due, in most part, to the fact that the ship rolls a great deal in the heavy seas. When the transmitter is set up at its permanent base, this trouble undoubtedly will disappear.

As much as the KJTY transmitter is crystal-controlled and is highly stable, the shifting of its frequency output is more probably an amplitude variation. Listeners who encounter this trouble are advised not to retune their receivers, but to leave them alone; the signals will swing back periodically. Short-wave transmission is tricky enough from fixed stations, and becomes more so from mobile stations.

Secrecy of Messages

In connection with reception of the KJTY transmissions to American test stations, Mr. Cohan emphasizes an important point that is quite generally overlooked by radio listeners. This concerns the secrecy provision in the Radio Act of 1927, the federal law covering radio communication. We are quoting this part of the law in full:

Sec. 27. No person receiving or assisting in receiving any radio communication shall divulge or publish the contents, substance, purport, effect, or meaning thereof except through authorized channels of transmission or reception to any person other than the addressee, his agent, or attorney, or to a telephone, telegraph, cable, or radio station employed or authorized to forward such radio communication to its destination, or to proper accounting or distributing officers of the various communicating centers over which the radio communication may be passed, or to the master of a ship under whom he is in actual response to a subpoena issued by a court of competent jurisdiction, or on demand of other lawful authority, and no person not being authorized by the sender shall intercept any message and divulge or publish the contents, substance, purport, effect, or meaning of such intercepted message to any person: and no person not being entitled thereto shall receive or assist in receiving any radio communication and use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto; and no person having received such intercepted radio communication or having become acquainted with the contents, substance, purport, effect, or meaning of the same or any part thereof, knowing that such communication was so obtained, shall divulge or publish the contents, substance, purport, effect, or meaning of the same or any (Continued on page 42)

Note

In addition to the radio equipment described on page 6 of the January issue, four Silver Masterpiece II's were taken on the Byrd Expedition. These are being used for short-wave broadcast reception and emergency communication purposes.
The "Uni-Shielded Short-Wave Three"

SUMMARY: In spite of the development of large, supersensitive receivers like the superheterodyne, many people want small, simple sets that are easy to construct, simple to tune and economical to operate. The "Uni-Shielded Three" more than fills the bill, and we recommend it heartily.

By H. L. Shortt

While the "Uni-Shielded Short-Wave Three" has been designed especially for the short-wave novice, it is really capable of satisfying the most discriminating short-wave fan. Its outstanding features are high r.f. sensitivity, simplified circuit and mechanical design, smooth regeneration control, ease of tuning, use of low-current drain two-volt tubes, specially designed short-wave coils, antenna tuning control, all-pentode operation, unusually thorough bypassing, newly developed self-shielded chassis design of high efficiency, and, last but not least, low cost. These and other features will be explained in detail in the latter part of this article.

The circuit consists of a stage of r.f., using a type 34 pentode V1, a regenerative detector also using a 34 pentode V2, and a single audio stage using a 33 pentode power output tube, V3. Since these three pentodes are all two-volt filament tubes, the A supply of this receiver may be two ordinary bell-ringing type 112-volt dry cells, an Air Cell A battery, or one cell of a 6-volt storage battery, or any standard storage battery. Of course, the correct voltage reducing resistor will have to be used with each particular type of A supply to bring the voltage down to the required 2-volt value. For example, a 2.7-ohm resistor will have to be used in series with an Air Cell battery or with a single cell of a storage battery, a 3-ohm resistor will be needed in series if two 112-volt dry cells are used, etc. The total filament current is only .38 ampere and this drain is so light that even the 112-volt dry cells should last a long time without requiring replacement. Three 45-volt B batteries are required and 132 volts of C battery. Only .02 ampere is drawn from the B battery, hence this set is extremely economical in operation.

The Circuit

Analyzing the circuit, the first feature to attract attention is the trimmer condenser C1. This permits adjustment for various length aerials, so that the set will work just as well on a long aerial as on a short one. The antenna tuning condenser also provides an extra adjustment when tuning in weak, distant stations, although it is not ordinarily used for this purpose. It will be noted that the antenna is connected through C1, directly to the r.f. tube V1. That is to say, the signal is impressed directly upon the grid of V1, dispensing with the antenna coil or coupler.

Tuning is accomplished by means of a .00014 mf. variable condenser C6 shunted across a plate impedance coil L1. The latter constitutes the longer winding G of a special four-prong, plug-in coil. The shorter winding of this coil, T, serves as a tickler, being connected in series with the plate of the detector tube V2. The regenerative action thus obtained is very strong.

Regeneration is controlled in the conventional (that is, for screen-grid tubes) manner, by varying the screen-grid voltage of the detector. The potentiometer R4 is used for this purpose. This method of control is smooth and effective.

The short-wave plug-in coil is of special design. Four of these coils are used to cover the band from 15 to 200 meters (20,000 to 1500 kc.). A feature of the coils is the band spread effect attained through proper design and the use of shielding.

Values of .00025 mf. for the grid condenser C7 and 10 megohms for the grid leak R3 have been found to give best results. However, in some cases it may be desirable to use a smaller grid leak such as a 5 or even a 3 megohms.

The 2½ mh. r.f. choke, L2, serves to block off r.f. currents from the audio circuit. These currents are bypassed through the .00025 mf. mica condenser C8. Values both of the r.f. choke and of the bypass condenser have been calculated carefully for high frequency reception and should be adhered to for best results.

The use of an audio plate choke at L3 adds immensely to the efficiency of the Uni-Shielded Three, permitting a higher plate voltage on the detector and thus increasing the sensitivity to an amazing extent.

Since the output amplifier pentode V3 uses a C battery for negative grid bias, a grid resistor R7, having a value of 500,000 ohms, is used.

The author demonstrates the method of tuning the "Uni-Shielded Three."
The conventional .01 mf. coupling condenser, C10, is employed between the detector and the audio stage. The 33 output tube has an undistorted power output of 700 milliwatts. This tube is capable of producing considerably greater power output than three-electrode power amplifiers of the same current drain. Furthermore, the 33 has greater amplification than is possible in a three-electrode amplifier, without serious sacrifice in power output. The power-handling ability of the 33 tube is made possible by the addition of both a suppressor and a screen between the grid and plate. The suppressor is placed next to the plate and is connected inside the tube to the filament.

The .001 mf. condenser C11 improves tone quality since it bypasses certain of the harsh or scratchy higher audio frequencies which are often especially noticeable with plate output tubes. The triple tube open circuit jack J1 permits earphones or loudspeaker to be plugged into the output circuit as desired. When the plug is inserted in the jack, this also automatically closes a second circuit between B minus and the chassis. The jack is insulated from the chassis.

**Unique Chassis Design**

The Uni-Shielded Short-Wave Three derives its name from its unique chassis design. The chassis, panel, and shielding are in one piece, as shown in the photographs. In effect, this results in a sloping panel of pleasing appearance, a "U" shaped shielded well for the three tubes and the plug-in coil and also effective shielding for the parts beneath the chassis. This design dispenses with extra shielding and, moreover, is efficient, rugged, compact, and economical. The chassis will readily slide into a metal or wood carrying case and presents a neat, attractive appearance.

While the Uni-Shielded Three has sufficient power to operate a loudspeaker on many stations, it was purposely designed to have high r.f. sensitivity so as to bring in the hard-to-get foreign stations on earphones. In other words, instead of increasing expense and complicating the circuit by the addition of audio stages, the designer concentrated on producing a simplified circuit, actually capable of bringing in extreme DX with sufficient power to be heard readily on a good pair of earphones. With the ordinary three-tube short-wave receiver, this condition is generally reversed, as most such receivers are designed with a "showy" audio system, but with a relatively weak r.f. circuit which falls down badly when it comes to bringing in real distance. The Uni-Shielded Three is easy to operate, since it is perfectly stabilized and more than amply bypassed. Naturally, a certain amount of skill and experience is needed to bring in.

(Continued on page 40)
The Army Amateur Radio System

Unique organization sponsored by the Signal Corps performs patriotic and valuable service for the country; membership is voluntary and activities non-military

By Capt. Garland C. Black
(Signal Corps, U. S. Army)

For centuries past man has been exploring the earth and not until recently has he devoted his efforts to the stratosphere, up above the earth's surface. Parallel to this we find that the broadcast listener has been exploring the radio waves between 550 and 1,500 kilocycles, always searching for new and more distant stations, until today he has extended the search up above 15,000 kilocycles.

What is there up above 15,000? This is a question many a listener asks himself as he reads the advertisements expounding the wonders open to the owner of a short-wave receiver. Let us see to what that part of the radio spectrum is allotted. If one consults the frequency allocations as set forth in the rules and regulations of the Federal Radio Commission, it is found that some of these higher frequencies are set aside for the following services: aviation, police, government, general communication, visual broadcast, experimental, and amateur communication.

Many of these services are already familiar fields to thousands of listeners. Particularly is this true of the police systems, airway systems, and the amateur phones, not to mention the visual broadcast or television. Some of the other services, such as the amateur bands where code is used, are not so well known. However, these channels are extremely interesting to those who are "in the know." Amateurs Activities

Let us consider some of the activities of these amateur radio stations. But first what is an amateur station? The term "amateur station" means a station used by a person, holding a valid license issued by the Federal Radio Commission, who is interested in radio technique solely with a personal aim and without pecuniary interest. There are several bands of frequencies allotted for amateur radio communication, the more popular ones being from 1,715 to 2,000 kc., 3,500 to 4,000 kc., 5,000 to 7,500 kc., and 11,000 to 14,000 kc. These are commonly referred to as the 160-, 80-, 40-, and 20-meter bands, respectively.

The number of amateur stations has increased rapidly since the World War until now the number is probably in excess of 10,000. These stations carry on communication among themselves and not only do the operators derive considerable pleasure from their contacts, but they also have done a great deal to advance the art of radio communication. Amateurs as a group are very resourceful and ingenious. They have achieved prominence by furnishing communication from certain areas in the United States during times of disaster when other means of communication have been interrupted. They have their own local, sectional, and national organizations, the most prominent being the American Radio Relay League, formed by Hiram Percy Maxim in 1914, and which today is the largest amateur organization in the world.

Purpose of the A.A.R.S.

A number of years ago the Chief Signal Officer of the United States Army conceived the idea that it would be desirable to bring about an affiliation between the United States Army Signal Corps and the civilian radio transmitting amateurs of the United States. This affiliation was desired for the following purposes:

1. To provide an additional channel of radio communication throughout the continental limits of the United States that could, in time of disaster or emergency, be used as a substitute for telephone and telegraph lines destroyed by earthquake, fire, flood, ice, tornado, riot, or insurrection.

2. To place at the disposal of representatives of the American National Red Cross and military commanders, including the National...
Guard, such amateur radio communication channels as might be developed under this plan.

(3) To provide civilian radio operators with a knowledge of the Army methods of radio procedure and methods of technique essential to operate such a radio network.

(4) To establish contact with a considerable number of civilian amateur radio operators for the purpose of acquainting them with the Signal Corps and its activities, and securing their aid in experimental work, tests, etc.

(5) To render such encouragement and assistance as might be desirable to firmly establish and perpetuate the American Amateur.

From the very beginning the work met with a wholesome response from the amateurs. This affiliation is known as the ARMY AMATEUR RADIO SYSTEM. Its membership averages about 1,000 active amateurs. No attempt is made to enlarge upon this figure, as this number of amateur radio stations, strategically located throughout the continental United States, is sufficient to provide the desired radio network for establishing the emergency communication channels.

The members of the Army Amateur Radio System do not receive any additional pay or compensation as a result of their affiliation with the Signal Corps, nor are they carried as members of any military reserve or other organization. The work is purely voluntary on their part and what benefits they derive from their activity is solely the pleasure that can be obtained through handling traffic under such a scheme and by knowing that they are rendering a service to their country.

Because of the fact that the system is organized and its operation supervised by the Signal Corps, it is natural to find the organization primarily based upon the military organization of the United States which divides the country into nine geographical sections known as Army corps areas. The Chief Signal Officer of the Army administers the operation of the system as a whole. The direct operation and administration of the system within each corps area is conducted by the corps area signal officer. This decentralization results in a closer relationship between the amateurs and a representative of the Chief Signal Officer, and permits of desirable variations in the organization due to the inherent differences between the various sections of the country. Obviously it would be impracticable for all of these stations to operate one with another without some definite scheme for operation. This is achieved by assigning the stations to groups, each of which operates on a definite frequency at a prescribed time, and also arranging for key stations within each group to work with its groups. These groups are known as "nets." The following nets are organized: an Army net, nine corps area nets, forty-eight state nets, five district nets for each state, and where necessary, local nets for the districts.

Make-up of the Net

The Army net comprises the station in the office of the Chief Signal Officer and a station representing each corps area headquarters. Each corps area net comprises the station representing the corps area headquarters and a station representing the state organization of each state within the corps area. Each state net comprises the state control station and a station representing each of the five districts within the state. Each district net comprises the district station and stations located throughout the district. When this number of stations is too great for all to operate within one net, local nets are organized. In this manner, stations located throughout our entire country are tied into one large network so that a message from any part of the country can be transmitted to any other part by being relayed from its local or district net through its state net, corps area net to the Army net and then to the specified other corps area net, to the proper state net and district net on to the designated local station.

