1930 EDITION

SHORT WAVE MANUAL

Compiled by the Technical Staff of

RADIO NEWS

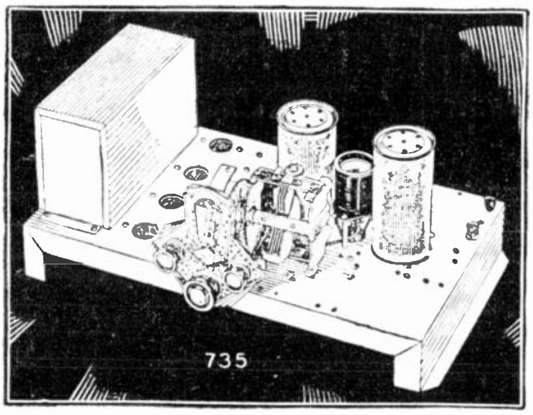
50¢

Opening Now the All-Electric Era in Short-Wave Reception

Two-Hundred-Dollar Results—$74.75

As trim and stylish-looking a one-dial set as was ever built to "sell on looks"—yet embodying such extreme performance as only Silver-Marshall can build into a set with three screen-grid tubes, band-selector tuning, and even *screen grid power detection*—five times as efficient as '27 power detection. Four tuned circuits—highly shielded—an audio amplifier combining resistance coupling and 245 push-pull—complete built-in ABC power unit—chassis only $18\frac{3}{8}$" by $9\frac{1}{2}$"—all at the price of $74.75 net, less tubes and cabinet, in the S-M 722 Band-Selector Seven. Tubes required: 3—'24, 1—'27, 2—'45, and 1—'80. Component parts total $52.90 net. For use with any 90-120 volt d. c. electro-dynamic speaker.

Ideal for mounting in any of the cabinets mentioned below.



SHORT-wave reception has become the thrill-producer of modern radio—in spite of batteries and ungainly receivers with difficult control. Now, with the new S-M 735 Round-the-World Six bringing every marvel of the low-wave bands within the perfect convenience and unsurpassed neatness of installation suggested in the illustration—no one who really enjoys distance reception should be without the all-electric 735. A 224 a. c. screen-grid tube, so connected as to produce *2½ times greater amplification* than the '22, and a two-stage S-M audio amplifier (245 push-pull)—free from hum, even in distance reception. Four plug-in coils cover from 16.6 to 200 meters. Two extra coils (cost $1.65) cover the broadcast band, with an altered connection built into the coil so as to greatly increase selectivity.

Yet the 735 is low-priced—$64.90 net, wired complete with built-in power unit; the component parts total $44.90 net. Tubes required are: 1—'24, 2—'27, 2—'45, and 1—'80.

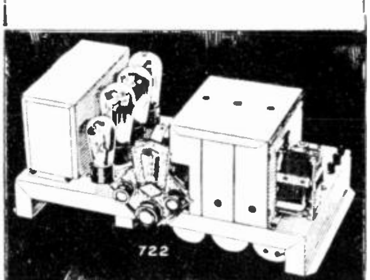
735DC, for battery use only, $44.80 net less tubes and cabinet. Tubes required: 1—'22, and 4—'12A. Component parts total $26.80 net.

Either set fits perfectly in any of the cabinets referred to at the left.

Surpassing the Famous Sargent-Rayment Seven

You know the Sargent-Rayment Seven—universally found to be the most sensitive broadcast receiver ever developed. Here, in the new 712 Tuner, is every feature of the 710 Sargent-Rayment—the five tuned circuits, the ultra-perfect shielding—the extra-fine r. f. coils—all built into an all-electric strictly single-dial tuner, with band selector tuning and power detection. Tubes required: 1—'27, 3—'24. Completely wired in satin-finish metal shielding cabinet, less tubes, $54.90 net. Works into any audio amplifier.

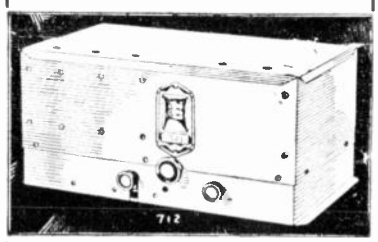
Component parts, including shielding cabinet, total $40.90. Fits beautifully (with controls central) in any cabinet with space $18\frac{1}{2}$ by $9\frac{1}{2}$ by $7\frac{3}{8}$-inch high.



Up-To-The Minute Cabinets

S-M 707 metal shielding table cabinet in beautiful crystalline brown and gold for 722 or 735, $7.75 net.

Three beautiful console cabinets, adapted especially for mounting S-M 722, 735, or 712 with 677 by the I. A. Lund Corporation, are available from leading supply houses: see the new S-M Fall Catalog.



New 677 Amplifier

An ideal audio amplifier for the 712 is the new S-M 677. Fully equipped with the famous Clough system (in push-pull) the 677 takes radio or phonograph input; supplies all ABC power required for the 712 (2½ volts a. c., 180 volts B). Tubes required: 1—'27, 2—'45, 1—'80. Completely wired less tubes, $58.50 net (or for 25 cycles $72.50). Component parts total $43.40.

Over 3000 Authorized S-M Service Stations are being operated; many are proving highly successful and profitable. The nearest one is ready to serve you if you want a custom-built set; write us for address if you do not know it. If you build professionally and do not have the S-M Service Station franchise—write us.

Complete circuit diagrams of the 722 and 735 were first published in the RADIOBUILDER for August. Valuable suggestions on building and servicing are to be found in every issue. Use the coupon.

SILVER-MARSHALL, Inc.

6405 West 65th St., Chicago, U. S. A.

Silver-Marshall, Inc.
6405 West 65th Street, Chicago, U. S. A.

....Please send me, free, the new fall S-M Catalog; also sample copy of the Radiobuilder.

For enclosed.............. in stamps, send me the following:

50c Next 12 issues of The Radiobuilder
$1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:

No. 3. 730, 731, 732 Short Wave Sets
No. 4. 255, 256, etc., Audio Transformers
No. 5. 720 Screen Grid Six Receiver
No. 6. 740 "Coast to Coast" Screen Grid Four
No. 7. 675ABC Hi-Voltage Power Supply
No. 8. 710 Sargent Rayment Seven
No. 9. 678PD Phonograph Radio Amplifier
No. 10. 720AC All Electric Screen Grid Six
No. 12. 669 Power Unit
No. 14. 722 Band Selector Seven
No. 15. 735 Round the World Six
No. 16. 712 Tuner (Development from the Sargent Rayment)
No. 17. 677 Power Amplifier for use with 712

Name ....

Address ....

The 1930 Short-Wave Manual

By the leading short-wave authorities in collaboration with the technical staff of

RADIO NEWS

Vol. 1 No. 2

Edited by

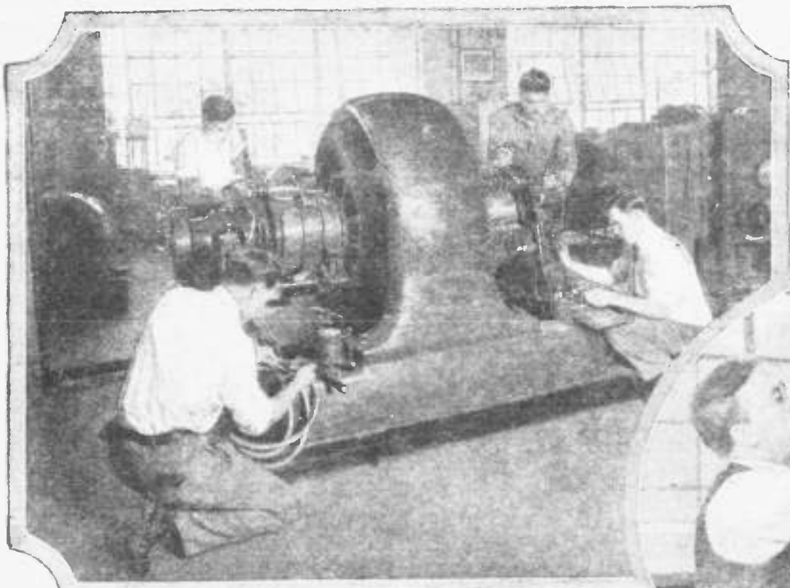
JOHN B. BRENNAN, Jr.
Technical Editor, Radio News

EDWARD W. WILBY
Associate Editor, Radio News

Published by

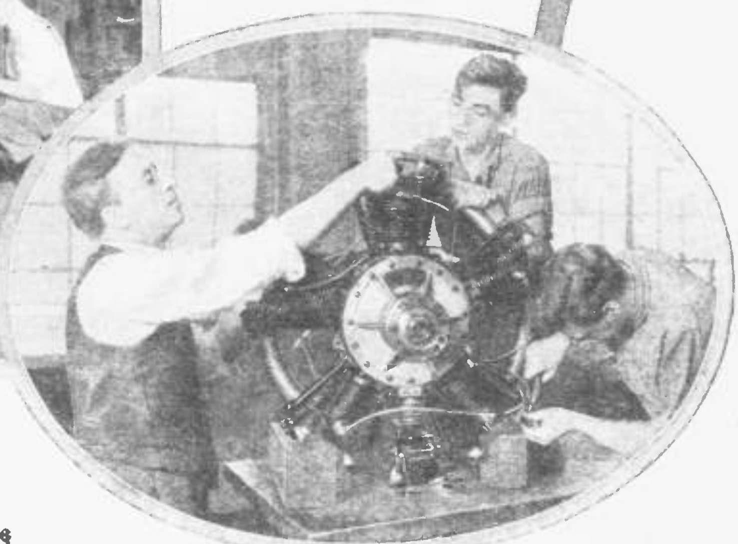
EXPERIMENTER PUBLICATIONS, Inc.

381 FOURTH AVENUE NEW YORK, N. Y.



Learning about the converter used to change alternating to direct current at the great Coyne Shops

Coyne men working on the valves and timing of a Velie Radial Aircraft Engine



—follow this amazingly easy way into ELECTRICITY

—and you're through in 90 DAYS!

SAY good-bye to 25 and 35 dollars a week. Let me show you how to qualify for jobs leading to salaries of $50, $60 and up, a week, in ELECTRICITY — NOT by correspondence, but by an amazing way to teach, RIGHT HERE IN THE GREAT COYNE SHOPS. You become a practical electrician in 90 days! Getting into Electricity is far easier than you imagine!

LEARN—*by doing the work with your own hands* IN 90 DAYS

The secret of Coyne-training is that it is ALL PRACTICAL work. No books—no dry lessons—no useless theory. In the great shops of Coyne you learn the "ins and outs" of Electricity by actual work on real electrical equipment — the finest outlay in the country. And best of all—experts work right with you every step of the way, showing you all the electrical secrets that are essential to your success!

NO BOOKS—NO PRINTED LESSONS

Experience not required I don't care if you don't know an armature from an air brake—I don't expect you to! I don't care if you're 16 years old or 48—it makes no difference! Don't let lack of money stop you either. Most of the men at Coyne have no more money than you have.

Big pay jobs are waiting Our employment bureau gives you lifetime service. Two weeks after graduation, Clyde F. Hart got a position as electrician for the Great Western Railroad at over $100 a week. That's not unusual. We can point to Coyne men making up to $600 a month. You can go into radio, battery, or automotive electrical business for yourself and make up to $15,000 a year.

Railroad fare allowed Make up your mind today to get into one of these big pay electrical jobs. If you act now—I'll allow your railroad fare to Chicago and give you these courses free! AVIATION ELECTRICITY, RADIO and AUTOMOTIVE ELECTRICITY! And besides that, I help you to a part time job while learning! Don't lose another minute—make this the turning point in your life. Send this coupon RIGHT NOW.

COYNE
ELECTRICAL SCHOOL
500 S. Paulina St., Dept. 20-83
Chicago, Ill.

Get this **FREE BOOK**

This school is 30 years old—endorsed by many large electrical concerns. Simply mail the coupon and let me tell you all about it in the big, free Coyne book.

USE THE COUPON

Mr. H. C. Lewis, *President*
COYNE ELECTRICAL SCHOOL, Dept. 20-83
500 S. Paulina St., Chicago, Ill.

Dear Mr. Lewis:

Without obligation send me your big free catalog and all details of Railroad Fare to Chicago, Free Employment Service, Radio, Aviation Electricity, and Automotive Courses, and how I can "earn while learning."

Name..................................

Address..................................

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

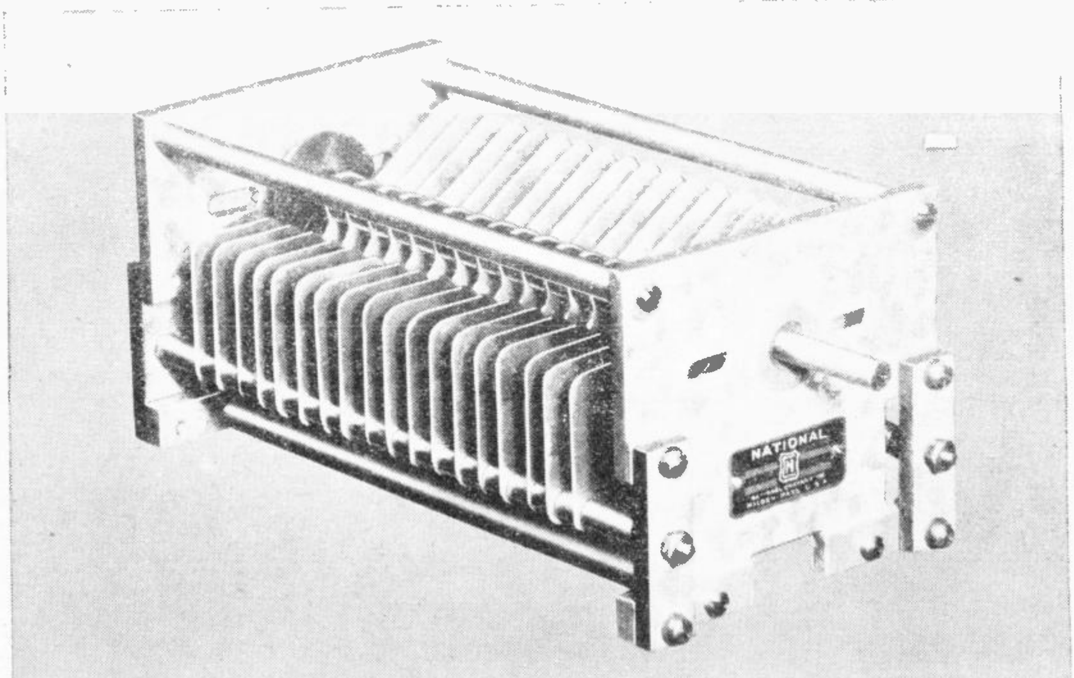
EDITORIAL

WITH the co-operation of American and Canadian amateur enthusiasts, Mr. Paul F. Godley, in December, 1921, journeyed to Ardrossan, Scotland, a town located on the coast west of Glasgow, to attempt the picking up of signals transmitted by the North American amateurs on wavelengths around 200 meters. A number of these amateur transmitters used powers of 50 watts and less. The tests were successful in that Mr. Godley was able to pick up a number of the signals. Remember, though, that special preparations were made for these tests in that each district was assigned a distinct time for transmitting during the ten-day test. It is very doubtful that, if the transmissions had been conducted in a haphazard manner, any satisfactory reception would have resulted. Again in November, 1923, a number of European broadcasting stations operating on wavelengths between 200 and 550 meters, co-operated with North American broadcasters in a series of broadcasts known as the Transatlantic tests. These tests were conducted with the idea of creating enthusiasm among the general public in long-distance reception. The programs were received more or less satisfactorily by a large number of listeners on both sides of the Atlantic. Here again, though, as in the tests of 1921, definite hours were allotted for the European broadcasts, during which time the North American transmitters were silent. The same procedure was followed while the North American stations attempted to broadcast their programs to the European listeners. These tests of 1923 served their purpose, in that large numbers of listeners on both sides of the Atlantic were able to hear for the first time foreign programs. Strangely enough, though, events have taken a turn in another direction. With the growth of number of stations on the North American continent to some 700 odd and their accommodation in the relatively small number of 96 available channels, it has naturally followed that engineering emphasis has been placed not so much on extreme distance-getting ability as on the ultimate perfection of selectivity and faultless audio reproduction. The availability of the high quality programs on the chain networks, together with the very evident improvement with the type of programs being broadcast by the smaller station, has in a large measure removed the desire on the part of the listener in to sit up until the wee small hours in an effort to listen to a particular program originating perhaps half-way across the continent.

NOTWITHSTANDING these facts, there is a tremendous amount of interest being displayed in long-distance reception. This interest lies not so much in the reception of interstate transmission as in the reception of signals which originated in other countries, countries sometimes on the other side of the world. It remains, therefore, for some medium other than the broadcast receiver and the wave band between 200 and 550 meters to provide us with this long-distance reception. The answer is "short waves." Short-wave receivers really do some remarkable things. Actually they bring in at points on the North American continent stations located in European cities as well as Japan and Australia. Such receivers, which, by the way, are inexpensive, offer some of the greatest thrills for real radio thrills. By means of plug-in coils, it is possible to cover a number of wave bands within the range of the tuning dial. In these bands can be found signals being exchanged by thousands of amateur stations which exist, code and phone communication between planes in flight and between a plane and ground station. Excellent code instruction is at our disposal by listening to the many excellent short-wave commercial communication systems. In a realm all by itself is the extra long-distance reception of programs emanating from broadcast stations which transmit simultaneously on short waves. Short-wave receivers enjoy the same variations in circuit design as does their bigger brother, the broadcast receiver, the simpler types employing the regenerative detector with an audio amplifier, while later designs incorporate the screen-grid tube in one instance as an r.f. blocking or coupling unit and again as a tuned r.f. stage. Then, of course, there is the multi-tube short-wave superheterodyne receiver adaptable for reception on from 15 to 200 meters. Up to a short time ago the filament supply for such receivers was provided by either a storage battery or dry batteries, but with the perfecting of the -27 heater type tube the lighting lines are now being called upon to supply the necessary filament and plate potentials.

IN this manual the editors have collected and compiled the most reliable and authoritative data having to do with the design, construction and operation of short-wave transmitters and receivers which it has been possible to obtain.

Edward W. Wilby



NATIONAL TMU

NEW MODEL TRANSMITTING CONDENSERS

These new transmitting condensers are made in two series: 5,000 volt and 7,500 volt, and embody all the very latest features for efficiency and steadiness of signal. All plates have rounded edges, and similar fine points of design and sturdy construction will be found throughout.

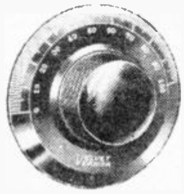
Micalex Insulation

NATIONAL TMU Transmitting Condensers can be furnished with Micalex insulation under special license agreement with R. C. A. Under this agreement Micalex insulated TMU Condensers may be sold only for amateur and experimental uses.

It is not possible for us to furnish Micalex insulation for condensers intended for commercial and other uses than those listed above. In such cases we are equipped to furnish Krolite, hard-rubber or other standard and accepted insulating materials.

Prices

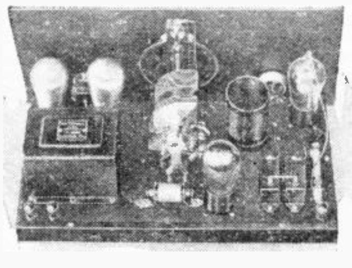
Model TMU Condensers are made in stock sizes up to .0005 mfd. in the 5000 volt series, and up to .00025 mfd. in the 7500 volt series. Special sizes can be made to order. Write us today for complete prices and information, mentioning Radio News Shortwave Manual.



National Velvet Vernier Dials

Original Model A

The original and matchless Velvet Vernier Dial used by amateurs the world over. Available in various divisions. List Price: 3⅜" diameter or 4" diameter $2.50.



The National SW-4 screen grid short-wave set. A compact, efficient short-wave set with an audio system really designed for short-wave work. Equipped with special cabinet and coil storage for 5 coils in addition to the one in use in the set. Will operate on NATIONAL A. C. power-supply unit. Price of parts with four transformer coils, without cabinet or tubes, $49.50—cabinet $5.25 extra.

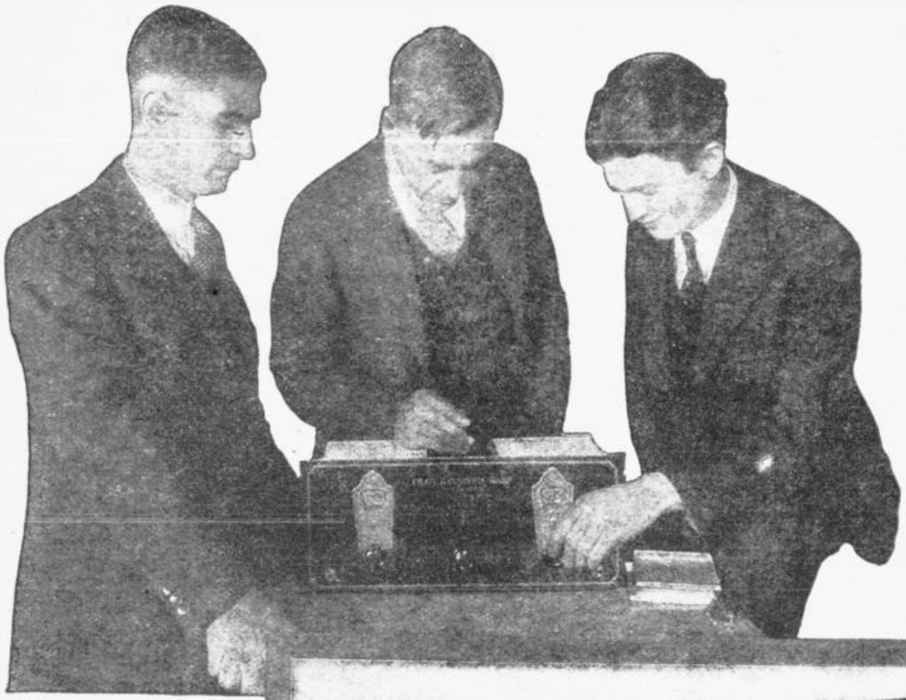
The National Precision Velvet Vernier Dial Type N, a 4" solid German silver precision dial with real vernier, making accurate reading possible to 1/10 division. Especially designed for short-wave receiver, transmitting and precision laboratory equipment uses. List price, each $6.50.

Write for full information and prices

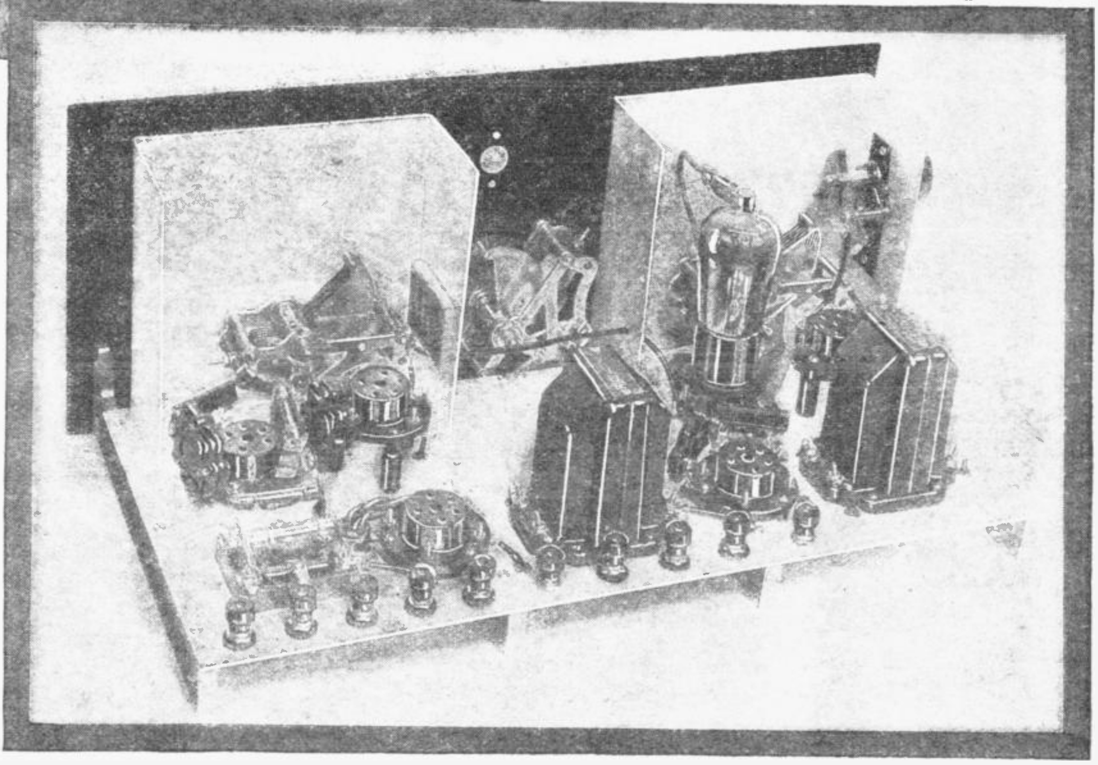
NATIONAL COMPANY INC.
ENGINEERS AND MANUFACTURERS
61 SHERMAN ST., MALDEN, MASS.

Hitting the A.C.

By Robert Hertzberg



Robert Hertzberg, the author, David Grimes and John Geloso, pilot engineers who helped develop the A.C. Super-Wasp



A back view of a completed four-tube A.C. Super-Wasp with the back halves of the shield cans removed to show the parts mounted inside. The audio channel is situated along the rear edge of the sub-base

THE one feature of short-wave operation that in the past has deterred many radio fans from plunging into the fascinating short-wave game has been the necessity for batteries as the source of filament and plate current. Short-wave broadcasting (as distinctly distinguished from short-wave amateur *telegraphy*) started to develop just at the time the all-electric broadcast set achieved commercial practicability. Hitherto it was necessary to consider short-wave receivers purely in terms of battery operation. The present generation of radio fans who think twice about making another battery set, read about the extraordinary DX work being done on the short-waves and become duly aroused over it, but comparatively few of them have cared to go to the trouble of buying batteries. They have inquired:

"Why can't the short-wave set be operated from the lamp socket, just as all broadcast receivers are?"

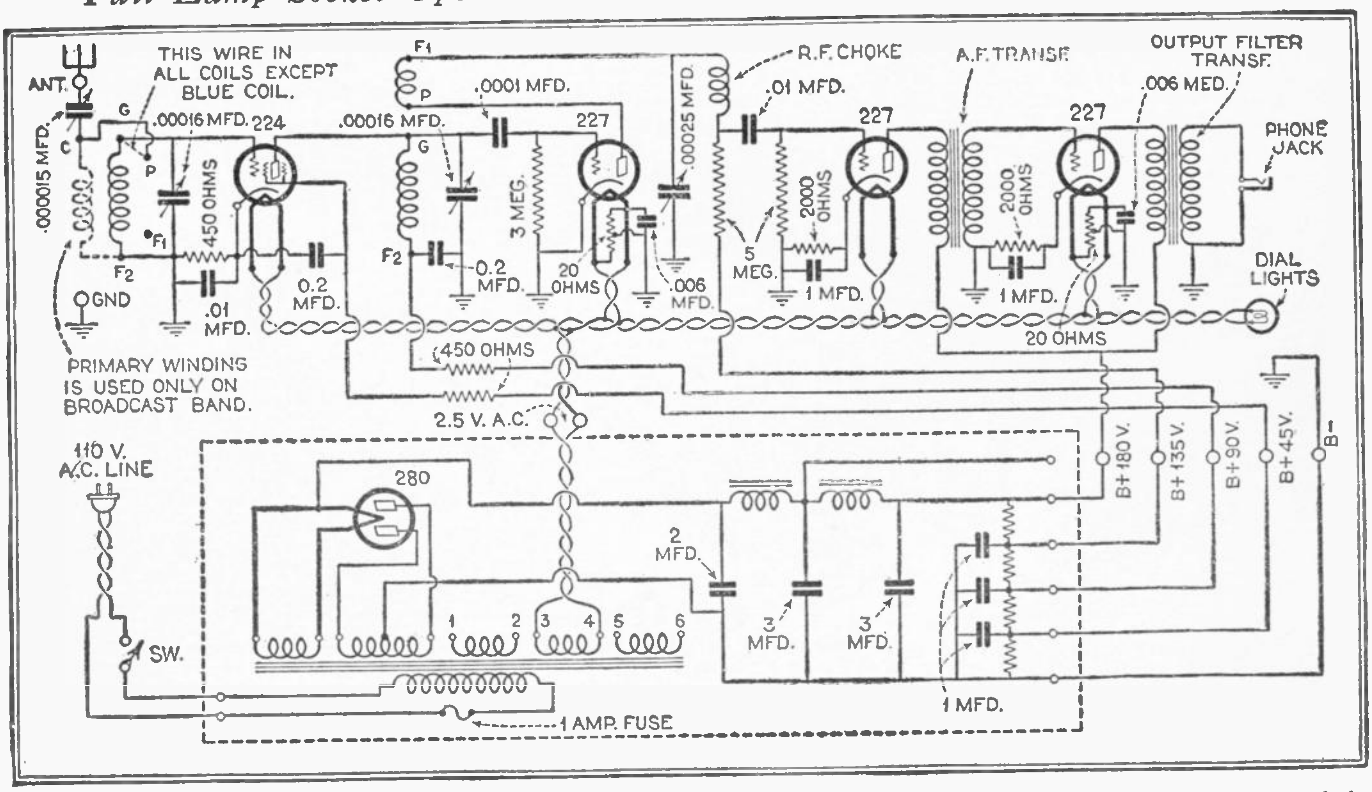
Ever since the first few short-wave broadcast "hounds" picked up G5SW in Chelmsford, England, and PCJJ (now PCJ) in Eindhoven, Holland, the kit and set manufacturers have realized that the short-wave DX "hound" would be an even more rabid canine than his predecessor, the regular broadcast-band DX-er, but they would have to supply him with the conveniences he has grown accustomed to with broadcast sets.

Battery-operated short-wave sets brought out by a number of companies catering to the experimenters have enjoyed considerable success, but the market has hardly been scratched. The fact that so many owners of short-wave sets enjoy consistent loud-signal programs from stations in distant corners of the earth is proof that the game is not quite as uncertain as it was several years ago, when the tuned screen-grid short-wave r.f. amplifier was unheard of and when a movement of the operator's eyebrows threw the set out of tune and made the signals disappear.

Among the firms whose engineers had been growing gray hairs over the a.c. short-wave problem is the Pilot Radio & Tube Corporation, whose battery-operated "Super-Wasp" (described in the April, 1929 issue of RADIO NEWS) has been eagerly gobbled up by radio fans anxious to hear Europe and Africa—and who have heard them quite satisfactorily. It has been the endeavor of these engineers to convert this outfit into an a.c. receptor, and until a short time ago the invariable result of their efforts was a loud, buzzing noise somewhat resembling the disturbance created by a dull buzz saw going through knotted pine. Finally, through the combined ingenuity of David Grimes, John Geloso and Robert S. Kruse, this noise was eliminated, and out of the Pilot laboratory has emerged an a.c. short-wave receiver that slides into oscillation as smoothly and gently as any battery set, with nothing but a very weak residual 60-cycle hum to indicate the nature of the power supply.

High Spots With the SUPER-WASP

All the Thrills of Short-Wave Operation Plus All the Conveniences of Full Lamp-Socket Operation With This Compact Four-Tube Receiver



The complete circuit diagram of the four-tube A.C. Super-Wasp receiver and its associated power supply unit. The complete set of parts for this receiver are supplied in kit form by pilot, and are accompanied by complete instructions on how to build the receiver

IN the June, 1929, issue of RADIO NEWS Mr. Hertzberg brought the battery-operated Super-Wasp to the attention of short-wave enthusiasts. It is a four-tube short-wave receiver of very fine design, for those days.

Meeting with almost instantaneous popularity, it was a foregone conclusion that this very efficient short-wave receiver for a.c. operation would be the next forward step.

Mr. Hertzberg's article describes in detail the obstacles which had to be surmounted before this ideal could be realized.

At this writing (middle of October, 1929) the "A.C. Super-Wasp," as the new set has been named, has been on the market about a month, and the enthusiastic reports voluntarily submitted by their delighted owners prove conclusively that the receiver is a reliable, commercial product, not merely an experiment at the expense of the public.

Like the original battery-model Super-Wasp, the a.c. version uses a stage of tuned screen-grid r.f. amplification, and a regenerative detector, the audio system differing slightly in that it comprises one resistance stage and one transformer coupled stage, with an output transformer to protect the earphones or loud speaker. The fact should be emphasized that the A.C. Super Wasp is so quiet it may be used for long stretches with earphones; with a loud speaker the slight hum does not appear at all.

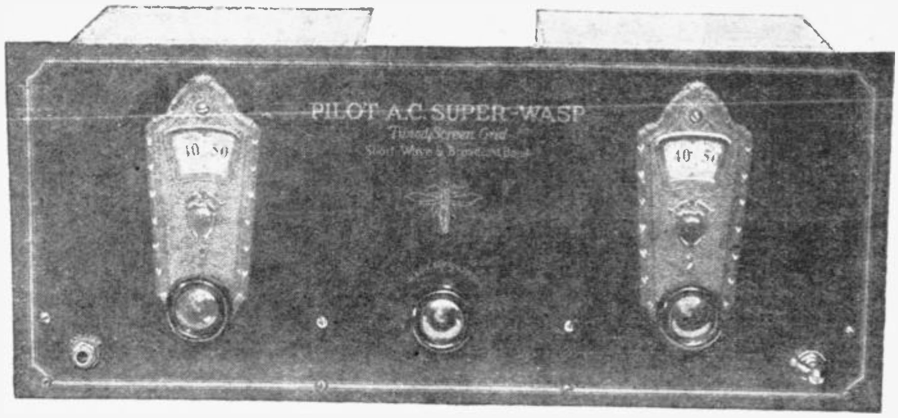
The components of the radio-frequency and detector stages, respectively, are enclosed within aluminum shield cans, additional protection against the detuning effect of the operator's body being supplied by a metal front panel.

The set is marketed in kit form, everything down to the last washer and soldering lug being supplied. No power pack is furnished with the kit, as any standard 171A pack of adequate filament capacity may be used. However, the set is intended to work particularly with the Pilot No. K-111 pack, which delivers exactly the right voltages.

The receiver tunes from 14 to 500 meters, five pairs of plug-in coils being included with the kit. These are the well-known Pilot coils which fit into standard UY five-prong tube sockets. The importance of providing a general-purpose short-wave receiver with this wide wavelength range was brought out by the company's experience with the battery set, but it served to complicate the a.c. problem considerably.

In the investigational and laboratory work which led up to the final satisfactory development of the A.C. Super-Wasp much data was unearthed which, aside from indicating the various problems which arose in connection with this job, are of inestimable value because they apply to the problem in general, of eliminating the sources of hum in radio receivers.

The first experiments conducted with standard a.c. tubes (224 in the r.f. stage, 227's in the detector and audio positions) disclosed two general classes of "hums." The first class was what we termed "residual hum" because it could be heard



The front panel view of the A.C. Super-Wasp. Tuning is accomplished by the two main tuning dials, while the center knob controls regeneration

in the earphones at all positions of the tuning dials. It was arising from the audio circuit. The second class we called "tunable hums," which were very numerous and could be brought in on several places on each set of coils. They appeared to have definite wavelengths, and could readily be tuned out by manipulation of the tuning dials.

It was fairly easy to trace the residual hum right down to the detector tube, it being a question of 60-cycle induction caused by the construction of the tube itself. It was also present in the two audio stages, but the succeeding amplification was not as great as the total following the detector. Hence it was not as noticeable as that from the latter source. A study of the design of the 227 tube was started, and meanwhile a redesign of the entire audio circuit was undertaken. It was obvious that too much audio amplification was undesirable for reasons other than a.c. hum amplification, so we incorporated a system of one resistance coupled stage following the detector, and one transformer coupled stage after that. Pilot tubes with the electrical characteristics of the standard 227-type are used in all three positions, with a 224, of course, in the screen-grid stage. Other features of the Pilot 227's are entirely different, as will be shown.

The use of the first resistance coupled stage reduced the residual hum much more than the reduction of audio amplification explained. The resistance units did not act like a.c. pick-up coils, as did the transformer windings in the same location.

You may wonder why a power tube is not employed in the last stage, and why a 227 is deliberately retained. The answer is that power tubes operate on raw a.c. This is quite all right for loud speaker sets, but if you want to learn how much hum there is really present with such a tube (either the 171A or 245 type), just listen to the output of any standard broadcast receiver with a pair of earphones. The use of an output transformer allows an acceptable compromise between the tube impedance and the impedance of a loud speaker, so that the tonal quality of the set on broadcast signals is not particularly ruined, as one might suspect.