In order to place this system at the disposal of the Red Cross, each Red Cross chapter is assigned to an Army Amateur station and the branches of these chapters are also assigned to stations. This permits each Red Cross chapter or branch to have one or more of these radio stations at its disposal as a means of providing it with communication during times of emergency.
How to Get Started on an Amateur Phone Set

FOR ages, it seems, I have been talking about getting busy on the construction of that "ultimate" transmitter; but somehow or other, the time slipped by, and I had nothing to show for my thoughts. It was high time, then, that I formulated some definite idea as to what the transmitter should be. There followed days and days of scrounging through all available literature for designs which, as nearly as possible, would coincide with my whims and fancies, to say nothing of my pocketbook.

To my way of thinking, a transmitter must meet some definite requirements. They are: (1)—highest usable performance in terms of possible reliability; (2) ease of construction and adjustment; and (3) cost. By cost, I mean that it is not only necessary to have available constructional details, but that it will appeal to a host of amateurs who have just entered the game or who, like myself, have put off the time of entry on the air until some such occasion as this tempted them sufficiently.

Mr. Brennan, standing before his transmitter, a moderately priced, low power affair.

Mr. Brennan, standing before his transmitter, a moderately priced, low power affair.

1932. I am presenting herewith the design and constructional details of a complete 160-1 meter amateur phone transmitter installation. This design, it is felt, will appeal to a host of amateurs who have just entered or re-entered the game or who, like myself, have put off the time of entry on the air until some such occasion as this tempted them sufficiently.

By John B. Brennan, Jr.

Obtaining a License

Before entering into a description of the actual design features of the complete transmitter, it is well, perhaps, to settle a number of questions which are sure to arise in the minds of those who are not now licensed amateur radio operators, but who, at one time or another, have seriously considered taking

Summary: This is the first of a series of two unusually complete constructional articles describing the step-by-step procedure in building a high quality phone transmitter. QNA, RS has been the report received by the author in practically every one of the phone contacts made with other "hams." Simplicity of construction, ease of adjustment and operation and moderation in the price of the parts employed are only a few of the outstanding features.

List of Parts for the Transmitter

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Quantity</th>
<th>ITEM</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1</td>
<td>Cardwell Standard Variable Cond.</td>
<td>123-B</td>
<td>.0005 mf.</td>
</tr>
<tr>
<td>C6-C10-C13</td>
<td>3</td>
<td>Cardwell Midway Variable Cond.</td>
<td>406-B</td>
<td>.00025 mf.</td>
</tr>
<tr>
<td>C8</td>
<td>1</td>
<td>Cardwell Midway Variable Cond.</td>
<td>402-B</td>
<td>.001 mf.</td>
</tr>
<tr>
<td>C-12</td>
<td>1</td>
<td>Cardwell Midway Variable Cond.</td>
<td>404-B</td>
<td>.100 mf.</td>
</tr>
<tr>
<td>C2-C4-C7</td>
<td>3</td>
<td>Aerovox Mica Fixed Condensers</td>
<td>1450</td>
<td>.005 mf.</td>
</tr>
<tr>
<td>C3-C5-C9</td>
<td>3</td>
<td>Aerovox Mica Fixed Condensers</td>
<td>1450</td>
<td>.00025 mf.</td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>Aerovox Mica Fixed Condensers</td>
<td>1450</td>
<td>.001 mf.</td>
</tr>
<tr>
<td>R1-R3-R5-R6</td>
<td>4</td>
<td>Electro Center-tap Fila, Resistors</td>
<td>20 ohms</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>1</td>
<td>Aerovox Resistor</td>
<td>1 watt</td>
<td>50,000 ohms</td>
</tr>
<tr>
<td>R4</td>
<td>1</td>
<td>Aerovox Resistor</td>
<td>2 watt</td>
<td>1000 ohms</td>
</tr>
<tr>
<td>R7</td>
<td>1</td>
<td>Electra Potentiometer</td>
<td>3500-4500</td>
<td>1,200-5,000 ohms</td>
</tr>
<tr>
<td>R8-R9</td>
<td>2</td>
<td>Electro Tapped Voltage Divider</td>
<td>D-200</td>
<td>20,000 ohms</td>
</tr>
<tr>
<td>T1</td>
<td>1</td>
<td>Acrast Microphone Transformer</td>
<td>9625</td>
<td>200-2000 ohms</td>
</tr>
<tr>
<td>T2</td>
<td>1</td>
<td>National Audio Transformer</td>
<td>A100</td>
<td>1-10,000</td>
</tr>
<tr>
<td>T3</td>
<td>1</td>
<td>National Class B Input Transformer</td>
<td>B1</td>
<td>variable</td>
</tr>
<tr>
<td>T4</td>
<td>1</td>
<td>National Class B Output Transformer</td>
<td>B0</td>
<td></td>
</tr>
<tr>
<td>T5-T6</td>
<td>2</td>
<td>Acrast Power Transformers</td>
<td>6758</td>
<td></td>
</tr>
<tr>
<td>V1-V2-V3-V4</td>
<td>7</td>
<td>Eveready-Raytheon Tubes</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td>1</td>
<td>Eveready-Raytheon Tube</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>V9</td>
<td>2</td>
<td>Eveready-Raytheon Rectifier Tubes</td>
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<td></td>
</tr>
<tr>
<td>L-1-L2-L3-L4</td>
<td>4</td>
<td>Inductors wound as described in text (or supplied in kit form by the Insulin Corp. of America)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L5-L6</td>
<td>2</td>
<td>Audio Chokes</td>
<td>4714 30-Henry, 150 ma.</td>
<td>65 doubles 8-8.5 mf.</td>
</tr>
<tr>
<td>C14-C15-C16-C17</td>
<td>3</td>
<td>Acrast Electrolytic Filter Cond.</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>L7-L8</td>
<td>2</td>
<td>Five-Prong Insulin Co. Sockets</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>L9-L10</td>
<td>2</td>
<td>Four-Prong Insulin Co. Sockets</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>L11-L12</td>
<td>2</td>
<td>Diacs 4 inches dia.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>L13-L14</td>
<td>2</td>
<td>R. F. Transmitting Chokes as per winding details in Fig 3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td>1</td>
<td>Weston 6-1/2 Amp. Thermo-Couple Ammeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td>1</td>
<td>Weston Type 301, 0-200 milliammeter</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>Insulin Corp. Panels 1/2 inch thick, 17½ inches long by 8 inches wide</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>1</td>
<td>Universal Double Button Microphone</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>A. C. Line Switch</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>Breadboards 12&quot; by 16&quot;</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Lumber for frame as shown in Fig 2.
this important step in the future. Anyone who is a citizen of the United States, native born or naturalized, may apply for the amateur operator's examination.

There are three classes of amateur operator licenses. Class C applies to those who reside more than 125 miles from any one of the numerous cities where examination places have been set up. To these people written examinations are given in their own homes after they first demonstrate before some local amateur radio operator their ability to pass a code test.

The Class B license applies to all newcomers in the game who live within the 125 mile radius of one of the examination centers. Those falling in this category must present themselves at the examination centers and pass a code test administered by one of the examining inspectors. Then they are given the written part of the examination. This embraces such items as questions on regulations of the Federal Radio Commission, transmitter and receiver design, and theory and operation of transmitters and receivers.

The Class A license, carrying so-called unlimited privileges, applies only to those previously licensed amateur operators who have held one of the above licenses for a year or more and who pass a rather extensive written examination covering a wide variety of questions on theory and practice of telegraph and phone transmitters.

The Class A license allows an amateur to operate a c.w. station in any one or all of the various frequency bands set aside by the Federal Radio Commission for amateur use. It also permits the operation of phone stations in any one of the phone channels.

Class A privileges allow phone operation in all of the following frequency bands:

1800 kc. to 2900 kc. ("160 meters")
2900 kc. to 4000 kc. ("75 meters")
4150 kc. to 11,250 kc. ("20 meters")
28,000 kc. to 28,500 kc. ("10 meters")
56,000 kc. to 60,000 kc. ("5 meters")
400,000 kc. to 410,000 kc. ("51/2 meter")

Class B and C privileges extend to phone operation in all of the above bands excepting the two marked with an asterisk. These two bands are for the exclusive use of holders of Class A licenses.

From the above it will be seen that before an amateur can engage in phone operation in the 75-meter (3900-4000 kc.) band, the band most prominently associated with amateur phone work, he must first hold a Class B or C license for at least one year. Then he becomes eligible for the Class A examination.

For this reason the transmitter description which follows concerns itself with a 15-meter outfit—one which will prove satisfactory for use by Class A, B and C license holders, and with alterations in coil winding, for operation in the 3900-4000 kc. band.

The Circuit

The circuit of the complete transmitter, as built and operated by me, and which has rendered satisfactory service to scores of other "hams" throughout the country is shown in all its details in Fig. 1.

It will be seen that, essentially, the transmitter consists of three main units, as follows: (1) the r.f. section, comprising the master oscillator, the intermediate or buffer r.f. stage and the final r.f. modulated amplifier; (2) the audio channel, comprising the microphone, speech amplifier, and Class B modulator stage; and (3) the dual power supply comprising an individual power supply unit for each of the aforementioned units.

To supply to the antenna a steady c.w. signal, free from frequency modulation, the circuit shown has been found extremely satisfactory. Stability of frequency is assured.
by the fact that the oscillator is separated from the final r.f. amplifier stage by a buffer stage, which also functions to furnish the requisite input excitation to the final amplifier stage.

Oscillator, buffer, and final amplifier all use type 46 tubes. In the oscillator stage the outer grid cathode terminal on socket) is connected to the plate in a series-fed Hartley circuit. In the buffer and final amplifier stages the two grids are tied together, as shown in the circuit diagram.

Referring to the circuit diagram, the variable condensers (C1, C6 and C10 tune their respective circuits to the operating frequency, while in the buffer and final amplifier stages the condensers C8 and C12, respectively, furnish the requisite neutralizing mediums. The antenna is tuned to resonance with the tank circuit of the final r.f. amplifier by means of the series tuning condenser, C13.

Take particular note of the fact that only 250 volts is applied to the plate of the oscillator. This lower-than-usual plate potential is purposely applied to guard against an erratic oscillatory condition. In the buffer and final amplifier stages the plate potential, under operating conditions, is 400 volts.

Coupling from one stage to another is obtained by the capacitors C5 and C9.

It has been found advisable to shunt the filament terminals of each of the r.f. tubes with its own center-tap resistor, the mid-point of which is grounded. Thus each stage is assured of having short, direct returns to ground and unwanted coupling between stages is prevented.

The Audio Channel

In the audio arrangement shown, employing Class B amplification in the modulator stage, approximately 20 watts of audio power is delivered, an amount sufficient to fully modulate an r.f. input of about 40 watts.

The circuit, as can be seen, is perfectly straightforward, and consists of a microphone stage employing a type 56 tube, transformer coupled to a 46 Class A driver, operated at a plate potential of 250 volts. This stage feeds into a pair of 46's in push-pull, Class B, which in turn furnish the audio power to the r.f. amplifier.

Class B transformers, originally designed for use with type 10 tubes, were found to work quite satisfactorily at the voltage values indicated for the 46's.

Volume, or gain control, is furnished by means of a 0-500,000-ohm potentiometer R7, shunted across the secondary of the microphone transformer T1. A 200-ma. meter M2 connected in series with the plate supply to the 46 modulator tubes functions as an excellent volume level indicator.

The Power Supplies

For furnishing the requisite plate and filament potential to the tubes in the transmitter, two power supplies, identical in every respect, are employed. One of them furnishes all the plate and filament supply required by the audio channel, while the other is used solely to furnish the same kind of supply to the r.f. channel.

The primaries of the two power transformers are connected in parallel and, through a series line switch, to the 110-volt a.c. supply. This line switch, at first, controlled the entire operation of the transmitter. The one drawback to this arrangement was that in coming back at a station which had been successfully contacted, it took some time—a matter of seconds—before my station again got on the air, due to the thermal lag of the heater of the 56 tube.

This condition was overcome by inserting an additional switch in series with the plate supply to the voltage divider of the r.f. power supply so that while the heater and filament supply to all the tubes was uninterrupted, the plate supply to the r.f. tubes might be broken during listening periods.

The power transformer secondary is rated at an output of 350 volts either side of its center-tap. Several filament windings are provided, but the two which interest us most are the 2.5-volt, 3.5-ampere winding suitable for furnishing filament supply to the type 82 rectifier tubes and the 2.5-volt, 9-ampere winding for furnishing filament supply to the tubes in the transmitter proper. In the r.f. channel the filament consumption is on the order of 7 ampères, while for the audio channel it is 6.55 ampères, both these figures being well within the 9-ampere rating of the filament windings of the power transformers.

Heavy duty chokes, capable of passing 150 milliamperes and rated at 30 henries, are employed in the filter section, together with electrolytic condensers having two 8-mf. sections in each can. Purely for safety's sake and better regulation of the power supply, the voltage divider resistors R5 and R9 are of the 75-watt type and have a resistance of 20,000 ohms, each one being supplied with two variable taps for picking off the intermediate voltages. Under proper load conditions

**Under normal operating conditions the various tubes will impose a drain on the power supply as follows:**

- **Oscillator, 15 ma.**
- **Buffer amplifier, 15 ma.**
- **Final r.f. amplifier, 100 ma.**
- **Speech Amplifier, 5 ma.**
- **Interstage audio amplifier, 20 ma.**
- **Class B Modulator, 10 to 20 ma. without speech, 100 ma. peaks with speech.**
the taps are arranged to provide 400 and 250 volts. Proper load conditions can be determined with the aid of the milliammeter which temporarily may be connected in the plate supply circuits to the various tubes.

**Constructional Details**

Originally the transmitter was laid out in breadboard fashion, but it decidedly was not an object of art in this condition. Later, its constructional features were revamped with a marked improvement, not only in appearance but in operation and ease of adjustment.

A wooden rack, such as that shown in Fig. 2, was built to take four removable slide-in shelves. Then, for the shelves, four 12" by 16" breadboards were procured from a house-furnishing store and disposed of in the following manner: the shelf sliding in at the bottom of the rack contains both power supplies; the one immediately above it houses all the audio apparatus; next above this one comes the oscillator-buffer stages; and finally at the top is the final r.f. amplifier shelf.

Referring again to Fig. 2 it will be seen that one size of lumber is used throughout in the construction of the rack. The lumber is clear pine, free from knots, and is 7/8-inch thick by two inches wide. The front uprights are 36 inches long and the rear uprights 24 inches long. The front and rear uprights are joined together laterally by four pieces on each side, these pieces being 12 inches long. Five cross-members stretching the full width of the rack join the side assemblies together. These are 16 inches long.

To each of the breadboard bases is fastened a bakelite panel, each of the four panels being 8 inches wide by 17¾ inches long. In the original construction I used veneer panels, and, from a transmitting standpoint, with some measure of success. However, I made the error of painting these panels with a paint which proved to be highly conductive and I obtained a swell grid leak action. Although I don't know exactly, I'm sure many good amperes which should have gone backwards were dissipated in the paint on the panels. Therefore, with all possible haste I changed over to bakelite panels.

I found that there was a distinct advantage to be gained by the use of the shelf and rack method of construction. First, it was highly convenient to mount and wire the parts on one baseboard at a time. Then, as each shelf was completed it was slid into place in the rack. Secondly, when it came time to make slight adjustments, it was decidedly convenient to be able to remove only that shelf with which I was concerned at the moment, without having to disturb the wiring or connections to the remaining shelves.

The several accompanying photographs show quite plainly the layout of the parts on the four shelves. Beginning at the top shelf, the tank tuning condenser C10 is mounted at the right of the panel, while the antenna tuning condenser C15 is to the left. Midway between these two, and lower down on the panel, is the neutralizing condenser, C12. Directly above it is located the antenna ammeter, M1. On the shelf itself, the tank inductor, L3, is located directly behind the neutralizing condenser, while the two 46 tubes, V3 and V4, are mounted either side of it. Other parts are located as indicated. The antenna coupling coil L1 is mounted on a brass strip which is slotted so as to permit the coil to be slid back and forth for variable coupling between it and the tank inductor L3. Plate, input and filament connections are brought to Fahnestock clips arranged along the rear of the baseboard.

The next lower shelf assembly is as follows: on the panel the oscillator tuning condenser, C1, is at the right and the buffer stage tuning condenser, C6, at the left. The neutralizing condenser C8 is located between them. Directly behind the oscillator tuning condenser is the oscillator inductor L1, while behind it is the oscillator tube, V1. The buffer inductor L2, and the tube V2 are likewise located behind the tuning condenser, C6. Other parts employed are located as indicated.

Next below this panel and shelf is the audio channel, and, when viewed from the front, as the others are the microphone switch and gain control are located at the left of the panel while the volume level indicator meter is to the right. On the baseboard, from left to right, are located in order the microphone transformer T1, the inter-stage coupling transformer T2, the Class B input transformer T3, and the output Class B transformer T4. Behind the transformers are located the several audio tubes, as shown, while the Fahnestock clip connectors are...
disposed along the rear edge of the baseboard.

The last and lowest shelf in the rack contains the dual power supply. Only the line switch is mounted on the panel, in the center. Along the front edge of the baseboard are the rectifier V10, power transformer T6, rectifier V9 and power transformer T3. Behind them are the filter units C16-C17-L6 and C14-C15-L5. The two voltage divider resistors R8 and R9, together with the Fahnestock clips for voltage supply, are located along the rear of the baseboard.

**Aerial Kinks**

The twin problems of how to use two or more aerials with one short-wave receiver and two or more short-wave receivers with one aerial frequently arise.

The first is easy of solution. Simply take all the leads-ins from the respective aerials and connect them to the aerial binding post of the receiver. This sounds like terribly obvious advice, but many people seem to have the idea that special coupling coils are needed. The use of a number of aerials, running in different directions, is advantageous in some locations. At some experimental short-wave receiving stations three or four independent aerials, spaced as much as several miles but feeding into a common receiver, have been found to compensate to a large extent for fading effects. The same signal may be fading when it hits one aerial but not another, and therefore good reception is sometimes obtained when a single aerial is useless.

Only on this shelf alone was it found advisable to run the connecting wires underneath the baseboard. This was necessary because the power apparatus available at the time the receiver was rebuilt was of the sub-panel construction type. If other parts allowing wiring above the baseboard are available, they may readily be used providing they meet the voltage requirements as outlined previously.

The circuit diagram Fig. 1 shows how the various shelves are interconnected. In a following article, full instructions for adjusting the transmitter preparatory to putting it on the air will be given, together with data on various types of antenna which may be found desirable for 160-meter operation.

One thing more. The coils employed were home-made and full details for winding them are given in Fig. 3. For those who wish to purchase their coil kit all ready for winding without the attendant troubles of drilling holes and purchasing an oversupply of wire, arrangements have been made with the firm mentioned in the list of parts to furnish a complete kit.

**License Exams**

Prospective radio amateurs living in the southwest will be interested to learn that examinations for all classes of operator licenses will be held at 9 a.m., C.S.T., at the following points:

- Oklahoma City, Okla., Civil Service Building. Examination days: February 2nd, May 4th, August 3rd, November 2nd.
- San Antonio, Tex., Civil Service Room, Post Office Building. Examination days: March 2nd, June 1st, September 7th, December 7th.
- Dallas, Tex., 464 Federal Bldg. Examination days: every Tuesday and Friday except when one of these days is a National holiday or when an examination is being held in San Antonio or Oklahoma City, as shown in the foregoing schedule.

It is requested that each applicant notify the Federal Radio Commission, Division of Field Operations, 464 Federal Building, Dallas, Tex., in advance.
Philco Model 16 All-Wave Receiver

The Philco Model 16 all-wave receiver is an eleven-tube outfit of advanced design. All the tubes are of the 6.3-volt a.c. type, which seem to be replacing the 2.5-volt type in many sets. The combined output of the oscillator (76) and the first detector (77) feeds into a two-stage intermediate-frequency amplifier tuned to 460 kc. and using 78's. Quiet automatic volume control is provided by a 78.

Majestic Model 10 Short-Wave Converter

The Majestic Model 10 short-wave converter is a two-tube-plus-rectifier unit, completely self-contained and self-powered. When used with a broadcast receiver of the t.r.f. type, the combination becomes a superheterodyne; when used with an existing broadcast super, the combination is a sort of double super. The aerial change-over switch on the converter also acts as power switch for the receiver.
Many listeners are not aware of the fact that transatlantic telephone communication is carried on by short-wave radio. In tuning over a band you may run across some speech that sounds as though it was being run through a meat grinder. You recognize the fact that it is speech, but it is impossible to understand any of it. The reason is very simple: if a person uses the telephone to speak to anyone in Europe, in all probability that person demands privacy. To insure privacy, the telephone company literally scrambles the speech before it goes over the air, and then unscrambles it again at the other end. This method is technically known as "inverted speech." Another method used to make the voice unrecognizable is to remove the carrier and one side band, which introduces a kind of distortion. It is second, and rather unknown, method that will be simply analyzed here, since it offers a solution to the problem of amateur phone interference.

It is a simple matter to determine the difference between scrambled and single side-band transatlantic phone: if, during a short time that there is no speech, a carrier can be heard, then scrambled; or, inverted, speech is being used; if the carrier cannot be heard, then single side-band phone is being used.

The 80 and 160 meter bands consist of frequency ranges of 3900 to 4000 kilocycles and 1800 to 2000 kilocycles, respectively. This means a frequency range difference of 100 kilocycles in the 80-meter band and 200 kilocycles in the 160-meter band. Now, if 10 kilocycles is sufficient separation between adjacent channels, there are available in the 80 meter band:

8000-8100
10
or 10 channels: and in the 160 meter band:

2000-1800
10
or 20 channels. All told, there are 30 separate channels in these two bands with thousands of amateurs trying to occupy them at one time.

If we were to express, as a ratio, the number of stations working in these bands, to frequencies, to the number of channels available, or, in other words, the number of stations per channel, the ratio would be great in favor of the number of stations.

There are three methods of transmission used in present day communications:

1. The most common method of sending out transmitted waves, consisting of a carrier frequency and two side bands.
2. Transmitting the carrier frequency and only one side band (either one).
3. Suppressing the carrier and one side band (either one) and transmitting the remaining side band only.

The first is the well-known method used in radio broadcasting; the second is used mostly in carrier telephony; and the third, in carrier telephony and trans-oceanic communications. Considering the third method only, as it is the one we are interested in at present, it can be said that the method of suppressed-carrier single side-band transmission is by no means new. It has been used extensively in radio and telephony with a great deal of success for the past fifteen years, especially in carrier telephone systems and trans-oceanic communications. Single side-band transmission has a large number of advantages over ordinary methods of transmission, and also has certain disadvantages—if they could be called disadvantages—as will be seen in the following enumeration of both the advantages and so-called disadvantages of single side-band transmission. The advantages are:

1. There is a power saving of approximately 5/6 of the power required in the ordinary method of carrier transmission. This is so because the carrier in ordinary methods of transmission represents about 2/3 of the radiated power. And the other 1/3 is present in the two side bands—each side band has 1/6 of the total power. If the carrier is suppressed, 4/6 of the power is immediately saved, and if one side band is also suppressed, another 1/6 of the power is done away with. In all, then, 4/6 plus 1/6, or 5/6, of the original power is saved. The remaining side band, therefore, can be radiated the same distance (or at least that reduced intensity with but 1/6 of the power necessary to transmit over the same distance using the carrier method of transmission.

2. The channel width is cut in half, because only one side band is transmitted, whereas the carrier method occupies the whole channel. Since both side bands are transmitted. This makes it possible to have two stations operating with no interference between them; or, better still, if conditions allow, only one station need occupy each channel, and by each transmitting either the upper or lower side band, practically no interference is set up.

The so-called disadvantages are:

1. The necessity for extremely high-precision, tested apparatus, such as balanced modulators, local oscillators, and highly-selective filter circuits, which are needed for making this method of transmission effective.

2. The necessity for a separate, or local, oscillator of definite frequency and amplitude which is necessary for complete demodulation and recognition of the original signals at the receiving station. However, it can be seen that if the apparatus mentioned above is obtained, or built, and meets the circuit requirements, the above disadvantages actually become advantages, as they make for a successful transmitter, creating no interference, and thereby answering the problems to be discussed here.

The method of suppressed-carrier, single side-band transmission is a subject that has not been discussed or written about to any great extent in the past. It would be advisable, then, to discuss briefly, and in order, the general theory of modulation, the production of side bands, and the principles of suppressed-carrier single (Continued on page 39).
Grid-Bias Resistor Chart

<table>
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<tr>
<th>TYPE</th>
<th>PLATE SUPPLY</th>
<th>SCREEN VOLTS</th>
<th>GRID VOLTS</th>
<th>GRID RESISTOR IN OHMS</th>
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The chart above was computed for convenience of the determination of the proper grid-bias resistor for most of the tubes in common use today. The value of the bias resistor is given, not only for each tube, but for each different plate voltage recommended for each tube. To facilitate the use of the chart, the corresponding value of screen voltage is stated. There are several abbreviations to be noted: The first is that some tubes may be used for a variety of purposes, and each purpose requires a different value of grid-bias resistor; an abbreviation—the letter in parentheses—has been used to designate the use of the tube:

(A) means class A amplifier.
(B) means class B amplifier.
(C) means converter—first detector in supers.

(D) means detector. Aside from these general classifications, there are several tubes that may be connected so that they are triodes class A, pentodes class A, or triodes class B. These uses may be easily distinguished because of the wording, "triode, pent., or triode." Whether or not the triode is used as a class A or class B amplifier is represented by (A) or (B), respectively. For example, consider the type 89 tube: the values of grid-bias resistors corresponding to the various plate voltages preceded by the notation, "(A) triode," mean that when the type 89—power tube is connected for use as a triode class A amplifier, the values of grid-bias resistors are as shown alongside the corresponding values of plate voltage. Then, too, there are other tubes which cannot be used—rather, are not recommended for use—in audio circuits. Such tubes are designated "(A) r.f."

A glance at the values of resistors recommended will show that their sizes are odd, and cannot be purchased in the open market. The values given are exactly those computed. Purchase resistors as close to those specified as possible—L.M.
Where Does Noise Come From?