It was found that a great deal of hum was caused by an unbalanced field created by the filament of the 227 tube. The standard 227 has a straight filament running through the center of the heated cathode. It is apparent that at one instant the bottom of the filament will be positive while the top is negative, shortly followed by a reversal of this condition. The electron field within the cathode is thus rapidly twisted back and forth during each alternation of the heating current, and a noticeable a.c. hum results.

To avoid this trouble, a special 227 tube was designed in which the filament is doubled back on itself within the cathode cylinder, in the fashion of a hairpin. In this arrangement the electronic field is neutralized at every point and no disturbing upheavals take place on the reversals of the heating current.

The above precautions killed the a.c. residual hum or, at least, reduced it to a negligible minimum. The tunable hums next came under surveillance and these were the most exasperating puzzles. We studied the hums with the antenna entirely disconnected from the set. This removed some of the disturbances which were coming in from the ether. This class of disturbance, and sometimes hum, is beyond our power to solve. Such effects would be as noticeable on any other type of set.

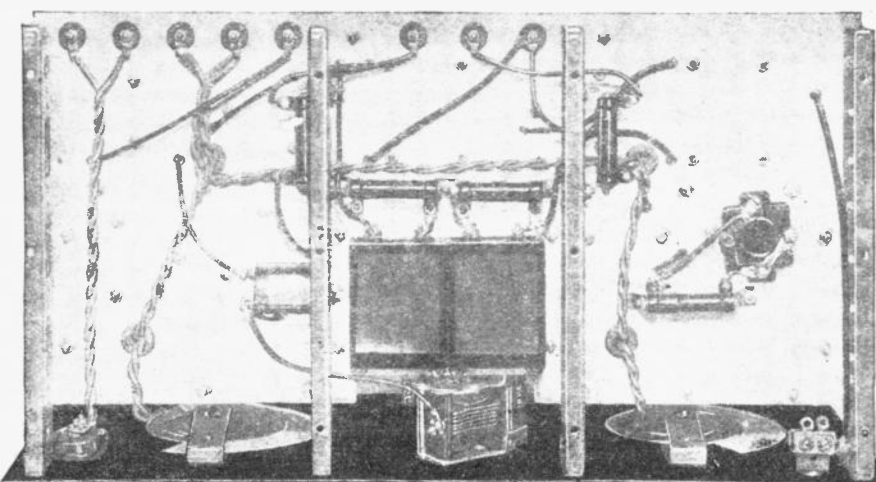
By far the greater number of our hums continued to persist, even after we had removed the antenna. These obviously existed in the receiver itself, and, as such, fell under the curable classification. Those on the red and orange coils, within the wavelength bands of 14 to 50 meters, were the strongest. They must have arisen from some high-frequency oscillation in the set modulated by the 60-cycle current. Some combination of inductance and capacity was acting as a transmitting circuit. This was finally found to be actually true. The capacity of the oscillating sysem is the internal capacity of the cathode-heater combination. The inductance is that of the leads combined with that of the center-tapped resistance connected across the filament. This resistance unit actually has enough inductance to be troublesome at the very short waves. The cure consists in merely adding a capacity across one side of this center-tapped "inductance" so as to kill the resonant combination. A casual glance at the audio circuit of the A.C. Super-Wasp will reveal these .006 mfd. by-passing condensers across the mid-tap resistors in both the detector and last audio circuits.

With these two culprits put away, there still remained other hums, occurring on the higher wavelength coils up in the green and blue range (100-500 meters). These were obviously caused by similar circuits except with higher inductances and capacities, so that the wavelengths were longer. As a further clue to their cause, they did not occur until the plate and grid connections were made for the screen-grid tube. They existed in these leads and were obviated by the insertion of the .2 mfd. by-passing condensers and the small chokes. The chokes are commercial, cylindrically wound resistors; but their main function in the plate and screen-grid leads is a choking one. They are indicated on the sketches as 450-ohm resistors.

There is one other point of special mention that should not be overlooked. Many of you are already familiar with the "squawking" of the ordinary regenerative receiver at the very point of oscillation. It is most annoying, not only because of the racket, but because that particular point is the one at which signals are most likely to be heard. This was given considerable attention in the a.c. design and, as a result, it has been completely subdued. The high resistance in the plate circuit of the detector accounts for this. There appears to be a highly critical condition existing in the

(*Continued on page* 82)

A view of the under side of the sub-base of the A.C. Super-Wasp. Note that, so as to reduce hum to a minimum, the filament wires are twisted



A Portable Short-Wave Transmitter and Multiwave Receiver

by Wm. H. Wenstrom, Lieutenant, USA

THERE are finite limits to all terrestrial DX. The antipodes are only twelve thousand miles away; in time London palls and even Australia goes stale. Our morale may rise on hearing the signals of a transatlantic airplane, but it really takes a jump when we hear our friend say from the far shore of a mile-wide lake: "We reached the cove before the storm hit—everybody safe."

For such occasions, and for more prosaic work as well, this low-power portable transmitter is designed. Its reliable daylight range is two miles with phone and twenty miles with code.

Of course, "communication" is a dual affair and depends as much on the receiver as on the transmitter. The description of a suitable receiver follows this article. The transmitter's dimensions are slightly different from those of the receiver, but in general it is designed as a companion unit.

As in the receiver, one-fourth inch bakelite serves as the panel and also as the framework of the set. Though this construction is not the most compact, it has advantages. It is very easy to assemble, strong and rigid, and accessible—when the panel is tipped forward all parts are instantly exposed to view.

Circuit Details

The transmitter circuit is a series-fed Colpitts, often called the Hoffman split Colpitts. It is shown in Fig. 1. All standard oscillator circuits are much alike in efficiency, despite the arguments of their advocates; but the Colpitts has two advantages which make it ideal for portable use: first, one variable condenser absolutely controls the oscillator frequency over a wide range (see calibration curve, Fig. 6) with no guesswork inductance clips, no flopping out of oscillation, no plate current acrobatics; second, two large condensers directly across the tube elements keep the emitted wave exceptionally steady—practically as steady as that of an oscillator-amplifier circuit. In addition, the series feed brings the plate supply and grid bias leads into the radio frequency circuit at points of low potential. A minor disadvantage of this circuit—no control of grid feedback, as evidenced by heavy plate currents—is nullified by using a high value of grid leak (around 10,000 ohms).

The Power Supply

After the circuit itself, the matter of power supply demands consideration. An "A" battery of dry cells may be essential when the outfit is packed on horses or mules, but for most uses a small storage battery, which will deliver a more constant voltage, is preferable. The plate battery, however, is a different matter. Dry "B" batteries are bulky enough; wet ones are out of the question. No dynamotor is made small enough for a set like this. The only trouble with the dry "B" battery is its bulk and weight; in other ways it is ideal. For any sort of economy we must use heavy-duty units, of which two or three, even though equipped with a handle, are not too easy to carry. The plate battery, then, is limited to either 90 or 135 volts—preferably 135.

We now have to find a tube that will produce some semblance of antenna amperes on the meager plate voltage of 135. It is a good deal like asking a confirmed drunkard to get hilarious at a prohibition picnic. Several UX-201A's in parallel would take up too much space, but it fortunately happens that the UX-171 is

OSCILLATOR OUTPUT AND COMPARATIVE EFFICIENCY

On 85 meters, antenna and counterpoise terminals shorted through r. f. ammeter

	Ep	Ip	EIp	R.F.	Efficiency Index*
UX-171A	96	21	2.19	.75	.34
	142	40	5.68	1.30	.23
UX-112A	96	16	1.53	.60	.39
	142	28	3.98	1.00	.25
UX-201A	96	11	1.06	.45	.42
	142	16	2.37	.60	.26
WE-216A	96	12	1.15	.50	.44
	240	42	10.01	1.40	.14

*THE EFFICIENCY INDEX IS OF VERY DOUBTFUL VALUE, AS IT IS ENTIRELY COMPARATIVE, AND PROBABLY INACCURATE.

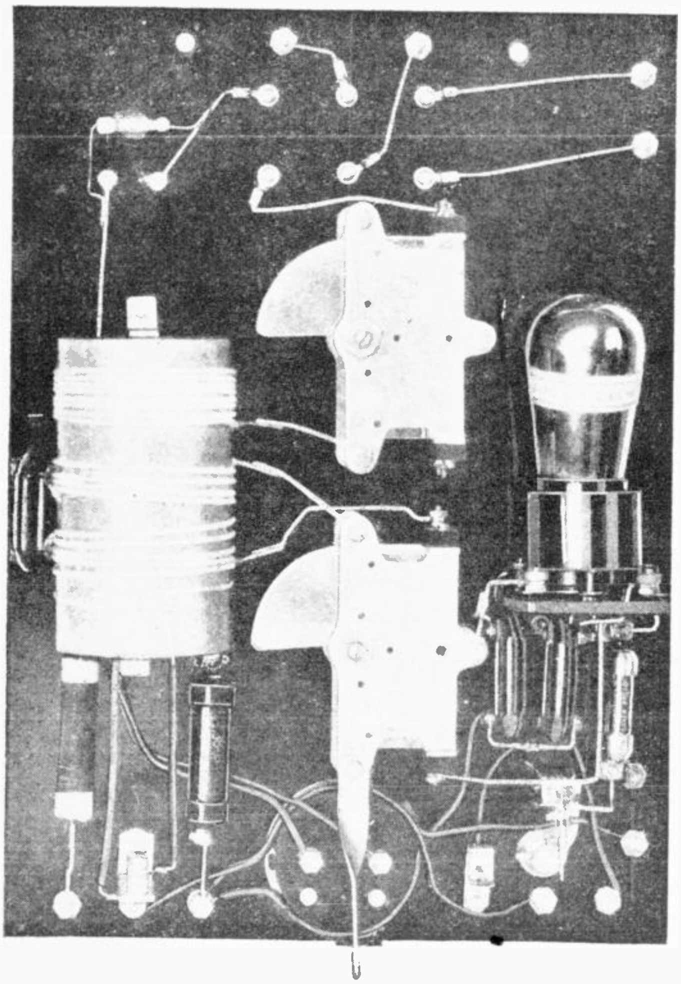
THE PURPOSE OF THIS TEST WAS TO GET AN IDEA OF THE PERFORMANCE OF VARIOUS TUBES IN THE PORTABLE TRANSMITTER. THE UX-171A, OR 171, WAS CHOSEN BECAUSE OF ITS HIGH R. F. OUTPUT WITH A LOW VOLTAGE PLATE BATTERY.

Short-wave transmitter designs are legion, and so are multi-wave receivers; but to provide portability, in both instances, is distinctly a horse of another color. And this is exactly what Lieutenant Wenstrom has done in the case of the transmitter and receiver described here.

With a conservatively rated, dependable daylight range of two miles for telephone, and twenty miles for code transmissions, the short-wave transmitter is adaptable to a wide variety of uses—some of which are suggested in the accompanying illustrations. And it is worth emphasizing, that the word "portable," in this case, is decidedly not a mere figure of speech.

The companion receiver—equally literally portable—covers a range of both short and broadcast channels and is so designed as to accommodate any type of "B" supply available. It also provides for phonograph pick-up, voice amplifier adaptation, and for the use of power audio output where (in fixed locations) the latter is at hand.

The author's particular fetish, in designing these portables, has been accessibility; a feature especially desirable in equipment which is to be used under camping or traveling conditions.



A rear view of the transmitter, showing placement of parts

ideal. Its superiority is shown in the oscillator output table. The figures were secured with a 171A, but apply also to the 171, which is more rugged and generally satisfactory. (See page 9.)

Sometimes there arises the question of code versus phone. In reality there is no such question, for a phone experimenter must, under the law, be a code man as well. This is not at all unreasonable, for really good phone work demands a higher degree of technical skill than does code. Code usually has a range ten times as great as equi-powered phone, but phone is very handy when there is a great deal to say.

In choosing the operating band for this transmitter, we must hark back to its primary purpose, which is to cover dependably the distance of an ordinary camping trip or pleasure drive. The twenty-meter and forty-meter bands are unsuitable because of their pronounced skip-distance and because they are not open to phone. Though phone is permitted in the 160-meter band, this band would require too large an antenna. Thus by elimination do we arrive at the best—the 80-meter bzand. Coil specifications and arrangements are shown in Fig. 5.

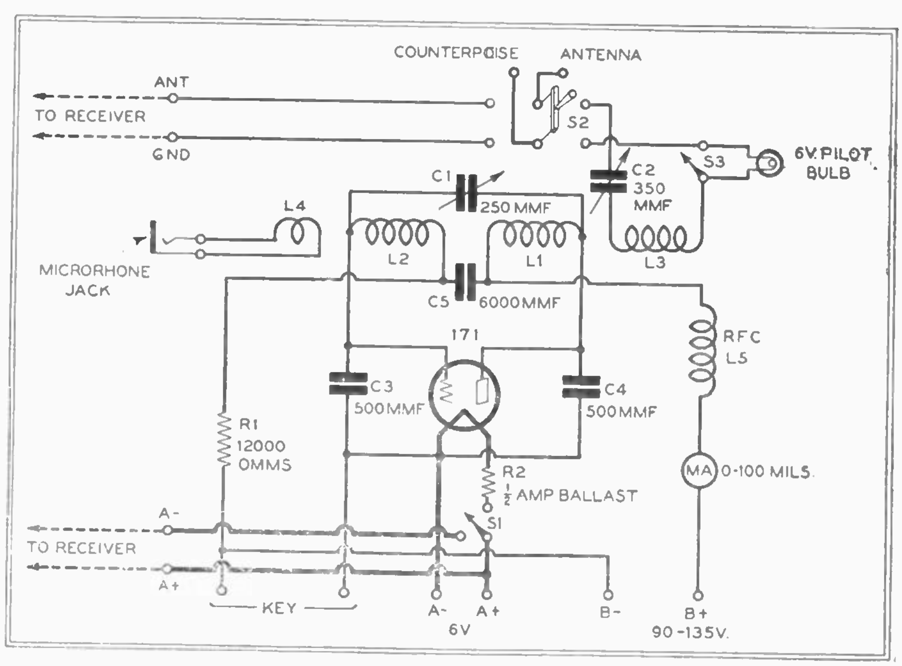
Suitable Antennas

The antennas used with this set are described in some detail in the receiver article. Their exact dimensions appear in the diagram (Fig. 2), and the photographs show their construction. The special insulators, cut from 3/8" hard rubber rod, are worth noting.

Constructional Details

The construction of a portable, being more exacting than that of a fixed set, should be unhurried. It might be well to start construction and preliminary tests several months in advance of actual portable use. This is particularly true of this set, as there is no danger of its going suddenly out of date. There are very few parts, and the photographs show clearly how they are assembled and wired. Some experimenters may wish to vary the arrangement. Down the center line and at noted distances from the panel top are: the change over switch, S2, which is removed from its base and mounted directly on the panel (2 in); the antenna condenser, C2 (5 in.); the oscillator tuning condenser, C1 (9½ in.); and the milliammeter (1⅜ in. from bottom). The coils of No. 16 d.c.c wire (except modulating loop of No. 20) are wound on a fiber form 2½ in. by 4½ in. The coils are held rigidly in place by a "dope" of

Fig. 1—The circuit diagram of the transmitter



celluloid dissolved in acetone. Of course any "dope" on short-wave transmitter coils is pure heresy, but in this case the most important thing is that they stay in place. The coil form is fastened to the panel by angles on the right (from panel front) of the condensers. The condenser C5 is fastened directly to the center coil ends. Above the coil, to the right of the changeover switch, is the socket for the antenna resonance bulb, mounted directly in the panel; and the shorting switch S3, also mounted in the panel. Below the coil, and held by bus bars, are the grid leak R1 and the radio frequency choke, L5. The latter is about one hundred turns of No. 30 wire on a half-inch wooden cylinder. Below these parts is the microphone jack.

On the left of the condensers is the tube socket, far enough down to have its base even with the oscillator condenser. There is plenty of room above it for a UX-210 tube when the set is used at a fixed location. Directly below the socket and held by bus bar are the "Colpitts" condensers, C3 and C4, and to the left of them is the filament ballast, R2. The filament changeover switch, S1, projects through the lower left part of the panel, balancing the microphone jack on the right.

The carrying case is made of ½ inch white pine, nailed together with heavy brads and provided with a suitcase handle. The lumber cutting dimensions follow:

1 piece 11⅛" x 15⅛" (back)
2 pieces 4½" x 11⅛" (top and bottom)
2 pieces 4½" x 14⅛" (sides)

Though the portable receiver had a front cover this set has none, because its many binding posts do not allow one. For use in an auto, or in any place where it has a tendency to tip over, the box should be screwed to a 1-inch base of convenient size.

The key, and a small knife switch to close the key circuit for phone, are mounted on a separate board ¼" x 5" x 10". This board is provided with a twisted pair lead long enough so that the key may be used on any convenient rest, such as the operator's knee. The microphone, which may well be salvaged from an ordinary telephone, is provided with a twisted pair lead ending in a plug. To reach the microphone terminals, rather inconspicuous screws on the inner frame, the outer case must be taken apart. The A battery lead is another twisted pair, with battery clips at the far end; or the far end may terminate in a plug which fits a jack on the car dashboard. The B batteries are tied tightly with heavy clothesline into a bundle as compact as possible, and like the other units connect to the set through a twisted pair lead. There follows a list of the parts used in this set, though any parts which are mechanically and electrically similar may be used:

TRANSMITTER PARTS LIST

C1—Cardwell .00025 mfd. variable condenser;
C2—Cardwell .00035 mfd. variable condenser;
C3, C4—2 Sangamo .0005 mfd. fixed condensers;

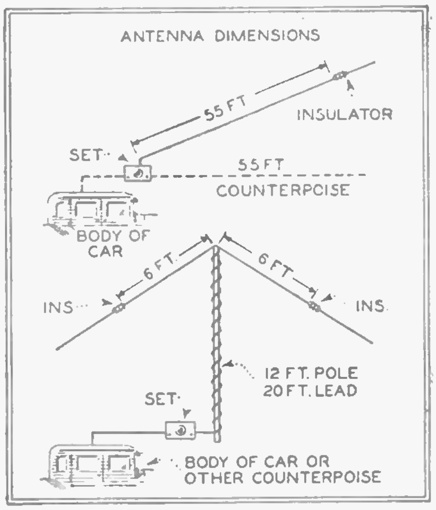
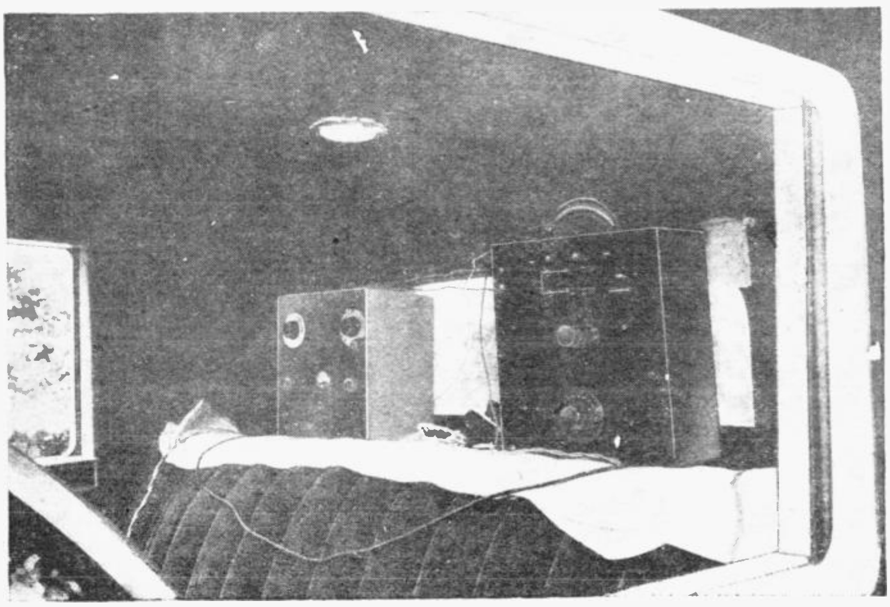


Fig. 2—Some suggested antenna systems (above)

Below: The portable receiver and transmitter ready for use in a coupe



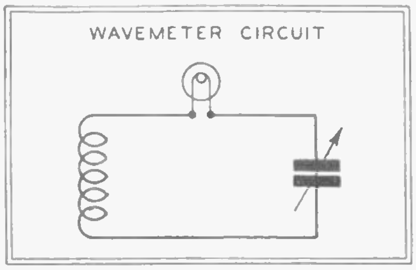


Fig. 3—A wavemeter, whose circuit is shown above, is helpful in calibrating the transmitter

C5—Sangamo .006 mfd. fixed condenser;
L1, L2, L3, L4—4 Home made coils (see coil diagram and text);
L5—Radio frequency choke (see text);
R1—Western Electric resistance, type 38-B (see text);
R2—Daven ½ amp. ballast, with mounting;
S1—Yaxley junior jack switch, SPDT;
S2—Trumbull knife switch, DPDT (see text);
S3—Midget knife switch, SPST (see text);
1—Benjamin spring socket, type 9040;
1—Weston milliammeter, type 506, 0-100 mils;
2—Dials, 3 inch bakelite;
1—Lamp socket, miniature (see text);
1—Bulb, 6 v. pilot;
12—Eby binding posts, large size;
1—Bakelite panel, ¼" x 10⅛" x 14⅛";
1—Carrying box, complete.

OPTIONAL HEISING MODULATOR PARTS

T1—Thordarson small type 2:1 audio transformer;
R3—R.C.A. rheostat, type PR-535, O-1.5—6 ohm;
R4—Tobe grid leak, .5 meg.;
L6—Primary of R.C.A. filament transformer, type UP-1656;
2—Sockets, Fahnestock clips, baseboard, etc.;
1—Two stage speech amplifier;
1—Cone speaker.

Before any operation is attempted, a wavemeter should be procured. It is simple enough to make. As shown in the diagram, Fig. 3, its parts are three: a coil, a condenser and a flashlight bulb. The bulb should be of the 1.25 volt variety, as higher voltage bulbs give too broad a reading. Once made, the wavemeter must be calibrated through the receiver from a standard one. Its use is the simplest of all: With the transmitter in operation, place the wavemeter coil near the oscillator and turn the wavemeter dial until the bulb lights brightest. Of course, one must use caution—or a plentiful supply of bulbs.

Operation

First of all connect the "A" battery, see that the tube lights, and check the voltage across its terminals. Then connect a 45 volt "B" battery to the set, leaving the antenna and counterpoise off and setting the oscillator condenser at about 50. When the key is closed the milliammeter should read about 5 mils. Next connect a short length of wire directly between the antenna and counterpoise binding posts. Tuning the antenna condenser should change the milliammeter reading—at one point should almost double it. This test indicates that the tube oscillates normally; but to make sure of it place the receiver across the room from the transmitter, with no antenna or ground on either. The receiver easily picks up the loud cw whistle of the transmitter. Then plug the microphone into its jack, and get someone to talk into it. The telephone signals should be clearly audible in the receiver headphones. It will be noticed at this point that plugging in the microphone lowers the wavelength about a quarter of a meter.

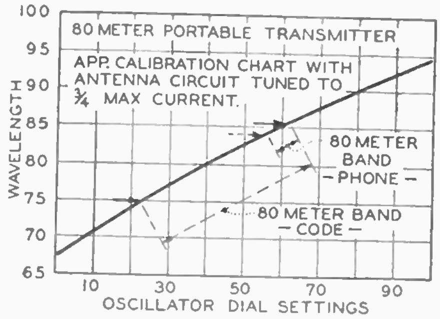
The set is now completely tested and ready for full-powered operation. Actual communication tests should be made from a fixed location before trying portable work. Connect the antenna and counterpoise or ground, and also the 90-135 volt B battery. With the 90 volt battery, the plate current will run somewhat as follows: Antenna detuned, 12 mils; antenna tuned to maximum, 50 mils; normal operation, 25 mils. With the 135 volt B battery: Antenna detuned, 18 mils; maximum, 80 mils (will soon ruin tube); normal operation, 40 mils. As the pilot light reaches normal brilliance at about .1 ampere, one can guess at the antenna current. With the antenna condenser tuned somewhat below the maximum for normal operation, the antenna current runs about .08 ampere for 90 volts and .12 ampere for 135 volts.

Before any real operation, the transmitter must be carefully calibrated—an easy proceeding with the flexible Colpitts circuit. Each new set should be calibrated individually, and a chart like the one in the diagram should be made up. Both the transmitter and the wavemeter may be checked against the receiver on such known wavelengths as 62 meters (KDKA) and 74.7 meters (NAA).

It is worth noting that a Federal license is required for transmission, and that an amateur must stay strictly within the prescribed bands. The 80 meter band extends from 75 to 85.7 meters (4.000—3.500 kc.) for code, and from 84.5—85.7 meters (3.550—3.500 kc.) for phone. While a few careless or deliberate amateurs operate off wave, just as a few drivers labor under the delusion that they own the highways; if every amateur followed suit the whole fraternity would soon be wiped out by government action. When the transmitter is used for portable work with the Portable Multiwave Receiver, the binding posts on the left side of the panel are used. The A battery posts are connected by twisted pair to the external battery plug of the receiver, and jumpers run from the upper left binding posts on the transmitter to the antenna and ground posts on the receiver. When using the single wire antenna, a .00025 mfd. condenser is wired in the antenna jumper to change the antenna fundamental so that the 80 meter receiver coil will oscillate normally. To transmit, throw S1 and S2 to the right, lighting the transmitter filament and connecting antenna and counterpoise to the transmitter. To receive, throw both switches to the left, lighting the receiver filaments and connecting antenna and counterpoise to the receiver.

The 80-meter transmitter with complete accessories. Its simplicity and compactness are apparent

Fig. 6—Below, an approximate calibration chart of the 80-meter transmitter



It is best to arrange the first tests with some amateur friend not over 20 miles away. When outsiders are worked later, the operator either tunes in a station calling CQ and calls him when he signs off, or himself calls CQ and searches for an answer in the form of his own call sent by some other station.

The choice of good location will greatly facilitate portable work. Hollows below the general land level and heavily wooded spots are unfavorable to transmission. Electrical conductors, good or bad, absorb radio frequency energy. This absorption is not very important in reception, but the waves should at least be given a fair start from the transmitter. Of course, nothing absolutely stops transmission — submarines transmit under water—but poor locations do cut down the range, and open spaces on water or fairly high ground are best.

When the set is used for some time in a fixed location, more complicated arrangements may be found worth while. For this work a fixed receiver, such as the National Thrill Box or Pilot Super-Wasp, may be used. The transmitter is preferably placed up out of the way in another room and operated by remote control. Since more power is available, a UX-210 can be substituted for the UX-171, and storage battery, generator d.c. or rectified, filtered a.c. may be used on the plate. The plate current runs 45 to 60 mils at plate voltages around 300 or 350. Up to 500 volts may be used if the current is kept down by detuning the antenna.

With increased power, loop modulation becomes unsuitable, and is replaced by Heising modulation. For telephone work the transmitter becomes, in effect, a miniature broadcasting plant. This sounds complicated but, as a matter of fact, the arrangements are quite simple.

(*Continued on page 78*)

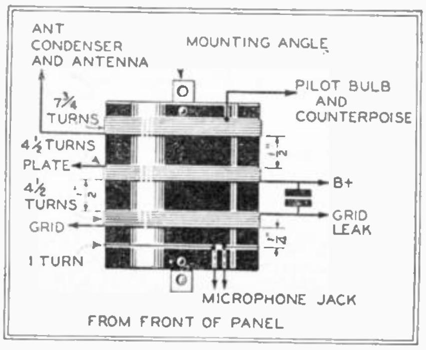


Fig. 5—Details of the coil construction

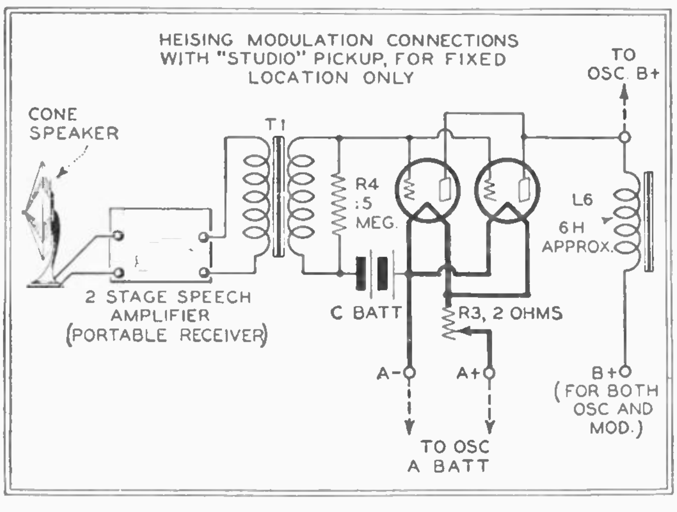
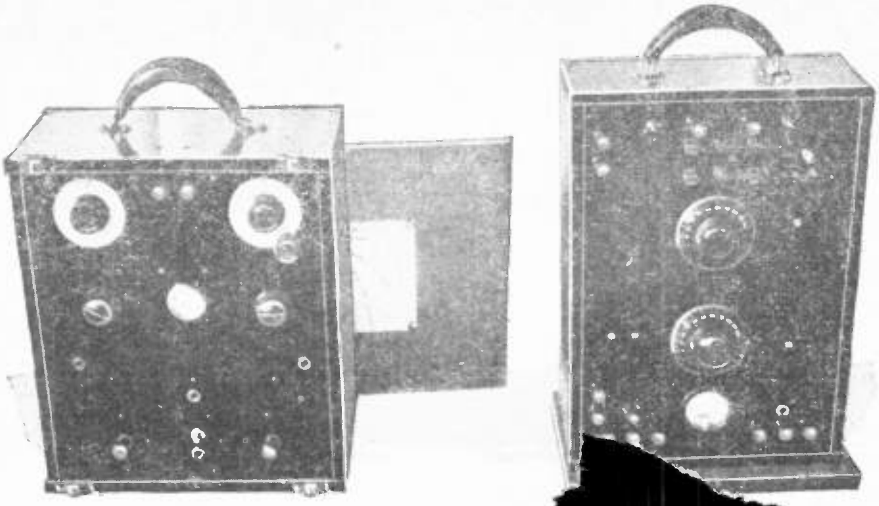


Fig. 4—In a permanent location phone transmission can be improved by the use of a voice modulation system whose circuit is shown at the left



The portable multiwave receiver, described below

The transmitter, described in the preceding pages

Wenstrom's Multi[illegible]e Receiver

A Companion Unit to the Port[illegible]ble Transmitter

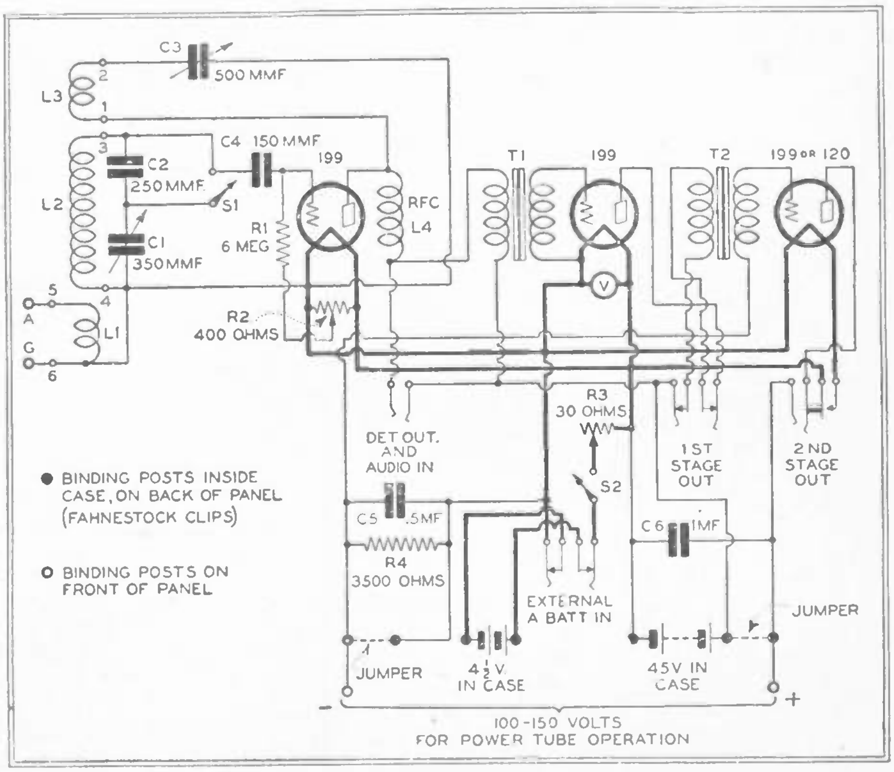
PORTABLE receivers maintain a refreshing variety unknown to the more staid and domestic sets of the home. We find puzzling extremes—portables that monopolize a large truck, and portables assembled in a nutshell. The search for compactness can easily be carried to ridiculous extremes; for a thumbnail portable, requiring phones and batteries much larger than itself, gains very little in overall convenience. For real portability, batteries should be included in the set, and the assembly should be of a size and weight easily carried in one hand. These requirements bring us logically to about half-suitcase dimensions; and indicate a carrying box built to fit the set rather than a set crammed into the odd corners of some ready-made container. The design and construction of a portable, needless to say, is more difficult than that of a fixed set.

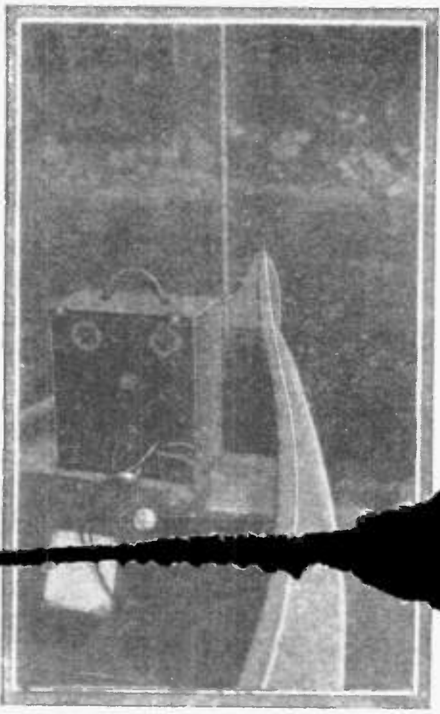
The circuit used in this receiver and shown in Fig. 1 is easily recognized as a slight modification of the standard regenerative circuit. It covers a wide range of wavelengths. The regenerative detector with one or two stages of audio is practically standard where maximum performance and dependability are desired from minimum apparatus. While the circuit is not as sensitive as some multitube arrangements, it is more reliable and generally satisfactory.

Antenna Design

As the set is ill adapted to loop reception, some form of antenna circuit must be used for everything except local work. Portable antennas are as varied as the sets themselves, but a fairly constant rule is that the smaller and more convenient an antenna, the less signal it picks up. For use with this set three forms have been developed which do quite well for their size. The first is a single wire about 50 feet long, attached at its free end through an insulator to thirty feet of light clothesline which can be made fast to the highest support that happens to be available. For easy coiling the wire should be stranded, flexible and insulated, like lamp cord; and the insulator should be made from $\frac{3}{8}$ inch hard rubber rod, as the standard types are too large. This antenna is probably the best of all, but in some locations, such as a moving car or a small boat, it is not so suitable. For this work we use something reminiscent of the wave coil investigated some years ago by General Squier. Thirty or forty feet of bell wire is wound spirally on a solid bamboo fishing pole eight or ten feet long, the turns falling about one or two inches apart. The top end of the wire is fastened to the top end of the pole, which of course is vertically upright in use, and the bottom end of the wire is connected to the antenna terminal on the set. The third design, a modified umbrella antenna, is also built on a bamboo pole about twelve feet long; but the bell wire lead is not over twenty feet long with turns widely spaced, and two flexible wires each about six feet long are sol-

Fig. 1—Circuit diagram of the multiwave receiver; a slight modification of the standard regenerative circuit





THE RECEIVER, AS SET UP IN A CANOE

dered to the bell wire at the pole top, and held out from the pole at convenient angles by insulators and guy cords at their lower ends.

Unless a good conductive ground exists, such as a water pipe or a metal fence, a counterpoise, or insulated wire laid under the antenna, is desirable. The frame of an auto makes a good counterpoise, as does any large metallic object insulated from the ground. Various makeshift grounds, such as a metal plate or wire in a lake or stream, or a nail driven into a live tree, have possibilities.