It is well known that extraneous noise in the output of a radio receiver may be caused in several different ways. A few of these are:

1. Atmospheric static
2. Power supply noise
3. Man-made static
4. Poor connections
5. Defective or poor quality parts

There are, however, other noise sources which persistently remain after the above sources have been eliminated. These become evident as a ready hissing sound when the receiver sensitivity is high. When an attempt is made to eliminate these sources of noise, it is found that a certain minimum remains which approaches the value predicted theoretically as due to thermal agitation and "shot" effect.

Thermal-agitation noise is supposed to be due to the random movements of electrons within a conductor. It has no particular frequency, but consists of a series of pulses.

Shot-effect noise is produced by the emission of electrons. Electricity is not an infinitely fine grained fluid, but consists of discrete particles, that is, electrons. From the theory of emission it can be predicted that a certain noise current is present in the electron current. This noise current consists of a series of pulses similar to the thermal-agitation effect.

On a purely theoretical basis, relations have been derived for calculating both the thermal-agitation voltage and the shot-effect voltage. Measurements show agreement between calculated and measured values.

Figure 1 shows a block diagram representing a receiver. Assume a standard signal applied to the receiver input. When the signal voltage is increased from zero, the a.f. output voltages increase first as the square of the input voltage, then linearly with input voltage. This is true for diodes as well as other types of detectors. The range of square-law increase will depend on the type of detector. For a diode operated with a large input signal, the square-law range may be entirely negligible. In more modern receivers there is sufficient a.f. gain between the diode and the tube so that the output will be according to the square law at the 50-milliwatt output level. In general, we may say, that at the initial noise level, a detector will follow the square law.

Frequently, a receiver has no noticeable noise until a carrier is tuned in. Figure 2 shows how the noise-output voltage and the a.f. output voltage increase as the carrier voltage is increased.

In the square-law range, the noise-output voltages increase linearly, while the a.f. output voltages increase according to the square law. In the linear range the noise-output voltages are constant, while the a.f. output voltages increase linearly.

The laws of increase of noise and a.f. voltage are different. As the signal is increased, both carrier voltages and sideband voltages increase proportionately. The noise-input voltages existing independent of signal appear as a constant sum in the receiver. In both instances the output is proportional to the product of the carrier and sideband voltages.

As the detection becomes linear, the output is no longer proportional to the product of the voltages, but is directly proportional to the smaller of the two voltages and is independent of the magnitude of the larger voltage. Since the carrier is the larger voltage, increasing it does not increase the noise-output voltage. The increase in a.f. output voltage results because the sideband voltage is increased.

It is interesting to note that the ratio of noise-output voltages to a.f. voltages varies inversely as the signal input voltage throughout the square law and linear range of operation.

It is evident that as the signal is increased, the noise will become a negligible factor and that as the signal is decreased the noise will eventually become greater than the a.f. output. This latter condition may occur at a low level.

The noise voltage usually originates either in the grid circuit or in the plate circuit of the first tube. Under conditions of very low gain in these circuits, the second tube may also contribute to the noise.

Since the noise is a series of pulses it excites the associated circuits in the frequency range to which they respond. It is amplified by the succeeding stages provided they are in circuit with the initial circuit either directly or through the medium of a frequency converter. For example, if the noise originates as a band of radio frequencies, it is changed by the converter to many other signals which are changed to the corresponding bands of intermediate frequencies. Thus, the noise voltage appears at the detector input and also in the a.f. output, although it may become inaudible until sufficient carrier voltage is supplied at the detector input.

Effect of Circuit Constants

Refer to Figure 1 and suppose the input to the first tube is short-circuited so that only plate-circuit noise is amplified. Then, by adjusting Gain II the noise-voltage input to the detector may be made any value either large or small. Changing the plate-load impedance Z has the same effect as changing Gain II. Both noise and signal are changed in the same ratio. Cutting the frequency band width either in the i.f. or a.f. stages gives a satisfactory apparent reduction in noise, since the ear is most sensitive to high frequencies. Of course, the higher a.f. components of the signal are reduced at the same time.

**Summary:** This masterly article describes the various causes and sources of noise in radio receivers, and pays particular attention to the little-known thermal agitation and "shot" effects. Since noise in short-wave reception has become the main limiting factor in set design, the information given herewith should be of timely interest and appeal.

---

![Block diagram of a typical receiver, arranged for purposes of noise analysis. High gain in the initial amplifier stages reduces the noise level. Z₁ and Z₂ are the respective input and output impedances of the first tube.](image)

**FIG.1**

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**SHORT WAVE RADIO**
If the noise-volts input to the detector is low enough so that the detector becomes linear before the noise voltage reaches the audible level (approx. 0.1 volt across 4,000 ohms), no amount of increase in signal will produce audible noise. This is evident by referring to the curves of Fig. 2.

Theory shows that the shot voltage is inversely proportional to the square root of the plate current of a tube. The variation of plate-circuit noise voltage with plate current is found to change in proportion to the square root of the plate current and to be almost independent of the plate, screen and grid voltage, and of whether or not the tube has oscillator-input voltage on it.

High gain in the first tube gives low output noise for any receiver sensitivity. For example, in a superheterodyne receiver, a first detector tube gives less gain for the same plate current than an amplifier tube. Hence, for a given sensitivity, a set which uses a first detector in the first tube position will have more noise than a similar set which uses an amplifier.

When gain is controlled in the first tube, the gain decreases faster than the square root of the plate current. That is, noise output goes up more than the noise is decreased, but the gain is decreased more than the noise is decreased. It would be advantageous then, in practice, to secure this decrease in gain in the succeeding stage. Thus, in the first tube to be operated at a fixed bias with small signal input, the lowest noise will be obtained by choosing a tube with high gain and low plate current, and by operating this tube at the highest value of plate current permissible. Operating with high plate current increases the gain more than it increases the noise. It is assumed that the plate resistance is not reduced enough to affect the results.

Similarly, if two or more tubes are put in parallel and the plate resistance remains high enough to be negligible, the gain will be increased by raising the number of tubes in parallel. The plate current is increased by raising the number of tubes. The noise, for the same overall sensitivity, is thus reduced by a factor of the square root of n. RCA Radio Corp., Inc.

**Hum Elimination in AC-DC Receivers**

The continued popularity of the AC-DC receiver intensifies the necessity of more elaborate precautions to eliminate hum difficulties which arise in connection with the design and production of these receivers.

Hum may be divided into two classes: (1) that which is present when no signal is being received and that which is apparent with an impressed signal.

The principal sources of hum when no signal is being received are:

1. Unbalance in power supply to receiver.
2. Insufficient filtering of rectified power.
3. Heater cathode leakage.
4. Incorrect by-passing of cathode resistors.
5. Incorrect cathode resistor in detector-oscillator circuit.
6. Coupling from oscillator to input of 2nd detector.

The principal sources of hum when signal is present are:

1. Reradiation from rectifier.
2. Overloading of input stage with strong signal.
3. Hum caused by unbalance of the power line as checked by reversing the line plug. If any difference in hum is noted, this indicates an unbalanced condition. This may usually be cured by employing a value condenser, of about 0.1 mfd, for each section between each side of the line and the chassis.
4. Insufficient filtering is one of the most frequent sources of hum because of the limited space which can be used for filters in some sets. If a 12Z3 rectifier is employed the value of inductance or capacities should be increased if possible. If a 25Z5 is used as a half-wave rectifier with both cathodes in parallel, some improvement may be noted by separating the field of the speaker from the rest of the filter system.

The condition of this system is that the excitation and plate voltage may be adjusted independently by changing values of filter condensers.

The heater cathode leakage should be kept at a minimum in order to help reduce hum. Further reduction may be effected by making certain that the tubes most subject to hum have their heaters connected into the voltage supply in such a way as to be nearest the negative plate-supply terminal. Usually it will be found that the best arrangement is the following, starting from the negative plate-supply lead: 2nd detector, detector oscillator, output tube, to be followed by the remaining tubes. The series resistor usually should be connected to the side of the line feeding the rectifier plate or plates, followed by the rectifier heater. Bypassing the cathode resistors of both the second detector and output tube with large capacity low voltage electrolytic condensers should aid in reducing hum content.

Many detector-oscillator circuits operate the detector-oscillator tube with a relatively low bias resistor in the cathode circuit (500 ohms or less). This condition can lead to hum conditions since the peak oscillator voltage on the grid of this tube is considerably higher than the grid bias, causing grid current to flow during part of each cycle. Besides introducing hum this gives rise to poor selectivity and gain. It may be necessary to readjust the coupling in order to employ a resistor of the proper value (10,000 ohms).

Most broadcast receivers of this type utilize a 2-gang condenser and a circuit requiring a detector oscillator, an intermediate amplifier at 456 kilocycles, a second detector and an output tube, as well as a rectifier. In most cases the intermediate transformer is of the single-tuned type. With a set of this kind hum is often very troublesome at the low-frequency end of the dial, while it is satisfactory at the high-frequency end. This difficulty is due to the fact that sufficient attenuation is not available between the oscillator and the second detector to prevent hum.

**SUMMARY:** The eight principal causes of hum in a.c.-d.c. receivers are described herein, and many practical suggestions for their cure are offered. Of course, the information given applies just as fully to straight a.c. short-wave receivers, many of which suffer from the very hum troubles mentioned.

Mysterious "modulation hum," which is present only when signals are being received, is disclosed as a result of inadequate filtering.
How Capt. Hall Obtained a Verification from Mussolini!

SOME time ago I wrote in an article that 2R0, Rome, Italy, was hard to hear and harder to hear from. Since that statement appeared I have had some “fine business” with them. Here is the story in detail:

Almost two years ago, when I decided to go after “verifies” with a vengeance I described a program that I had heard transmitted from 2R0 station and requested a verification. After waiting nearly two months, and not receiving any reply, I wrote again. Still no answer. In all I wrote nine letters, each time including an international reply coupon. Each letter was written after an interval of about a month and after each letter my anger rose. In July 1925 it reached the “boiling point.” At that time 2R0 was the easiest of the foreign locals to hear. So one day I wrote down a program I heard and also wrote a letter. To the station? No! To Premier Benito Mussolini. In my letter I told him that I had sent nine letters to this Government-controlled station, also mentioning the reply coupons, and had never received an answer. I also wrote that I was not the only one who had experienced this discourtesy from this station. The letter, to put it plainly, was very “hot.” After sending the letter off registered mail, with a return receipt required, I waited further developments. In the middle of August the return receipt arrived signed, so someone had gotten the letter.

One day in November the mail included a legal looking envelope with “Consul General of Italy” written across the left-hand corner. The enclosed letter was from the Consul General of New York City and requested my presence at his office as he had something to tell me. I went there that same day and saw the Consul himself. He told me that he had a communication from Mussolini. To make a long story short, H. Duce himself had taken my letter and had given it to his secretary for a thorough investigation of conditions at 2R0. Among other things they found that the program I had enclosed was broadcast on that day, so this was a verify from Mussolini!

A Thorough Investigation

But they did not think that sufficient. They made a thorough investigation of why the station had not answered. The station’s alibi was that they had never received any of my nine letters. So the Secretary forwarded all data to the Consul here and he was to find out further details from me. I told him that many fans had “black-balled” 2R0 as one of the stations that did not answer. He said all information that I had given him would be forwarded to Italy, but the officials in Charge of Foreign Affairs would handle it. Said the Consul, “You will hear from us again.”

Indeed I did hear from them again. About three months passed and I got another letter from the Consul and down to the office I went for the second interview. He said, “Premier Mussolini thanks you so much for writing him, because he is interested in just these things. His policy is to investigate the smallest complaints. May I add that he has employed at 2R0 an Englishman to answer all correspondence. So tell your friends that 2R0 will from now on answer all letters promptly and we are sorry for this misunderstanding.”

And you who receive your new 2R0 verifies can thank Premier Mussolini for them. It is needless to say that when I wrote another letter to the station I received my verify in twenty-one days.

* * *

Bombay, India

BOMBAY! Bombay! Oh, what a place! People often ask me what thrilled me most when I came alongside of it and I always say Bombay. When my ship came within sight of that grand and truly Far Eastern City, I was like a child going to the circus for the first time. The build, the native dress of the peoples, and the innumerable religions that are such an interesting study in themselves all intrigued me. I could write pages about my impressions of Bombay.

Right now I correspond with a most interesting high caste gentleman of Bombay who is also a short-wave fan. His name is D. R. Wadia and he has initiated his charming wife into the secrets of his hobby. Together they tune and listen to programs from the old and new worlds. Mr. Wadia has heard every continent but North America and it would greatly thrill him to hear a station announcement from America. His “veries” include LSX, HVJ, VK2ME, VQ7LO, G5SW, FYA, PCJ and VU2BF.

Now about his receiver. He has used almost every standard commercially built receiver, but has been getting some of his best catches on an American superhet. He is a most excellent friend and I feel highly honored to list him as one of my correspondents.

Pictures of Mr. Wadia and his wife are reproduced here.
Mail From Readers

The mail bag has been overflowing with letters from fans from all parts of the United States.

Mr. W. J. Rohrer of York, Pa., wrote of reception of PSK, on 36.65 meters. This is the station that radiates programs for the Radio Club of Brazil and is on 7 to 7.30 p.m. E.S.T. every night. Requests are asked for and a veri promised.