Receiver Design

The parts are mounted in a rather unique way—a way that bears some resemblance to the deck construction of a broadcast transmitter. A one-fourth-inch bakelite panel serves not only as the panel but also as the whole frame of the set. Everything except the batteries is mounted directly upon it with no other support. Perhaps each radio designer may be permitted one fetish that he expounds above all others—the writer's happens to be accessibility, and it was developed fixing military sets that had to work but wouldn't. The all-panel mounting is ideally accessible, as well as strong and rigid, for when the panel is slid out of the box and laid face down, all the parts are spread out as on a breadboard.

Tubes of the 199 type are chosen for their small size and battery economy. The rather small gain of these tubes makes two stages of audio desirable even for headphone work. UX-199s might be used with separate sockets; but as a 3 gang shock absorber socket is made for UV-199s these were decided on. The gang socket is more compact, stronger, and easier to mount. As one sometimes wishes to use a loudspeaker on a strong

COIL TABLE

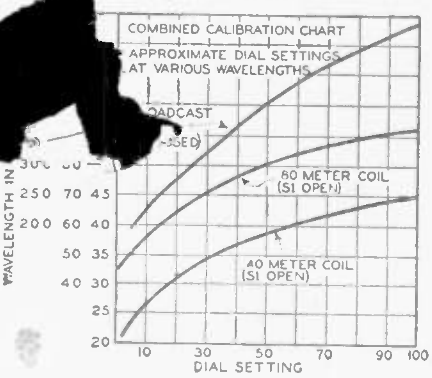
Band	*Coil Range*	*Type*	*Pri. turns*	*Grid turns*	*Tickler*
40*	23—45 m.	S-M No. 111-C, a[illegible]	2	5	20
80*	45—92 m.†	S-M No. 111-B, altered	3	13	35
Broadcast	200—550 m.	S-M No. 111-A		Unaltered	
Marine	600—1400 m.	S-M No. 111-D, optional		Unaltered	

*THE FIRST TWO COILS ARE ALTERED FROM SILVER-MARSHALL STANDARD. ON PRIMARIES AND GRID COILS TURNS ARE TAKEN OFF; ON TICKLERS TURNS ARE ADDED; NO CHANGE IN WIRE SIZE.

†THE 80 METER COIL GOES UP TO ABOUT 135 METERS WITH SWITCH S1 CLOSED.

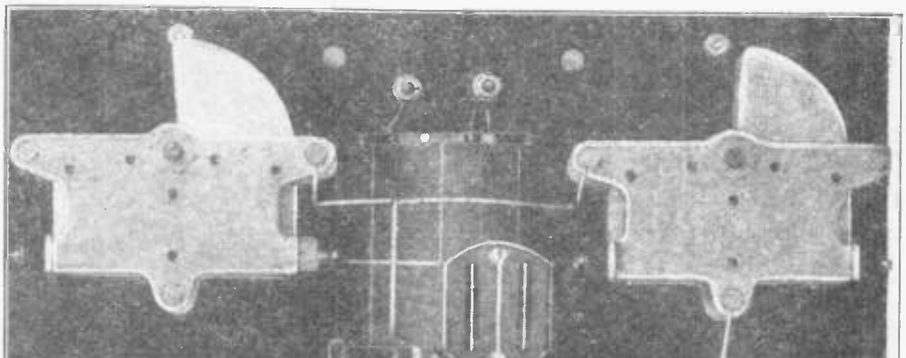
signal and the 199 is entirely inadequate as an output tube, the set is designed so that a 120 tube may be used in the last stage. The Sonatron V-120 fits the gang socket; the UX-120 requires an adapter. The grid bias of this tube is secured from a resistance in the set, and requires no separate C battery.

FIG. 2. BELOW, A CALIBRATION CHART OF THE PLUG-IN COILS



Most portables cover only the broadcast band, but this one has a much greater range of usefulness due to its Silver-Marshall plug—in coils. As the broadcast band is considered most important, the circuit constants are arranged to cover it completely with one coil. There is also much of interest between 25 and 100 meters, including the 40 meter and 80 meter amateur bands, so that this range is covered with two coils. An optional coil, chiefly of interest to yachtsmen, covers the ship and radio compass waves. These coils are fully described in the calibration chart, Fig. 2, and in the coil table. Note that the amateur bands are placed well up in the short wave coil ranges, on the flat part of the curve.

A QUARTER-INCH BAKELITE PANEL SERVES NOT ONLY AS THE FRONT PANEL BUT AS THE SUPPORT FOR ALL PARTS



The .00035 mfd. condenser used for tuning through the broadcast band would of course be too large for the short wave coils. We resort to an unusually compact way of getting a smaller tuning condenser for the short waves. A fixed condenser equipped with a shorting switch is wired in series with the variable one. With the switch closed the tuning capacity goes up to .00035 mfd.; with it open the limit is about .000145 mfd. A potentiometer controls the grid bias of the detector and regulates its selectivity and sensitivity. It is usually negative for code reception and positive for phone.

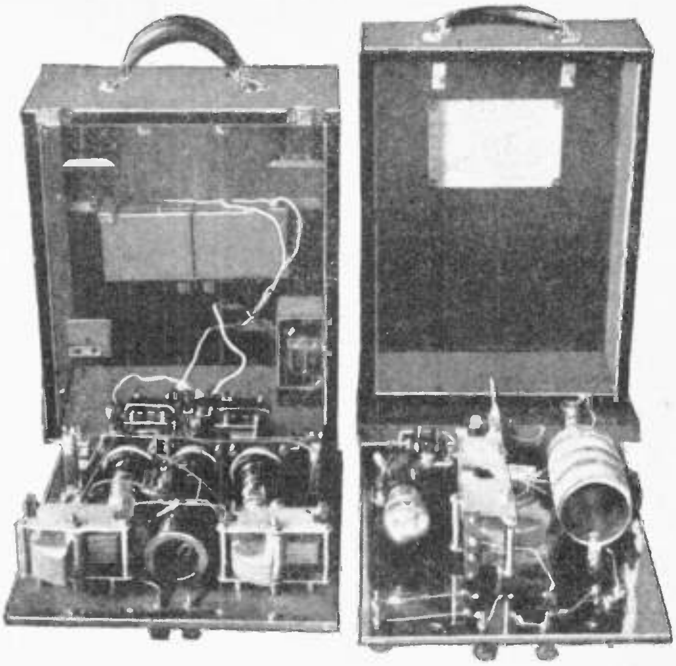
The filament voltage is controlled by a high resistance rheostat and a midget voltmeter. This system permits the use of any A battery, dry cell or storage, and insures correct operation of the delicate 199 tubes. So that different batteries will not affect the amplifier grid biases, the rheostat is wired in the A+ lead.

Though the jack system seems quite complicated, it is decidedly useful. The first jack is across the primary of the first transformer, and serves for testing the detector output, as well as to introduce an audio input with the detector tube removed. This last connection is handy when an electric phonograph pickup is used, or when the set acts as a speech amplifier. The first-stage output goes to a conventional two-circuit jack. The output jack of the second stage is a filament lighting one, so that the last tube is lit only when in use.

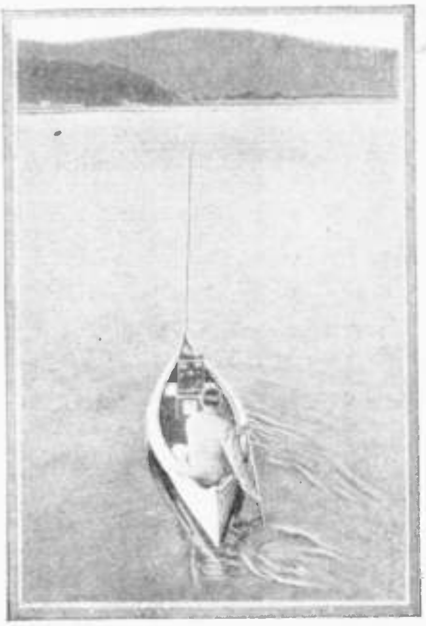
The battery system also seems quite weird at first, but it was planned from much portable experience. The internal A battery consists of two 4½ volt C batteries wired in parallel, the leads from which go to the inside contacts of a double-circuit jack. When an external A battery is plugged into this jack, the internal one is automatically cut out. This external A battery may be three dry cells in series, or a 4 or 6 volt storage battery. If the set is to be used much in a car, the metal dashboard can be drilled for an ordinary open circuit jack. The back of the dash near the hole is scraped clean, grounding the sleeve contact, and a wire is run from the tip contact to the ammeter. This jack makes a convenient outlet from the car battery to a radio set or an emergency light.

The internal 45-volt B battery, applied to all tubes alike, consists of two 22½ volt units of the very smallest size (2" x 2½" x 3½"). When a power tube is used in the last stage two jumpers, or short pieces of connecting wire, are removed. This removes the internal B battery from the last tube, and permits to function the resistance which, at the rated current, applies the correct C bias to the power tube grid. The B-C battery for the power tube is then connected to external binding posts. Due to the automatic grid bias, this B-C source can be practically anything between 90 and 150 volts—from batteries or eliminator.

Note, at the right, the compact internal arrangement of parts, of both receiver and transmitter



Below—All local New York stations were easy to get, on the Hudson, at West Point; WGY and WICP also came through well



Below—Ready for real work, in the open country

Constructional Details

The arrangement of parts is clearly shown in the photographs. Permissible variations will doubtless occur to the experimenter. The front panel is of bakelite, and measures 11 by 13 inches. Its ¼ inch thickness insures the strength necessary to support all the heavier parts, which are bolted directly to it with machine screws. A few lighter parts are held by bus bar, which is used in some places to strengthen construction. Other connections are made with small, rubber-covered wire. After the panel has been drilled, the mounting of parts can proceed by three distinct sections.

The top section includes the tuning and regeneration condensers, placed close to the outside edges of the panel to leave plenty of room between them for the plug-in coil. The condenser centers are two inches below the panel top. The coil socket is held horizontally by brackets midway between the condensers and 4⅜"

(*Continued on page* 80)

How an International Daily Gets the WORLD

TRANSCRIBING THE NEWS AFTER IT HAS BEEN RECEIVED AT HIGH SPEED IN CODE ON A DICTOPHONE CYLINDER

TODAY there are people who feel that their adventure is at an end; that it has passed them by. To them is this story written. These are the radio adventurers, the thousands of those busy people who used to go roaming around the world by way of their radio sets in the evening after a busy day at work. Most of them limited this roaming to the North American continent.

But just to show them they are wrong, let us unfold a tale of present-day radio adventure which has been every bit as stimulating as the early broadcast days and which can be duplicated by any experimentally inclined radio reader today.

Newspaper life presents as romantic an angle to young men as the stage does to young women. The rapidly shifting scenes of daily events, the rush to cover these; the speeding of the stories to the office, and after going through the "machinery" of copy desks, make-up, presses, etc., the appearance of the paper on the street. To be true, a few hours afterwards the news is usually forgotten, but the press is already getting the next day's batch of copy.

Gathering the news is interesting, but when the lot of working at the getting of this news to the office—in other words, the establishment of a system of communication—came the writer's way, he discovered, much to his pleasure, that this was just as thrilling.

The *Monitor* is an international daily newspaper and as such it is almost totally dependent upon distant sources for its news. Thus it has a leased wire which runs from Boston to New York, thence to Washington, and finally to Chicago, besides using the regular Western Union and Postal services. This takes care of the American continent.

World-Wide Coverage

But "international" means world-wide and thus rafts of news come in from every capital in the world. Cables and radio through the regular companies are used daily, but we found we needed more than that. We needed the high-speed service possible when one controls their own communication lines.

Before seeking to conquer the world (by radio) we decided to test out a single link in the chain and therefore chose the England-to-America circuit for our experimental work. The majority of our European news is routed through our London bureau, which in turn sends it by radio from the British station at Rugby. This is picked up in Halifax, where it is received on a tape, and then decoded and sent via land line telegraph to headquarters in Boston.

By taking this news directly from England, we could save the time consumed in the extra handling at Halifax. Now the problem was to do it.

First we had to consider the source of our receiving station. It would not do for us to receive messages if they had to be re-sent or carried by messenger any distance. This would offset the time we hoped to save. This, in turn, meant that the receiving had to be done right at our regular location, about one and a half miles from the shopping district, in a location that is pretty nearly all commercial now.

A row of apartment houses of wooden construction flank the street where our main office is located. Several of these are in use as extra offices, so to get away from the effect which a steel building would have on reception we started in with these. We set up a short-wave set with batteries and moved it from building to building, and finally came to one that gave us less interference than the others. Various electrical machinery in and near these buildings cause plenty of problems—or did.

NEWS by RADIO

By Volney D. Hurd, Radio Editor, Christian Science Monitor

Operator Leads Flea's Life

During the summer months when this work was started in an effort to find the best channel, we found that our messages were coming over on about eleven wavelengths. The operator had to be as flexible as a flea. We took on a real "ham," George Hinckley, 1GA, who showed an enthusiastic devotion to the work, was experimentally inclined and therefore fitted for the kind of work we were doing.

Well, the wavelengths ranged from 17 to 20,000 meters, if you like variety. This meant a good long-wave receiver as well as a short-wave set. We started on short waves at first and rigged up a pretty fair job. Shielded-grid tubes were used and little was known about them at the time. We could only see trouble ahead, as we had been warned of the difficulties of stability at short waves.

We discarded much good advice and built a set much like a broadcast receiver, and this worked out with no effort as far as stabilizing it was concerned. Easy! "And long waves are much more stable," we had always been educated to believe, mostly by "super-het" enthusiasts.

So we gaily built a long-wave receiver after the short-wave pattern. Instability was the only thing it seemed to know. We generously told each other what we thought of all the people who had kidded us about long waves, and then went ahead.

The problem was licked by falling back upon the old idea of tuned and untuned stages. We had wanted a stage of r.f. plus a regenerative detector. What we finally did was to place an untuned stage betwen the r.f. stage and the detector. It worked beautifully. The set was perfectly stable. Plug-in honeycomb coils were used and we could get up and down the various bands with ease.

Finally we settled down for some copying. Tests were made at all hours and we found that by changing the wavelengths from time to time we could get pretty good reception from England. We knew the news schedules and settled down for "a listen." It came. A series of high-pitched sounds in dots and dashes coming so fast that it sounded like a peanut roaster. We had overlooked the fact that England was sending the stuff with an automatic transmitter at the rate of 100 words per minute. "What to do?"

Tape Recorders? No!

Tape recorders are nice, but tricky. They demand extra tuning and also tuning of the audio amplifier usually to make them "perk" properly. "What do do?"

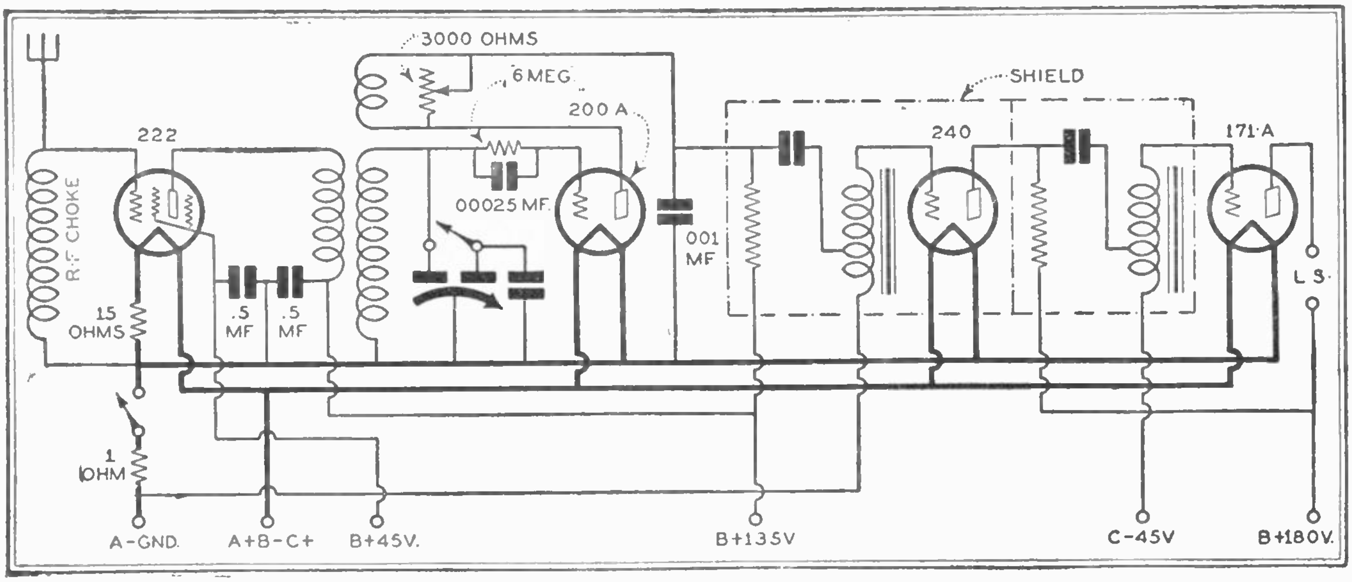
We finally hit upon an idea that proved to be the solution. In the cellar were several dictophones that had been discarded. We got one of these upstairs, cleaned it off, tied the earphones onto the speaking tubes connection and started up. We speeded the record up as fast as the thing would go, and on went the message. Then we took it off, slowed down the dictophone, put it on the reproducing point and listened in. There was our code coming in at about twenty words a minute as nicely as you please at a much lower pitch.

This bore out a theory we had had regarding tapes. If you want a man to get a message from you, you don't want to translate it into French and then retranslate it into English in order for him to hear it. It seemed that the tape was a slow line in the regular practice. Operators spend years developing their powers of hearing so that they can read code accurately. Then to train such men to read tape is like teaching them touch reading after they have used their eyes on print all their lives.

Another thing is that in the dictophone, the static crashes are reproduced not nearly as bad as when the headphones are used directly, nor as bad as trying to read tape with static discharges on it. We have proved this in turning out more accurate messages than with a tape recording station, on mornings when the interference has been bad. Thus the dictophone idea seems to have much merit.

Two problems still faced us; weak signals and man-made interference. To get a good kick out of the short-wave receiver seemed to be a problem. We

AN INTERIOR VIEW OF THE NATIONAL SHORT-WAVE RECEIVER, WITH THE REMOVABLE COILS FOR DIFFERENT WAVE BANDS READILY ACCESSIBLE



CIRCUIT DIAGRAM OF THE NATIONAL SCREEN-GRID SHORT-WAVE RECEIVER WHICH EMBODIES TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

wanted plenty of "sock" to operate the dictaphone, yet the quality must be pretty good too. This was solved in a great part when James Millen sent us over the new National short-wave job.

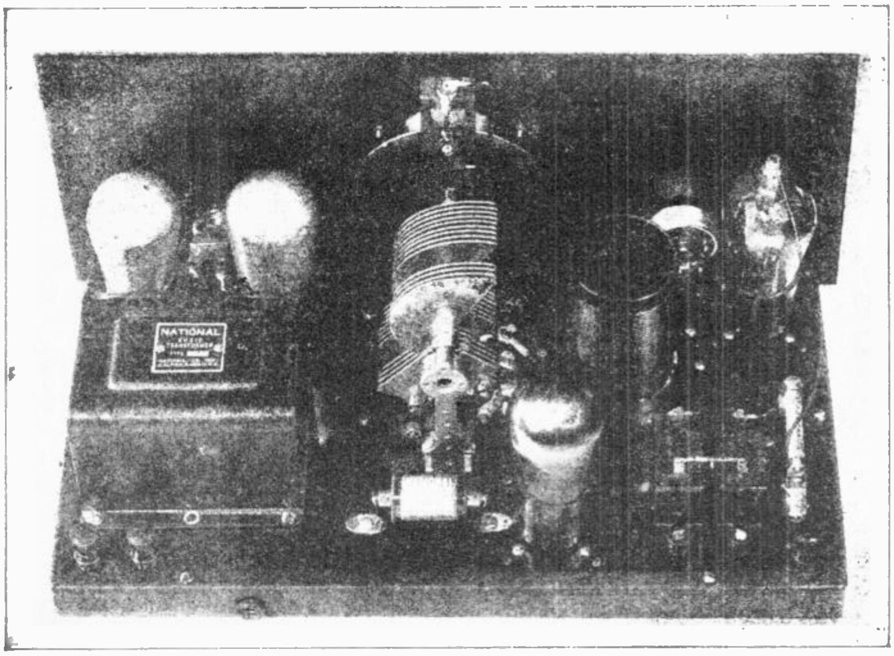
The Part Audio Plays

This has a two-stage audio amplifier which has been developed to give an awful wallop and yet maintain good quality. Feeding this into the dictaphone did a real job for us. It certainly has a lot of kick for a short-wave set. With its single dial it made it easy to land the station we wanted. Incidentally, we liked to listen to broadcast between times and had little room for an extra receiver for this purpose. This National job has plug-in coils that cover the broadcast band and produces a tremendous kick in the audio end, yet with good quality . . . thus we can have good music between times. In fact, this set would seem to indicate that the old idea of lots of audio has much merit. We could play "locals" with just a regenerative detector and an untuned shield grid input with only a two-foot piece of wire for an antenna, and this in the daytime. Surely a lot of this kick was in the audio end.

But we are wandering. We still had the long-wave problem, and finally Hinchley solved this by an additional tuning coil in the antenna circuit which pepped the long-wave set right up and also made it very sharp in tuning, a far too uncommon quality in all the long-wave receivers we have ever used before.

Now we were getting our stuff in good style. And here is where the oldtime adventurer is missing a lot. By all means get yourself a good short-wave receiver and a good long-wave one too. This latter type has been forgotten, but there are worlds of interesting things coming in on these waves. You can get news dispatches being sent around the world, besides any number of official press services sent out by foreign countries for their colonies and ships at sea.

BELOW—THE SHORT-WAVE CHASSIS REMOVED FROM ITS CABINET, SHOWING NOT ONLY THE TUBES IN PLACE, BUT SHOWING ALSO THE TWO-SECTION TUNING CONDENSER AND THE SMALL SWITCH WHICH CONNECTS THE TWO SECTIONS



The British Official Press, GBR, 18,940 meters, which goes on the air at 7:00 A. M. and 3:00 P. M., Eastern Standard Time, is particularly good; its stuff is sent very slowly, so an inexpert operator really has no trouble in copying it quite easily. This provides a splendid code practice for beginners.

This same press matter also comes over at the same hours between 17 and 18 meters. At 7:00 P. M. in the evening this official press comes over at 35 meters, a convenient wave and time for most experimenters. It also comes over at long-waves at this time.

Of course, much of the most interesting stuff comes high speed and the natural question is, what is the experimenter going to do for a dictophone?

Shopping for Dictophones

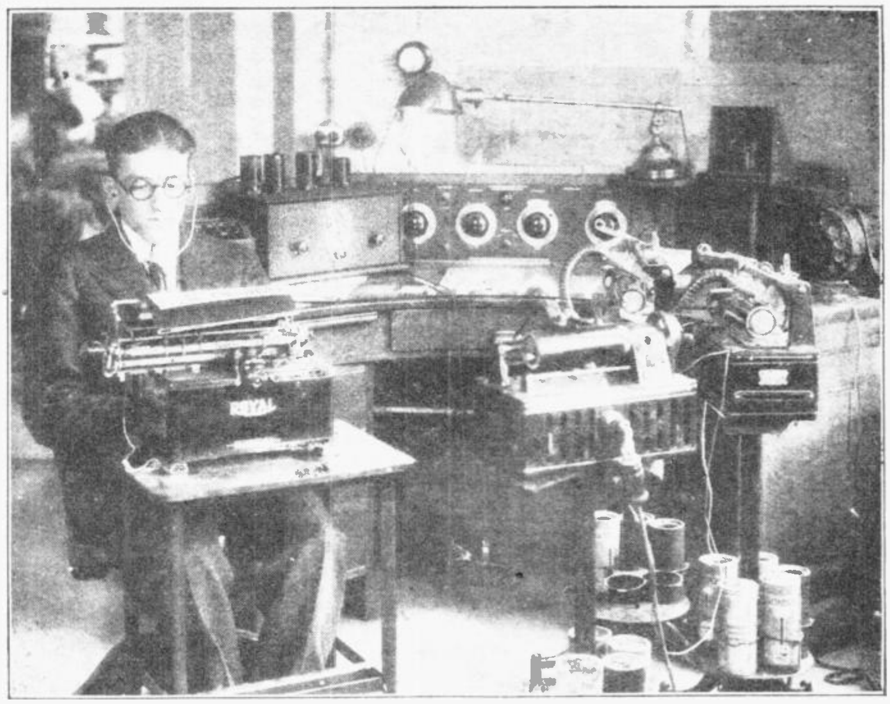
Well, the ones we used are marked up on our books at about $25.00 each. Thousands of these, sold ten or more years ago, are probably no longer used and yet are satisfactory for receiving code perfectly well. Shopping around a bit, there is no doubt that they could be inexpensively picked up. Records may be shaved for a few cents and used as many as 75 times.

Of course, taking high-speed code regularly means continuous reception and we couldn't change records without losing a lot. So we got another dictophone and set this alongside, as well as a third or transcribing machine for reading off the records. Finally, we got hold of a record shaver so we could have a fresh flock of records each day.

Now just when one record is about full, we throw on the second machine, which records the last few turns of the nearly finished record's message. The first record is then put on the transcribing machine and a blank takes its place on the first machine, which is then ready when machine number two has nearly finished its record.

With the receivers we have, the operator can set the machines going and transcribe at the same time the high-speed stuff is being recorded, merely stopping for a few seconds at six to eight-minute intervals to change machines and records. It is a smoothly working proposition.

A double dictaphone tube was made and the reception is taken on a single loud speaker unit instead of phones. Thus, feeding both machines, there is no receiving set adjustment of any sort necessary when reception is shifted from one machine to another. In order to monitor this incoming copy a pair of ear plugs such as are used on a stethoscope was fastened to a rubber tube which was in turn fastened to the common listening lead by a metal tume. Incidentally, this feature leads to an interesting discovery, and that is that by using these ear pieces and a speaker unit outside, noises are not heard by the operator anywhere near as much as when he is wearing headphones; furthermore, the weight is almost nil.



ABOVE—THIS MIGHT BE CALLED AN "ENSEMBLE" VIEW OF THE NEWS-GATHERING FACILITIES, WITH GEORGE HINCHLEY, THE RADIO OPERATOR, LISTENING TO THE SLOWED-DOWN CODE FROM THE DICTOGRAPH CYLINDER

Suppressing Interference

Interference was the last problem. It presented itself early when the dictaphone, electrically operated and of course set up near the receivers, drowned out all signals. A small "antenna plug-in" type of filterette was applied to these machines and stopped that. Then a couple of motors in the basements had big filters applied to them.

Finally we came to the rotary converter. We are in a d.c. district and yet wanted to avoid batteries. We all have heard the story that it is impossible to obtain short-wave reception using an eliminator. Well, using the baby National model, the Velvet, I believe they call it, we operated the short-wave set perfectly with an a.c. supply, and even used an "A" eliminator at times.

But the converter itself offered real problems. It had come equipped with a filter, but this was on the a.c. side. The manufacturers neglected to think of the other side, leading to the d.c. lines, which were running all around us like a cage. We put a large sized filterette on the d.c. side of the generator and our interference troubles were over.

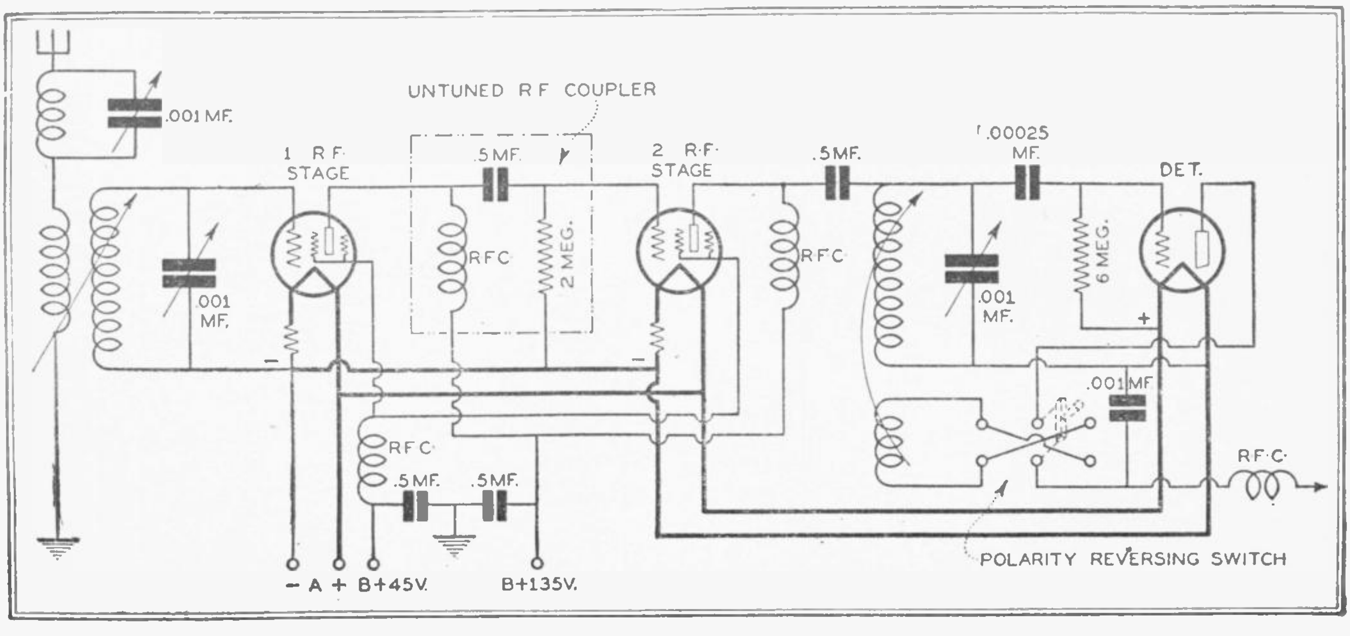
The result of all this is that our radio editorial force is now studying code after seeing all the fun that 1GA gets out of copying interesting items from all parts of the world. This, in turn, means that some more short-wave and long-wave sets are going to be built, for why have code if you cannot use it in the evenings at home?

Adventure? Come on, you armchair adventurers! Don't toy with stations in the United States. Code is quickly learned. Get a good receiver or two, and you can know any of the world's events before even your local newspaper.

Both the receivers we used are easy to make and operate. Too easy! We would like to impress you with what a difficult thing it all is and how intricate is the machinery needed, but the fact is that they can be built by anyone who can build a broadcast receiver. So come on and join us.

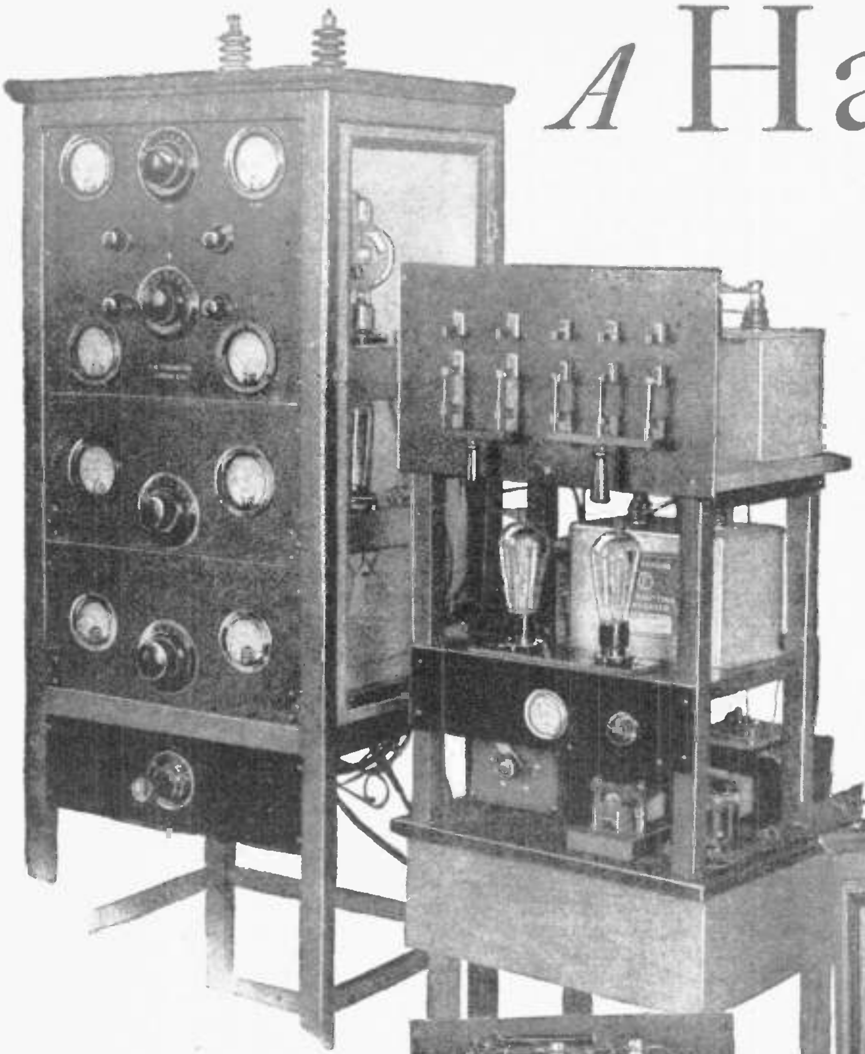
Those of you who listened in on the National Broadcast Company's rebroadcast of the British services of Thanksgiving, on the morning of July 7, got quite a kick out of hearing a voice from London and then one from Australia. Why not get that kick first-hand, and multiply it, by learning to understand the dot and dash?

BELOW IS THE CIRCUIT DIAGRAM OF THE LONG-WAVE RECEIVER WHICH, AFTER EXPERIMENTATION WITH OTHER CIRCUITS, MET ALL REQUIREMENTS

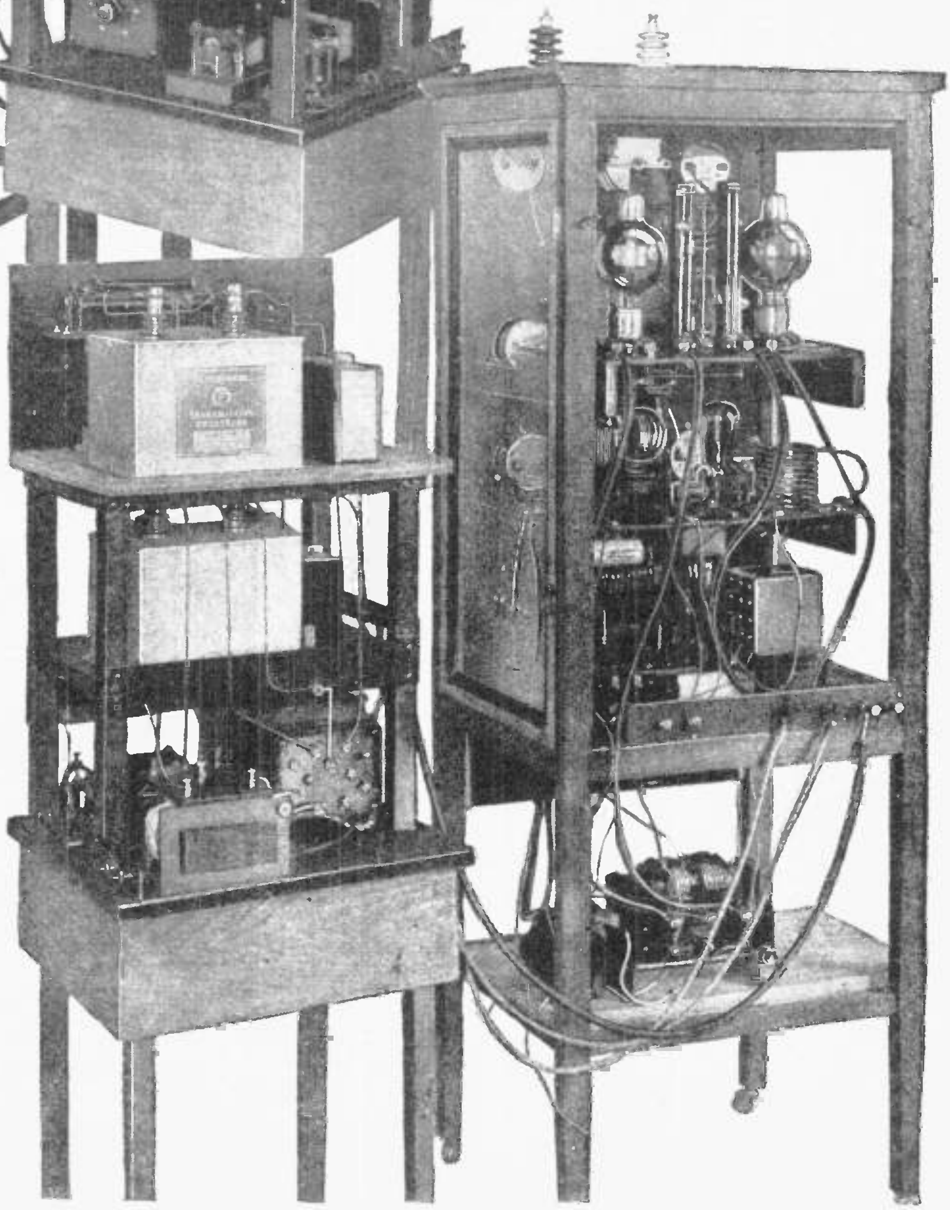


A Ham Set

Lester Spangenberg's
Controlled
Is a Real



Below is a rear view of the transmitter unit, showing the various pieces of apparatus of the several sections, while to the left is a rear view of the power-supply rack

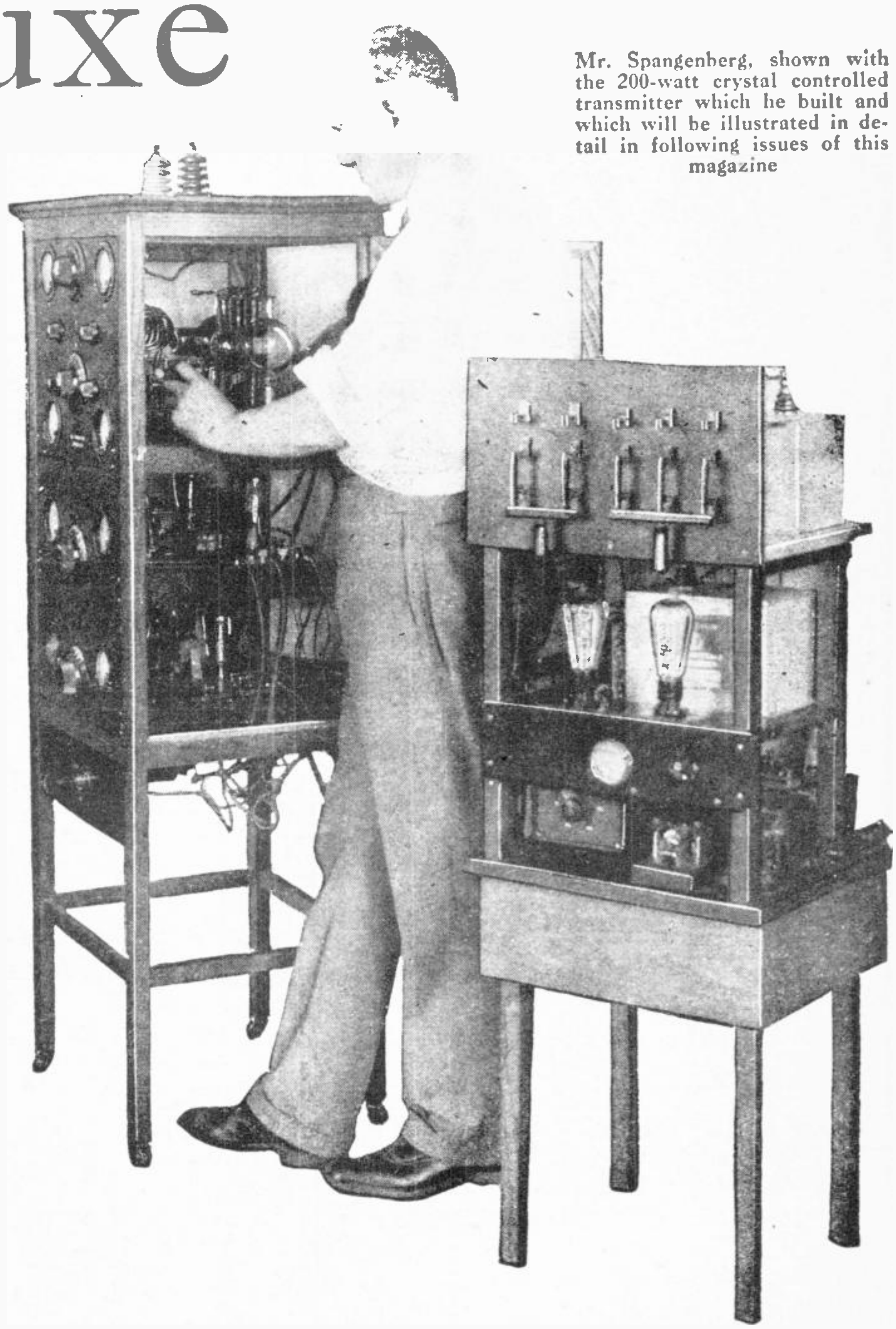


The photographs on this page of Mr. Spangenberg's 200-watt crystal controlled short-wave transmitter give sufficient detail of the mode of construction employed to enable the experienced and more advanced short-wave enthusiast to adopt some of the excellent ideas embodied in this outfit.

Above is shown the front view of the transmitter proper, illustrating the three shelves or sections, one for each of the frequency changes and the push-pull amplifier. To its right is shown the front view of the power-supply rack.

De Luxe

200 Watt Crystal Transmitter Outfit



Mr. Spangenberg, shown with the 200-watt crystal controlled transmitter which he built and which will be illustrated in detail in following issues of this magazine

THERE are few amateurs who have had the experience and the facilities for research at their disposal which Mr. Spangenberg has crowded into his excellent transmitter. In a single unit we have the result of many years' experience. All the experimental work has been done and here we have a finished transmitter that really works.

Mr. Spangenberg may well be ranked as one of the old-timers in amateur radio. He became a "ham" in 1906 and has been plugging along at it ever since. Lester, as most of the old timers know him, operated a station when there was little known and less published about radio; when a ham had to do some real experimenting and when carrying on a chat with a fellow in the next town was a great accomplishment. He had been a member of the American Radio Relay League from the time it started and during the war was a Radio Inspector for the U. S. Naval Radio Aircraft Section with headquarters at the Bureau of Steam Engineering, Washington, D. C.

As early as 1919 Spangenberg was operating a broadcasting transmitter, one of the first in the vicinity of New York. He is a member of the Institute of Radio Engineers and the Radio Club of America.

In the transmitter shown here, Mr. Spangenberg has incorporated everything a modern short-wave, C.W. transmitter should comprise. This transmitter is far and away ahead of the self-oscillating set of last year. And one of the unique features is the frequency doubling circuit which really came to be used because Mr. Spangenberg had two sets—one for the 7,000 kc. and one for the 14,000 kc. band, which have been combined and improved.

Consideration of the use to which the transmitter was to be put was worked right into this job and it is useful for the rapid handling of traffic as well as operating over long distances.

Experiments Leading Up to the Final Selection of Tubes

One circuit tried out by Mr. Spangenberg in designing his transmitter was made with a UX-210 tube in the 3,500 kc. band, controlled by a crystal. The frequency was doubled by the use of a 203A tube in the 7,000 kc. band which was to control the two UX-852 tubes in a push-pull circuit in the 14,000 kc. band.

After a lot of experimenting it was found that the UX-203A tube would not push the two UX-852 tubes in the push-pull circuit and double the frequency at the same time. So the final arrangement which is shown here was worked out. The circuit now in use is as follows: The UX-210 tube is employed in the 3,500 kc. band and is controlled by the crystal. This frequency is fed into the next 210 tube and its accompanying frequency doubling circuit, bringing the frequency up to 7,000 kc. The second 210 feeds into the 203A in a second frequency doubling circuit and the final 14,000 kc. is then fed into the two 852 tubes in the push-pull, power-amplifier circuit, which is coupled to the antenna circuit.

Only the two frequency changers and the push pull power amplifier are mounted in the main frame. For a clear concise understanding of the method of construction employed it is only necessary to refer to the several photographs accompanying.

Each of the above three units are mounted individually on its own shelf and is readily removable without disturbing connection to the other units.

The apparatus comprising the power supply, together with the various switches, key relay, etc., is mounted as shown as a separate unit.

This transmitter is to be the basis for a series of articles by Mr. Spangenberg, in which he will give all the details necessary for the construction of a transmitter of similar design.

Putting the Portables Through Their Paces

Further Experience With the Portable Transmitter and Multiwave Receiver Described Last Month

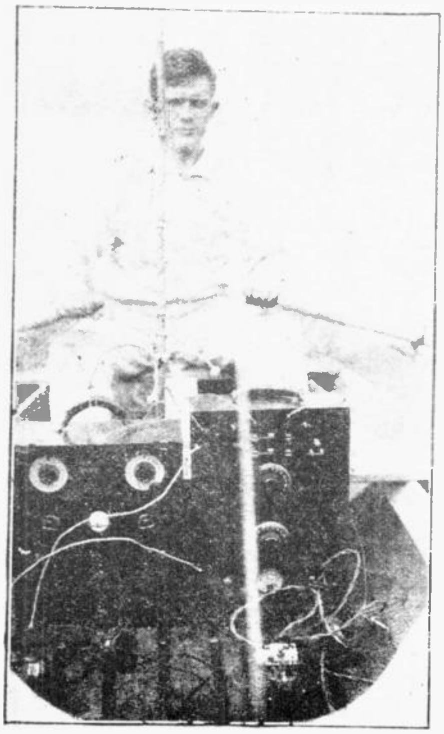
BY WILLIAM H. WENSTROM
Lieut. U. S. Army

THIS rather imposing title covers several aims. Under it we narrate some further field tests with the portable transmitter and receiver described in the article in this manual, on page 9, and explore more thoroughly some of the fascinating angles of portable work, even lapsing occasionally into reminiscence.

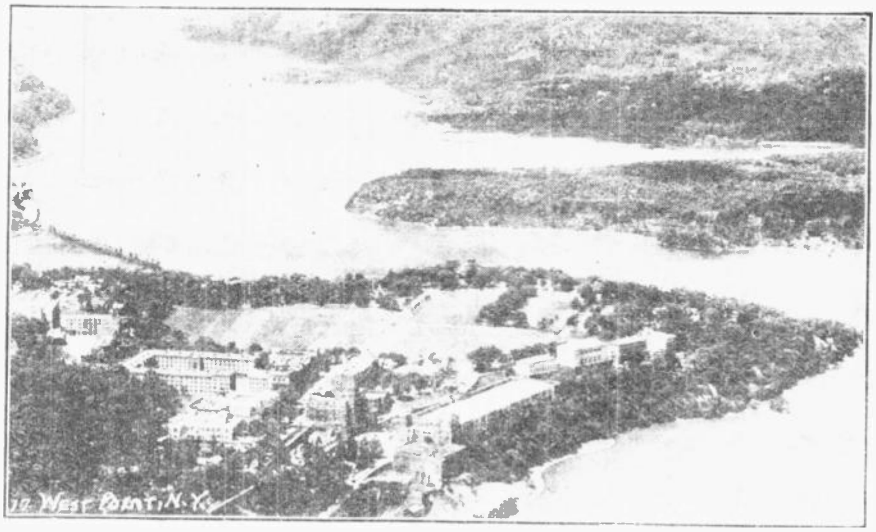
Further Tests

On a recent warm night we took the receiver up on the roof of a building, about 250 feet above the Hudson River, to see what could be done with the broadcast coil. To give the 30-foot antenna and the two diminutive 199 tubes at least a fighting chance, we naturally waited until the New York broadcasters were supposedly off the air. But the first thing we heard was WEAF, relaying the Fort Worth celebration in honor of the endurance fliers, Robbins and Kelly—interesting enough to bear listening to for a time, while Saturn and then a copper moon rose slowly over the Garrison hills. A light fog clung close to the river and its banks, the center of a high-pressure area was approaching—all in all it was a good radio night. The first "outside" station to be logged was WJR at Detroit, followed in a few minutes by WENR and WCVN at Chicago, and WLW at Cincinnati. These were all at loud headphone volume. Then came WPNJ at Milwaukee, fainter but distinct. An elusive voice and strain of music turned out to be, after some trying, WBAP at Fort Worth. By straining ears and patience, not to say conscience, we might have reached the coast; but Fort Worth seemed enough—we took the set downstairs, leaving the night to Saturn and the moon.

ROWING OUT ON THE HUDSON READY TO COMMENCE THE TESTS



AN AERIAL VIEW OF WEST POINT SHOWING THE TERRAIN IN WHICH THE TESTS WERE MADE



On a morning test from the same location with the 111-D coil, plenty of ships came in around 600 meters, calling each other and shore stations, sending position reports and traffic. Up on 1,000 meters the double dash signal of Fire Island Lightship whined out continually, telling of fog on the Atlantic south of Long Island.

Another test was made on the Hudson. We set up the receiver in a 12-foot rowboat, with the umbrella (diagrammed in last issue) and a copper ground plate for contact with the water, and drifted around with the wind and current for an hour or two, picking up plenty of stations and a healthy sunburn. The time was around 5 P. M., broad daylight, of course, and the antenna was quite small. On the broadcast coil WEAF, WOR, WJZ, WABC, WODA and WAAT, all around 50 miles distant, were clearly audible. Then WPG came through with loud headphone volume from Atlantic City, about 150 miles away. On the 80-meter coil several amateurs in the 1st and 8th districts—New England and the eastern mid-west—were copied. This was up to expectations, as the 80-meter band never is very populous in the daytime.

With the 40-meter coil there was some difficulty in tuning, as the wind was rising and swinging to eastward, driving the waves around the bend in the river. The detector circuit was steady enough, but it was difficult to tune the dials accurately and stay in the boat at the same time. However, scores of amateurs were heard in the narrow 40-meter band, as well as many commercial stations outside it. Finally, as the climax of this test, we logged the crystal-clear whistling signal of 9EK, cutting through the 40-meter bedlam all the way from Madison, Wisconsin. Both stages of audio were used in these water tests.

Of course the receiver was designed for use with an antenna, but in the 40- and 80-meter bands much can be done with the set box alone, using only the self-contained wiring as a pick-up. As a test of this we took the set box up on the aforementioned roof one evening, and perched it somewhat precariously on a stone cornice. On the 80-meter coil amateurs came through from the 1st, 8th and 3rd (Middle Atlantic States) districts, and some amateur phones on 85 meters were

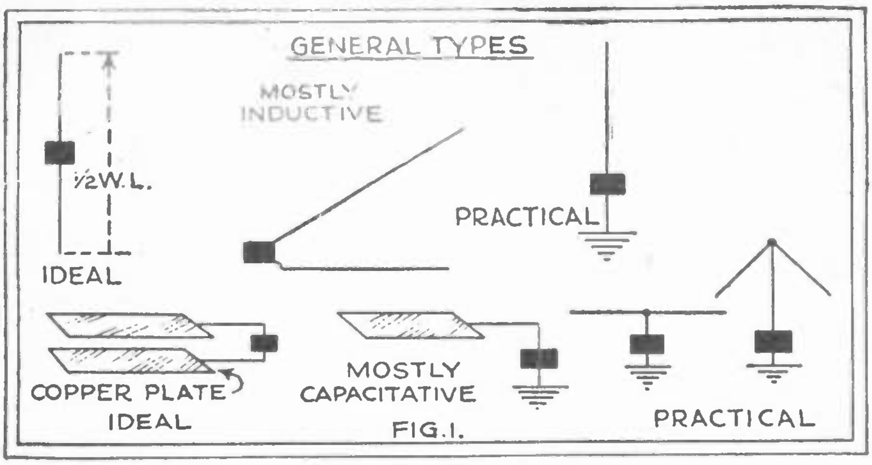


FIG. 1.

heard but not located. On the 40-meter coil swarms of amateurs could be heard, among them 1AOI of New England, 3ON of the Middle Atlantic States, and 9CRJ of the Middle West. And this was with the set box alone, no antenna or ground, using a 199 detector and one stage of audio!

On another evening we did some interesting work in the car with a ten-foot wire stretched over the top, from radiator cap to spare tire, for antenna. On the broadcast coil WABC, WJZ, WOR and WEAF of the New York area came through faintly; WPG at Atlantic City somewhat better. Ignition noise was worse than on the previous car tests described in the last issue, because the very small antenna did not pick up a signal strong enough to be heard well through it. With the motor idling and at speeds up to 10 or 15 miles per hour one hears a series of clicks, which merge into a steady roar at about 20 miles per hour. The signal-noise ratio was somewhat improved by using a short wire as counterpoise instead of the car body.

We drove over the Storm King Highway, which winds along the mountainside at varying elevations above the Hudson, listening to the carrier of WABC. The signal strength usually increased on the heights and decreased in the hollows, though this was not an absolute rule. Signals also increased whenever the road led out over the river in rounding a mountain shoulder. These effects are much more pronounced close to a transmitter, before the sky wave has begun to come down in any great strength. A few years ago in El Paso, when making tests in a car with another portable set, we drove over a sharp rise towards the transmitter three or four miles distant. The signals increased greatly at the brow of the rise; the effect was like coming suddenly around the corner from a quiet street into the noise of a thoroughfare, or like stepping into the beam of a searchlight. We noticed, also, that the signals followed street-car lines, doubtless on the wired wireless principle. In this field alone there is plenty of opportunity for research. Of course the big stations have mapped their fields, but our knowledge of wave propagation along the ground, or anywhere else, is very far from complete.

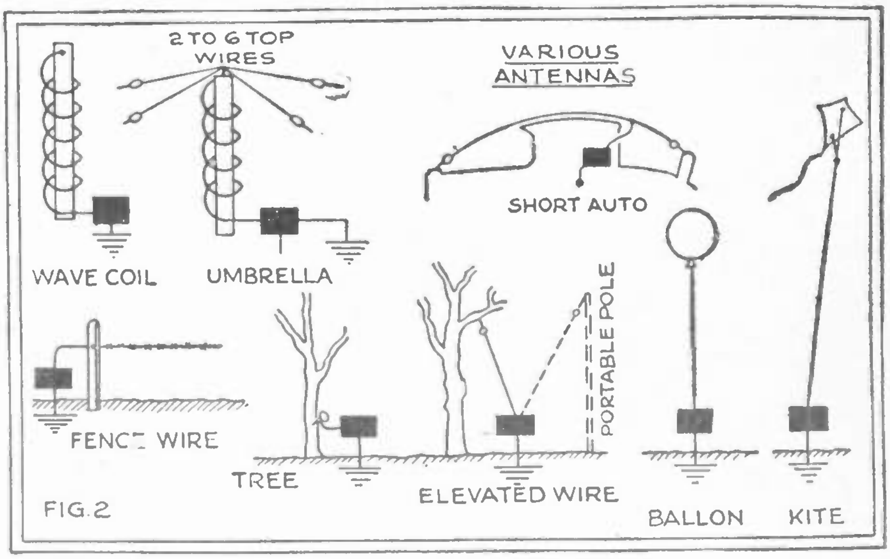


FIG. 2

The transmitter, also, has had its share of activity. On a boat test around West Point we kept a regular schedule of transmissions with two listeners, Lieuts. Bullene and Shingler, at West Point. The umbrella antenna was used with a copper plate ground. Lieut. Corput and the author manned the rowboat, which moved up the river with as much majesty as such a craft can muster when it has to keep out of the way of large and fast river steamers. The passengers crowded to the rails at sight of this grotesque cockleshell desecrating the Revolutionary scenery. At Cold Spring, two miles above West Point, we switched on the transmitter and began describing the scenery in the best McNamee manner, meanwhile thinking "Two miles—two watts input with phone—it won't work."

Then we dropped down the river to Constitution Island, one mile from the receiver, and continued our discourse. Dropping further downstream, we rounded the bend and came within sight of the building where the receiver was, still talk-

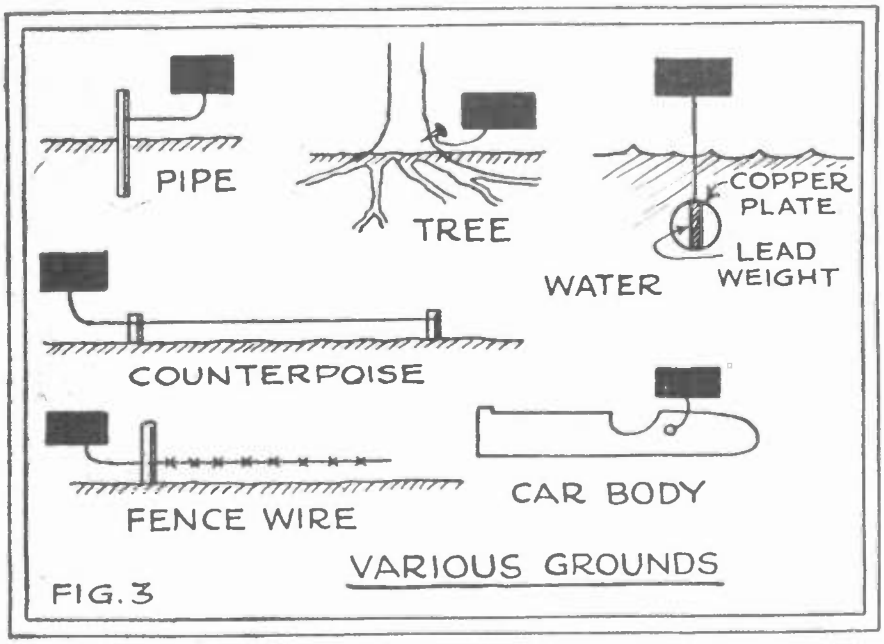


FIG. 3

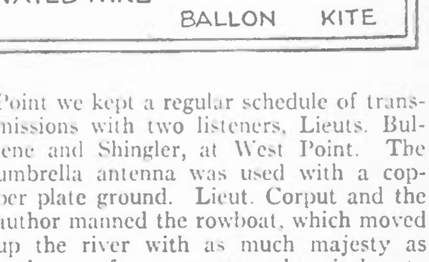


FIG. 4

A TEMPORARY SET-UP ON THE ROCKS AT THE EDGE OF THE HUDSON

ing continuously into the unimpressed microphone. As we came opposite the building, the boat a quarter mile out in the river, the impression grew that we had been talking to ourselves, or at most to whatever fishes had happened along. We asked the mike: "If you hear this, please come out on the roof, and wig-wag O. K." We paused, unbelieving. Then a small figure appeared on the roof; it was signalling with a handkerchief "OK—all OK." We were ready to call the test a success. We found later that every word had been understood.

On another day we tried out the transmitter in the car with that ridiculously small antenna—the 10-foot wire over the top. With Maj. Moreno at West Point and Lieut. Bullene at Highland Falls as listeners, we drove up to Lusk Reservoir and switched on. Again we fell back on the radio announcer's standby, describing scenery. The West Point receiver was three-fourths of a mile distant and the Highland Falls one one and a half miles away, and both heard us. Signal strength was none too good at Highland Falls, but better than expected with the small antenna. Then we started the car and drove slowly along the road, still talking. Several casual passers-by appeared quite dumbfounded to see an apparent lunatic sitting in a car talking to himself. During the winding drive down the hill towards the West Point receiver, it again seemed impossible that anyone could be really hearing us. Yet when we passed the house, there was Maj. Moreno out in front. He had heard every word, and had further noted signal strength changes that corresponded with the undulating terrain over which we had come.

Operating Notes

The receiver's performance depends to a large extent on the detector tube. As the average 199 is none too good in this respect, it is well to check over a number of tubes, selecting the best detector by trial. The potentiometer allows some control of the tube's oscillating characteristics by fixing the grid bias. With the potentiometer turned slightly to the negative side, the detector should go into oscillation with a smooth hiss, and the set is most sensitive to weak code or phone. With the potentiometer turned positive, oscillation occurs with a sharp plop; this position is best for loud code or phone. The most sensitive adjustment of the tickler condenser, of course, is as near as possible to the oscillation point—below it for phone, and above it for code.

We might mention here two uses of the receiver in addition to ordinary reception. Most campers and boatmen have been caught in summer thunder squalls, usually with inconvenience and sometimes with danger. Such a squall may approach almost unseen behind hills or cloud formations, but its approach can be sensed from the heavy crashing static, growing more frequent, which precedes it. With a little practice in listening and observing, one can learn a good deal about thunderstorm progress, particularly by referring to a good meteorology text. The field is little explored, and holds some interesting possibilities.

Yachtsmen who venture out on the broad ocean will find the 111-D coil very useful. Ships can be copied, and some estimate of surrounding ocean conditions can be made from their reports. Radio beacons, listed on the Government charts, will be heard in foggy weather, and their relative loudness will give some indication of the boat's position.

Turning now to the transmitter, we might add some further information on license requirements. First, an amateur operator's license must be obtained by making application to the nearest Supervisor of Radio and taking an examination. In addition, a station license must be applied for, but as an ordinary station license is good for use in one location only, this must be a portable station license, good anywhere in the radio district. Strictly speaking, a portable amateur radio transmitter cannot be used on a boat, as this class of service is in general covered by the limited commercial license. However, the chances are that an application for a limited commercial license on yacht "Pansy, 12-foot rowboat at present located on waters of Long Pond," would scarcely be taken seriously by the Supervisor.

One detail of the transmitter construction needs emphasis. While the coils look somewhat flimsy in the photograph, in reality they are as solid as rock, and must be so to keep the calibration constant. The "dope" is made from some

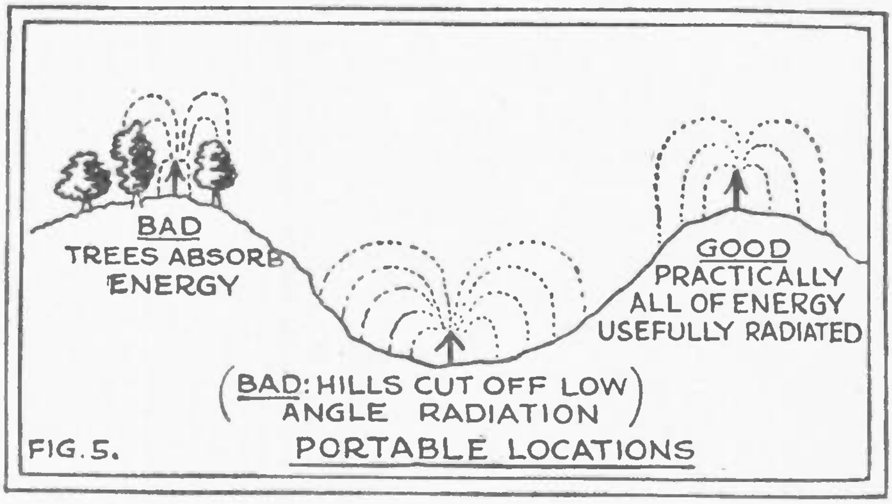


FIG. 5. PORTABLE LOCATIONS

BELOW, A GOOD LOCATION AMONG THE WOODS, THE TREES OFFERING A MEANS FOR STRINGING THE PICK-UP WIRE

form of celluloid, such as photograph negatives, dissolved in acetone. Both the form and the coils are given a heavy coating.

The transmitter-receiver arrangements will be found very convenient for two-way communication. To change from "send" to "receive," after the set-up has once been made, one need only throw two switches, an operation requiring perhaps two seconds. During the Long Island tests we worked with Garden City and Mitchel Field, both over a mile distant from the car set-up, first one and then the other. In fact, all three stations engaged in a more or less indiscriminate conversation, and the portable station had no difficulty in keeping up with the two fixed ones. For portable two-way work, it is best at first to bring all stations close together, within a few yards, and calibrate each receiver on each transmitter so that in long range work time will not be wasted hunting all over the band for desired signals. The times of operation, or schedules, must be determined beforehand and rigidly adhered to.

Antennas and Locations

To cover thoroughly the subject of antennas no less than a book would be required, but some of the essentials can be indicated here. Needless to say, antenna design is very important in portable work. Outside of such special types as loops, wave antennas and reflectors, the ideal antenna, as indicated in the diagram, would be a single wire one-half wave length long and interrupted at its center by the radio set, or possibly two large copper plates with the set connected between them. We can rarely put these ideals into practice in portable work; we must employ close approximations of the ideals—for transmitting, as close as possible. Receiving sets will work on almost anything,

A VIEW SHOWING OPERATING CONDITIONS IN A 12-FOOT ROWBOAT WITH AN UMBRELLA TYPE ANTENNA

TRANSMITTER AND RECEIVER SET UP ON THE CORNER OF ONE OF THE BUILDINGS AT WEST POINT

depending on the sensitivity required. The only trouble likely to be encountered with receiving antennas is a failure of the set to oscillate when the antenna fundamental is too near the desired frequency, and this trouble is easily cured by connecting a series condenser in the circuit. But the transmitter refuses to radiate efficiently from some of the weird combinations that delight the receiver. We must use either an elevated single wire about $\frac{1}{4}$ wave-length long with some form of counterpoise or good ground underneath it; or we must approximate the plates of a condenser, using a short overhead wire or mesh and an excellent ground or a quite massive counterpoise (such as a car body) beneath it.

The diagrams (Figs. 1 to 4) show some of the practical pick-up forms. The umbrella and short auto wire follow the condenser type. The "wave coil" gets more inductance into a limited height, as 20 to 40 feet of wire is wound spirally around a 12-foot pole of light bamboo. (The coil may also be wound on a large pasteboard cylinder, but this is far from portable.) All three of these antennas are compromises between efficiency on one hand, and compactness and convenience on the other. When used with the transmitter, they require a loading coil of about fifteen or twenty turns on a $2\frac{1}{2}$-inch form before the antenna circuit will tune up to 85 meters.

Grounds for either transmitting or receiving must be of low resistance. A long metal pipe may be driven into damp soil on land. On the water the problem is easier—a clean copper plate weighted down by lead will do very well. If no good ground can be had we use a counterpoise in its place—a wire insulated from the ground—a car body—a sheet of metal or screening. For receiving a fence wire may do, or even a nail driven into a tree or shrub. The receiving antenna proper may be almost anything—a light wire carried by a balloon or kite, a fence wire, a tree. Finally, there are the horizontal forms of antenna—two insulated wires laid along the ground in opposite directions, or a fence wire interrupted by the set.

We mentioned last month the importance of location in portable work, an importance which in the case of transmitters can scarcely be exaggerated. We must remember that we are dealing, in effect, with light waves of very low frequency. If we wished to signal with a searchlight we should not put it down in a hollow, surrounded by obstructions. The same principles apply, with less rigidity, to a radio transmitter. Even at broadcast frequencies obstructions close to the transmitter cast appreciable "shadows"; at 80 meters these effects are more noticeable; at 5 meters and less the waves behave almost like light. Not only should the transmitter be set up, when possible, on high, unobstructed ground with a "clear shot" towards the receiver, but it should be kept as far as possible from elevated wires, trees, foliage and other conductors, good or bad, which may absorb a large part of the outgoing energy. Favorable and unfavorable locations in a given terrain are shown in the diagram.

An interesting case in point occurred a few years ago near El Paso. The lower Rio Grande valley was flooded, troops were rushed from Fort Bliss thirty miles to the stricken area, and my platoon handled the radio communication. The field radio sent with the troops late in the afternoon having failed to report in about 10 P. M. as expected, the Radio Sergeant and I drove hurriedly down the valley to see what was wrong. We found that the first set-up had been made in the only place then available—a railroad cut surrounded by hillocks and trees. After we had moved the set to a more open location, the front yard of a ranch house, communication was established with Fort Bliss. Later in the day, when rising water surrounded the transmitter on three sides, its signals actually became louder, probably due to complete surface reflection from the water.

This third factor in portable transmitter efficiency, ground conductivity, is not very well understood even now. We know that a highly conductive surface is to be preferred—broadcast transmitters are often built on salt marshes—but there are still many obscure vagaries of the terrain that are difficult to explain. There was a point in the desert sand two or three miles east of Fort Bliss from which our transmitters could never work successfully, though they were clearly heard from locations nearer or locations beyond it. There

(*Continued on page 78*)

"The S-W Four"

A New Departure in Short-Wave Receiver Construction

By SAMUEL EGERT

THE short-wave receiver described in the accompanying article is of interest on several counts. Not the least of these is the fact that this receiver has been selected for an important bit of work in connection with the *Graf Zeppelin's* visit to this country.

The Columbia Broadcasting System announced, some time ago, its plan to have Frank E. Nicholson, aboard the dirigible, send daily accounts of progress and of life on board; these to be rebroadcast through stations of the Columbia network. It is a part of this plan, to rebroadcast Mr. Nicholson's voice just as soon as the *Graf Zeppelin* is near enough to permit voice reception on short waves.

Paul Green, technical director of the Columbia System, is responsible for arranging to keep in touch with the dirigible, and after careful examination he selected for that purpose the set here described. Aside from the merit implied by its selection for this important work, the S-W Four will appeal to the radio experimenter both because of the efficiency of the circuit employed, and because of the clean-cut engineering evidenced in the planning of the three compact units comprising the radio frequency, detector, and audio frequency sections.

THERE'S a thrill waiting for you in the lower wavelength bands, where great distances are spanned by comparatively small sets consisting of two, three or four tubes.

Even the wide imagination of the authors of the Arabian Nights could not conceive of listening to their fellow men half-way around the world.

The amazing properties of short waves stagger the imagination. Think of it . . . cosily ensconced in your favorite chair, the chimes of Big Ben in London, the far-off countries of Holland, New Zealand, Spain, are at your mercy. Listening to these stirs the imagination to the realization of another wonder accomplished by man. There's more to be done, but at present the field is wide open for the man who can appreciate the tremendous scope of this hobby and wants to look just a little below the surface.

In (July, 1929) RADIO NEWS Mr. Curtis Glenn described quite vividly what he listened to in the short span of twenty-four hours. Yet, even so, the surface has just been scratched. Given a good, efficient receiver, the possibilities of listening to far-off signals, signals from the ends of the earth—yes, signals that virtually travel 'round the earth—are boundless.

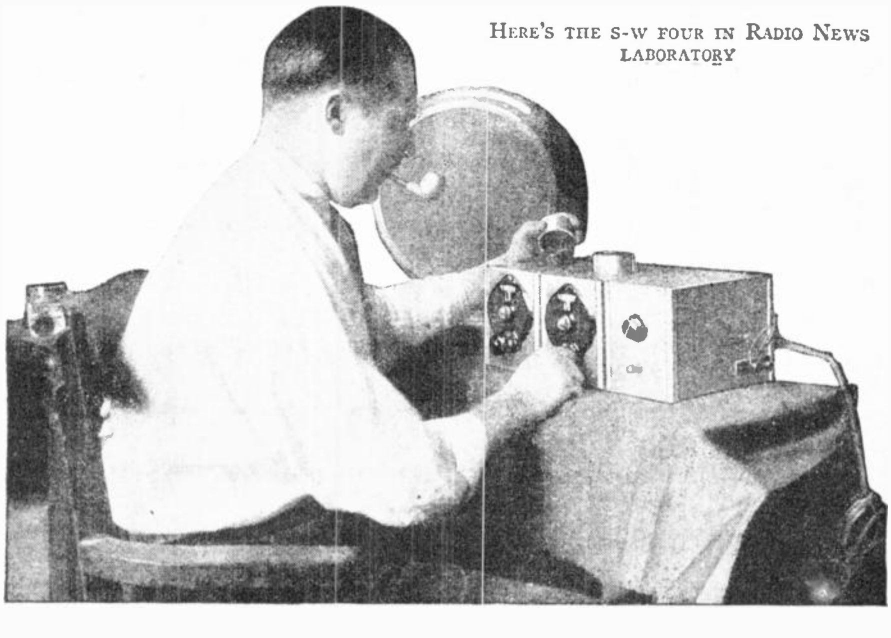
It is with the idea in mind of providing such an efficient receiver that the one described here was designed.