Edward Weppler of West Lafayette, Ind., reports excellent reception of the following: CP5, La Paz, Bolivia on 49.40 meters; HBJ, Bogota, Colombia, on 20.06 meters; KAY and KAX, Manila, P. I., working on 20.03 meters and 15 meters, respectively; LSN, Buenos Aires, on 30.3 meters; YV1BC, Caracas, Venezuela, on 50.20 meters; IRM Rome, Italy, on 36.52 meters, and ZFA, Bermuda on 50.4 meters.

Most of these stations are commercial phone circuits and have no regular schedules and are on the air only when traffic permits.

How to Get Moscow

Mr. L. E. Goerner of Oberlin, Ohio, reports the impossibility of receiving Moscow. Maybe he does not have the latest dope on this catch. RV59 is on 50 meters from 4 to 6 p.m. E.S.T., and on Sunday RNE, on 25.00 meters, also transmits the same program. One is likely to hear RNE most any morning testing with America or Germany. RV59 is considered one of the foreign "locals" here in New York. We hear them best from about 4.45 to 6 p.m. It is easy to identify this station, as their broadcasts consist solely of talks in foreign languages. On Sunday, Wednesday and Friday, English is spoken. Station announcements are given at the even half hours and are as follows, "Hillo, Hillo. Here is Moscow." This is said several times by either a lady or man announcer and the playing of the "International" follows. When writing to this station for a verification the address is "Radio Centre, Solianka 12 Moscow, U.S.S.R." Do not write Russia if you expect to have your letter delivered.

Mr. C. E. Schiller, of Muskogee, Okla., writes of regular reception of EAQ, TI4NRH, Pentons, France; Germany, England, LSL, HRM, VK2ME, several phones and the Byrd Expedition. This fan is using a seven-tube, all-wave super.

Mr. H. N. C. of Poughkeepsie, N. Y., wrote asking about 2RO, Rome, Italy. I think this article will clear up his question. If not fire them along.

Short Waves in the Evening

Frank Gilellen, Jr., of San Diego, Cal., "razza" me for saying it is possible to get stations on the low waves in the evenings. I do not know about reception in California but here in New York we heard Germany on 19 meters until 9.30 p.m., France on 25 meters until midnight, England on 79 meters and numerous 20-meter phones until the sun comes up, every night last summer. Let us hear your ideas on this subject.


Guy R. Bigbee, Fort Benning, Georgia, wants to know why I said W2XE blanketed my reception of F3ICD, Saigon, Indo-China. F3ICD has been off the air for almost two years and when I was hearing them W2XE used to come on the air with all its power and drowned out all hope of further reception of this Far Eastern station.

Kenneth Pratt, of Milton, Mass., requests the address of G6RX, the English phone heard on 69.44 meters. It is: Engineer-in-Chief's Office, General Post Office (Radio section) 86 Wood Street, London E.C. 2.

This correspondent also wants to know the call letters of the Japanese station mentioned in a previous article. It is JOGK, a 10 kw. station on Kyushin Island.

* * *

New Catches

New catches by the writer were:

"Radio Budapest," sending a special program on 45.86 meters, call letters HAT2.

"Radio Kopack," on about 50.00 meters, sending a special broadcast to India from 3.15 to 5.41 p.m. E.S.T.

"Radio Vienna" or U0R2 on Sunday. Full details in next article.

Heard for the past month: Germany, France, Spain, Morocco, Russia, Australia, Dutch East Indies, South America, Canada and Nova Scotia. Try for HC2RL, Guayaquil, Ecuador; Schedule 5.45 to 8 p.m. E.S.T. on Sunday, and 9.15 to 10.45 on Tuesday.

* * *

A Friend in Japan

Six thousand eight hundred and fifty miles from New York City lives a man who has become one of the best friends I have. His name is Shokichi Yoshimura and he lives in Moji, Japan. He has a collection of "veries" that is astonishing and every letter he writes tells of his new "finds" on the ether waves. We short-wave fans in the United States are principally interested in pulling in stations in foreign countries, but Mr. Yoshimura is thrilled when he catches a United States or South American station. He uses a superhetodryne converter which is attached to a regular broadcast receiver. This converter uses 22's, 227's, and a 290. He has been an ardent tuner for several years and in his spare time he is also a licensed amateur and a member of the J.A.R.L. This alone
Suggestions on Tuning

The Matter of Comfort

Many otherwise excellent short-wave receivers have their main tuning knobs too high on the panel, and the operator, in many cases, is forced to twist his hands into strained positions in order to manipulate the controls. To overcome this trouble, it is sometimes advisable to place a couple of books in front of the set, on which the hands may be rested in a normal, comfortable manner.

This sounds like a small matter, but a set of strained wrist and forearm muscles is likely to take all the joy out of foreign-station fishing.

Incidentally, a good kink in this connection is to replace small tuning knobs with man-sized knobs an inch and a half or more in diameter. These avoid cramping of the fingers and give a sort of extra vernier action. The General Radio “jumbo” knob, which is 2½ inches in diameter, is swell for the purpose.

Practically all control shafts are ½ inch in diameter, and installing a new knob is only a matter of one minute’s work with a small screwdriver.

* * *

Those Harmonics Again!

Newcomers to the short-wave field are invariably fooled by foreign-language programs broadcast by small stations in big cities like New York, Philadelphia and Chicago. These programs are spuriously scattered into the short-wave regions as uninvolved harmonics of the regular broadcast-band transmitter. Just because you hear someone spouting in German, Italian, Spanish, or Bohemian, don’t jump to the conclusion that you have brought in Europe. Wait for a final announcement, which, disappointingly enough, may be in good American English.

By the same token, don’t attempt to identify legitimate short-wave stations according to the language used by the announcer. Many of the European stations, which are frankly operated for propaganda purposes, put on special programs and announcers for the particular benefit of certain foreign countries. For instance, the Berlin stations DJA and DJC frequently have popular talks in Spanish, and even a knowledge of that language will not always enable you to guess the source of the program until it is all over, when an announcement is made in German and then in English.

When PCJ, the Philips Radio station in Eindhoven, Holland, was active a few years ago, it had a versatile announcer, Edward Startz by name, who fluently spoke six or seven tongues. There was never any difficulty about identifying PCJ, for no matter where you lived or were educated you were bound to understand at least one of the announcements! This was probably the reason PCJ was the most popular and widely followed short-wave station on the air. Its present absence from the air waves, reputedly due to political reasons, is certainly lamentable.

* * *

Airplane Call Letters

A number of readers have inquired as to how operators of airplane radio transmitters never give their call letters, as other stations do. The answer is that mobile craft of this kind have five-letter calls, many of which are real tongue-twisters. By special dispensation of the Federal Radio Commission, the operators are not required to use them when engaged in communication with their ground dispatchers. Planes flying established routes are easily identified by the ground operators according to their numbers and the names of the pilots, and the official call letters, therefore, are not very important.

* * *

Keep a Log

Too many listeners depend upon their memory for dial settings of important foreign signals. Every set owner should maintain a “log” of some kind, if it is only a ten-cent ruled notebook.

Several different methods of listing are possible. Some fans arrange their “catches” according to either wavelength in meters or frequency in kilocycles (depending on how the set dial is calibrated), with different sections for each wave band. Other people arrange them according to countries. Another popular method is by the hours of the day. Some methodical set owners who take pride in their international reception have two separate logs, so that they can spot dial settings easily and quickly.

* * *

C. W. Reception

Because some short-wave superheterodynes designed especially for broadcast reception do not incorporate local oscillators, some people have the idea that these sets are not capable of picking up C.W. (continuous wave) telegraph stations.

Theoretically, it should not be possible to receive such stations, but a peculiar heterodyning technique makes reception on neighboring frequencies, with the result that strong signals appear in the receiver. Besides, some commercial radio-telegraph stations transmit modulated signals, which are reproduced quite well without the aid of a local oscillator.

* * *

A. V. C. Noise

In some receivers employing automatic volume control, there appears to be excessive noise between stations, because the absence of a carrier causes the sensitivity or gain to rise to maximum automatically.

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.
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 last column the 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.

<table>
<thead>
<tr>
<th>Station</th>
<th>Country</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.30</td>
<td>E, LSN, Buenos Aires, Argentina</td>
<td>9 to 10 p.m., irregular</td>
</tr>
<tr>
<td>32.00</td>
<td>B, T4NRRH, Costa Rica</td>
<td>8 to 10 p.m.</td>
</tr>
<tr>
<td>31.56</td>
<td>B, YV3BC, Caracas, Venezuela</td>
<td>9.30 to 10.30 p.m.</td>
</tr>
<tr>
<td>36.65</td>
<td>E, PSK, Rio de Janeiro, Brazil</td>
<td>8 p.m., irregular</td>
</tr>
<tr>
<td>40.55</td>
<td>E, HJ3ABD, Bogota, Colombia</td>
<td>9 to 11 p.m.</td>
</tr>
<tr>
<td>41.55</td>
<td>B, HKE, Bogota, Colombia, Mon.</td>
<td>6 to 7 p.m. and Tues. 8 to 9 p.m.</td>
</tr>
<tr>
<td>41.60</td>
<td>B, HJ4ABB, Manizales, Colombia</td>
<td>9 to 10 p.m.</td>
</tr>
<tr>
<td>45.00</td>
<td>B, HCB2L, Quito, Ecuador, Sun.</td>
<td>5 to 7 and Tues. 9 to 11 p.m.</td>
</tr>
<tr>
<td>45.31</td>
<td>B, PRADO, Ribambela, Ecuador, Thurs. 9 to 11 p.m.</td>
<td></td>
</tr>
<tr>
<td>45.60</td>
<td>B, HJ1AB8, Barranquilla, Colombia</td>
<td>6 to 10 p.m.</td>
</tr>
<tr>
<td>47.00</td>
<td>B, HJ5ABD, Cali, Colombia, Thurs.</td>
<td>Sat. and Sun. 7 to 9.30 p.m.</td>
</tr>
<tr>
<td>48.00</td>
<td>B, HJ3ABF, Bogota, Colombia</td>
<td>7 to 10.30 p.m.</td>
</tr>
<tr>
<td>48.50</td>
<td>B, TGW Guatemala, 6-12 p.m.</td>
<td></td>
</tr>
<tr>
<td>48.78</td>
<td>B, YV3BC, Caracas, Venezuela</td>
<td>6.30 to 10 p.m.</td>
</tr>
<tr>
<td>48.95</td>
<td>B, YV1BMG, Maracaibo, Venezuela</td>
<td>8 to 11 p.m.</td>
</tr>
<tr>
<td>50.20</td>
<td>B, YV1BC, Caracas, Venezuela</td>
<td>5 to 10 p.m., irregular</td>
</tr>
<tr>
<td>50.20</td>
<td>B, HJ4ABE, Tungo, Colombia</td>
<td>9 to 10.30 p.m.</td>
</tr>
<tr>
<td>73.00</td>
<td>B, HCB2, Quito, Ecuador, 7.30 to 9.45 p.m.</td>
<td></td>
</tr>
<tr>
<td>75.50</td>
<td>P, KD3, Mexico City, Mexico</td>
<td>8 to 9 p.m. and 5 to 6 p.m.</td>
</tr>
<tr>
<td>26.00</td>
<td>E, XAM, Merida, Yucatan</td>
<td>7 to 8 p.m., irregular</td>
</tr>
<tr>
<td>32.09</td>
<td>E, XDC, Mexico City, Mexico</td>
<td>7 to 7.30 p.m., irregular</td>
</tr>
<tr>
<td>47.50</td>
<td>B, HIZ, Santo Domingo, 5 to 6 p.m.</td>
<td></td>
</tr>
<tr>
<td>47.80</td>
<td>B, HIIA, Dominican Republic</td>
<td>Mon., Wed. and Fri. 1 to 1.30 p.m., Tues., Thurs. and Sat. 7.30 to 9.30 p.m.</td>
</tr>
<tr>
<td>50.40</td>
<td>B, HIX, Santo Domingo, Tues. 8 to 10 p.m.</td>
<td>Sun. 2.30 to 4.30 p.m.</td>
</tr>
<tr>
<td>31.28</td>
<td>B, VK2ME, Sydney, Australia, Sun. 1 to 3 a.m., 5 to 8.30 a.m. and 9 to 11 a.m.</td>
<td></td>
</tr>
<tr>
<td>31.55</td>
<td>B, VK3ME, Melbourne, Australia</td>
<td>Wed. 5 to 6.30, Sat. 5 to 7 a.m.</td>
</tr>
<tr>
<td>25.60</td>
<td>B, V8RR, Winnipeg, Canada</td>
<td>6 to 10 p.m., irregular</td>
</tr>
<tr>
<td>49.10</td>
<td>B, W8HRY, Halifax, N.S., 8 to 11 p.m., 5 to 10 p.m.</td>
<td></td>
</tr>
<tr>
<td>49.22</td>
<td>B, V8GW, Bowmanville, Canada</td>
<td>6 to 8 daily, 6 to 8 p.m.</td>
</tr>
<tr>
<td>49.29</td>
<td>B, V8BJS, St. John, N. B., 5 to 10 p.m.</td>
<td></td>
</tr>
<tr>
<td>49.42</td>
<td>B, V8E0S, Vancouver, B.C., Fri. 12 to 1.30 p.m.</td>
<td></td>
</tr>
<tr>
<td>49.96</td>
<td>B, V8VDR, Montreal, Canada</td>
<td>8 to 10 a.m., Sun 11 to 10 p.m.</td>
</tr>
</tbody>
</table>

NOTE: All times given are approximate and subject to change.
**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 for those 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; AT&T, American Telegraph & Telephone Co.; MIT, Mackay Radio Telegraph Co.; MIT, Mass. Institute of Technology.