Many Good Features

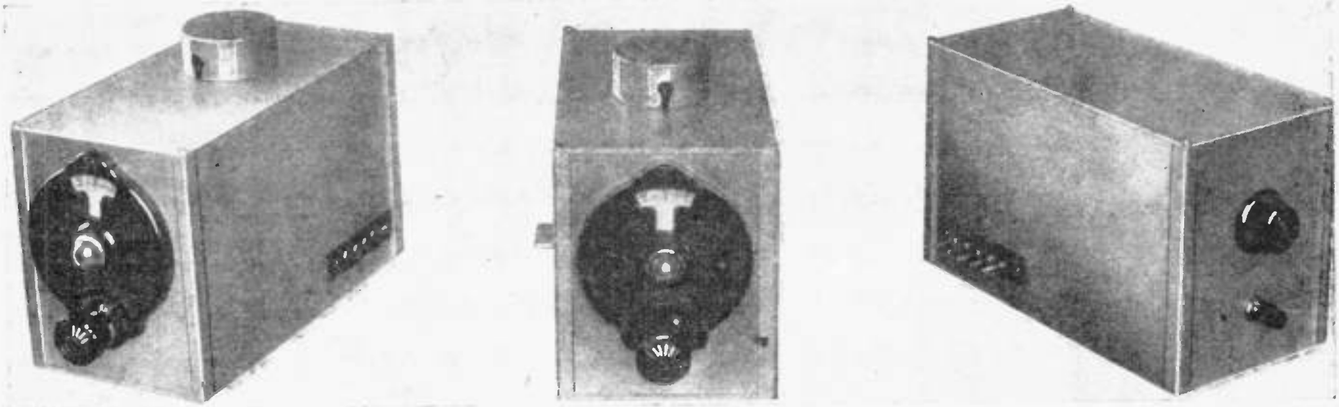
The S-W Four is one of the most modern short-wave receivers that can be built today. Its neatness, its isolation of each individual stage, its ease of tuning, coupled with the high grade of material employed throughout, make it a set far surpassing others in quality and volume of tone; it possesses a sensitiveness which enables it to pick up foreign stations as if they were in your back yard. Short-wave station 5SW, England, comes in on the loudspeaker and can usually be gotten whenever operating, even though static conditions may be quite bad. Holland can be heard on the phones quite loud and clear and can be heard on the loud speaker on a clear night. With this receiver California, KDKA, WGY are considered locals and can be tuned in on the loudspeaker. Besides, there are at present about six hundred short-wave stations in operation located in every part of the world. Given a good night for reception, as sensitive a set as the S-W Four and a fairly decent location—well, you can see for yourself—the possibilities are unlimited. One thing is certain, the S-W Four presents to every man something worth while in which to lose himself after a hard day's work is done. Here is really a new and better way to get back all the enjoyment you derived from your broadcast band experience, with a double redemption.

Use of Shielding a Major Factor

The distinct superiority of the S-W Four is the shielding. Each stage is individually shielded, enabling the r.f. amplifier, detector and audio amplifier stages to work with absolutely no intercoupling. Their use counteracts flux lines between stages, enabling the set as a whole to function with the highest degree of efficiency. This outstanding feature is immediately recognized when you tune the set. A certain amount of pep can be recognized which places it head and shoulders above others which do not use complete individual shielding. The shielding arrangement of the coils is both novel and effective. The small metal caps protruding from the tops of the units need only be removed to replace the plug-in coils. Coils can be replaced in a second's notice without in any way hampering the operation of the receiver. When you replace a coil, you will notice that a grooved socket is furnished, en-

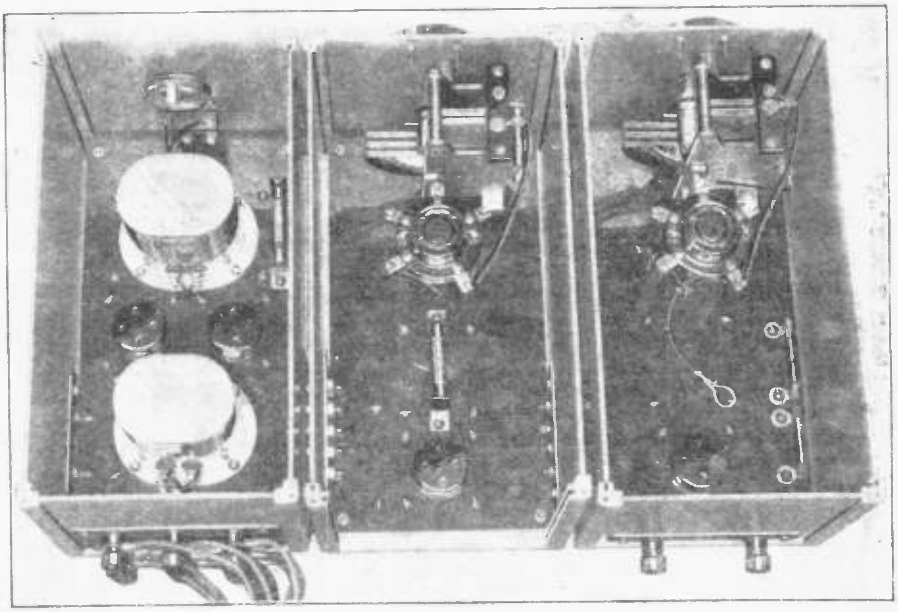


HERE'S THE S-W FOUR IN RADIO NEWS LABORATORY

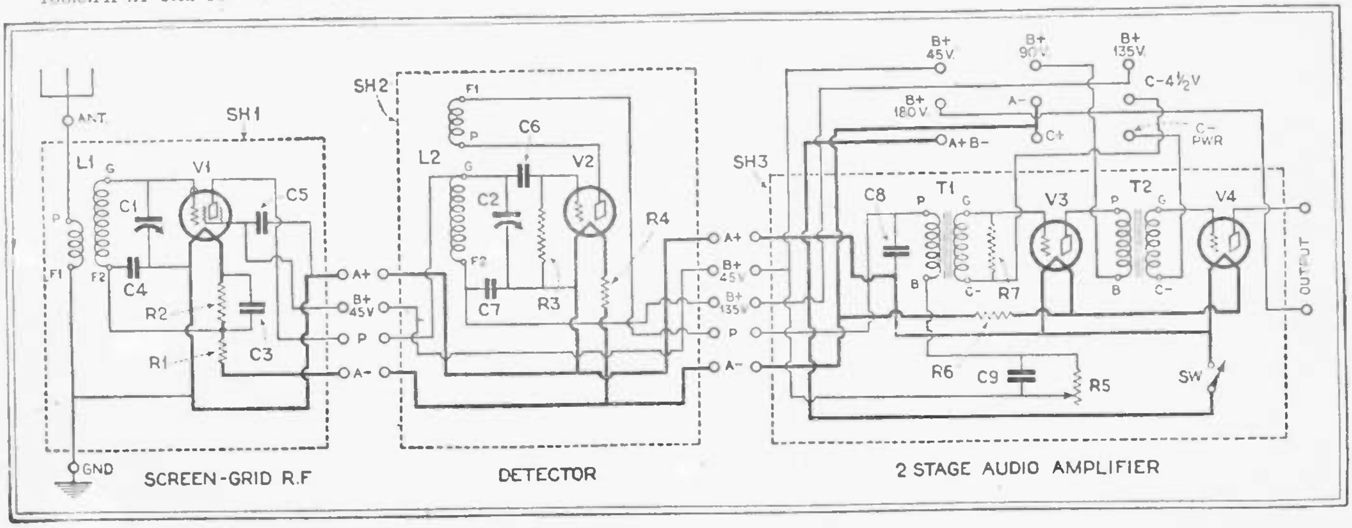


Three individual units in separate shielded compartments constitute the completed S-W Four. Here are shown, from left to right, the tuned antenna r.f. stage, the detector stage and two-stage a.f. channel

abling you to merely turn the pins of the coil around in the groove until they automatically fall into place in their respective positions in the coil socket. This avoids a good deal of delay and affords a convenience that is immediately appreciated. The circuits in the shielded units are connected together by means of small plugs and jacks mounted on insulated bakelite strips. The use of this method enables you to obtain a positive connection from unit to unit without in any way hampering the quality of the shielding. When plugging the cans together, you will notice that there are four contact plugs and jacks betwen the r.f. and detector units and five between the detector and audio units. This avoids any possible error of the proper placing of the r.f. and detector units. In spite of all these shielding requirements, the set has a fine appearance and would always attract rather than detract attention to itself. You will notice that the units are separated by a space of about one-fourth of an inch. This is an absolute necessity. We have found from experience that the potential (or voltage) at the front of the detector or r.f. units is different from the potential (or voltage) at the rear of these units. These potentials are induced by the flux lines of the two coils. This potential (or voltage) difference is so small that only very accurate instruments could be employed to measure their differences; however, these potentials are very noticeable in the phones or in the speaker when the units come in contact with each other. A cracking noise is heard and it is due to the shorting of these small potential (or voltage) differences. Therefore, to avoid this disturbance the units have been separated one-fourth of an inch. This seemingly small feature adds a tremendous benefit to quietness of operation and is in reality a blessing in disguise.

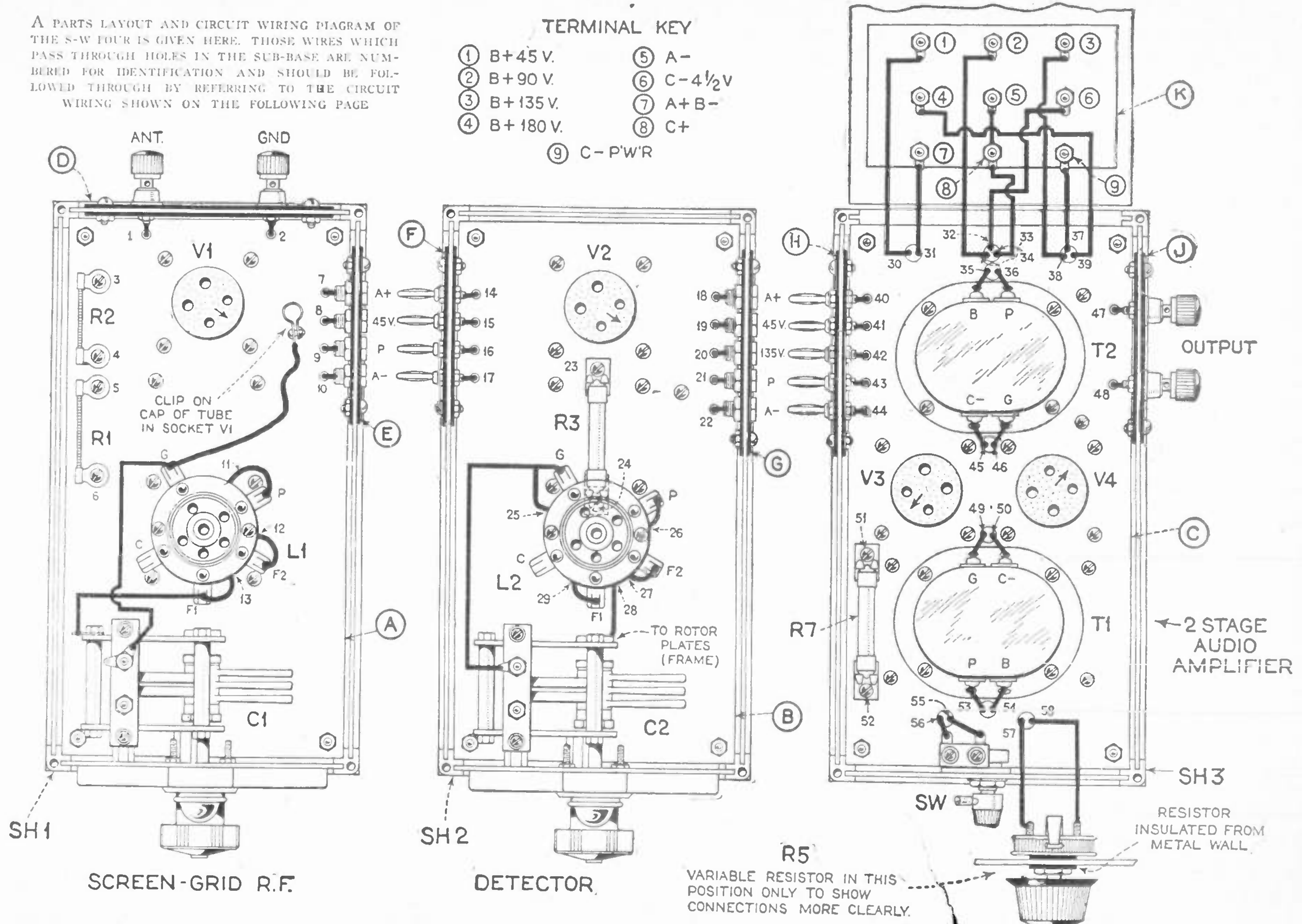


The general layout of a majority of the parts in the three units is clearly indicated here. Those components which are mounted on the underside of the sub-bases are shown in position on page 29

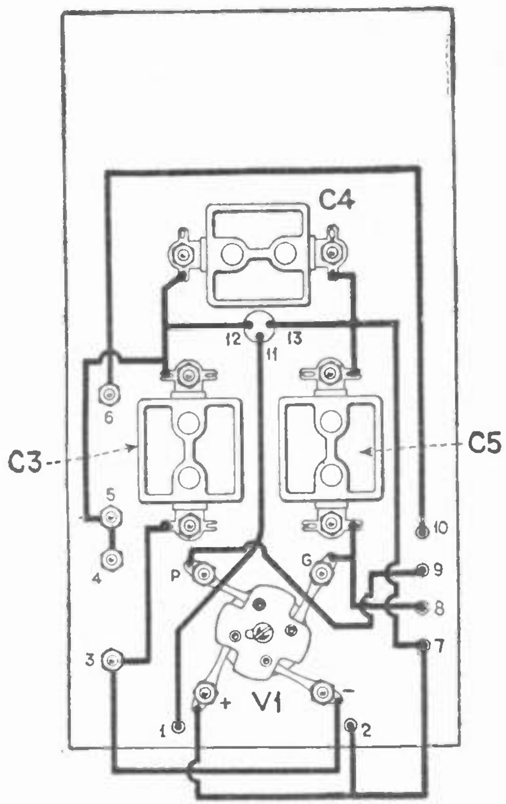


To gain a clear idea of the individual circuits of each of the shielded stages, it is only necessary to compare the complete circuit diagram, shown here, with the photograph at the top of this page

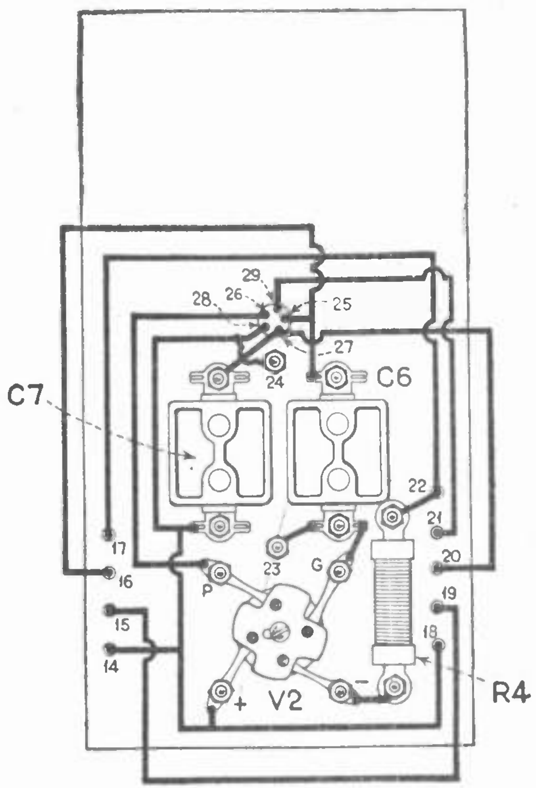
A PARTS LAYOUT AND CIRCUIT WIRING DIAGRAM OF THE S-W FOUR IS GIVEN HERE. THOSE WIRES WHICH PASS THROUGH HOLES IN THE SUB-BASE ARE NUMBERED FOR IDENTIFICATION AND SHOULD BE FOLLOWED THROUGH BY REFERRING TO THE CIRCUIT WIRING SHOWN ON THE FOLLOWING PAGE



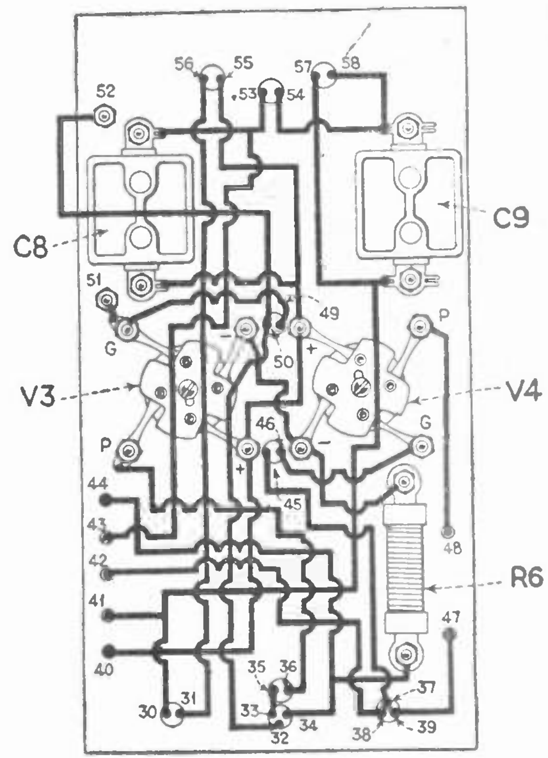
SCREEN-GRID R.F.

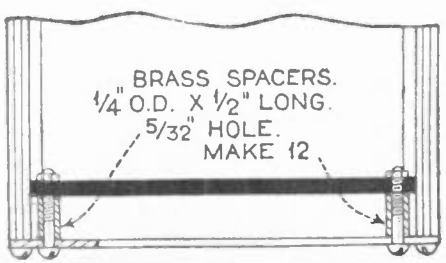


DETECTOR



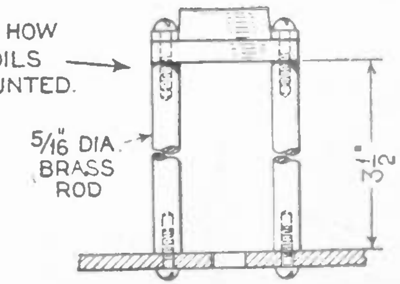
2 STAGE
AUDIO AMPLIFIER





THIS VIEW SHOWS HOW BASES Ⓐ Ⓑ Ⓒ ARE MOUNTED IN SHIELD BOXES.

THIS VIEW SHOWS HOW SOCKETS FOR COILS L1 & L2 ARE MOUNTED.



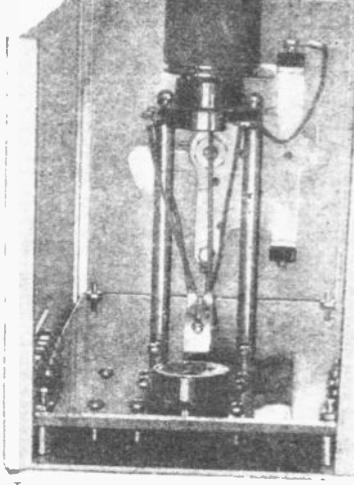
Besides showing the details of wiring on the under side of the sub-base, to the left are shown the details for raising the sub-base from the bottom of the shield can so that such parts as fixed condensers, resistors and tube bases may be located.

Due Consideration Given Parts Layout

Proper low-wave reception is difficult to attain. Every small item of construction must be taken into account. If only one of these items is inadvertently passed over, the efficiency of a short-wave receiver is reduced markedly. Therefore, it was important that we should not overlook the selection of the parts, the placement of the parts, the method of wiring and the quality of each part when adapted to our needs. It was only in this manner that we finally succeeded in developing the easily operated, easily constructed and highly efficient receiver that is described here.

Great care was taken in determining the proper position for each part. Grid leads are as short as possible. This is a primary requisite in a set of this type, for in long grid leads a great deal of energy can be lost due to the characteristic of high frequencies to form counteracting flux lines to the flux lines of the regular coil. Every connection in the set is made on the shortest path possible. Bending wires which carry high frequencies is also a poor policy, for here again we have a high rate of signal dissipation.

Only the best of apparatus is used in the receiver. The taper plate condensers used offer a straight-line tuning effect. That is to say as the dials are turned from minimum to maximum the wavelength rises in direct proportion to the

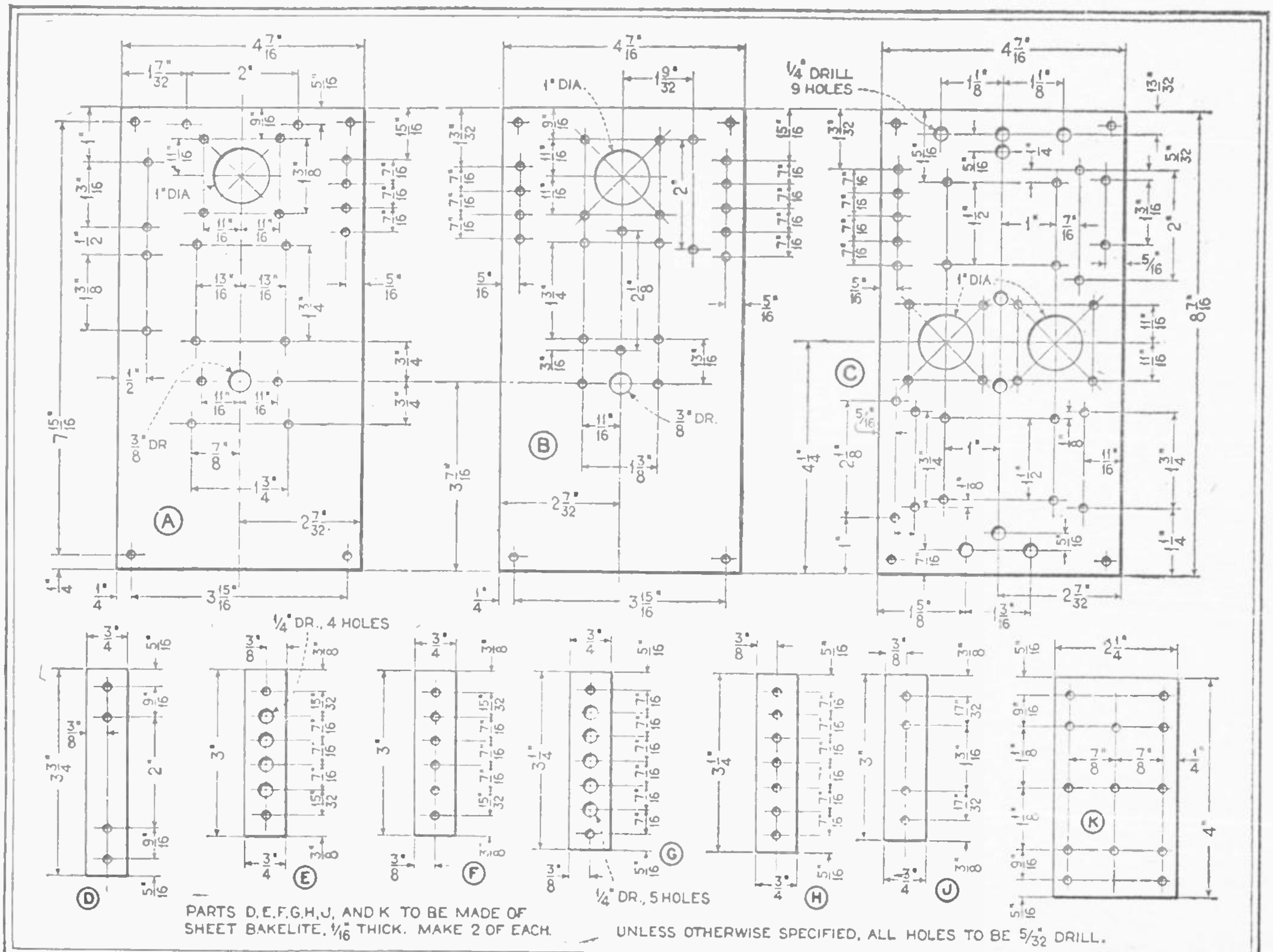


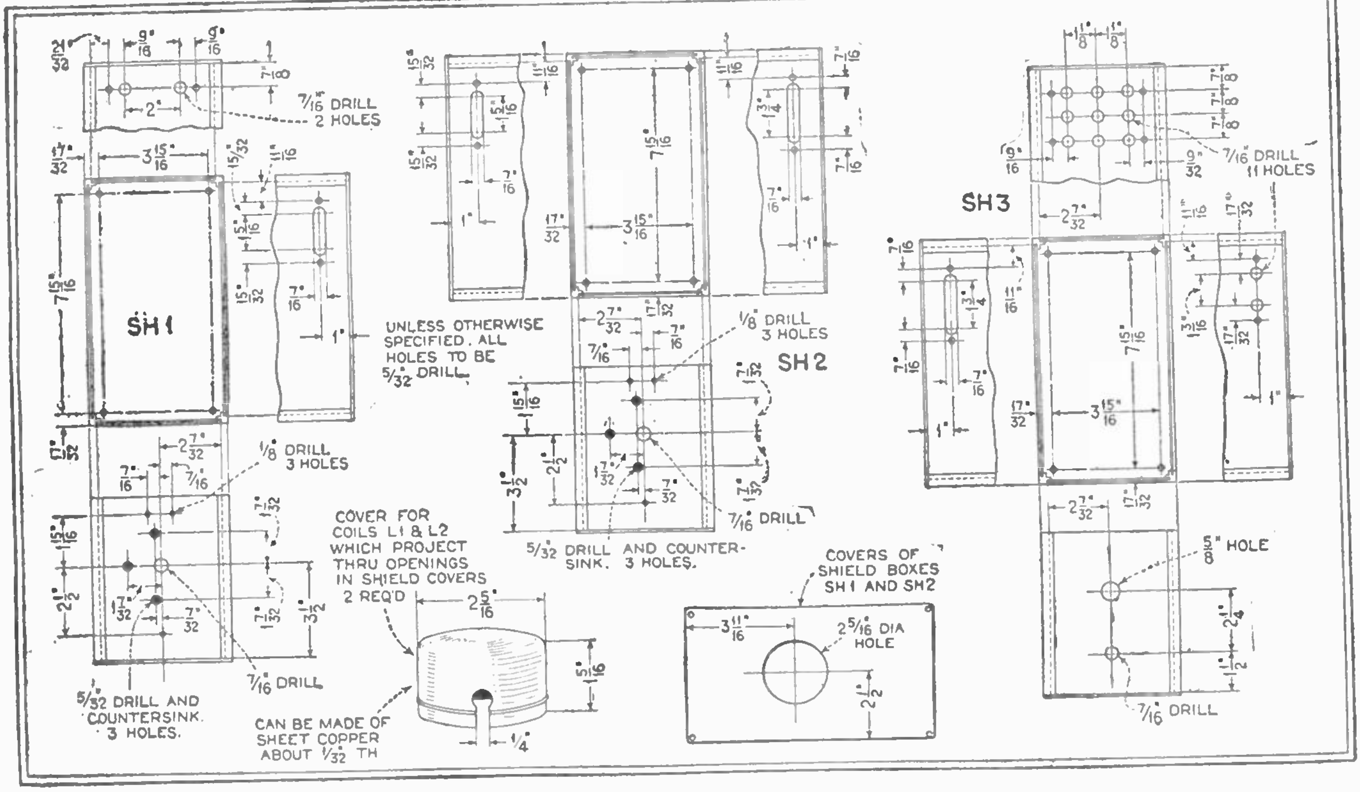
IN THIS CLOSE-UP VIEW OF ONE OF THE TUNED STAGES IS SHOWN THE DETAILS FOR MOUNTING THE COIL SOCKET ON SPACER RODS SO AS TO SUPPORT THE PLUG-IN COIL

numbers on the dial. The condenser is solidly constructed. One needs only to examine it closely to appreciate its qualities. Its taper plates give you the advantage of a small circle circumscribed by the plates and help towards reducing the size of the shielded units. Straight-line frequency condensers of the logarithmic type of plate would be so large as to hit against the side walls of th[illegible] unit.

The sockets employed enable [illegible] user to enjoy a short-wave set th[illegible] not microphonic. These sockets also [illegible]rd a strong and reliable contact from [illegible]et to tube. It is not necessary to [illegible] the value of this advantage, for every sure contact on a receiver of this type is nothing more than another closed link in the chain of sensible design features.

IF THE CONSTRUCTOR HOPES TO ACCOMPLISH THE SAME RESULTS IN THE OPERATION OF THE S-W FOUR AS OBTAINED BY THE AUTHOR, IT IS A FOREGONE CONCLUSION THAT THE WELL-PLANNED DISTRIBUTION OF THE PARTS SHOULD BE STRICTLY ADHERED TO. THE SEVERAL DRILLING LAYOUTS GIVEN BELOW WILL AID MATERIALLY IN THE ACTUAL CONSTRUCTION. A, B AND C SHOW THE LOCATION OF HOLES OF THE ANTENNA STAGE, DETECTOR STAGE AND TWO-STAGE AUDIO AMPLIFIER SUB-BASES RESPECTIVELY. IN THE LOWER PART OF THE DRAWING IS SHOWN THE DRILLING NECESSARY FOR THE BAKELITE PIECES WHICH SUPPORT THE BINDING POSTS AND PIN-JACKS, ETC. FROM LEFT TO RIGHT THE FIRST TWO ARE MOUNTED IN THE FIRST OR R.F. CAN AND ARE THE ANTENNA-GROUND STRIP, D, AND FOUR-PRONG PIN-JACK STRIP, E; THEN THE LEFT AND RIGHT PIN-JACK STRIPS F AND G, OF THE DETECTOR STAGE; THEN THE PIN-JACK STRIP, H, AND LOUD SPEAKER BINDING POST STRIP, J, OF THE TWO-STAGE AUDIO UNIT; FINALLY THE BINDING-POST STRIP FOR THE BATTERY TERMINALS





DRILLING DIRECTIONS FOR EACH OF THE SHIELDED UNITS ARE GIVEN HERE; ALSO NOTE THAT DIMENSIONS AND PLACEMENT OF THE HOLES IN THE TOP OF THE SHIELD CANS, ALLOWING ACCESS TO THE COILS, ARE SHOWN

Fixed filament resistors are used for every tube. In this manner, we are able to control the complete filament system by means of a single switch. This method of filament adjustment is a distinct advantage in a short-wave set. It enables each tube to work at its highest point of filament efficiency at all times. Rheostats employed on short-wave sets have always given trouble. Scraping and scratching noises in the phones disturb the operator when the rheostat is turned and the level of sensitiveness of a receiver is often brought far below normal due to the lack of filament voltage impressed upon the tube.

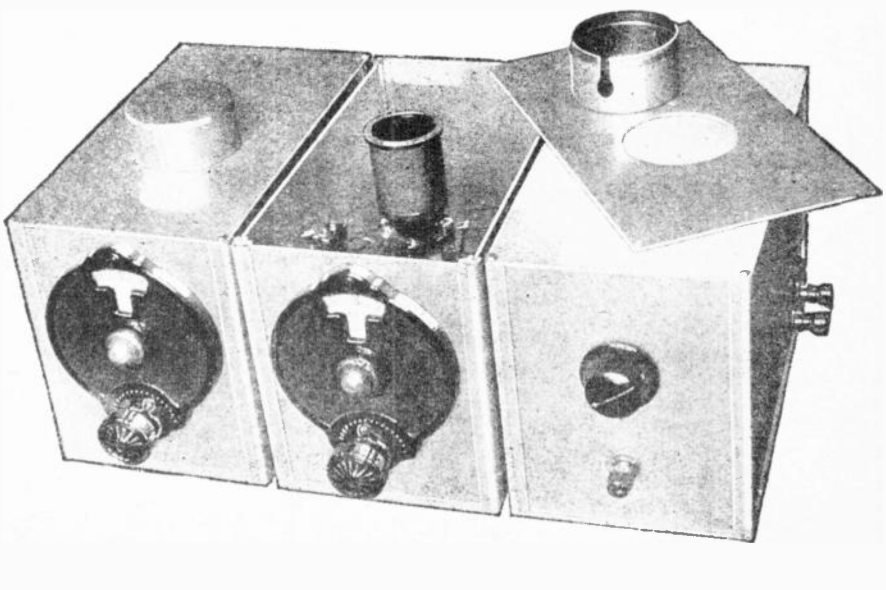
Another feature which is highly important in the operation of the set is its application of by-pass condensers. Applied in the proper fashion, the latter tend to reduce the noises that might be produced by the movement of various parts. Every possible means of reducing these disturbances have been taken into account. Highly efficient fixed condensers enabled us to accomplish this desired effect. Five .006 mfd. condensers are used to by-pass the set properly. A .0001 mfd. condenser is used in the detector grid circuit and a .002 mfd. condenser is used across the first audio transformer primary to enable the detector to oscillate properly.

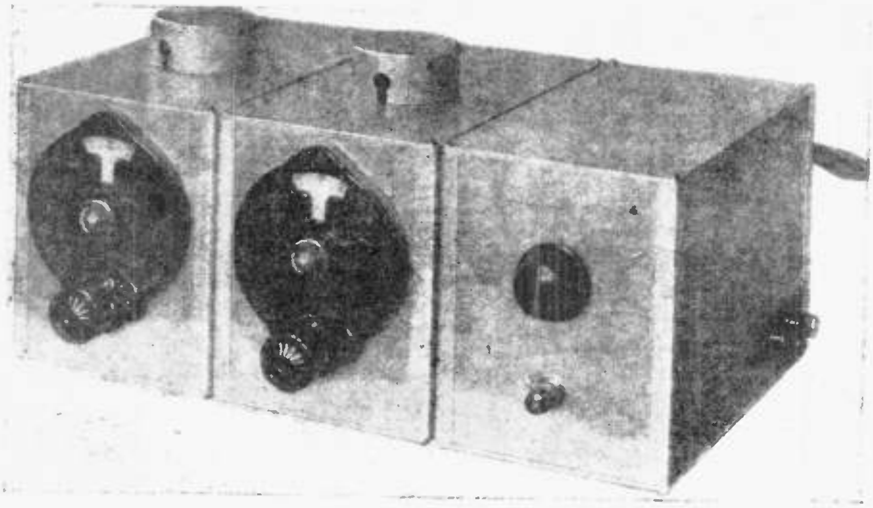
In the operation of the regeneration control, the by-pass condenser across the control helps considerably toward quietness of operation. The noise that is heard in an ordinary receiver, due to this control, is here diminished and the ease of its operation is a pleasure rather than a hindrance toward attaining the highest degree of sensitiveness of the receiver. The regeneration control is a 100,000 ohm variable resistance. This control fits ideally into its important position. Its smoothness of operation and its ability to control the amount of regeneration necessary offers a distinct advantage to the operator. He will find that when operating this control, at times, it will be hard for him to distinguish when the set is oscillating and when it is not oscillating.

Amertran transformers are employed in the audio system, enabling us to obtain a sufficient amount of amplification. This type of transformer has always been a leader in its field and has held the confidence of the radio world to its desirabilities since radio has come into its own.

The method of mounting the parts in their proper positions is unique. It is another one of the features of the set which takes the eye of the man who appreciates something good. All the parts of the set, except those which are mounted upon the shielded units, are affixed to small bakelite panels which fit snugly in the bottom of the cans. These small bakelite bases are raised about one-half an inch above the bottom of the can by means of brass bushings. By mounting these bases in this manner it is possible to mount the fixed condensers, the grid leak holders, the sockets, etc., directly upon these bases. This method of mounting presents a clean-cut neatness and enables you to wire the units below the bakelite panels. The latter has a distinct advantage. Wiring leads can be made as short as possible, because there are no disturbing obstructions below the panels to hinder their course.

A VIEW OF THE ASSEMBLED RECEIVER WITH THE DETECTOR STAGE TOP REMOVED TO SHOW PLACEMENT OF THE COIL UNIT IN ITS SUPPORTING SOCKET





THE COMPLETED SHORT-WAVE RECEIVER, LINED UP AND READY FOR USE. THE SWITCH IN THE RIGHT HAND UNIT TURNS ON AND OFF THE CURRENT TO ALL OF THE TUBES

The socket for the coils is mounted on 3/8" brass bushings and is raised to enable the coils to protrude high enough over the top of the shielded unit to make the interchange of the coils a simple operation.

Separate binding posts are employed to allow the operator to use any type of tube he might wish in the detector and audio circuits. There are individual "B" battery leads for every tube in the set, all fixed to a common "B—." Different "B" voltages can be experimented with to bring out the maximum efficiency of each individual tube. The set also has separate "C" battery connections for the two audio tubes.

Another important feature of this set is its absence of choke coils. Choke coils have the peculiar habit of causing fringe howls which hamper the quality of reception and also cause dead spots that paralyze the operation of the set over a small wave-length range. These hindrances are completely done away with in the S-W Four, due to its correct shielding characteristics and the manner in which the by-pass condensers were employed. When operating the S-W Four, you will find that it is alive over the whole wavelength range and is entirely free from fringe howls.

The dials are the best adapted to this set. A hairline indicator is part of the dial and helps considerably when attempting to log some distant station. The dial has a fine operating vernier which enables you to tune this set very accurately.

Coil Specifications

As mentioned before, the coils are of the plug-in type. They are handy and can be placed away in any small convenient place. If desired, coils can be supplied to enable you to obtain broadcast band reception. The coils' bases have five prongs, the cathode prong being the dummy. The detector and r.f. coils have the same number of turns on both the primary and secondary windings.