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### List of International Call Assignments

<table>
<thead>
<tr>
<th>Block of Calls</th>
<th>Country</th>
<th>Amateur Prefix</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAA-CEZ</td>
<td>Chile</td>
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<td>CEA-CKZ</td>
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<td>CQA-CRZ</td>
<td>Portuguese colonies:</td>
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<td>Cape Verde Is</td>
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<td>Portuguese Guinea</td>
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<td></td>
</tr>
<tr>
<td>Madeira</td>
<td>CT3</td>
<td></td>
</tr>
</tbody>
</table>

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### Block of Calls | Country | Amateur Prefix
---|---|---
J | Japan | J |
K | United States of America | W |
LAA-LNZ | Norway | LA |
LCA-LNZ | Argentine Republic | LU |
LZA-LNZ | Bulgaria | LZ |
M | Great Britain | G |
N | United States of America | W |
OVA-OCZ | Peru | OK |
OVA-OHZ | Finland | OH |
OVA-OKZ | Czechoslovakia | OK |
OVA-OTZ | Belgium and colonies | ON |
OVA-OZZ | Denmark | OZ |
PA-PJZ | The Netherlands | PA |
PA-PJZ | Curacao | P |
PKA-PKZ | Dutch East Indies | PK |
PPA-PYZ | Brazil | P |
PZA-PZZ | Surinam | P |
RHA-RQZ | U.S.S.R. ("Russia") | RA |
RVA-RVZ | Persia | RV |
RXA-RXZ | Republic of Panama | RX |
RVA-RVZ | Lithuania | RV |
SAA-SMZ | Sweden | SM |
SPA-SRZ | Poland | SP |
STA-SUZ | Egypt: | SU |
STH-SVZ | Egypt proper | ST |
SVA-SZZ | Greece | SV |
STA-TT | Turkey | TA |
TFA-TFF | Iceland | TF |
TFA-TGF | Guatemala | TG |
TFA-TFF | Costa Rica | TI |
TVA-TRZ | Territory of the Saar Basin | TS |
TVA-TRZ | Hejaz | TH |
TVA-UKZ | Dutch East Indies | UH |
UHA-UHZ | Luxembourg | UL |
UNA-UNZ | Yugoslavia | UN |
UNA-UNZ | Austria | UO |
UOA-OCZ | Canada | VE |
VHA-VNZ | New Zealand | ZK |
VHA-VNZ | New Zealand proper | ZL |
VHA-VNZ | British Samoa | ZM |
VHA-VNZ | Paraguay | ZP |
VHA-VNZ | Union of South Africa | ZT |
VHA-VNZ | Union of South Africa | ZU |
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<tr>
<th>Station</th>
<th>Frequency (kc.)</th>
<th>Distance (m.)</th>
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<td>EAJ25</td>
<td>6,000</td>
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<td>EAO</td>
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<td>EBE</td>
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<td>30.00</td>
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<td>29.70</td>
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<tr>
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<td>11,705</td>
<td>26.06</td>
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<td>EYB</td>
<td>7,200</td>
<td>41.50</td>
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<td>ERB</td>
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<td>44.07</td>
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<td>EFG</td>
<td>6,600</td>
<td>45.00</td>
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<tr>
<td>EPH</td>
<td>1,576</td>
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<td>10,400</td>
<td>18.76</td>
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<td>29.70</td>
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<tr>
<td>Call Sign</td>
<td>Frequency</td>
<td>Power</td>
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<td>W3XL</td>
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<td>17,780 kc.</td>
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<td>W3XK</td>
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<td>W3XK</td>
<td>9,570 kc.</td>
<td>39.01 m.</td>
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<td>W3XK</td>
<td>6,140 kc.</td>
<td>48.86 m.</td>
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<td>W3XK</td>
<td>4,750 kc.</td>
<td>61.5 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>4,000 kc.</td>
<td>69.67 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>2,500 kc.</td>
<td>115.78 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>1,250 kc.</td>
<td>230.75 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>500 kc.</td>
<td>468.38 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>250 kc.</td>
<td>930.91 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>125 kc.</td>
<td>1860.01 m.</td>
</tr>
<tr>
<td>W3XK</td>
<td>60 kc.</td>
<td>3600.01 m.</td>
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</tbody>
</table>

**Portable and Mobile Stations:**

- **W3XK:** 500 kc., 69.67 m.
- **W3XK:** 2,500 kc., 115.78 m.
- **W3XK:** 1,250 kc., 230.75 m.
- **W3XK:** 500 kc., 930.91 m.
- **W3XK:** 250 kc., 1860.01 m.
- **W3XK:** 125 kc., 3600.01 m.
- **W3XK:** 60 kc., 6480.01 m.

**实验电台 W3XK**

- **W3XK:** 500 kc., 69.67 m.
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### 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. This is 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 1000 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).

<table>
<thead>
<tr>
<th>Location</th>
<th>Call Frequency Power</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>(kc) (watts)</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
- The list includes police radio stations in cities across the United States.
- The frequency is given in kilocycles (kc), and the power in watts.
- The list is arranged alphabetically by city names.

### LICENSED MUNICIPAL POLICE RADIO STATIONS

- **Location:** Various cities in the United States.
- **Call Frequency Power:** Includes frequency in kilocycles (kc) and power in watts.

### LICENSED STATE POLICE STATIONS

- **Location:** Various states in the United States.
- **Call Frequency Power:** Includes frequency in kilocycles (kc) and power in watts.

### CONSTRUCTION PERMITS ISSUED FOR MUNICIPAL POLICE STATIONS

- **Location:** Various cities in the United States.
- **Call Frequency Power:** Includes frequency in kilocycles (kc) and power in watts.
**Uni-Shielded Short Wave 3**

**A Low Cost Set for Beginners!**

Here is the ideal in S.W. Receiver for beginners! It is available in two models—the Uni-Shielded “Two” and Uni-Shielded “Three”. Either gives remarkable performance but because of its lower price the Uni-Shielded “Two” will prove the more popular. This set has been purposely designed to have high r.f. sensitivity in order to bring in hard-to-get foreign stations. It brings a new thrill to short wave fans! There is nothing tricky about the tuning or control regeneration of this simplified set.

**Self-Shielding a New Feature!**

The design of the Uni-Shielded “Two” is such that the chassis itself provides effective shielding of the tubes and for the parts beneath the chassis. It is a minimum of parts and is no wonder the Uni-Shielded “Two” is compact, rugged and economical to build!

**Amazingly Low in Price**

Ordinarily one would expect performance such as is obtainable with the Uni-Shielded “Two” only from a much more expensive receiver. The unique, simplified design plus elimination of all unnecessary parts makes this set one of the most inexpensive yet efficient S.W. Receivers yet developed. Complete kit of parts for the Uni-Shielded “Two” less cost tubes $5.75

<table>
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<tr>
<th>Set of Tubes</th>
<th><em>$1.93</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Set of 4 Coils, 15 to 200 meters</td>
<td><em>$1.35</em></td>
</tr>
<tr>
<td>Also Available in 3 Tube Model</td>
<td></td>
</tr>
<tr>
<td>- to cover the same similarity of constant but because of its greater power the “Three” brings in stations more easily than the “Two”</td>
<td>Complete kit of parts for the Uni-Shielded “Three”</td>
</tr>
<tr>
<td>- less coils and tubes</td>
<td><em>$7.45</em></td>
</tr>
<tr>
<td></td>
<td>Complete set of 4 coils, 15 to 200 meters</td>
</tr>
</tbody>
</table>

**Single Side Band Phone Signals**

(Continued from page 26)

The two bands of high frequencies $w + w_c$ and $w - w_c$, which extend on either side of the carrier frequency $w_c$, are called the side bands. The band having a higher frequency than that of the carrier is known as the upper side-band, and the one having the lower frequency is called the lower side-band. These two bands of high frequencies are generated in addition to the carrier frequency when the process of modulation takes place in the circuit. During the process of modulation, the voice frequencies combine with the carrier frequency in such a manner that the entire band of audio frequencies are raised in the frequency scale to new positions adjacent to the carrier frequency, as explained above. It is to be understood that the voice components consists of a large number of complex wave vibrations of different amplitudes and frequencies and for this purpose can be said to lie between the limits of 100 and 5000 cycles per second.

To illustrate the above paragraphs, assume a transmitter in which the oscillator is tuned to 100 kilocycles (100,000 cycles). Then $w_c$, the carrier frequency, will be equal to 100,000 cycles. If this carrier were modulated in some manner by a single frequency tone from another source, such as a 400-cycle note from an audio oscillator, then
The Famous
HAMMARLUND "PRO"
RECEIVER MAY NOW BE OBTAINED
in a number of models, to fit the needs of both "home" and "mobile" operators.

The New Hammarrlund "Pro"
with crystal filter (less tubes)............. $111.72
with automatic volume.......... $118.86 extra
We carry complete stock of Hammar
lund Radios.

GENERAL RADIO
We carry a complete stock of General Radio parts and Service Station Panels and accessories, as illustrated in last month's advertisement. Write for bulletin No. 935.

Experimenter's everywhere are taking to
TRIPLETT METERS like a duck to water. A complete line of quality service equipment is now available at low prices. Take the 1179 perpetual tester for example. For the first time a complete service labora
tory in one oak case. All necessary voltage, current and resistance measurements, shield
ted two range oscillator, out put meter and a complete selective analyzer panel. Also
hundreds of other items for less than
$34.66
A folder to describe the complete line of Triplett meters and test instruments will be gladly
sent on request.

ALL WAVE RECEIVERS
We have been watching the trend of the broadcast field toward this type of receiver and after thorough investigation hastily recommended ZETPH No. 28 to our non-amateur short wave friends. List price $2.50. Write for descriptive folder.

The WING 5 Meter Transceiver is becoming increasingly popular. Light weight, compact size and simplicity make it ideal for portable or automobile use.
With tubes............. $18.25
Fixed plate matched triode antenna complete........... $2.50

SPEAKER SPECIALS
Weight Dustcover 6" dynamic speaker with 250 ohm field and pentode potentiometer. $2.75
Weight Dustcover 5" dynamic speaker with 250 ohm field and pentode output transformer. $2.50

The Radio Amateur has found it convenient to keep at LEEDS. Only quality merchandise at wholesale prices. We do not publish a catalog; quotations on all short wave equipment furnished by return mail.

The three component frequencies
produced in the plate circuit of the modulating circuit would consist of:
Component No. 1 equal to \( \omega \), or 100,000 c.p.s.
Component No. 2 equal to \( \omega + \omega' \), or 100,000 + 400, or 100,400
Component No. 3 equal to \( \omega - \omega' \), or 100,000 - 400 or 99,600 c.p.s.

Analyzing the Results
Analyzing these results further, it can be seen that only two terms contain the modulation frequencies. The other term represents only the carrier. Whether the carrier is modulated or not, this term remains the same. The carrier frequency, therefore, contains itself in no intel
ligence. It is merely the reservoir for the power necessary to transmit intelligence in the side bands. Also, it can be seen that either one of the two side bands (upper or lower) contains in itself all the intelligence of the original modulating signals. It is therefore possible, therefore, to eliminate or suppress both the carrier and one side band and still transmit a wave (remaining side band) containing all the intelligence necessary for successful communication.

If, now, the carrier only were suppressed at the transmitter, and another (local) oscillator at the re
ceiving station generated a carrier into the receiver, exactly the same amplitude and frequency as the sup
pressed transmitting carrier, then the incoming side bands would com
bine with the local carrier, and the received currents would now be ex
actly the same as if the original carrier had been transmitted. The re
ceiver cannot discriminate between the local carrier and the original carrier, so that reception will take place in a normal manner. The local carrier combines, or beats, with the received side bands and produces frequencies equal to the difference between the local carrier and the voice components, produc
ing, after detection, the original modulating signals.

It can also be seen that if only one side band were transmitted (either upper or lower), exactly the same received signal would be secured, which in itself contains all of the original local carrier fre
quencies in single side-band transmission without appreciable distort
ion of the received signals.

The Uni-Shielded Short-Wave Three
(Continued from page 17)

Oscillator Frequency
It might be mentioned at this point that the frequency of the local oscillator is not as critical in single side
band transmission as in methods where both side bands are transmitted. A difference of about 50 cycles can be tolerated between the original and local carrier fr
quencies in single side-band transmission without appreciable distortion
of the received signals.

The Uni-Shielded Short-Wave Three
(Continued from page 17)

low-power foreign stations, but there is nothing tricky about the tuning or the control of regeneration.

In constructing the receiver, the four sockets are mounted first. Then, the jack J1, plate choke L3, tuning condenser C6, and switch SW1 are mounted on the front panel. As men
tioned above, the jack must be insulated from the panel by fiber wash
ers. The twin binding posts, BP1, BP2, and tuning condenser C1 are mounted on the rear panel. Adjustment of C1 is made from the rear of the set.

The r.f. choke L2 is fastened beneath
the chassis between the sockets provided for L1 and V2. The other small parts, which include carbon resistors and mica and cartridge condensers, are soldered in place while the set is being wired.