The number of turns on the coils are given as follows:

Coil	Primary	Secondary	Wavelength
A	5½	6½	17 to 32.5
B	5½	13½	31 to 58
C	9½	25½	57 to 110
D	15½	49½	104 to 204
E	19⅔	82½	190 to 358
E	30⅔	155	344 to 647

Operating Instructions

Full constructional and wiring details for assembling and wiring the S-W Four are contained in the drawings accompanying. However, before placing the finished units together, first connect the batteries to their respective positions on the back of the audio unit. Then place a tube in the audio unit and turn the filament switch to see if it lights properly. Then if both the audio tubes light correctly, connect the detector and audio tubes together by means of the plugs and jacks, and test the filament of the detector stage. Finally, test the r.f. stage. If all the tubes light properly, screw the tops of the shielded units in their respective positions, making sure that they are screwed down tight. This is very important, for if the cans are not tight, they will cause scraping noises in the phones.

The tubes recommended are as follows: A UX222 is employed in the r.f. unit; a UX112A is advisable in the detector unit; a UX201A is advisable in the first audio, and a UX112A or a UX171A may be used in the final audio stage. Make sure that the proper "B" and "C" voltages are used for the tube selected.

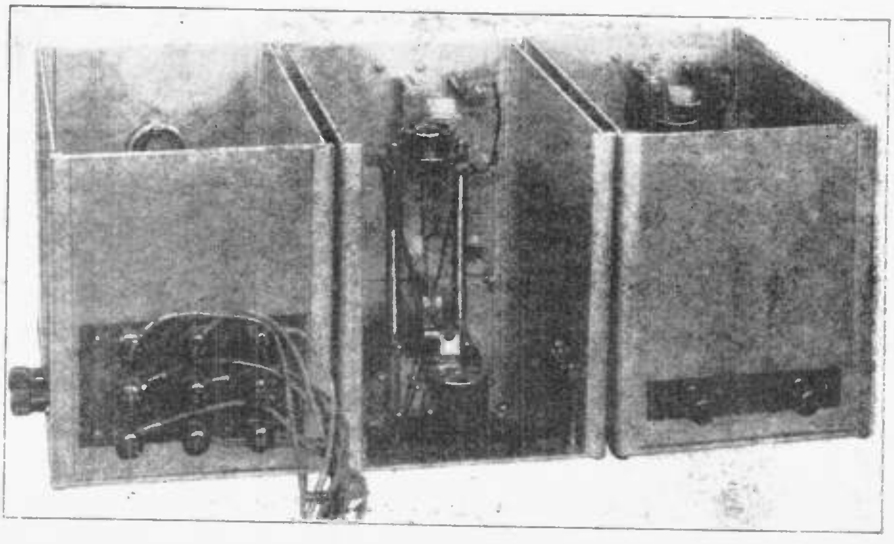
Now, when the batteries, the antenna and ground and the speaker are finally connected, plug in the matched set of coils and cover them with the shielded caps. Turn the filament switch. You should hear a slight rushing sound in the phones. If the set is squealing, turn back the regeneration knob, which is mounted on the front wall of the audio unit, to a point just below the position where oscillation began.

The numbers of the r.f. and detector dials do not always work together. To determine the proper relation between these dials, set the detector dial at 50. Then turn the r.f. dial around until you hear the noise level or most sensitive spot that you can obtain. You will recognize this sensitive spot, for at this position the rushing noise is greatest for position 50 on the detector dial. The general idea of tuning is to keep the two dials in step, indicating a sensitive state for every point on the detector dial. The reason I mention the detector dial is because it is the main tuning control of the receiver; however, the r.f. dial has an effect which must be taken into account always. The r.f. dial usually works in advance of the detector dial when like coils are used in the coil sockets. When the detector dial reaches 80, the r.f. dial may read 100. Here, only the r.f. coil should be changed to the next higher coil to tune for a higher wavelength. Now the detector reading will be higher than that of the r.f. dial and when the detector dial reaches 100, it should then be changed for the next higher coil. In this manner all the wavelengths will be reached by changing one coil at a time.

The regeneration control is easy to operate. Best results are not always obtained just below the point of oscillation. Stations may come in louder when the oscillation control is moved a little further away from this point. To adjust

(Continued on page 84)

IN ADDITION TO SHOWING FURTHER MOUNTING DETAILS OF THE COIL SOCKETS THIS PHOTOGRAPH SHOWS HOW TO CONNECT THE BATTERY LEADS TO THEIR RESPECTIVE BINDING POSTS SO AS TO AVOID THE POSSIBILITY OF SHORT-CIRCUIT



Some Facts About Volume Control Systems

The experimenter has a variety of systems to choose from, for the efficient controlling of volume from his short-wave receiver

By John Rutherford

YEARS ago when crystals and other less effective forms of detectors were used to receive radio signals, the amount of volume which was obtained from a radio receiver was such as to be heard only through the use of earphones. The invention of the vacuum tube changed all this. With the use of the vacuum tube as a detector large amounts of signal were obtained and shortly after its invention it came into wide use as an audio-frequency amplifier. Progress in the development of better amplifier tubes, better audio-frequency transformers, and better loud speakers, then reached the point where it was necessary to consider some means of controlling the amount of volume coming out of the loud speaker. If no such control were used the volume would be so great at times as to be practically unbearable. As the art progressed improvements were made in circuits, various systems of control being incorporated in them. Although we are concerned primarily with type of volume

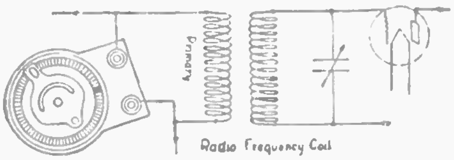


Fig. 1—A variable shunt resistance across the r.f. primary circuit

control which is particularly useful in short-wave receivers, it is necessary at this time to review briefly the types of control which have been in prominent use during the past several years in broadcast receiver circuits, since systems which have been found satisfactory for use in these types of receivers have been borrowed for use in short-wave receiver circuits.

One early type of volume control consisted of a variable resistor which was inserted in one side of the "A" supply to the filament terminals of the vacuum tube. Volume was controlled by altering the amount of filament voltage which was supplied to the tubes by cutting in or out more or less of the resistance. As more resistance was added to the circuit, less voltage was supplied to the tubes and consequently less volume was obtained. A disadvantage of this type of control was that the tube characteristics were seriously affected by the reduction in filament voltage and thereby rendered the signal unsatisfactory from a "tone quality" standpoint.

Later on a system of volume control was devised whereby a variable resistance was shunted across the secondary of either the first or second audio-frequency transformer. As the resistance of the shunt circuit was reduced the volume became less because of the fact that the secondary of the transformer was virtually short-circuited and thereby rendered inoperative. More volume, or rather full volume, was obtained when all of the resistance was in the circuit. This system, while admirably controlling volume, had

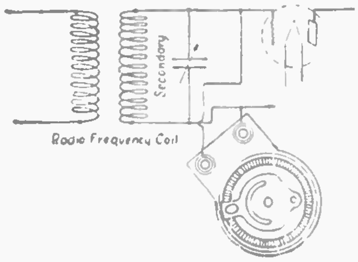


Fig. 2—Shunting the control across the r.f. secondary circuit

the great disadvantage of controlling the volume of the signal obtained *after it had been received* and rectified by the detector circuit; with such a system, on local stations a signal might be obtained which would be so strong as to actually overload the detector tube, causing distortion even though the volume control was manipulated in a vain effort to prevent the distortion. It is easy to understand that a volume-control system such as that just described would not serve in the dual capacity of cutting down the volume and

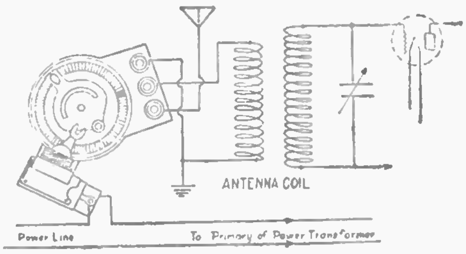


Fig. 3—A volume control system for the antenna circuit

at the same time preserving tone quality. This system has often been likened to that of controlling the speed of an automobile by putting the gears in high speed and then applying the brakes to slow down or stop the car. It is easy to imagine what would eventually happen to the brakes.

Attempts have been made even to place the volume control across the output terminals of the audio-frequency amplifier. That is between the last audio stage and the loud speaker. The same disadvantages hold true here as those explained just previously. That is, the volume control is in the wrong place. What we erroneously do in such cases is to build up a very large audio signal and then cut it down by some mechanical means so that it meets with our requirements for volume. Think how much easier it would be to actually place the volume control in such a place in the circuit so that this condition would not be obtained.

Some experimenters have advocated the placing of the volume control resistance as far ahead of the detector circuits as would be practical. In many instances this is possible, going so far as to place the volume control directly in the antenna circuit. In such a position the variable resistance actually regulates or determines the amount of r.f. signal energy which passes on into the detector, or, if the receiver is of a multi-tube type, into the radio-frequency stages. Other experimenters have advocated the use of variable resistances, both of straight resistance and potentiometer type, either in

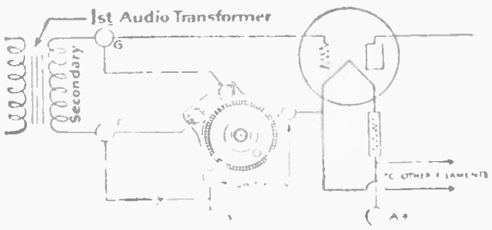
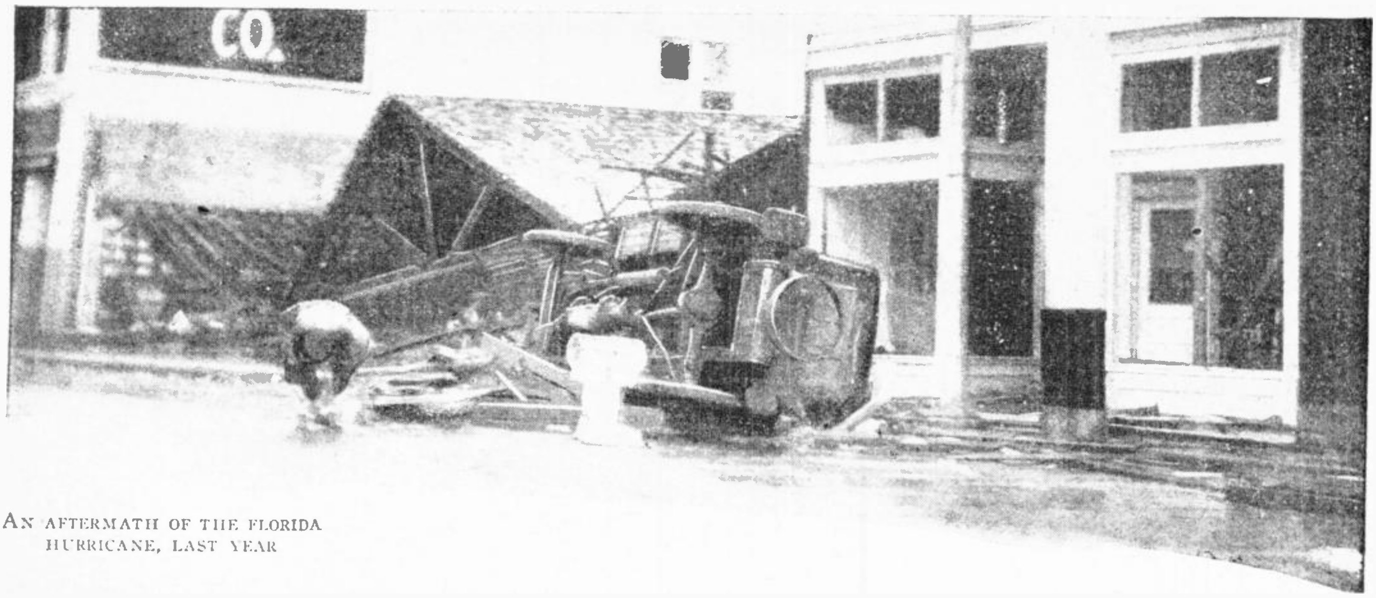


Fig. 4—Regulating volume by resistance control in the audio amplifier

series with the "B plus" leads to the plates of the r.f. tubes or directly shunted across their plate coils. Then, too, there are those who have suggested that resistors of the variable type be shunted across the secondary circuit of the radio-frequency amplifier tubes. Fig. 1 shows a variable resistance of the Electrad tonatrol type connected in shunt directly across the primary of a radio-frequency transformer. The resistance unit connects from the plate of the tube directly to the "B plus" terminal of the primary of that coil. Fig. 2 shows the variable resistance shunted across the secondary circuit of a radio-frequency transformer to control volume. The advantages are rather outweighed by the disadvantages. Control of volume is obtained all right, but so is a broadness of tuning which, in tuned circuits, is not at all desirable. Fig. 3 shows a variable resistor shunted across the antenna coil of a radio-frequency amplifier, the control being of such a type as to include a switch which

(*Continued on page 77*)



AN AFTERMATH OF THE FLORIDA HURRICANE, LAST YEAR

© International

For REAL THRILLS Get Down in the AMATEUR WAVE

Sitting Comfortably in Your Own Home and Run- to Flood Relief Reports, with DX Friendships

BY WILLIAM H.

"And only the Master shall praise us,
and only the Master shall blame;
And no one shall work for money,
and no one shall work for fame,
But each for the joy of the working,
and each, in his separate star,
Shall draw the Thing as he sees It for
the God of Things as They are!"

THUS does Kipling, writing of art and life, epitomize the spirit of the scientific amateur. There are many branches of science, but the same spirit of endeavor pervades them all. It may be astronomy, fascinating to many, perhaps too remote for most; or meteorology, wherein also the experiments are prepared by nature, but become vital only when they result in a holiday rainstorm. Usually, however, a man likes a hobby that he can get his hands as well as his mind on; he wants to strive for perfection with limited means, and achieve success in difficult and specific efforts.

Two avocations which can be described by that overworked adjective, "practical," yet reflect some glow of pure science, are aviation and radio. Most of us are interested in them both; which one is best, there is no need to decide; which is cheapest, is plainly apparent. You can get on the air day after day for a few dollars; to get in the air more or less continually will cost a few hundred. Both arts alike transcend old notions of time and space, and both in their future development will be inseparably intertwined.

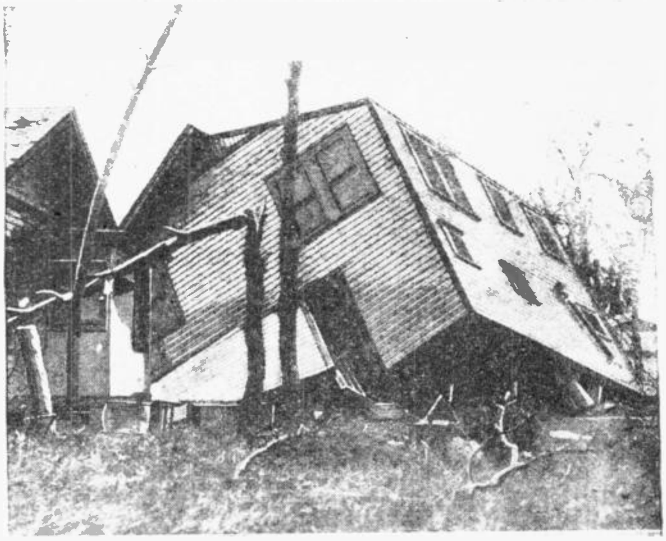
There are now over fifteen thousand transmitting amateurs in the United States alone, and many more in other parts of the world. Many of them sit down of an evening for a pleasant code chat with some foreigner in a far country; or some explorer in arctic cold or equatorial heat. Others talk to a friend in the next state or county by radio telephone, collect weather information for air transport lines, or handle domestic traffic with the speed and certainty of commercial stations. And some may probe that nebulous, frigid sea of helium many miles above the earth's surface with their light-speed waves, investigating a problem that goes back to known physics and forward to the unknown changes rung in the altitude of the northern lights by the ever-varying energy shot out from our distant yet all-powerful sun.

We may divide radio amateurs, according to their particular interests, into three great classes. First of all are the distance-getters. It is a great moment for the beginner, of course, when he works his first station—hears another operator calling him after his first timid transmission. The exalting trepidation most of us feel at this time corresponds to the mental fog that besets most pilots on their first solo flight. But the next high-water mark on our log books is when we first raise "down under"—the Antipodes, or indeed any distant foreigner. I can remember distinctly enough, raising my first "big DX" some years ago from El Paso, Texas, when in the very early morning Z-1AA answered U-5AKT's hundred-watt growl. It was Mr. C. C. N. Edwards of Auckland, New Zealand, and we held perfect communication for more than an hour. It is a marvelous thing, rightly considered, to engage in easy thought exchange with another human being over eight thousand miles away, whose night is your day, whose down is your up, whose direction is not north or east but *straight down* through the solid earth. And high power is not essential for distance. W2CX, here at West Point, has worked France with a UX-210 tube and an input power barely sufficient for two auto headlights. As for what *can* be done on 40 meters, more than one experimenter has transmitted thousands of miles with 90 volts of "B" battery on a 199! But for all its fascination we are probably right in re-

BANDS

ning the Gamut from Exploration
Thrown in for Good Measure

WENSTROM



garding mere distance-getting as a passing phase for every individual operator, mostly because of the spherical shape of the earth. This, if memory does justice to history, also perplexed Alexander. But in science there are always new worlds to conquer, and there is never time, whatever the inclination, to sit down and weep.

A second group of amateurs, probably the backbone of the fraternity, is the traffic handlers. They are expert operators who pride themselves on their sending, copying and rapid, clean-cut procedure. They are valuable potential material for the army and navy in our new scheme of national defense; they keep in touch with expeditions; and in emergencies and disasters, as we shall see later in this article, they often perform distinguished and hazardous service. Of course, the other amateur types also gladly do their part in emergencies, as anyone who holds a license must be at least a fair operator.

The third type, not too numerous but perhaps most interesting, is the experimenter—the man who subordinates operating to engineering. He is more interested in his angle of radiation than in his

RADIO AMATEURS HAVE PLAYED IMPORTANT ROLES IN SUCH DISASTERS AS (TOP ILLUSTRATION) THE FLOODS WHICH INUNDATED PARTS OF GEORGIA, AND THE TORNADO WHICH PLAYED JACKSTRAWS WITH HOUSES IN LAKE WORTH, FLA. TO SAY NOTHING OF THE THRILLS OF CONTACTING BY RADIO WITH THE BYRD ANTARCTIC EXPEDITION

extreme range, and is probably a good deal of bother to other "hams" when he asks them to stand by and note what difference in signals, if any, is occasioned by his circuit changes. Yet he is the man who has placed amateur radio on the technical pinnacle it occupies today. Many of us can recollect that, as late as 1924, the short waves were considered valueless for long-distance communication by most professional engineers, though high frequencies had been used long before in the experiments of Hertz and Marconi. In that year, students in the foremost electrical schools were taught the Austin-Cohen formula, which conclusively stated that the shorter the wave, the shorter the distance to be expected with it. It was the experimenting amateurs who proved the Austin-Cohen formula seriously in error at the high-frequency end of the spectrum, and they proved it unmathematically and empirically by actually reaching Europe and the Antipodes with waves below a hundred meters in length. Today, hundreds of high-power commercial stations, backed by millions in capital, are fighting for assignments in these formerly despised bands.

Radio amateurs have contributed greatly to the progress of civilization by keeping exploring expeditions in touch with their home bases. In the summer of 1925, when the able schooner *Bowdoin* sailed to Labrador and Greenland, an amateur went along as her operator, and kept contact from the arctic circle with other amateurs all over the United States. In the same year the big steam whaler, *Sir James Clark Ross*, was shoving her steel nose into the frigid antarctic seas around the great ice barrier, and putting down 40-meter signals in Massachusetts. On one occasion her operator put a microphone in the ground lead of an oscillating receiver and talked 50 miles across the icy ocean to a smaller boat. Up in Greenland, in the following year, the University

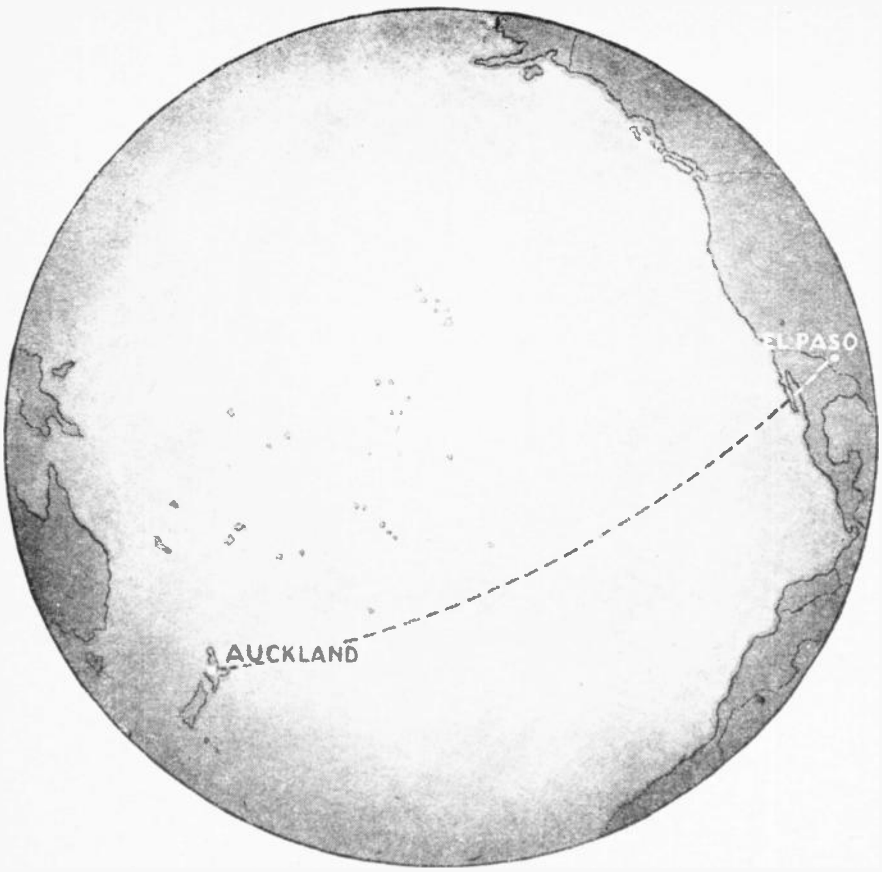
CARL BEN EIELSON and Sir Hubert Wilkins when they made their flight over the south polar regions used the government house at Deception Island (shown at the right as radio headquarters). This station not only supplied the world with news, but was in communication with a number of amateurs who had the vicarious pleasure of direct contact without having to resort to newspapers.

BOTH THE LICENSED AMATEURS AND THE ARMY SIGNAL CORPS, WORKING ON SHORT WAVES, WERE INVALUABLE MEANS OF COMMUNICATION DURING THE DISASTROUS NEW ENGLAND FLOOD OF A LITTLE MORE THAN A YEAR AGO

of Michigan station began to dig in on the Greenland ice cap, amateur transmitter and all; and it is still there, doing meteorological work of the utmost value and maintaining constant touch with home. And down in the steaming jungles of Brazil another short-wave transmitter went with the Dyott expedition, to fling its clear-cut signals over the hemisphere from the backwaters of the Amazon. Radio equipped expeditions grow in number each year—an electric voice is now almost standard practice—but their complete stories would fill several books. The amateurs are always glad to help out, for the spirit of adventure is strong in us, even if we cannot all journey beyond the known horizon's rim.

WIRE COMMUNICATION SELDOM SURVIVES UNDER CONDITIONS SUCH AS PICTURED HERE. IT IS THEN THAT THE RADIO AMATEUR COMES INTO HIS OWN

This coöperation was well demonstrated to me personally in the summer of 1926, when we had a 37-meter experimental transmitter aboard the army transport *Château-Thierry* on a trip from San Francisco to New York. As the ship was only in port for three days before sailing, everything about the installation was hurried. The two 50-watt tubes, under the ministrations of a 750-volt dynamotor which later developed particular talents for absorbing most of the moisture and dirt in the tropics, delivered a bare 30 watts to the antenna; and the lead-in had to run through a bolt hole in



THE AUTHOR'S FIRST REAL DX THRILL; HOLDING MORE THAN AN HOUR'S TWO-WAY COMMUNICATION FROM EL PASO, TEXAS, WITH A BROTHER AMATEUR IN AUCKLAND, NEW ZEALAND

the steel wall. A local engineer predicted our signals would never get out at all, and we were inclined to agree with him. The final sailing whistle found us perched high up on the foremast, stringing the antenna as the ship backed out into the harbor. The inside installation was finished at sea, the next afternoon, and within an hour we had raised 6CUB at Venice, California. During that night, as the ship forged southward off Lower California, we clicked with St. Louis, San Francisco, Fort Leavenworth (Kansas), Dallas, Indianapolis, Oklahoma City, Minneapolis and El Paso! The crisis was past; the jinx had apparently blown overboard in the fresh sea breeze. But it returned temporarily a few days later when the dynamotor developed fever heat combined with a pronounced disinclination to run, and had to be taken apart for a thorough overhaul.

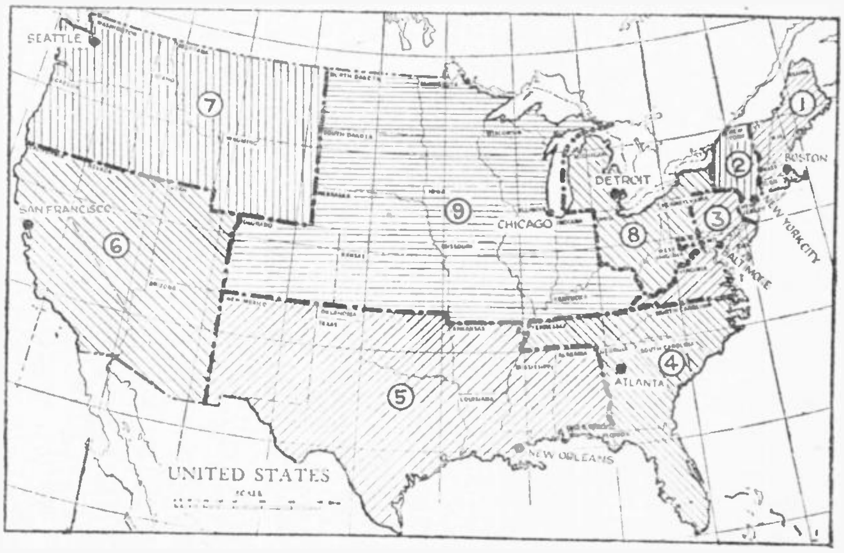
Receiving was none too good, though we did hear one or two Australians. The physical and electrical noise levels were high, the receiver suffered considerably from the ship's vibration, and when the big whistle just above the roof went into action the receiver practically stopped receiving altogether and devoted all its energies to jumping up and down on the table. The atmospherics were atrocious, growing into one continuous roar as the blue Mexican and Central American mountains moved along the eastern horizon in a stately and unhurried procession. The long-wave static was so bad that we had to put through some official traffic to Balboa on the short-wave set, after repeated attempts with the 5-kilowatt long-wave arc extending through 36 hours.

Finally the brilliant green hill jungles of Panama appeared to port, and the next morning we were cruising slowly back and forth in the bay outside the canal entrance. That night, at the dock in Balboa, we spoke the cruiser *Memphis* off Seattle, 3,500 miles away, and sent messages home through 4RY at Montreat, North Carolina. So the voyage continued, through the canal, across the Caribbean to Columbus' Island, and up the Atlantic Coast; and always these unselfish private operators were ready, day after day, to talk for a few minutes, to send us news or to relay our messages.

Quickly as expeditions have seized on radio, they have been no less progressive with aviation. Up in Alaska the first Wilkins expedition did some splendid flying under the most adverse conditions, and its two amateur radio operators worked all around the territory with low-power sets. When Wilkins and Eielson were forced down on the ice far north of Barrow and walked laboriously back to the coast, they had to abandon their plane and with it one of the transmitters. As a result the Barrow transmitter went into another plane for the later flights, and Mason, the Barrow operator, had to improvise a transmitter out of the odds and ends available. This he did, using cut-up tin cans, cigar boxes and flashlight bulbs; and what is more, the set worked, putting out dependable signals for several hundred miles.

During the aerial derby from California to Hawaii in 1927, amateurs maintained a constant circuit for the newspapers between the coast and the islands, and worked some of the planes as well. Everyone remembers how, when some of the early starters were lost at sea, Major Erwin with generous courage pointed his "Dallas Spirit" towards Hawaii in search of them. Eichwaldt, the navigator, operated a small transmitter on 33 meters which gave amateurs all over America news of their tragic but splendid flight. Hundreds of miles out over the darkened Pacific their clear and steady transmissions began to wobble, indicating rough air and uneven speed, despite Eichwaldt's unhurried telegraphic banter. Then came the first SOS, but "Belay that" immediately canceled it. Eichwaldt explained that they had been in a spin, but had pulled out of it. In a moment, however, the unsteadiness of their note told of another spin, and as the plane plunged down to its end Eichwaldt sat there, calmly tapping out with even spacing the final SOS, and setting an example of courage and attention to duty for all the radio operators of the future. The amateur listeners on

(*Continued on page 84*)



A MAP SHOWING THE NINE RADIO ZONES OF THE UNITED STATES, WITH THE CITY INDICATED IN WHICH EACH ZONE SUPERVISOR IS LOCATED

Short-wave Stations of the World

KC	Station	
2020	CGH	The Pas, Man., Can.
2240	CGF	The Pas, Man., Can.
2506	KHBA to KHBV—(Airplanes) Boeing Air Transport, Inc.	
	KFM	Boeing Air Transport, Sacramento, Calif.
2760	VCW	Mile 356, Man., Can.
2980	CFB	Provincial Air Base, District of Patricia, Ont., Can.
2980	CFG	Gold Pines, Ont., Can.
2980	CFI	Woman Lake, Ont., Can.
2980	CFJ	Red Lake, Ont., Can.
3000	WEP	Cape Charles, Va.
3005		U. S. Govt.
3010	KFM	Boeing Air Transport, Sacramento, Calif.
	KFO	Boeing Air Transport, Oakland, Calif.
	KJE	Boeing Air Transport, Reno, Nev.
	KKO	Boeing Air Transport, Elko, Nev.
	KMP	Boeing Air Transport, Omaha, Neb.
	KMR	Boeing Air Transport, North Platte, Neb.
	KOE	Boeing Air Transport, Cheyenne, Wyo.
	KQC	Boeing Air Transport, Rock Spgs., Wyo.
	KQD	Boeing Air Transport, Salt Lake City, Utah
	KQM	Boeing Air Transport, Des Moines, Iowa
	KQQ	Boeing Air Transport, Iowa City, Iowa
	KRA	Boeing Air Transport, Cedar Rapids, Iowa
	KRF	Boeing Air Transport, Lincoln, Neb.
	KTU	Boeing Air Transport, Redding, Calif.
	KZJ	Boeing Air Transport, Seattle, Wash.
	WBQ	Boeing Air Transport, Chicago, Ill.
3035		U. S. Govt.
3050	WGI	Alpena, Mich.
3061	PB8	Rotterdam, Netherlands
3065		U. S. Govt.
3070	WKZ	Potomac Power Co., Cumberland, Md.
3093	PB7	Groningen, Netherlands
3095		U. S. Govt.
3110	WJV	Phila. Elec. Co., Phila., Pa.
3125	PB6	The Hague, Netherlands
3195		U. S. Govt.
3200	CGJ	Isle Maligne, P. Q., Can.
	CGO	Montreal, P. Q., Can.
	CGQ	Quebec City, Can.
	CGS	St. Narcisse, P. Q., Can.
	CGT	Shawinigan Falls, P. Q., Can.
3210	W1XAC	Providence, R. I.
	W3XK	Washington, D. C.
3226		Amsterdam, Netherlands
3235		U. S. Govt.
3265		U. S. Govt.
3286	KFM	Boeing Air Transport, Sacramento, Calif.
	KFO	Boeing Air Transport, Oakland, Calif.
	KJE	Boeing Air Transport, Reno, Nev.
	KKO	Boeing Air Transport, Elko, Nev.
	KMP	Boeing Air Transport, Omaha, Neb.
	KMR	Boeing Air Transport, North Platte, Neb.
	KOE	Boeing Air Transport, Cheyenne, Wyo.
	KQC	Boeing Air Transport, Rock Spgs., Wyo.
	KQD	Boeing Air Transport, Salt Lake City, Utah
	KQM	Boeing Air Transport, Des Moines, Iowa
	KQQ	Boeing Air Transport, Iowa City, Iowa
	KRA	Boeing Air Transport, Cedar Rapids, Iowa
	KRF	Boeing Air Transport, Lincoln, Neb.
	KTU	Boeing Air Transport, Redding, Calif.
	KZJ	Boeing Air Transport, Seattle, Wash.
	WBQ	Boeing Air Transport, Chicago, Ill.
3290	KFK, WFA to WFF—Byrd Expedition	
3295		U. S. Govt.
3297	PB1	Rotterdam, Netherlands
3301	WBV	West Penn. Power Co., Charleroi, Pa.
	WOB	West Penn. Power Co., Connellsville, Pa.
3320	CGE	Selkirk Mines, Man., Can.
3320	CKO	Noranda, P. Q., Can.
3331	WPM	Inland Waterways Corp., Birmingport, Ala.
		Soerabaia, Java
3333		Lwow, Poland
		Warsaw, Poland
3340	VE9CH	Geizers Hill, Nova Scotia
3340	CKA	Geizers Hill, Halifax, Nova Scotia
3426	WIDC	Yacht "Abacena" Box 879, Jacksonville, Fla.
3345–3415		U. S. Govt.
3430	WHF	Potomac Edison Co., Williamsport, Md.
3436	WIDH	Yacht "Buccaneer," J. D. West, Michigan Ave., Manitowoc, Wis.
3445		U. S. Govt.
3466	KTT	Drier Bay, Alaska
3475		U. S. Govt.
3480	VE9AZ	Maple Mount, Ont., Can.
	VE9BD	Long Lake, Ont.
	VE9BF	Timagami, Ont.
	VE9BG	Savant Lake, Ont.
	VE9BH	Cat Lake, Ont.
3500	(85.7m)	Limit of amateur 3500 kc band
3575	W1MK	ARRL, Hartford, Conn.
4000	(75.0m)	Limit of amateur 3500kc band
4010	WLC	Rogers City, Mich.
4015	NAA	U. S. Naval Radio, Arlington, Va.
4017		U. S. Govt.
4020		U. S. Govt.
4025		U. S. Govt.
4030		U. S. Govt.
4044	KOG	Mutual Tel. Co., Honolulu, T. H.
4045		U. S. Govt.
4050		U. S. Govt.
4050	JHL	Hiroshima, Japan
4052	KFVM	Yacht "Idalia," U. S. A.
4055		U. S. Govt.
4060		U. S. Govt.
4065		U. S. Govt.
4070		U. S. Govt.
4075		U. S. Govt.
4080	JBD	Keijo, Japan
		U. S. Govt.
4085		U. S. Govt.
4090		U. S. Govt.
4100	IDM	Rhodes, Italy
	JYD	Tokyo, Japan
	W8XA	Any Ford Plane, U. S. A.
4105		U. S. Govt.
4110	JPP	Tokyo, Japan
4118	KHBA to KHBV (Airplanes) Boeing Air Transport, Inc.	
4135		U. S. Govt.
4144	KHL	Mutual Tel. Co., Wailuku, T. H.
	KHM	Mutual Tel. Co., Lihue, T. H.
	KHO	Mutual Tel. Co., Kaunakakai, T. H.
	KLN	Mutual Tel Co., Hilo; T. H.
4148	WIDH	Yacht "Buccaneer," J. D. West, Michigan Ave., Manitowoc, Wis.
4150	JKF	Kuji, Japan
4155		U. S. Govt.
4188	KFM	Boeing Air Transport, Sacramento, Calif.
	KFO	Boeing Air Transport, Oakland, Calif.
	KJE	Boeing Air Transport, Reno, Nev.
	KKO	Boeing Air Transport, Elko, Nev.
	KMP	Boeing Air Transport, Omaha, Neb.
	KMR	Boeing Air Transport, North Platte, Neb.
	KOE	Boeing Air Transport, Cheyenne, Wyo.
	KQC	Boeing Air Transport, Rock Spgs., Wyo.
	KQD	Boeing Air Transport, Salt Lake City, Utah
	KQM	Boeing Air Transport, Des Moines, Iowa
	KQQ	Boeing Air Transport, Iowa City, Iowa
	KRA	Boeing Air Transport, Cedar Rapids, Iowa
	KRF	Boeing Air Transport, Lincoln, Neb.
	KTU	Boeing Air Transport, Redding, Calif.
	KZJ	Boeing Air Transport, Seattle, Wash.
	WBQ	Boeing Air Transport, Chicago, Ill.
4205		U. S. Govt.
4230	JEW	Osaka, Japan
4235		U. S. Govt.
4250	WRB	Miami, Fla.
	WRP	Pinecrest, Fla.
4255		U. S. Govt.
4265		U. S. Govt.
4280	W1XAC	Providence, R. I.
	W2XQ	Univ. Wireless Com. Co., N.Y.C.
	W2XDY	Jersey City, N. J.
	W3XE	Baltimore, Md.
	W6XT	San Francisco, Calif.
	W9XC	Univ. Wireless Com. Co., Chicago, Ill.
4286	VER	Ottawa, Ont., Can.
1286		Cadiz, Spain
		Matagorda, Spain
4290	JKB	Kagoshima, Japan
4295		U. S. Govt.
4300		U. S. Govt
4305		U. S. Govt.
4310		U. S. Govt.
4365		U. S. Govt.
4370		U. S. Govt.
4375		U. S. Govt.
4380		U. S. Govt.
4405	KFK, WFA to WFF—Byrd Expedition	
4430		U. S. Govt.
4436		U. S. Govt.
4440		U. S. Govt.
4445		U. S. Govt.
4500	W2XBV	R. C. A., N. Y. City
	W6XC	R. B. Parrish, Los Angeles, Calif.
4510	KWV	Pacific Air Transport, Bakersfield, Calif.
4515	KTF	M. R. T. Co., Midway Island.
4525		U. S. Govt.
4530	VE9AI	Toronto, Ont., Canada
	VE9AQ	Nipigon, Ont., Canada
4540	W6XAI	L. A. Rdo. Club, Los Angeles, Calif.
	W8XF	Rdo. Air Service Corp. Cleveland, Ohio
4575	W9XAD	J. G. Branch, Chicago, Ill.
4593	WGT	R. C. A. San Juan, P. R.
4600	W2XBS	R. C. A. New York City
	W2XBA	WAAM, Inc., Newark, N. J.
4685	W2XE	Richmond Hill, N. Y.
4700	CGF	The Pas, Man., Can.
	CGK	Hudson, Ont., Can.
	CGL	Winnipeg, Man., Can.
	W8XAV	Westinghouse, E. Pittsburgh, Pa.
	W1XAB	H. P. Hines, Portland, Me.
4800	W2XBU	H. E. Smith, Beacon, N. Y.
	W1XAY	J. S. Dodge, Lexington, Mass.
4835	G5DH	Dollis Hill, England
4835	GKP	Dollis Hill, England
4835	GZZ	Cleethorpes, England
4900	JEW	Osaka, Japan
	UQ	Bluefields, Nicaragua
	W3XK	Jenkins Lab., Washington, D. C.
4916	CFA, CGA, CJA—Drummondville, P. Q., Can.	
4920	JEW	Osaka, Japan
4937	CFA, CGA, CJA—Drummondville, P. Q., Can.	
4983	UOG	Vienna, Austria
4990	ISL	Agoi, Italian Somaliland
	IDX	Asmara, Italy
4997	CFA, CGA, CJA—Drummondville, P. Q., Can.	
5000	JPS	Sapporo, Japan
	W3XL	R. C. A. Bound Brook, N. J.
		Lwow, Poland
		Warsaw, Poland
5060		Spain
5070	JBD	Keijo, Japan
5100	WKA	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
	UW	Cape Gracias, Nicaragua
5120	JCX	Nawa, Riu-Kiu Ids., Japan
5140		Spain
5160	KWT	M. R. T. Co., Palo Alto, Calif.
5170	JHL	Hiroshima, Japan
		Nauen, Germany
5250	JPP	Tokyo, Japan
5260	XMT	Mobile on Railroad, China
5263	WQN	R. C. A., Rocky Point, N. Y.
5270	JPP	Tokyo, Japan
5350	JKV	Kanazawa, Japan
5355	GBM	Leafield, England
5360	JKV	Kanazawa, Japan
		Oxford, England
5400	JKF	Juki, Japan
5410		Chigiqui, Panama
5450	IDO	Rome, Italy
		Riga, Latvia
5455	VER	Ottawa, Ont., Can.
5460	JEW	Osaka, Japan
5470	VQA	Jesselton, Bermuda
5490	CKA	Geizers Hill, Halifax, Nova Scotia, Can.
5500	JYZ	Tokyo, Japan
5505	WQN	R. C. A., Rocky Point, N. Y.
5525	WCY	R. C. A., Cleveland, Ohio
	WRL	R. C. A. Duluth, Minn.
	WGO	Ill. R. C. A., South Chicago, Ill.
5525	WIDC	Yacht "Abacena," Box 879, Jacksonville, Fla.
5533	KRK	M. R. T. Co., Palo Alto, Calif.
5550	W2XBH	C. G. Unger, Brooklyn, N. Y.
	W7XO	Nw. Rdo. Service Co., Seattle, Wash.
5570	WHD	N. Y. Times, New York City
	WAM	I. R. T. Co., Buffalo, N. Y.
	WDI	I. R. T. Co., Detroit, Michigan
	WME	I. R. T. Co., Duluth, Minn.
	WTL	I. R. T. Co., Cleveland, Ohio
5585	KHBA to KHBV—(Airplanes) Boeing Air Transport, Inc.	
	KFM	Boeing Air Transport, Sacramento, Calif.
	KFO	Boeing Air Transport, Oakland, Calif.
	KJE	Boeing Air Transport, Reno, Nev.
	KKO	Boeing Air Transport, Elko, Nev.
	KMP	Boeing Air Transport, Omaha, Neb.
	KMR	Boeing Air Transport, North Platte, Neb.
	KOE	Boeing Air Transport, Cheyenne, Wyo.
	KQC	Boeing Air Transport, Rock Spgs., Wyo.
	KQD	Boeing Air Transport, Salt Lake City, Utah
	KQM	Boeing Air Transport, Des Moines, Iowa
	KQQ	Boeing Air Transport, Iowa City, Iowa
	KRA	Boeing Air Transport, Cedar Rapids, Iowa
	KRF	Boeing Air Transport, Lincoln, Neb.

KC	Station	
	KTU	Boeing Air Transport, Redding, Calif.
	KZJ	Boeing Air Transport, Seattle, Wash.
	WBQ	Boeing Air Transport, Chicago, Ill.
5600	KFK, WFA to WFF—Byrd Expedition	
	WSL	M. R. T. Co., Sayville, N. Y.
5610		Nauen, Germany
5615	WAM	I. R. T. Co., Buffalo, N. Y.
	WDI	I. R. T. Co., Detroit, Mich.
	WME	I. R. T. Co., Duluth, Minn.
	WTL	I. R. T. Co., Cleveland, Ohio
5650	ICJ	Bengasi, Cyrenaica, N. Africa
	KFK, WFA to WFF—Byrd Expedition	
5660	PCH	Scheveningen, Netherlands
5660	VQB	Sandakan, Bermuda
5670	DAN	Norddeich, Germany
5690	W8XAL	Crosley Rdo. Corp., Harrison, Ohio
5700	ZLW	Wellington, N. Z.
5700		U. S. Govt.
5714	SAS	Karlsborg, Sweden
5715	GKQ, GKS—Dollis Hill, England	
5720	KHL	Mutual Tel. Co., Wailuku, T. H.
	KHM	Mutual Tel. Co., Lihue, T. H.
	KHO	Mutual Tel. Co., Kaunakakai, T. H.
	KLN	Mutual Tel. Co., Hilo, T. H.
	PWH	T. R. T. Co., Preston, Cuba
5760		Spain
5766	WGW	Vieques, Porto Rico
	WKK	Ceiba, P. R.
5770	UC	T. R. T. Co., Tela, Honduras
	UF	T. R. T. Co., Barrios, Guatemala
	XMH	Peking, China
5795	DIZ	Konigs Wusterhausen, Germany
5800	KMN	San Francisco, Calif.
	KNG	Portable, Calif.
5825	WQN	R. C. A., Rocky Point, N. Y.
5840	KRO	R. C. A., Honolulu, T. H.
5880	KJK	King Cove, Alaska
	KWR	Port Moller, Alaska
	KXW	Ikatan, Alaska
5900		Kootwijk, Netherlands
5920		Kootwijk, Netherlands
		U. S. Govt.
5925		U. S. Govt.
5930		U. S. Govt.
5940		U. S. Govt.
5945	KOG	Mutual Tel. Co., Honolulu, T. H.
		U. S. Govt.
5950		U. S. Govt.
5955		U. S. Govt.
5960	CFB	Provincial Air Base, District of Patricia, Ont., Can.
	CFG	Gold Pines, Ont., Can.
	CFI	Woman Lake, Ont., Can.
	CFJ	Red Lake, Ont., Can.
5960	VE9AZ	Maple Mount, Ont., Can.
	VE9BD	Long Lake, Ont.
	VE9BF	Timagami, Ont.
	VE9BG	Savant Lake, Ont.
	VE9BH	Cat Lake, Ont.
		U. S. Govt.
5990	CKF	Saskatoon, Sask., Can.
	CKM	Moose Jaw, Sask., Can.
5990	KFM	Boeing Air Transport, Sacramento, Calif.
	KFO	Boeing Air Transport, Oakland, Calif.
	KIE	Boeing Air Transport, Reno, Nev.
	KKO	Boeing Air Transport, Elko, Nev.
	KMP	Boeing Air Transport, Omaha, Neb.
	KMR	Boeing Air Transport, North Platte, Neb.
	KOE	Boeing Air Transport, Cheyenne, Wyo.
	KQC	Boeing Air Transport, Rock Spgs., Wyo.
	KQD	Boeing Air Trnasport, Salt Lake City, Utah
	KQM	Boeing Air Transport, Des Moines, Iowa
	KQQ	Boeing Air Transport, Iowa City, Iowa
	KRA	Boeing Air Trnasport, Cedar Rapids, Iowa
	KRF	Boeing Air Transport, Lincoln, Neb.
	KTU	Boeing Air Transport, Redding, Calif.
	KZJ	Boeing Air Transport, Seattle, Wash.
	WBQ	Boeing Air Transport, Chicago, Ill.
5996	WBZ	Westinghouse Elec. & Mfg. Co., Springfield, Mass.
6000	ICK	Tripoli, N. Africa
	KWT	M. R. T. Co., Palo Alto, Calif.
	VE9AO	Nipigon, Ont., Can.
	VE9OO	Toronto, Ont., Can.
6057	KGTH	Western Air Express, Salt Lake City, Utah
	KGTI	Western Air Express, Los Angeles, Calif.
6060	KGTJ	Western Air Express, Las Vegas, Nev.
	SAD	Stockholm, Sweden
	TFA	Reykjavik, Iceland
	XMP	Mobile on Railroad, China
6072		Vienna, Austria
6080	W2XCX	L. Bamberger & Co., Kearney, N. J.
6100	KII	Bristol Bay, Alaska
	KIW	Port Althorp, Alaska
	KNR	M. R. T. Co., Clearwater, Calif.
	KZN	Waterfall Cannery, Alaska
	UL	Managua, Nicaragua
6120	ICF	Messina, Sicily, Italy
6122		Mexico
6180	ICK	Italy

KC	Station	
6200	VAJ	Digby Id., Prince Rupert, B. C., Can.
6240	KSZ	Tex. Pipe Line Co., McCarney, Texas
	KYI	Tex. Pipe Line Co., King Mill, Texas
	KWT	M. R. T. Co., Palo Alto, Calif.
6275	WCY	R. C. A., Cleveland, Ohio
	WGO	Ill. R. C. A., South Chicago, Ill.
	WRL	R. C. A., Duluth, Minn.
6310		Victoria, B. C., Can.
6320	UA	T. R. T. Co., Pto. Castilla, Honduras
6350	ZLB	Awarua, Otago, N. Z.
6356		New Zealand
6360	VFA	Halifax, Nova Scotia
6365	WHD	N. Y. Times, New York City
6375	VAA	Ottawa, Ont., Can.
6379	KTA	M. R. T. Co., Guam
	SUC	Abu Zabal, Cairo, Egypt
6380	CRG	El General, Costa Rica
6380	GKQ	Dollis Hill, England
	ICX	Italy
	KGH	M. R. T. Co., Hillsboro, Oregon
	KIF	Davao, P. I.
	KPI	Cebu, P. I.
	KUI	Macleod & Co., Cebu, P. I.
	RFL	Feodosia, U. S. S. R.
	SUW	Abu Zabal, Cairo, Egypt
6383	G5DH	Dollis Hill, England
6410	SUW	Abu Zabal, Cairo, Egypt
6420	W3XK	Jenkins Lab., Washington, D. C.
6425	W1XAC	C. E. Mfg. Co., Providence, R. I.
6448	KAM	Pasay, P. I.
6470	KHCA to KHCJ—Western Air Express	
6510	KGE	Pacific Air Transport, Medford, Oregon
	KGT	Pacific Air Transport, Fresno, Calif.
6518	SGL	Stockholm, Sweden
	XDA	Mexico, D. F., Mexico
6525	IDZ	Italian Somaliland
	RIL	U. S. S. R. (Russia)
	SUW	Abu Zabal, Cairo, Egypt
	UG	T. R. T. Co., Tegucigalpa, Honduras
6550	KQS	Lone Pine, Calif.
	KOT	Los Angeles, Calif.
6580	KFK, WFA to WFF—Byrd Expedition	
6600	KFE	Marland Pipe Line Co., Ponca City, Okla.
	KEH	Marland Pipe Line Co., Borger, Texas
6637		Denmark
6660	ICK	Tripoli, N. Africa
	KEG	Pacific Air Transport, Vancouver, Wash.
	KEU	Pacific Air Transport, Los Angeles, Calif.
	KYU	Tex. Pipe Line Co., Wichita Falls, Texas
	WHW	Wireless Tel. & Comm. Co., Northbrook, Ill.
	WPM	Inland Waterways Corp., Birmingham, Ala.
6663	XAM	Merida, Yucatan, Mex.
6667	CRO	Costa Rica
6670	IDZ	Rome, Italy
	W3XI	Geo. E. Sterling, Baltimore, Md.
6680	DGK	Nauen, Germany
		Manila, P. I.
6680	VAA	Ottawa, Ont., Can.
6685	VQB	Sandakan, Bermuda
6690	VAA	Ottawa, Ont., Can.
6690	VAP	Port Churchill, Hudson Bay, Man., Can.
6690	VAY	Cape Hope Advance, Hudson Strait, Can.
6690	VBY, VCJ, VFL—Ottawa-Hudson Straits Stations, Can.	
6695	VFA	Halifax, Nova Scotia
6700	CKD	Winnipeg, Man., Can.
6700		Nauen, Germany
6710	WER	R. C. A., Rocky Point, N. Y.
6720	WBO	Ford Motor, Dearborn, Mich.
6725	WQO	R. C. A., Rocky Point, N. Y.
	RIL	U. S. S. R. (Russia)
6730	VOA	Jesselton, Bermuda
6737	KAL	Legaspi, P. I.
6740	IRI	Rome, Italy
	UG	Tegucigalpa, Honduras
	WEJ	R. C. A., Rocky Point, N. Y.
6750	GFJ	Air Ministry, London, England
	GFN	Air Ministry, London
6750	GFQ	British Royal Air Force, Aden, British Somaliland
	GFX	British Royal Air Force, Ismalia, Egypt
	GFZ	British Royal Air Force, Calafrana, Malta
	ZLF	Gen. Hq., N. Z. Military Forces, Wellington, N. Z.
	GFV	Baghdad, Iraq
6755	WND	A. T. & T., Deal Beach, N. J.
6760	VAI	Digby Id., Prince Rupert, B. C., Can.
6765	VFC	[illegible]
6770	WNN	T. R. T. Co., Mobile, Ala.
	WAN	T. R. T. Co., [illegible], Fla.
	DGG	Nauen, Germany
6775	VAY	Cape Hope Advance, Hudson Strait, Can.
6777	VAA	Ottawa, Ont., Can.
6780	SUW	Abu Zabal, Cairo, Egypt
678[illegible]	WBF	T. R. T. Co., Boston, Mass.
	WNU	T. R. T. Co., New Orleans, La.
6790		Spain
6800	XDF	Guadalajara, Jal., Mexico
6810	KOQ	Humble Pipe Line Co., Houston, Tex.
	KNB	Jay Peters, Inglewood, Calif.

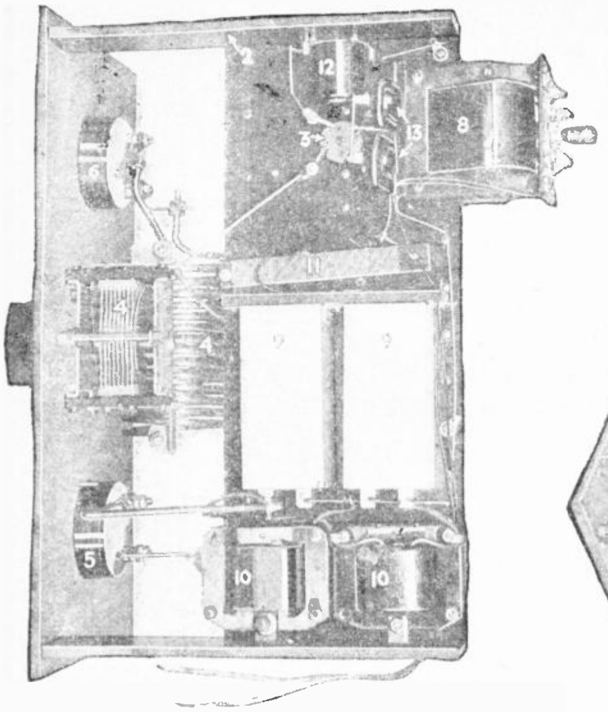
KC	Station	
	KZA	Jay Peters, Inglewood, Calif.
6814	GFA	Air Ministry, London
	GFH	Aldergrove, N. Ireland
	KHD	Quadra, Alaska
	KPM	Iloilo, P. I.
	KTA	M. R. T. Co., Guam
	KUH	Macleod & Co., Manila, P. I.
	SAA	Karlskrona, Sweden
	UR	T. R. T. Co., Cartago, Costa Rica
6815	KNW	M. R. T. Co., Palo Alto, Calif.
	CFA	Drummondville, P. Q., Can.
6818	HVA3	Hanoi, Tonkin, Fr. Indo China
6820	DIZ	Konigs Wusterhausen, Germany
		Warsaw, Poland
6820	PJC	Willemstad, Curacao, D. W. I.
6830	CFA, CGA, CJA—Drummondville, Can.	
		Pernambuco, Brazil
6837	VAA	Ottawa, Ont., Can.
	VAP	Port Churchill, Hudson Bay, Man., Can.
6840		Spain
6845	KEN	R. C. A., Bolinas, Calif.
6850	VAK	Gonzales Hill, B. C., Can.
6850	VRN	Bartica, British Guiana, S. A.
	VRV	Kamakusa, British Guiana, S. A.
	VRW	Enachu, British Guiana, S. A.
	VRY	Georgetown, British Guiana, S. A.
6860	KEL	R. C. A., Bolinas, Calif.
6875	W6XU	R. C. A., Bolinas, Calif.
6877	KTA	M. R. T. Co., Guam
6890	WGX	R. C. A., San Juan, P. R.
	KOS	Pampa, Texas
6900	WLG	Bypro, Ky.
	WLI	Cleveland, Ohio
	VAI	Point Grey, B. C., Can.
	DIZ	Konigs Wusterhausen, Germany
6920	WEE	R. C. A., Rocky Point, N. Y.
6935	WEB	R. C. A., Rocky Point, N. Y.
	W2XAS	R. C. A., Rocky Point, N. Y.
6940	KTF	M. R. T. Co., Midway Island
6942	SAD	Stockholm, Sweden
6950	GFN	Air Ministry, London, England
6950	GFY	British Royal Air Force, Ismalia, Egypt
6950	WKP	R. C. A., Rocky Point, N. Y.
	ZLF	Gen. Hq., N. Z. Military Forces, Wellington, N. Z.
6960	DIZ	Konigs Wusterhausen, Germany
6965	WIZ	R. C. A., New Brunswick, N. J.
6973	KAS	Surigao, P. I.
6977	SAS	Karlsborg, Sweden
6987	KPI	Cebu, P. I.
6990	KBT	Butuan, P. I.
	WCT	Ford Motor Co., L'Anse, Mich.
7000	(42.9)	Limit of amateur 7000 k. c. band
7150	W1MK	ARRL, Hartford, Conn.
7300	(41.1)	Limit of amateur 7000 k. c. band
7310	IOB	Fiume, Italy
7317	LMV	Tromsoe, Norway
7320	FSO	France
	IOB	Fiume, Italy
	JES	Osaka, Japan
		Warsaw, Poland
	UR	T. R. T. Co., Cartago, Costa Rica
7323	DHE	Nauen, Germany
7330	PMZ	All American Lyric Malaysian Expedition, Bandjermasin, Dutch Borneo
7340		Am. Pub. Com., New York City
	DEH	Nauen, Germany
7350	VE9OB	Ottawa, Ont., Can.
		Kootwijk, Netherlands
7355		Am. Pub. Com., Philadelphia, Pa.
		Am. Pub. Com., Boston, Mass.
7370		Am. Pub. Com., New York City
7389	UOK	Deutsch-Altenburg, Austria
7400	WEM	R. C. A., Rocky Point, N. Y.
7420	GFA	Air Ministry, London, England
7430	KGQ	Robt. Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Honolulu, T. H.
	KGX	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
7445	KGQ	Robt. Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Honolulu, T. H.
	KGX	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
7450	JAN	Tokyo, Japan
7480	PKI	Bengkalis Island, D. E. I.
	FWX	Sainte Assise, France
7496	KFUH	Yacht "Kaimiloa," via P. M., Honolulu, T. H.
	KGDQ	S. S. "Petaluma" P. & Santa Rosa Ry. Co.
	KGDQ	Yacht "Faith"
7500	RAM	Papeete, Tahiti
	CFA, CGA, CQA—Drummondville, P. Q., Can.	
	FSQ	Sainte Assise, France
	ISV	Bender Kassim, Italian Somaliland
	LVF	Flores, Guatemala, C. A.
	JOC	Ochiishi, Japan
	PB9	[illegible], Netherlands
7520	WEG	R. C. A., Rocky Point, N. Y.
7540	DIY	Konigs Wusterhausen, Germany
7600	KTZ	Alaska Packers, Naknek, Alaska
	KFU	Alaska Packers, [illegible], Calif.
7610		Nauen, Germany
7625		Am. Pub. Com., Milwaukee, Wisc.
		Am. Pub. Com., Los Angeles, Calif.
7640		Am. Pub. Com., New York City
		Am. Pub. Com., Washington, D. C.
7655		M. R. T. Co., Guam
7670		M. R. T. Co., Sayville, L. I., N. Y.
7690	PJZ	Willemstad, Curacao, D. W. I.

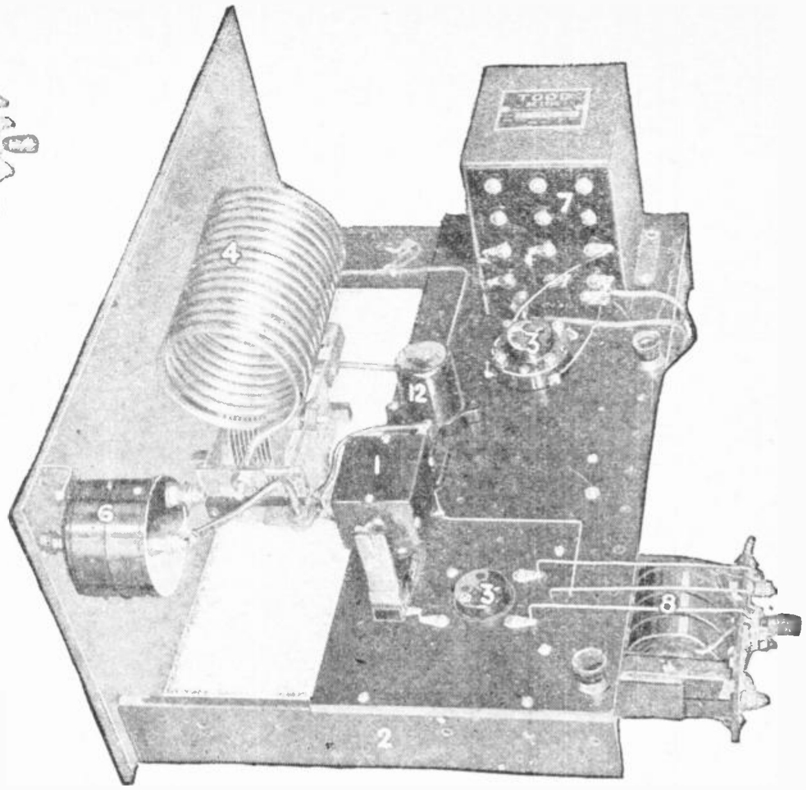
KC	Station	
7690	IDX	Italy
		Nauen, Germany
	JPP	Tokyo, Japan
		Mexico
		Denmark
	XOM	Moukden, China
7700	JPP	Tokyo, Japan
	JYB	Tokyo, Japan
	UO	Bluefields, Nicaragua
7715	KFE	R. C. A., Bolinas, Calif.
7720	GYA	Whitehall, London, England
7730		M. R. T. Co., Sayville, L. I., N. Y.
7732		Kootwijk, Netherlands
7745	KNW	M. R. T. Co., Palo Alto, Calif.
7760	KNN	M. R. T. Co., Honolulu, T. H.
7765		Kootwijk, Netherland
7775	WTF	Firestone, Akron, Ohio
7775	WMU	Southern Rdo. Corp., Linden, N. J.
7790	FUE	Mengam, NR. Brest, France
		Buenos Aires, Argentina
	OXZ	Denmark
	XDA	Observatory, Mexico, D. F.
7800	FWX	Sainte Assise, France
		Nauen, Germany
	JRV	Saipan, Japan
	UW	Cape Gracias, Nicaragua
7820	DFT	Nauen, Germany
		Am. Pub. Co., N. Y. City
		Am. Pub. Com., Chicago, Ill.
7835		Am. Pub. Com., New York City
		Am. Pub. Com., Chicago
		Kootwijk, Netherlands
7850		Am. Pub. Com., Flord Park, N.Y.
7860	SUC, SUW, SUX, SUY, SUZ—Abu Zabal, Cairo, Egypt	
7890	CFA, CGA, CJA—Drummondville, P. Q., Can.	
	ISL	Afgoi, Italian Somaliland
	JPS	Sapporo, Japan
	KFUH	Yacht "Kaimiloa" via P. M., Honolulu, T. H.
	PKH	Soerabaja, Java
	VQF	Batu Anam, Sarawak
7895	GYZ	Rinella Malta
7895	ISQ, IST—Afgoi, Italian Somaliland	
7900	HBC	Berne, Switzerland
	JPS	Sapporo, Japan
	W3XQ	Mountain Lakes, N. J.
		Nauen, Germany
7910	DFP	Nauen, Germany
7925		Am. Pub. Co., San Francisco, Cal.
7940	GLM	Dorchester, England
7955		Am. Pub. Com., San Francisco, Calif.
		Am. Pub. Com., Chicago, Ill.
7970	DGL	Nauen, Germany
7980	FLE	Eiffel Tower, Paris
7995	KFZQ	Yacht "Robador"
8000	HBC	Berne, Switzerland
	JKV	Kanazawa, Japan
	W6XAS	Portable, Calif.
	XKY	Kwaiyang, China
	XRO	Chungking, China
8005	GLK	Dorchester, England
8010	WLC	Michigan Limestone Co., Rogers City, Mich.
8030	NAA	U. S. Naval Radio, Arlington, Va.
8034		U. S. Govt.
8040		U. S. Govt.
8050	HJG	Bogota, Colombia, S. A.
	WCF	Chicago Fed. of Labor, Chicago
		U. S. Govt.
8060		U. S. Govt.
8075	KNN	M. R. T. Co., Honolulu, T. H.
8090		U. S. Govt.
8100	KUY	Bear Creek, Alaska
	WJD	Intl. News Service, New York City
	W6XF	C. J. Smith, Los Angeles, Calif.
8103	KFHW	Yacht "Poinsettia"
	KFVM	Yacht "Idalia"
	KGBT	Yacht "Enchantress"
8110	GKT	Burnham, England
8120		Manila, P. I.
		U. S. Govt.
8135		U. S. Govt.
8140		U. S. Govt.
8150	GKS	Dollis Hill, England
8150	UR	T. R. T. Co., Cartago, Costa Rica
		U. S. Govt.
8160		U. S. Govt.
8170	DGV	Nauen, Germany
		U. S. Govt.
8174		Kootwijk, Netherlands
8179	DIX	Konigs Wusterhausen, Germany
8180	DIX	Konigs Wusterhausen, Germany
8180		U. S. Govt.
8190	CKN	Esquimalt, B. C., Can.
8210	BLF	Bluefields, Nicaragua
	CAB	Puerto Cabezas, Nicaragua
8210	GKT	Portishead, Bristol, England
	KGH	M. R. T. Co., Hillsboro, Oregon
		U. S. Govt.
8214	GLKY	S. S. "Carinthia," England
8220	FUT	Toulon, France
8230	WHD	N. Y. Times, New York City
8230	WHDC	Yacht "Nomad" box 879, Jacksonville, Fla.
	GKS	Dollis Hill, England
8237	HIK	Barahona, Dominican Rep.
8240	SAB	Goteborg, Sweden
8250		U. S. Govt.
8255	IPI	Pisa, Italy
8300	HBC	Berne, Switzerland
	UL	Managua, Nicaragua
		Konigs Wusterhausen, Germany
8310		U. S. Govt.
8320	IDX	Asmara, Italy
8328	KTA	M. R. T. Co., Guam
8330	DAN	Norddeich, Germany
	FO	Leopoldville, Congo, Africa
	HVA3	Hanoi, Tonkin, Fr. Indo-China
8330	KFLF	Yacht "Ripple" Box 188, Bradenton, Fla.
	VAA	Ottawa, Ont., Can.
8333	XVX	Papeete, Tahiti, Fr. Oceanica
8350	WIDJ	Yacht "Temptress" QRD Tahiti
8370	WHDC	Yacht "Nomad" QSL via ARRL
8370	WAM	I. R. T. Co., Buffalo, N. Y.
	WDI	I. R. T., Co., Detroit, Michigan
	WTL	I. R. T. Co., Cleveland, Ohio
	WME	I. R. T. Co., Duluth, Minn.
8385	WCY	R. C. A., Cleveland Ohio
	WGO	Ill. R. C. A., Chicago
	WRL	R. C. A., Duluth, Minn.
8400	UQ	Bluefields, Nicaragua
		Konigs Wusterhausen, Germany
8410		U. S. Govt.
8422	FUT	Toulon, France
8425	WSL	M. R. T. Co., Sayville, N. Y.
8450	ICF	Messina, Sicily, Italy
	RKU	U. S. S. R. (Russia)
	UR	Costa Rica
	HVK	Vientine Laos, Fr. Indo China
8470		U. S. Govt.
8480		Nauen, Germany
8495	G5DH	Dollis Hill, England
8499	PCH	Scheveningen, Netherlands
8500	GCA	Tobermory, Isle of Mull, England
	UH	Cape Gracias, Nicaragua
8510	WUAA	U. S. Army Transport "Cambrai" Ft. Mason, Calif.
	WUAB	U. S. A. T. "Somme" Ft. Mason, Calif.
	WUAC	U. S. A. T. "Meigs" Ft. Mason, Calif.
	WUAF	U. S. A. T. "Chateau Thierry," Army Base, Brooklyn, N. Y.
	WUAG	U. S. A. T. "Grant" Ft. Mason, Calif.
8530		U. S. Govt.
8566	KFUH	Yacht "Kaimiloa" Via P. M., Honolulu, T. H.
8570	CKN	Esquimalt, B. C., Can.
8570	CFH	Halifax, Nova Scotia, Can.
	GYJ	Horsea, England
	G5DH	Dollis Hill, England
	IDB	Albania
	PCA	Amsterdam, Netherlands
	RAU	Tachkent, U. S. S. R.
	UR	Costa Rica
8570	VER	Ottawa, Ont., Can
8570	ZLF	Gen. Hq., N. Z. Military Forces, Wellington, N. Z.
8590		U. S. Govt.
8600	KWT	M. R. T. Co., Palo Alto, Calif.
		U. S. Govt.
8600	ZLB	Awarua, Otago, N. Z.
8610		U. S. Govt.
8620	CKN	Esquimalt, B. C., Can.
	CTO	Portugal
		U. S. Govt.
8630	GZZ	Cleethorpes, England
8640	GBM	Leafield, Oxford, England
8645	LPX	Monte Grande, Argentina
8650	KVUA	S. S. "Lake Ormoc" Ford Motor Co., Santa Ream, Brazil
8650	W1XAV	C. F. Mfg. Co., Providence, R. I.
	W2XBA	W. C. VonBrandt, Jersey City, N.J.
	W2XQ	Univ. Wireless Comm. Co., New York City
	W3XE	Radio Show, Baltimore, Md.
	W6XD	Portable, D. B. McGown, San Francisco, Calif.
	W6XT	C. L. Watson & R. C. Gray, San Francisco, Calif.
	W9XC	Univ. Wireless Comm. Co., Chicago, Ill.
8650	ZBW	Victoria Peak, Hong Kong, China
8670	CPC	Southern Rdo. Corp., Yacuiba, Bolivia
8670	DIW	Konigs Wusterhausen, Germany
8690	PJC	Williamstad, Curacao, D. W. I.
	GLKY	S. S. "Carinthia," England
	LPI	Buenos Aires, Argentina
8690	VPW	Singapore, Straits Settlements
8700	HBC	Berne, Switzerland
	VIS	Sydney, NSW, Australia
	VWZ	Kirkee, near Poona, India
8710	VQF	Kuching, Sarawak
	VQP	Miri, Sarawak
	VQV	Sibu, Sarawak
8720	KNN	M. R. T. Co., Honolulu, T. H.
	POT	Observatory, Rio de Janeiro, Brazil
8730		U. S. Govt.
8740		U. S. Govt.
8760		U. S. Govt.
8770	GZY	The Nore, Chatham, England
8771	GBI	Grimsby, England
8773	GBI	Grimsby, England
8780	GBI	Grimsby, England
8787	GBI	Grimsby, England
8789	GBI	Grimsby, England
8795	CFA, CGA, CJA—Drummondville, P. Q., Can.	
	CFH	Halifax, Nova Scotia
8800		India
		Great Britain
8810	IDM	Rhodes, Italy
	IDO	Rome, Italy
	KFK, WFA to WFF—Byrd Expedition	
8811	GBJ	Bodmin, England
8812	GBJ	Bodmin, England
8818	PCA	Amsterdam, Netherlands
	LGN	Bergen, Norway
8830	CM2RO	Cuba
	LPI	Buenos Aires, Argentina
	GBJ	Bodmin, England
	RKV	U. S. S. R. (Russia)
	VPO	Mombasa, Kenya, Africa
	XDA	Mexico, D. F., Mexico
8827	GBJ	Bodmin, England
8829	GBJ	Bodmin, England
8830	UR	T. R. T. Co., Cartago, Costa Rica
8850	KNW	M. R. T. Co., Palo Alto, Calif.
8860		U. S. Govt.
8870	GZQ	Aden Radio, British Somaliland
8870	NAZ	Managua, Nicaragua
8872		U. S. Govt.
8880		U. S. Govt.
8890		U. S. Govt.
8900	ZSB	Klipheuvel, Cape of Good Hope
8920	GBX	Rugby, England
8920	LPI	Monte Grande, Argentina
		Konigs Wusterhausen, Germany
8930	PJC	Curacao, D. W. I.
8930		M. R. T. Co., Sayville, N. Y.
	DIV	Konigs Wusterhausen, Germany
8950	FLE	Eiffel Tower, Paris
	WEL	R. C. A., Rocky Point, N. Y.
	WNB	Elgin, Ill.
8970	KNW	M. R. T. Co., Palo Alto, Calif.
8990	WEC	R. C. A., Rocky Point, N. Y.
9000	JPN	Palaos, Japan
	JRW	Japan
	PCA	Amsterdam, Netherlands
	UL	Managua, Nicaragua
	W6XB	R. C. A., Bolinas, Calif.
9010	KEJ	R. C. A., Bolinas, Calif.
9020	GBS	Rugby, England
		Spain
9031	KTF	M. R. T. Co., Midway Island
9040	CFH	Halifax, Nova Scotia
9050		U. S. Govt.
9055	CFH	Halifax, Nova Scotia
9056	WSBS	Yacht, "Carnegie" QSL Via ARRL.
9060	VE9AI	Toronto, Ont., Can.
	VE9AO	Nipigon, Ont., Can.
9070	KNN	M. R. T. Co., Honolulu, T. H.
9085	IDO	Rome, Italy
	KIXB	S. S. "West Cheswald"
		T. R. T. Co., Santa Marta, Colombia, S. A.
9090	CM2CF	Cuba
	CM2IQ	Cuba
	HZM	Brazzaville, Fr. Eq. Africa
	JES	Osaka, Japan
	PJC	Williamstad, Curacao, D. W. I.
	IDO	Rome, Italy
9091	CFA, CFG, CFJ—Drummondville, P. Q., Can.	
9100	UJ	T. R. T. Co., Santa Marta, Colombia, S. A.
9100	VPX	Penang, Straits Settlements
9100		Manila, P. I.
9118	SUS	Abu Zabal, Cairo, Egypt
9120		Nauen, Germany
		Paris, France
9140	DIV	Konigs Wusterhausen, Germany
9145	W6XN	G. E. Co., Oakland, Calif.
9160	GYP	Stonecutters Radio, Hongkong, China
	FLE	Eiffel Tower, Paris
9170	WND	A. T. & T., Deal Beach, N. J.
9200	UQ	Bluefields, Nicaragua
		Kootwijk, Netherlands
9210	VAA	Ottawa, Ont., Can.
9210	VAY	Cape Hopes Advance, Hudson Strait, Can.
9209	GBN	Leafield, Oxford, England
9225	G2YT	Poldhu, England
9230		Paris, France
9240		Kootwijk, Netherlands
9251	GBK	Bodmin, England
9253	GBK	Bodmin, England
9260	GBK	Bodmin, England
9267	GBK	Bodmin, England
9269	GBK	Bodmin, England
9280		M. R. T. Co., Guam
9332	CFA, CGA, CJA—Drummondville, P. Q., Can.	
9350	VPG	Accra, Gold Coast, W. Africa
9369	JCX	Nawa Radio, Japan
9369	FLE	Eiffel Tower, Paris
	LCGD	Whaler "C. A. Larsen" c/o Norwegian Consulate, Dunedin, New Zealand
	PTT	Brazil
	VIS	Sydney, NSW, Australia
9370	JHL	Hiroshima, Japan
9370	IDO	Rome, Italy
	W8XAO (WJR)—Detroit, Michigan	
9375	HVX	Papeete, Tahiti, Fr. Oceanica
	LDW	Fauske, Salten Fjord, Norway
	VJC	Raboul, New Guinea
9380	CM2MK	Cuba
	CM5CX	Cuba
	PKX	Malabar, Java
		England
	VOF	Batu Anam, Sarawak
	JHL	Hiroshima, Japan
9390	DIU	Konigs Wusterhausen, Germany
9400		Konigs Wusterhausen, Germany
9410	KGQ	Robert Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Honolulu, T. H.
	KGN	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
9424	SAS	Carlsborg, Sweden
9440		Nauen, Germany
9450	WES	R. C. A., Rocky Point, N. Y.
9458	DIU	Konigs Wusterhausen, Germany
9470	WET	R. C. A., Rocky Point, N. Y.
9480	GYU	Gibraltar, Mediterranean
9490	WEF	R. C. A., Rocky Point, N. Y.
9518	LCUO	S. S. "Nielsen Alonso" c/o Ing. J. Lehmkohl, Voldgate 1, Oslo, Norway
9520		Australia
9525	PKP	Medan, Sumatra, D. E. I.
	PTK	Brazil