In proceeding with the wiring, the grid
circuits should be wired first, then the plates, next the filament and finally the various bypass condensers.

The positive filament terminals of the tube sockets may be grounded directly to the chassis—also the

ground terminal BP2, the spring contact of jack J1, and the returns of the bypass condensers. The A

plus lead of the cable is also grounded to the chassis, as well as one end of the variable in-line potentiometer R4. The diagram shows the wiring to the bottoms of the tube sockets.

After the wiring is completed and checked, the cable should be connected to the batteries in prepara

tion for the initial test. Tuners, ear
phones, and one short-wave coil are plugged in and antenna and ground are connected. The coil covering the band up to 200 meters should be used for the received side band.

The control R4 is turned until the de

tector tube oscillates. Then a sta
tion whistle is tuned in. A slight
adjustment of the antenna tuning condenser soon determines the con


denser position for the desired reception for the particular antenna being used. Turning back the regenera
tion control slightly to the point just before the set "spills over" clears up the whistle and brings in the de

dired station, loud and clear.
The Army Amateur Radio System
(Continued from page 19)

disaster. Since the Red Cross organization is broken down into three zones, namely, the Eastern, Midwest, and Pacific, each with its own headquarters, Army Amateur Radio stations are also assigned to these three headquarters. Each radio station operator establishes and maintains liaison with his Red Cross representative and is kept fully informed as to the part he is to play in disaster, relief, and has prepared and on hand, ready to fill in on a moment's notice with the essential information, messages, and reports to be transmitted as radiograms to the zone headquarters in case of a disaster.

When Disaster Strikes
When disaster strikes a section of our country the district nets in the affected area are "alerted," as well as the state and corps area and Army stations together with any others that are essential to establish the desired communication for the disaster. When the number of stations within the affected area is sufficient, they are assigned to specific tasks, such as Red Cross messages, press dispatches, personal messages of inquiry and assurance, etc.

To train and qualify a thousand amateur radio operators scattered throughout the country to work efficiently under such conditions requires that they be extremely well drilled in routine operation and thoroughly familiar with the normal methods to be followed and also have a personal "operating acquaintance" with the other operators with whom they must work. Weekly drills are conducted each Monday night. At this time each net functions and messages are exchanged between stations within the net and between nets. In addition to this, the Army station in Washington sends out a message to all Army amateur operators which each station is required to copy and acknowledge receipt of to its corps area signal officer. Also the corps area sends out a message for all stations within the corps area. These operator messages usually contain information of general interest to all members or instructions to them.

The volume of traffic handled by some of the stations runs quite high. Particularly is this true of the corps area and Army stations, which are required to relay all of those going out from or in to their nets. The very nature of the work means that the stations' operators have a regular traffic load for their stations, thus providing an interest factor and at the same time affording them a wonderful opportunity to improve their ability as an operator.

Membership Requirements
Membership in the Army Amateur Radio System is open to any American citizen—women—and any amateur station and operator's license and who further is the owner and operator of an amateur radio station (transmitting and receiving), who signifies a willingness to keep all assigned schedules in conformity with the purpose of the system, and who, further, is willing to abide by such rules and regulations as may be promulgated from time to time. Any radio amateur meeting the above qualifications who is desirous of becoming a member should make application to his corps area signal officer.

Clarifying Some Radio Terms
To avoid confusion in the minds of our readers, we wish to clarify certain words and terms used on practically every page of the magazine. The notorious looseness of radio terminology which has been prevalent for the past few years is giving way to increasing accuracy, so all users of radio apparatus should acquaint themselves with the correct forms.

Coils having the property of electrical inductance are specifically referred to as inductors. Devices having the property of capacitance are called capacitors, although the older name condensers is likely to stick for quite a while. Devices having the property of resistance are logically resistors.

In most handbooks the antenna is defined as the entire radiating or intercepting system of wires, of which the aerial and ground are separate components. The tendency in the past has been to consider antenna and aerial as synonyms, although correctly the latter is actually only part of the former. Of course, where the ground plays no important part in the transmission or reception, as is the case with Hertzian antennas—the aerial wires by themselves constitute the antenna. This is a rather fine distinction which need not bother anybody.

Newcomers in the short-wave field are apt to refer to all short-wave transmitters as broadcasting stations. This is definitely wrong. Stations like GSA, DJC, Radio Colonial, Radio Roma, Moscow, W2XK, W2XAF and W2XE are legitimate relay broadcasting stations, because they transmit actual programs on a more or less regular basis. However, police, amateur, airplane and airport, and trans-oceanic radio-telegraph operators are not broadcasting stations but communicating stations, their messages being directed to specific receiving points. No amateur or airplane station ever "broadcasts"; it transmits.

NATIONAL
SHORT WAVE PRODUCTS

Type BM—3 in. Dial
This little 1" dial matches the well known NATIONAL 3 in. Dial in appearance, and like it has the famous Velvet-Vernier Drive with fixed range resistors especially suitable for compact receivers and other radio equipment where space is limited.

List Price, $.50

Short Wave Condensers
Fifty-two models! All embody the basic National features of insulated bearings, constant impedance/potential, isolantite insulation and non-resonant aluminum plates.

NATIONAL R39 Coil Forms
Made of the ultra low-loss material, National Coil Forms are designed for foil form paper and copper Wire Resistance. The Standard Coil Forms are 3 or 6 pronged. In ¼ diameter, 2½ long. List Price is $1.75 each. The 1½ Diameter Coil Forms 3 or 6 pronged, 3½ long List is $2.25 each.

Low-Loss Coil and Tube Sockets

Coupling Impedance—Type-S-101
For coupling output of detector to audio amplifier tube. Response uniform between 500 and 5000 cycles. Inductance of plate choke—700 Henries. Gives two or three times as much amplification as resistance coupling.

List Price, $.50

Send for the Free National Catalogue No. 220
Mail the coupon below for the National General Catalogue No. 220. Its sixteen pages describe a complete line of quality parts for the amateur radio equipment. These prices are subject to 40% discount when purchases are made through authorized National Catalogue Distributors.

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Great occasion: I enclose $ in stamps to cover mailing costs of your General Catalogue No. 220. Please mail it at once to the address below.

Name __________________________
Address _________________________
Hum Difficulties
(Continued from page 29)
oscillator voltage being impressed directly on the grid of the second detector. A double-tuned i.f. transformer will remedy this defect by supplying the additional attenuation required.

Another source of hum which acts in much the same manner is that due to common oscillation because of insufficient filtering in the plate and screen leads from the oscillator.

Usually hum which is present only on tuning in a signal is called "modulation hum." If the incoming power line has not been filtered the signal may be fed into the rectifier tube, where it is modulated with the rectified hum voltage and then re-radiated or carried by the antenna or input system to the receiver. A filter will correct this condition.

When large signals are applied to the receiver the grid of the input tube may be driven positive during part of the cycle grid. The remedy for hum arising from this source is to insert sufficient attenuation between the input system and the input of the first tube.

The foregoing suggestions are the results of extensive investigations which have been made during the past season on many universal type radio receivers that have come to our attention. In general, improvements in set performance have been realized by making arrangements similar to those discussed in this article.

-Hygrade Sylvania Corp.

Byrd Notes
(Continued from page 15)
information therein contained for his own benefit or for the benefit of another was not the thing: Provided. That this section shall not apply to the receiving, divulging, publishing, or utilizing the contents of any radio communication broadcast or transmitted by amateurs or others for the use of the general public or relating to ships in distress.

Of course, there is nothing wrong in listening in on short-wave signals of any kind, as by their nature, no radio transmissions are particularly secret. However, listeners are cautioned against calling up their local newspapers and telling them what they hear over the air. The KJTY, U.S. transmissions are regarded as point-to-point communications, and, therefore, fall within the scope of Section 27. The Columbia Broadcasting System has been flooded with requests for verifications on KTJY, and, of course, this is unable to supply these because the intercepted transmissions may have been tests, expedition business, or point-to-point transmissions of addressed material.

Curing Hand Capacity
H AND capacity effects sometimes appear unexpectedly in receivers using metal chassis and panel. This trouble can usually be traced to careless wiring insofar as the radio-frequency circuits are concerned. Instead of depending on the whole chassis and panel as the "ground" lead, it is desirable to bring all r.f. leads that require grounding to a common screw on the chassis, preferably a few inches back of the panel. Indiscriminate "grounding" at the most convenient mechanical points, which was practiced in many early t.r.f. and superheterodyne short-wave receivers, is now known to be responsible for mysterious effects that manifested themselves as uncontrollable oscillation, tuning interlock between apparently decoupled circuits, and general receiver instability.

Probably the most annoying result of careless r.f. grounding of this kind is dial noise. The dial mechanism has been found to form an actual loop circuit paralleling a sensitive tuning circuit, and slight changes in the resistance of the dial, due to the induced and uninduced electrical effects, produce horrible grating sounds. Lubrication of the dial is just as likely to aggravate the trouble as to cure it.

With Bartlett in the Arctic
(Continued from page 9)
frequency and at this point, Mr. Moe had difficulty in contacting the New York stations, although everyone else was easily communicated with.

Mr. Moe stated that between July 21st and August 10th, when there were three hours of daylight and the nights began to get longer, 20-meter reception was excellent.

Although the temperature was, as might be expected, exceedingly low, Mr. Moe stated that it in no way affected reception. He made a special note of the effect of aurora borealis. He noted that when this appeared, and his description of this weird act of nature was interesting one. "They were like blueish clouds on streaks, constantly shimmering," there was not a bit of noise. However, when the effect was medium, the signals died out completely. This is in contrast to many theories in the writer's mind. Measurements on which all the above reports are based was done between the hours of 6 and 9:30 p.m.

An interesting point was brought to my attention by Mr. Moe regarding the water used. Mr. Moe explained that when water is frozen, salt disappears, consequently providing not only fresh battery water but excellent drinking water.
Tickler Polarity

Many experimenters, when connecting up a regenerative circuit, try connecting the tickler first one way and then another in an attempt to determine which is correct.

Remember, the end of the tickler coil which coincides with the corresponding end of the secondary goes to the B+.

That is, if the two coils are wound in the same direction, and if the beginning of the secondary is the grid, then the beginning of the tickler winding is the B+.

If the two coils are wound in the opposite direction (hardly ever done), then the end of the tickler is B—.

A Tip on Selectivity

The selectivity of a number of stages of r.f. or i.f. amplification is the product of the number of stages and the selectivity of one of them, provided that the selectivity of each is multiplied, not added, to obtain the total selectivity.

Lining I. F. Amplifiers

When lining up an i.f. amplifier, do not rely on maximum noise—as many do—as the peak. If you use a modulated oscillator, you will find that maximum oscillator response and maximum noise do not occur at the same place. The first gives the greatest signal, the latter the greatest noise.

Keep Arrestor Clean

Dust has a tendency to drift into some types of outdoor lightning arrestors; remember this when testing an aerial installation.

Southern Exams

Southern examinations for all classes of radio operator licenses will be held in the Civil Service Room, Federal Building, Winston-Salem, N. C., on Saturday, February 3rd, 1934. The examination will be held in two sessions beginning at 1 p.m. and 7 p.m., the participants for amateur class A, commercial, and radiotelephone examinations must appear at 1 p.m. Edward Bennett, Room 17, Custom House, Norfolk, Va., is Inspector in charge.

Unique Tube Characteristics

(Continued from page 13)

the exhaust period. Therefore, this type of blue haze is in no way detrimental to the operation of these tubes.

Gas is a blue haze which is usually confined to the vicinity of the plate and filament structure. Its presence, when of large content, affects the operation of a receiver to the extent that erratic performance is noticeable. Gassy tubes should always be replaced with new tubes.

Testing for the above conditions can be best accomplished by actual operation in a receiver. It is not necessary to test for the blue glow evident in types 82 and 83, since this is characteristic of these two types of tubes.

When in doubt as to the blue content of other types of tubes, a sure test can be made by using a magnet next to the bulb. A gassy tube will not be affected in any way by the presence of the magnetic field or the fluorescent glow, which has no effect on the performance of the tube, will shift about as the magnetic field is shifted.—Hygrade Sylvania Corp.

Learning The Code

Many short-wave listeners become interested in the numerous code stations they hear, and eventually they decide to learn the code, so that they may be able to "copy" the mysterious dots and dashes. This is a commendable idea, for, as remarked previously in SHORT WAVE RADIO, a knowledge of the code greatly increases the enjoyment one can obtain from a short-wave receiver.

"The full Continental Code, which is universally used for all radio-telegraph transmission, appears in many radio textbooks. It is quite practicable for a person to study the code all by himself, as many stations send slowly enough to provide the beginner with plenty of practice.

"To be whole trick in learning the code is to think of the characters as "dits" and "dashes," not as dots and dashes. To memorize the character A, for instance, mumble to yourself, "Dit-dah, dit-dah, dit-dah" over and over until you can automatically say dit-dah whenever you see the letter A, and your brain automatically registers A when the dit-dah sound appears in a radio transmission. Go through the whole alphabet this way, taking a few characters at a time and forming simple words with them.

It is a good idea to learn how to send as well as to receive. Simple, effective code practice sets can be bought very cheaply, and will provide a lot of fun. The manipulation of a telegraph key is known in radio parlance as "pounding brass," for the reason that all such keys are made of brass.

When Seeking a Radio School

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 charges.

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MULTITESTER

Valometer Ohmmeter Milliammeter

Milliammeter The most complete tester for $25.00! Suitable for testing any type of radio, whether it be in the form of short-wave inside. It can never become obsolete! Triple Range Milliammeter It contains three ranges of measure from 0-2,000,000 ohms down to 0-2,000,000 ohms. Four Range Voltmeter containing 100,000 ohms down to 0-30-75-250 volts.

This tester, equipped with safety automatic selector switches, 2% accuracy, finely etched panels, with all self-contained batteries and de Luxe case. It is yours for...

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ALL-WAVE AIR SCOUT

ONLY SET OF ITS KIND IN THE WORLD

also the only receiver with 440 and 1,100 wave lengths, and a built-in oscillograph, 3600 miles away. A unique "microphone" clamps the receiver to your ear, and will not interfere with the conversation. It is equipped with a built-in amplifier, and a telephone, and is a complete receiver. Complete Kit with Tube, Earphone, Battery, Portable Case, etc., only...

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Antenna 01.10; 1)E Lynch for broadcast band

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YO, dyne.

One your "si,i, he! tl. Sul dry Coauercial R "No -Stat" -I IA; "Short "eliminate 12 than I Complete meters.

FOR its performance. Many "Short-Wave Guaran"e. fool 10 &I R. A.1. I the receiver.

Increasing the amount of regeneration will stop it, and taking the tube completely out of oscillation will stop it, but since the most sensitive point by far is just under oscillation, and since the noise is usually of an extremely annoying character, it is very desirable to remedy it if possible. One common, simple method of eliminating it is to shut about a 100,000 ohm resistor (commonly of the grid-leak type) across the secondary of the first audio-frequency transformer. If a 100,000-ohm grid leak is sufficient to stop the howls, it will be found that it does not cause any appreciable loss of amplification, and the circuit seems to remain exactly as it was before the addition of the resistance, except that the "fringe howl" has stopped.

Dead Spots in Tuning

Many owners of short-wave receivers are troubled by the fact that at certain dial settings so-called dead spots, or narrow frequency bands, exist, over which the receiver cannot be made to regenerate at all by means of the regeneration control, or an unusually large increase in its setting is necessary. These dead spots are caused in a variety of ways, and they may also be eliminated if their cause and nature is thoroughly understood.

A "dead spot" on the tuning scale of a receiver means simply that at the frequency corresponding to that dial setting, there exists a condition of resonance for which the feedback necessary to be reduced and the receiver does not oscillate properly. For the purpose of studying "dead spots," a regenerative receiver may be considered simply as an oscillator. Any oscillator can produce only limited power up to a certain point. Beyond this output drops rapidly, and finally the oscillator ceases to operate.

Resonance Absorption

Any circuit tuned to resonance with an oscillator absorbs energy from it. If this absorption is too great for the power of the oscillator considered, the latter cannot operate properly. This is the reason for the "dead spots" on the dial of a short-wave receiver; there are tuned circuits in the plate circuit of those frequencies. One of the offending circuits is usually the antenna circuit of the receiver. The antenna, with its coupling coil, is tuned by its total antenna-ground capacity to a definite frequency, determined by the values of inductance and capacity in the antenna circuit. If these values are such that the "natural frequency" is the same as that to which the regenerative receiver is tuned, the antenna circuit absorbs energy from the oscillating detector circuit, and the oscillator will "plop" out of oscillation, simply because it can no longer supply the total power required to keep it oscillating plus that being absorbed from it by the tuned antenna circuit. Under this condition, no oscillations can be produced ordinarily, or else a large increase in the setting of the regeneration control is necessary.

The regeneration control, however, has a limited range, and cannot be increased very far before its entire range has been covered, so that the receiver will no longer oscillate.

Antenna at Fault

The antenna system causes dead spots also at the harmonics of its natural frequency; but these are less pronounced and not so disagreeable, because the regeneration control setting need be increased only slightly for these. Dead spots may also be caused by resonance in the wiring of the detector itself or by apparatus near the receiver. It is possible to obtain dead spots from choke coils or tuned circuits near the receiver; it is not necessary for a circuit to be closed upon itself in order to produce a "tuned" circuit.

Assuming that all apparatus has been removed from the immediate vicinity of the receiver, let us consider various means for removing all dead spots from the dial. Since a dead spot is caused by resonance, it will, in general, be possible to eliminate such resonance by detuning the circuit causing the trouble. It is possible not to remove a dead spot from the dial but to get the frequency which is not covered by the receiver dial. In the case of dead spots caused by the antenna circuit, a variable condenser of the 23 plate midget type (.0001 m.f.) connected in series with the circuit will usually permit of shifting the dead spot to another frequency each time. In sets employing plug-in coils, the dead spot may disappear.
when a different coil is plugged into the receiver; but if the series condenser in the antenna circuit is variable, the dead spot can again be shifted outside the new tuning range. In the case of an r.f. choke causing a dead spot, turns of wire may be added to or removed from the choke to shift its natural resonance frequency and the dead spot.

Why the Dome-Shaped Radio Tube?

With all radio tubes, including the older types used mainly as replacements, now dressed in dome-shaped envelopes, the question was well asked, "Why the dome-shaped bulb?" The answer to that question is as follows:

One of the factors in adopting the dome-shaped bulb was the possibility of supporting tube weights on the top through the base of a large mica disc fitting into the dome tightly enough to support the elements at this point. This improvement made the tubes less sensitive to change in characteristics when subjected to shocks such as occur in shipping tubes in the sockets of radio receivers. However, the problem of a satisfactory fit between the horizontal mica disc and the walls of the bulb was a difficult one because of variations in bulb diameter, which cannot be controlled with the degree of uniformity necessary to prevent development of rattles caused by the mica striking against the glass.

Several of the more important types of tubes are now being made with mica vertical end pieces mounted on the usual horizontal or top mica spacer, these vertical members being shaped to permit sufficient spring to compensate for variations in the dome diameter. This innovation has been particularly satisfactory in the case of power output tubes such as Type 42. It has also been applied to some of the R.F. tubes and will be adopted to other types as soon as practical details of construction are worked out.

In construction the new condenser and filament show that they are particularly resistant to damage caused by severe blows or shocks, the small resilient mica pieces acting as buffers and protecting the tube elements. With this construction nothing short of breaking the bulb causes any damage to the tube.

Choppy Signals

The reception of voice or music signals on the short waves is sometimes accompanied by a peculiar chopping or wavering which resembles fading but it is too consistent to be classified as fading. In most cases this will be found due to interference from a high-speed radio-telegraph or picture transmitting station on a closely neighboring wavelength.

Radio signals that sound very much like the noise produced by a wad of newspaper held against the blades of an electric fan are usually television signals and will appear in electrical form. If the signals are heard about 100 meters, they may safely be classified as television; below 100 meters as picture transmission. Sooner or later the voice of an announcer will break into the television signals, but communication on the still picture channels is invariably done in the dots and dashes of the Continental Code.

Incidentally, there is no way the amateur can reproduce "still" radio pictures, as special, highly expensive apparatus, owned only by RCA, is required. Anyway, these pictures are not "broadcast," but are directed at particular stations, and therefore they fall in the same category as addressed radio messages.

New Pre-Selector & Amplifier for
NATIONAL FB-7A & FBX-A

Gives increased selectivity and sensitivity. Price, complete with 3-band sliding coil (specify which amateur band desired). Price, net $15.00 Extra coils, $3.00 each

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SHORT WAVE SETS

The Best Values... Dollar for Dollar... on the Market

ALAN ACE
110v. A.C.-D.C. S.W. (15 to 120 Meters)
3 Tubes — 457 — 46 — 525
Absolutely quiet Built-in Power Supply
Front panel plug-in coils; meter, outlet and field supply; phone jack on front panel; complete shielding in black-enameled woven metal cabinet.
Complete, incl. 4 coils, $5.00
200 m., lower tubes, $5.95
Set Aregnus tubes, $2.50
Kit with both types, $1.50
Broadcast coil, $1.90

ALAN PRIZE WINNER
A.C.-D.C. S.W. (15 to 120 Meters)
Competitively self-powered latest type 525-A and 152-C tubes. Provision for both phones and speaker. Complete, incl. 3 coils, $2.50
Kit of #3 or Aregnus tubes in metal. Complete kit of parts, incl. inviting 6 coils, $10.50
Broadcast coil for operating 200 to 500 meters, $6.00
200 V. A.C. or D.C. Adapter $1.25

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PROBABLY more confusion exists in the minds of experimenters regarding the purpose of class A, B, and C amplifiers than about any other tube connection. What seems to be more appreciated is the results of the connections rather than the purpose of the connections themselves. For instance, everyone knows—or at least realizes—that Class A amplifiers give undistorted output and excellent tone quality. Transmitting amateurs are familiar with class B and C connections, since their work utilizes these modes of connection to a greater extent than that of the receiving amateur.

The strange part about the entire situation is that there is no definite line of demarcation between classes A and B amplifiers; in fact, during the last year and a half, an intermediate type has been adopted called class A prime, but let us begin at the beginning and see if we can clear up this situation without becoming too technical or too involved.

Class A Amplifiers

A tube is said to be operating as a class A amplifier when the form of the output current variations are identical with the form of the input signal. A study of this definition will show that so long as this similarity obtains, the tube is a class A amplifier.

Let us see under what conditions, then, variation of plate current fluctuation and signal voltage can exist. If the grid voltage—plate current curves of tubes designed for class A operation are studied, it will be found that the curve is a straight line over a certain portion of the characteristic. Now, if the grid bias without signal is so adjusted that the operating point is at the midpoint of this straight portion, and furthermore, if the magnitude of the signal voltage is so adjusted that its extremes do not raise the bias beyond the straight portion of the characteristic, then class A amplification exists. In other words, because of the fact that the tube is continually operating on the straight portion of the characteristic, the increases and decreases of plate current coincide exactly with the signal.

This straight portion of the curve may exist in two distinct regions: first, with some positive bias on the grid, and second, with some negative bias on the grid. In the usual application, a negative bias is applied in order to minimize the distortion due to grid current. Although the amount of power obtainable with negative biases is smaller than that obtainable with positive biases, the maximum undistorted power output is greater. Since the efficiency of a power amplifier may be defined in terms of the power output per unit of signal voltage, and since the power output is a function of the plate current swing, it follows that the greater the plate current swing per signal volt applied, the more sensitive the tube as a power amplifier.

In plain English, this means that the more nearly vertical the grid voltage—plate current characteristic, the more sensitive the power tube.

The important point to keep in mind here is that in the class A amplifiers in general use today, the grid never swings positive with the highest permissible signal. In fact, a good rule to remember is that the peak value of the signal shall never exceed the fixed grid bias.

Class A Prime Amplifiers

In the class A prime amplifier, the grid bias is so adjusted that a very heavy signal can be applied which results in considerable grid current being drawn. This grid current ordinarily would give rise to considerable distortion were it not for the fact that input and output transformers designed for class A prime amplifiers have very low resistances and very low leakage reactances. With these two items reduced to a minimum, the grid current may reach very high values before the distortion becomes appreciable.

In class A prime amplification the bias is made more positive than in an equivalent class A amplifier. The result, therefore, is that with a heavy signal, the grid swings positively over the entire straight portion of the characteristic, one half the cycle and on the negative portion of the characteristic on the other half of the cycle. Grid power flows, therefore, during that portion of the cycle during which the grid is positive.
The results claimed for this mode of operation are high power sensitivity and low distortion.

Class B Amplifiers

A class B amplifier is essentially a detector—it rectifies the signal exactly as does a detector tube designed for the purpose. In this connection, the grid bias is so adjusted that when the grid rectification is negative the plate current increases and when the grid becomes negative on the other half of the cycle, the plate current remains unchanged from the value it normally has with no signal.

What seems to confuse most experimenters when considering class B amplifiers is the matter of grid bias. Some tubes require a very high bias for class B amplification while other tubes require no bias at all. This apparent fluctuation arises from the fact that those tubes (such as the type 46) specifically designed for class B work have their characteristics so shaped that rectification takes place with zero bias. On the other hand, some tubes require a high bias in order to bring the operating point near the lower bend in the curve in order to satisfy the requirements for class B operation. It will be noted that with this type of amplification, the average plate current depends upon the magnitude of the signal, so the actual power consumption is a function of the signal strength.

Since the amount of distortion present in the output of class B amplifiers may be as high as 30 percent, some means must be adopted to minimize it. Most of this distortion is in the form of even harmonics, present in the output of any detector tube. These even harmonics are present because the bottom parts of the signal have been eliminated in the process of rectification. Another tube connected so as to operate in phase opposition with the first will supply this missing half and theoretically, at least, considerably reduce the amount of distortion present. It is for this reason that all class B amplifiers have a push-pull connection.

Class C Amplifiers

- The third and last connection for amplifier tubes in general use is the class C amplifier. Although it has not as yet been adopted for general receiver output tubes, nevertheless, it has formed a very important part of transmitter circuits. In this amplifier, an exceptionally heavy signal is applied to the grid of the tube. In fact, the signal must be so large that the plate current fluctuates between saturation and zero. Now, saturation is that maximum possible current which can be drawn from a tube regardless of plate or grid voltage. It is obvious, therefore, that this type of amplifier is replete with harmonics which must be removed.

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