KC	Station	
	SNM	Sweden
9550	UL	Managua, Nicaragua
9555		Brazil
9580		Norway
		Konigs Wusterhausen, Germany
9585	7LO	(Broadcast, Box 777, Nairobi, Kenya, Africa
9590	VK2FC	N. S. W. Broadcasting Co., Ltd., Sydney, NSW, Australia
9600	LGN	Bergen, Norway
9610	LCK	Oslo, Norway
	LDW	Fauske, Salten Fjord, Norway
9630	CFA, CGA, CJA	—Drummondville, P. Q., Can.
9650	CM2KP	Cuba
9650	DGU	Nauen, Germany
9660	GZP	Matara, Ceylon
9660	W8XAG	E. T. Flewelling, Dayton, Ohio
9670	JBD	Keijo, Japan
	SAJ	Flottans Stations Radio, Stockholm
9680	PJZ	Willemstad, Curacao, W. W. I.
	VQV	Sibu, Sarawak
9690	DFF	Nauen, Germany
9700	W2XAL	Experimenter Pub. Co., Coytesville, N. J.
		Argentina
		Konigs Wusterhausen, Germany
9710	PTT	Brazil
	VLB	Awarua, Otago, New Zealand
9725	XDA	Mexico, D. F.
9730	DFO	Nauen, Germany
9740	HVM	Hanoi, Tonkin, Fr. Indo-China
9750	WNC	A. T. & T. Co., Deal Beach, N. J
9770	DES	Nauen, Germany
9770	DES	Nauen, Germany
	EAM	Spain
	RKI	U. S. S. R. (Russia)
9780	GYL	Seletar, Straits Settlements
9790	CPC	Southern Rdo. Corp., Yacuiba, Bolivia
9790	GBW	Rugby, England
9800	JKF	Kuji, Japan
9810	RCI	Kertch, Crimea, U. S. S. R.
	DFE	Nauen, Germany
9835	LCM	Stavanger, Norway
	PTQ	Quartel General, Brazil
9850	PJC	Willemstad, Curacao, D. W. I.
9870	WMI	A. T. & T. Co., Deal Beach, N. J.
9890	DGC	Nauen, Germany
9890	GYG	Bermuda Dockyard, Bermuda
9900	HZAI	Saigon, Fr. Indo-China
9910	DHD	Nauen, Germany
9910	EAX	Spain
9930	PCJ	Eindhoven, Netherlands
		France
		Nauen, Germany
9940	PJD	St. Martins, Curacao, D. W. I.
9950	GBU	Rugby, England
9961	KTR	Radio Corp. of the Philippines, Manila
9975	IPR	Italy
9994	GBM	Oxford, England
	PKH	Soerabaia, Java
10000	GBO	Oxford, England
	JBK	Kagoshima, Japan
	LCM	Stavanger, Norway
	LGN	Bergen, Norway
	CM2LA	Cuba
		France
		Mexico
10005	PKH	Soerabaja, Java
10010	KINR	Manila, P. I.
10020	VE9AI	Toronto, Ont., Can.
	VE9AQ	Nipigon, Ont., Can.
10030		Spain
10033	UOR	Vienna, Austria
10040		Nauen, Germany
10080		Nauen, Germany
10100	VOA	Jesselton, Bermuda
	VQF	Kuching, Sarawak
10115	DIT	Konigs Wusterhausen, Germany
10130	LVA	Observatory, Guatemala City, C. A.
10156	DIS	Konigs Wusterhausen, Germany
10170	KNR	M. R. T. Co., Clearwater, Calif.
	JES	Japan
	UI	Santa Marta, Colombia, S. A.
	HVA2	Hanoi, Tonkin, Fr. Indo-China
10190	GBO	Rugby, England
10200	VOB	Sandakan, Bermuda
10200	XGA	China
		Nauen, Germany
10210	DGD	Nauen, Germany
10220		Spain
10240	XGA	Mukden, China
10250		Scheveningen, Netherlands
10260		Scheveningen, Netherlands
10300		Spain
10339	PKP	Medan, Sumatra, D. E. I.
10340	HJG	Bogota, Colombia, S. A.
	JPS	Sapporo, Japan
10344		Kabarah, Fr. Sudan
10350	JPS	Sapporo, Japan
10390	KER	R. C. A., San Francisco, Calif.
10400	LAD	Norway
10414	KES	R. C. A., Bolinas, Calif.
10417	HVN	Saigon, Fr. Indo-China
10420		Kootwijk, Netherlands
		Scheveningen, Netherlands
10450	DGH	Nauen, Germany
	WAX	T. R. T. Co., Miami, Fla.
	WNN	T. R. T. Co., Mobile, Ala.
10470	WBF	T. R. T. Co., Boston, Mass.
	WNU	T. R. T. Co., New Orleans, La.
10490	KNN	M. R. T. Co., Honolulu, T. H.
10500	VQG	Nairobi, Kenya, Br. E. Africa
10500		Konigs Wusterhausen, Germany
10530	GBX	Rugby, England
	VK2ME	Sydney, N. S. W.
10550	WLO	A. T. & T. Co., Deal Beach, N. J.
10600	JRV	Saipan, Japan
		Nauen, Germany
10610	WEA	R. C. A., Rocky Point, N. Y.
10620	LP5	Monte Grande, Argentina
10630	WED	R. C. A., Rocky Point, N. Y.
10640		Sydney, NSW, Australia
10680		Konigs Wusterhausen, Germany
10700	JBD	Keijo, Japan
		Kootwijk, Netherlands
10708	GLKY	S. S. "Carinthia" England
10710	CFA, CGA, CJA	—Drummondville, P. Q., Can.
	8XX	Koukaza Park, China
10714	FUL	France
	LP5	Monte Grande, Argentina
10722	VQP	Miri, Sarawak
10736		Kootwik, Netherlands
10740		Kootwik, Netherlands
10750	WKI	F. T. Co., Newark, N. J.
10770	UR	T. R. T. Co., Cartago, Costa Rica
10790	ISP	Italian Somaliland, Africa
10790	VQF	Kuching, Sarawak
	PLR	Bandoeng, Java
10810	KNN	M. R. T. Co., Honolulu, T. H.
	DGT	Nauen, Germany
10830		M. R. T. Co., Guam
10845		Winnipeg, Man., Can.
10850	DFL	Nauen, Germany
10870	G5DH	England
	GKQ	Dollis Hill, England
10900	KKC	Federal Tel. Co., Palo Alto, Calif.
		Nauen, Germany
10903	G5DH	Dollis Hill, England
	KTO	Manila, P. I.
10910	ORU	Belgium
	VQG	Australia
	HVJ	Dalat, Fr. Indo-China
10930	GLQ	Ongar, England
	KGQ	Robt. Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Honolulu, T. H.
	KGX	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
10960	GBN	Oxford, England
10980	CKA	Geizers Hill, Halifax, Nova Scotia, Can.
11000	SUC, SUW, SUX, SUY, SUZ	—Abu Zabal, Cairo, Egypt
11040	WHD	N. Y. Times, New York City
11046	KRK	M. R. T. Co., Palo Alto, Calif.
11100	CKC	Calgary, Alta, Can.
11110	ICJ	Italy
	JYZ	Tokyo, Japan
		Nauen, Germany
11180		Konigs Wusterhausen, Germany
11190	OJO	Austria
	WKA	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
11200	HBC	Berne, Switzerland
	KFK, WFA to WFF	—Byrd Expedition
	WSL	M. R. T. Co., Sayville, N. Y.
11260		Germany
11280	GRA	London, England
	UJ	Santa Marta, Colombia, S. A.
11300	KFK, WFA to WFF	—Byrd Expedition
11340	DAN	Norddeich, Germany
11365	XOM	China
11400	WDJ	Crosley Rdo. Corp., Harrison, Ohio
	WKA	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
11410	HSP	Bangkok, Siam
11413	CFA, CGA, CJA	—Drummondville, P. Q., Can.
11420	GLY	Dorchester, England
11425		Dorchester, England
11440	DHA	Nauen, Germany
11452	CFA, CGA, CJA	—Drummondville, P. Q., Can.
11460		Konigs Wusterhausen, Germany
11490		New Zealand
11495	GBK	Bodmin, England
11500	ZMA	Apia, Samoa Islands
11500		Konigs Wusterhausen, Germany
11531	CFA, CGA, CJA	—Drummondville, P. Q., Can.
11540	UB	Almirante, Panama
	UF	T. R. T. Co., Barrios, Guatemala
	VIS	Sydney, NSW, Australia
11560	VMG	Apia, Samoa
11571	GBH	Beam Stn., Grimsby, England
11573	GBH	Beam Stn., Grimsby, England
11580	DIR	Konigs Wusterhausen, Germany
	GBH	Grimsby, England
11587	GBH	Beam Stn., Grimsby, England
11589	GBH	Beam Stn., Grimsby, England
11620	DFK	Nauen, Germany
		Konigs Wusterhausen, Germany
11621	FUT	Toulon, France
11630	UB	Almirante, Panama
11655	VIZ	Melbourne, Vic., Australia
11680	KIO	R. C. A., Kahuku, T. H.
11695	CKC	Calgary, Alta., Can.
	CKL	Winnipeg, Man., Can.
11720		Argentina
11720	PJZ	Willemstad, Curacao, D. W. I.
11758	GLKY	S. S. "Carinthia"
	JYZ	Tokyo, Japan
11780	UL	Managua, Nicaragua
11800		Konigs Wusterhausen, Germany
11801		Vienna, Austria
11810	WKA	Westinghouse, E. Pittsburgh, Pa.
11840		Nauen, Germany
11880	UL	Managua, Nicaragua
11900		Konigs Wusterhausen, Germany
11910	SUC, SUW, SUX, SUY, SUZ	—Abu Zabal, Cairo, Egypt
11920	DGS	Nauen, Germany
11940		Spain
11950	KKQ	R. C. A., Bolinas, Calif.
11980	GBO	Oxford, England
11980	LP	Buenos Aires, Argentina
11985	FSI	Sainte Assise, France
11990	CFA, CGA, CJA	—Drummondville, P. Q., Can.
11992	CFA, CGA, CJA	—Drummondville, P. Q., Can.
11993	HZA	Saigon, Fr. Indo-China
12000	JYZ	Tokyo, Japan
	UR	San Jose, Costa Rica
		Denmark
		Quebec, Canada
12020	VIY	Ballan, Vic., Australia
12025	VIY	Ballan, Vic., Australia
12045	NAA	U. S. Naval Radio, Arlington, Va.
	FUT	Toulon, France
12051		U. S. Govt.
12060		U. S. Govt.
12070		Cuba
12075		U. S. Gov.t
12085	FWX	Sainte Assise, France
12093	CFA, CGA, CJA	—Drummondville, P. Q., Can.
12100	UR	T. R. T. Co., Cartago, Costa Rica
12102		Quebec, Canada
12135		U. S. Govt.
12145		Manila, P. I.
12150	GBS	Rugby, England
		U. S. Govt.
12160	FWX	Sainte Assise, France
12165		U. S. Govt.
12170	GYL	Seletar, Straits Settlements
12180		U. S. Govt.
12195		U. S. Govt.
12200	JPM	Palaos, Japan
12210		U. S. Govt.
12225		U. S. Govt.
12240	GLQ	Ongar, England
		U. S. Govt.
12255		U. S. Govt.
12265		Dorchester, England
12270		Spain
12290	GBU	Rugby, England
12295	PJZ	Willemstad, Curacao, D. W. I.
12300	JAN	Tokyo, Japan
	JES	Osaka, Japan
12315		U. S. Govt.
12338	KFD	G. E. Co., Denver, Colo.
12340	WIDC	Yacht "Abacena" Box 879, Jacksonville, Fla.
12350		England
12400	PKK	Manokwari, New Guinea, D. E. I.
	JRW	Parao, Japan
	UJ	T. R. T. Co., Santa Marta, Colombia, S. A.
12465		U. S. Govt.
12492	GBM	Oxford, England
12500	G5SW	Marconi, Chelmsford, England
		Oxford, England
	JES	Osaka, Japan
	JEW	Japan
	VE9BE	De Forest Rdo. Corp., Toronto, Ont.
	HVN	Saigon, Fr. Indo-China
12511		Ontario, Canada
		Quebec, Canada
12615		U. S. Govt.
12705		U. S. Govt.
12720	VFA	Halifax, Nova Scotia
12750	VAA	Ottawa, Ont., Can.
12758	KTA	M. R. T. Co., Guam
12765		U. S. Govt.
12766	PCH	Scheveningen, Netherlands
12795		U. S. Govt.
12800	JBD	Keijo, Japan
12825	CGP	Term Point, N. W. T., Can.
	JBD	Keijo, Japan
	VCJ	Wakeham Bay, P. Q., Can.
12825	VAP	Port Churchill, Hudson Bay, Man., Canada
12825	VAY	Cape Hopes Advance, Hudson Strait, Can.
12840	W3XK	Jenkins Labs., Washington, D. C.
12850	KGO, W6XN	—Oakland, Calif.
12850	W1XAC	C. E. Mfg. Co., Providence, R. I.
12880	LAD	Norway
12885		U. S. Govt.
12900		U. S. Govt.
		France
12930	VER	Ottawa, Ont., Can.
12931	OUX	Vienna, Austria
12940	WAX	T. R. T. Co., Hialeah, Fla.
	WNN	T. R. T. Co., Mobile, Ala.
12970	WNU	T. R. T. Co., New Orleans, La.
	WBF	T. R. T. Co., Boston, Mass.
13000	KNW	M. R. T. Co., Palo Alto, Calif.
13030	KNN	M. R. T. Co., Honolulu, T. H.
13040	HZG	Noumea, New Caledonia
13045	PKH	Soerabaja, Java
	RAU	Moscow, U. S. S. R.
	RLT	U. S. S. R.
	XON	China
13095		U. S. Govt.
13110		U. S. Govt.
13125		U. S. Govt.
13140		U. S. Govt.
13155		U. S. Govt.
13160	PCH	Scheveningen, Netherlands
13180	DGG	Nauen, Germany
13187	KFK, WFA to WFF	—Byrd Expedition
13210	DHC	Nauen, Germany
13220	UR	T. R. T. Co., Cartago, Costa Rica
13290		U. S. Govt.
13305		U. S. Govt.
13308		U. S. Govt.
13320		U. S. Govt.
13330	FWX	Sainte Assise, France
13335		U. S. Govt.
13345	IRI	Rome, Italy
13360	DGI	Nauen, Germany
		Manila, P. I.

KC	Station	
13360	VAA	Ottawa, Ont., Can.
13375	VEA	Halifax, Nova Scotia
13390	WND	A. T. & T. Co., Deal Beach, N. J.
13400		Nauen, Germany
13410	WHR	R. C. A., Rocky Point, N. Y.
13450	WEX	R. C. A., Rocky Point, N. Y.
13460	UJ	T. R. T. Co., Santa Marta, Colombia
13465	GBQ	Rugby, England
13480	WAJ	R. C. A., Rocky Point, N. Y.
13500	GFJ	Air Ministry, London, England
13500	GFQ	British Royal Air Force, Aden, British Somaliland
	GFV	Bagdad, Iraq
	FGX	Ismailia, Egypt
	FGZ	Calafrana, Malta
	ZLF	Gen. Hq., N. Z. Military Forces, Wellington, N. Z.
13510	RKU	Turkestan
13520	VAJ	Digby Id., Prince Rupert, B. C., Can.
13526	GLH	Dorchester, England
13528	GLH	Dorchester, England
13535	GLH	Dorchester, England
13540	DFC	Nauen, Germany
13542	GLH	Dorchester, England
13544	GLH	Dorchester, England
13555	GBN	Leafield, Oxford, England
13575		U. S. Govt.
13580	GLH	Dorchester, England
13603	W6XN	G. E. Co., Oakland, Calif.
13630	GKS	Dollis Hill, England
	HJG	Bogota, Colombia
13636	PJZ	Willemstad, Curacao, D. W. I.
13640	GKT	Burnham, England
	KGBB	S. S. "Sachem" R. B. Metcalf
	KTA	M. R. T. Co., Guam
	RAU	Tashkent, U. S. S. R. (Russia)
	UA	Porto Castilla, Honduras
	UC	Tela, Honduras
	VIS	Sydney, NSW, Australia
	VIT	Townsville, Qld., Australia
13660	GLL	Dorchester, England
13675	VAA	Ottawa, Ont., Can.
13675	VAP	Port Churchill, Hudson Bay, Man., Can.
13690	KKZ	R. C. A., Bolinas, Calif.
13700	VAK	Gonzales Hill, B. C., Can.
13720	KEL	R. C. A., Bolinas, Calif.
	KEB	G. E. Co., Oakland, Calif.
13750	W6XU	R. C. A., Bolinas, Calif.
13753		M. R. T. Co., Guam
13760	KEB	G. E. Co., Oakland, Calif.
13774	DIQ	Konigs Wusterhausen, Germany
13780	WGT	R. C. A., San Juan, P. R.
13800	VAL	Point Gray, B. C., Can.
13820	SUC, SUW, SUX, SUY, SUZ	Abu Zabal, Cairo, Egypt
13830	WPE	R. C. A., Rocky Point, N. Y.
13870	WIY	R. C. A., Rocky Point, N. Y.
	W2XAS	R. C. A., Rocky Point, N. Y.
13880	KTE	M. R. T. Co., Midway Island
13900	GFN	Air Ministry, London, England
	ZLF	Gen. Hq., N. Z. Military Forces, Wellington, N. Z.
13900	WOP	R. C. A., Rocky Point, N. Y.
13920	CKW	Winnipeg, Man., Can.
13920	CKZ	Montreal, P. Q., Can.
13930	WIK	R. C. A., Rocky Point, N. Y.
13950		Oxford, England
13960	GBO	Oxford, England
		M. R. T. Co., Guam
13975	GYZ	Rinella, Malta
13990	WDJ	Crosley Rdo. Corp., Harrison, Ohio
14000	(21.43m)	Limit of amateur 14,000 kc. band
14400	(20.83m)	Limit of amateur 14,400 kc. band
14437	DIP	Konigs Wusterhausen, Germany
14440	GBW	Rugby, England
14470	WNC	A. T. & T. Co., Deal Beach, N. J.
14480		Spain
14500		Kootwijk, Netherlands
		Scheveningen, Netherland
14560	UJ	T.R.T.Co., Santa Marta, Colombia
		Kootwijk, Netherlands
		Scheveningen, Netherland
14590	DGZ	Nauen, Germany
14590	WMI	A. T. & T. Co., Deal Beach, N. J.
14600	UQ	Bluefields, Nicaragua
14680		M. R. T. Co., Palo Alto, Calif.
14700	UW	Cape Gracias, Nicaragua
14710		M. R. T. Co., Palo Alto, Calif.
14725	VRS	Mauritius
14740		M. R. T. Co., Sayville, N. Y.
14769	GLSQ	S. S. "Olympic" England
14770		M. R. T. Co., Sayville, N. Y.
14830	WKU	R. C. A., Rocky Point, N. Y.
14841	GFA	Air Ministry, London, England
14860	KGQ	The Robt. Dollar Co., San Francisco, Calif.
	KGR	The Robt. Dollar Co., Seattle, Wash.
	KGS	The Robt. Dollar Co., Honolulu, T. H.
	KGX	The Robt. Dollar Co., Los Angeles, Calif.
	WGA	The Robt. Dollar Co., New York City
14890	W1XS	R. A. Fessenden, Newton, Mass.
	KGQ	The Robt. Dollar Co., San Francisco, Calif.
	KGR	The Robt. Dollar Co., Seattle, Wash.
	KGS	The Robt. Dollar Co., Honolulu, T. H.
	KGX	The Robt. Dollar Co., Los Angeles, Calif.
	WGA	The Robt. Dollar Co., N. Y. City
14920	WAZ	R. C. A., New Brunswick, N. J.
	PJN	Paramaribo, Dutch Guiana
14950	CPC	Southern Rdo. Corp., Yacuiba, Bolivia
14991	KGDQ	Yacht "Faith" W. W. Shaw
15000	W1XS	H. A. Fessenden, Newton, Mass.
	CFA, CGA, CJA	Drummondville, P. Q., Can.
	GFR	England
	PJC	Curacao, Dutch West Indies
	UF	Barrios, Guatemala
	VIS	Sydney, NSW, Australia
	XGA	China
15010	WQG	R. C. A., Rocky Point, N. Y.
15035	DIQ	Konigs Wusterhausen, Germany
15100	W8XAV	Westinghouse, Pittsburgh, Pa.
	W2XBW	R. C. A., Bound Brook, N. J.
15130	W2XBW	R. C. A., Bound Brook, N. J.
15190	W2XBW	R. C. A., Bound Brook, N. J.
15200	W2XBW	R. C. A., Bound Brook, N. J.
15250	PCJ	Eindhoven, Netherlands
		Nauen, Germany
15380	UR	T. R. T. Co., Cartago, Costa Rica
15450	KWE	R. C. A., Bolinas, Calif.
15460	KKR	R. C. A., Bolinas, Calif.
	WBF	T. R. T. Co., Boston, Mass.
15490	KEM	R. C. A., Bolinas, Calif.
15500	ZLW	Wellington, N. Z.
15530	UL	T. R. T. Co., Managua, Nicaragua
15550	UL	T. R. T. Co., Managua, Nicaragua
15580		Am. Pub. Com., Garden City, N. Y.
	DFR	Nauen, Germany
15600		Nauen, Germany
15610		Am. Pub. Com., New York City
15640		Am. Pub. Com., Chicago, Ill.
15670		Am. Pub. Com., New York City
15700		Am. Pub. Com., Floral Park, N. Y.
15730		Am. Pub. Com., San Francisco, Calif.
15760		Am. Pub. Com., Boston, Mass.
15780	FWX	Sainte Assise, France
15800		Nauen, Germany
15820	DFN	Nauen, Germany
15850		Am. Pub. Com., San Francisco, Cal.
15880	GZZ	Cleethorpes, England
15881	GZZ	Cleethorpes, England
15890	PLG	Bandoeng, Java
15910		Am. Pub. Com., San Francisco, Calif.
15940	DGJ	Nauen, Germany
15960		Nauen, Germany
15970	WKO	R. C. A., Rocky Point, N. Y.
16000	WKO	R. C. A., Rocky Point, N. Y.
16030	WKW	R. C. A., Rocky Point, N. Y.
16060		U. S. Govt.
16080		U. S. Govt.
16100	KEB	G. E. Co., Oakland, Calif.
16112	KEB	G. E. Co., Oakland, Calif.
16120		U. S. Govt.
16150	VPG	Accra, Gold Coast, W. Africa
16180		Java
		U. S. Govt.
16270	WLO	A. T. & T. Co., Deal Beach, N. J.
16304	PCL	Kootwijk, Netherlands
16320		U. S. Govt.
16340		Loanda, Angola
		U. S. Govt.
16358	DIN	Konigs Wusterhausen, Germany
16380		Manila, P. I.
16393	PJZ	Willemstad, Curacao, D. W. I.
16400	WHD	N. Y. Times, New York City
16540		U. S. Govt.
16620		U. S. Govt.
16660	CKA	Geizers Hill, Halifax, Nova Scotia, Can.
16660	KTA	M. R. T. Co., Guam
	VAA	Ottawa, Ont., Can.
	VE9CH	Geizers Hill, Nova Scotia
16665	DAN	Norddeich, Germany
16670		Riga, Latvia
		Nova Scotia
		Kootwijk, Netherlands
16800	KFK, WFA to WFF	Byrd Expedition
16810	GKT	Portishead, Bristol, England
16850	IDM	Italy
	WSL	M. R. T. Co., Sayville, N. Y.
16900	PJC	Curacao, D. W. I.
16939	KFD	G. E. Co., Denver, Colo.
16940		U. S. Govt.
17000	IR2	Italy
17020		U. S. Govt.
17060		U. S. Govt.
17130	WKI	Federal Tel. Co., Newark, N. J.
17140	XGA	Mukden, China
17180		U. S. Govt.
17200	PJD	St. Martins, Dutch West Indies
		U. S. Govt.
17212	GZQ	Aden Radio, British Somaliland
17240	PLF	Bandoeng, Java
17241	GBO	Oxford, England
17241	LPV	Monte Grande, Argentina
17270	W9XB	L. E. Dutton, Culver, Ind.
17300	W1XAC	C. E. Mfg. Co., Providence, R. I.
	W3XE	Baltimore Radio Show, Baltimore Md.
	W2XBY	W.C.Von Brandt, Jersey City, N.J.
	W6XT	C. L. Watson & R. L. Gray, San Francisco, Calif.
17320	GYU	Gibraltar, Mediterranean
17340		Nauen, Germany
17341	DIM	Konigs Wusterhausen, Germany
17380	LPI	Argentina
17390	GYG	Bermuda Dockyard, Bermuda
17420	KNN	M. R. T. Co., Honolulu, T. H.
17460		U. S. Govt.
	DGR	Nauen, Germany
17480		U. S. Govt.
		Konigs Wusterhausen, Germany
17540	DFB	Nauen, Germany
		U. S. Govt.
17560	CKN	Esquimalt, B. C., Can.
17580	WBF	T. R. T. Co., Boston, Mass.
17636	KFVM	Yacht "Idalia" E. R. Parker
17640	KKC	Fed. Tel. Co., Palo Alto, Calif.
17650	VJZ	Rabaul, New Guinea
	G2BR	England
17660	KNW	M. R. T. Co., Palo Alto, Calif.
17717	KFK, WFA to WFF	Byrd Expedition
17700	DGY	Nauen, Germany
1[illegible]00		M. R. T. Co., Guam
1[illegible]20		U. S. Govt.
1[illegible]40	HSP	Bangkok, Siam
1[illegible]740		U. S. Govt.
1[illegible]741		U. S. Govt.
17[illegible]70	PHH	Huizen, Netherlands
17800	DIL	Konigs Wusterhausen Germany
17836		Kootwijk, Netherlands
1[illegible]840		Konigs Wusterhausen, Germany
		Kootwijk, Netherlands
17860	WOC	R. C. A., Rocky Point, N. Y.
	DIL	Konigs Wusterhausen, Germany
1[illegible]900	WIL	R. C. A., Rocky Point, N. Y.
	W2XAS	R. C. A., Rocky Point, N. Y.
1[illegible]910	WQB	R. C. A., Rocky Point, N. Y.
1[illegible]964	CFA, CGA, CJA	Drummondville, P.Q., Can.
17964	PJZ	Willemstad, Curacao, D. W. I.
17980	KOZ	R. C. A., Bolinas, Calif.
18020	KOJ	R. C. A., Bolinas, Calif.
18040	GBX	Rugby, England
18060	KUN	R. C. A., Bolinas, Calif.
18091	GBK	Bodmin, England
18093	GBK	Bodmin, England
18100		U. S. Govt.
	GBK	Bodmin, England
18107	GBK	Bodmin, England
18109	GBK	Bodmin, England
18140	GBW	Rugby, England
		Recife, Pernambuco, Brazil
18169	CFA, CGA, CJA	Drummondville, P. Q., Can.
18240		Nauen, Germany
18260	KNW	M. R. T. Co., Palo Alto, Calif.
		Sgravenhage, Netherlands
18282		Sgravenhage, Netherlands
18290	W6XN	G. E. Co., Oakland, Calif.
18310	GBS	Rugby, England
18315	GBS	Rugby, England
18340	WND	A. T. & T. Co., Deal Beach, N. J.
18360	CPC	Southern Rdo. Corp., Yacuiba, Bolivia
18400	PCK	Kootwijk, Netherlands
18420	VWZ	Kirkee, near Poona, India
18462	PJZ	Willemstad, Curacao, D. W. I.
18491	GBI	Grimsby, England
18500	GBI	Grimsby, England
18507	GBI	Grimsby, England
18509	GBI	Grimsby, England
18540	W2XT	R. C. A., Rocky Point, N. Y.
18571	GBJ	Bodmin, England
18573	GBJ	Bodmin, England
18580	GBJ	Bodmin, England
18587	GBJ	Bodmin, England
18589	GBJ	Bodmin, England
18600	JAN	Tokyo, Japan
18622	GBU	Rugby, England
18660	ZSB	Klipheuvel, Cape of Good Hope
18700	DIK	Konigs Wusterhausen, Germany
18700	VTC	Basrah, Iraq
18700	XGA	China
18740		Kootwijk, Netherlands
18750	JYZ	Tokyo, Japan
18780		M. R. T. Co., Palo Alto, Calif.
18790	CFH	Halifax, Nova Scotia
18800	CFH	Halifax, Nova Scotia, Can.
		Nauen, Germany
		Konigs Wusterhausen, Germany
18820	KGQ	Robt. Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
18900	WDS	R. C. A., Rocky Point, N. Y.
18916	DIK	Konigs Wusterhausen, Germany
18940	WTT	R. C. A., Rocky Point, N. Y.
18960	GBO	Rugby, England
18980	WEX	R. C. A., Rocky Point, N. Y.
		London, England
19020	KQH	R. C. A., Kahuku, T. H.
19050	GLS	Ongar, England
19060	GLG	Dorchester, England
19060	PLE	Bandoeng, Java
19091	GLW	Dorchester, England
19093	GLW	Dorchester, England
19100	GLW	Dorchester, England
19107	GLW	Dorchester, England
19109	GLW	Dorchester, England
19220	WNC	A. T. & T. Co., Ocean Township, N. J.
19300		Nauen, Germany
19310	SUC, SUW, SUX, SUY, SUZ	Abu Zabal, Cairo, Egypt
19390	LP4	Monte Grande, Argentina
19400		Konigs Wusterhausen, Germany
19443	DIJ	Konigs Wusterhausen, Germany
19460	DFM	Nauen, Germany
19500	PL3	Monte Grande, Argentina
19540		M. R. T. Co., Palo Alto, Calif.
	DFQ	Nauen, Germany
19580	GZP	Matara, Ceylon
19580		M. R. T. Co., Sayville, N. Y.
19600	LP3	Monte Grande, Argentina
19620		M. R. T. Co., Sayville, N. Y.
		Rdo. Corp. of America
	DFA	Nauen, Germany
19640	GBO	Oxford, England
19660	SUY	Abu Zabal, Cairo, Egypt
19680		Nauen, Germany
19680	GLX	Dorchester, England
19700	DFJ	Nauen, Germany
		Rdo. Corp. of America

(Continued on Page 82)





Further Constructional Details *of the* *Spangenberg* 200 WATT

Parts List for Crystal Oscillator Panel

1 3,500 kc. crystal and holder (1)
1 complete frame (2)
2 UX tube sockets (3)
1 Cardwell .00035 mfd. condenser and dial with coil attached (15 turns) (4)
1 0 to 100 milliammeter (5)
1 0 to 2 Weston thermo-couple r.f. meter (6)
1 Todd type T80-275 power transformers, 350 volts (with filament supply for UX280) (7)
1 Todd type F-7.5 filament transformer, 7½ volts (8)
2 Flechthem 6 mfd. filter condenser (600 volts) (9)
2 10-henry chokes (10)
1 15-ohm fixed rheostat for filament transformer (11)
2 General Radio 8-henry chokes (12)
3 Sangamo .002 mfd. condensers (13)
1 UX210 tube (14)
1 UX280 rectifying tube (15)

Parts List for Frequency Doublers

1 complete frame (1)
1 Cardwell .00035 mfd. condenser and dial with coil attached (10 turns) (2)
1 Cardwell .00025 mfd. double spaced condenser and dial with coil attached (5½ turns) (3)
1 UX tube socket (4)
1 RCA tube socket and mounting for UX203A (5)
1 Sangamo .002 mfd. condenser (6)
3 Sangamo .002 mfd. condenser (5,000-volt test) (7)
1 Jewell a.c. voltmeter, 0-15 volts (8)
1 Jewell milliammeter, 0-200 mils (9)
1 r.f. choke, ½" diameter, 400 turns No. 28 d.c.c. wire (10)
1 r.f. choke, 1" diameter, 350 turns No. 30 d.c.c. wire (11)
1 Ward Leonard vitrohm resistor, 10,000 ohm, type 507-8 (12)
1 key relay shunted with a 5,000-ohm resistor in series with ½ mfd. (1,80 volts) condenser (13)
1 UX210 tube (14)
1 UX203A tube (15)
1 high-voltage condenser, .002 mfd. (16)
2 200-volt condensers, .002 mfd. (17)
1 Faradon high-voltage condenser, .002 mfd. (18)
1 r.f. choke, 1¼" diameter, 300 turns No. 28 d.c.c. wire (18)

IN this article we take up the construction details of two of the sections of the Spangenberg 200-watt short-wave transmitter, the Ham Set DeLuxe, described on pages 20 and 21 of this manual.

On those pages the photographs showed quitely plainly the general scheme which was employed in assembling into a complete whole the four units which comprised the transmitter.

The illustrations accompanying show the layout employed in the crystal oscillator and the frequency doubler, the first two units to be described separately.

Above, to the left, is shown the underside view of the crystal controlled oscillator panel, while directly to its right is shown the constructional and assembly details of the top side of this unit.

Second from the right is shown the underside of the frequency doubler unit. The placement and layout of the various parts which comprise this unit are clearly indicated.

The photograph to its right shows the top view of the frequency doubler as seen from the back.

Each of the parts in both units is numbered to conform with the numbered part in the parts list. Also, the circuit diagram, shown at the right, is similarly numbered so as to indicate the position and use of the part in the circuit.

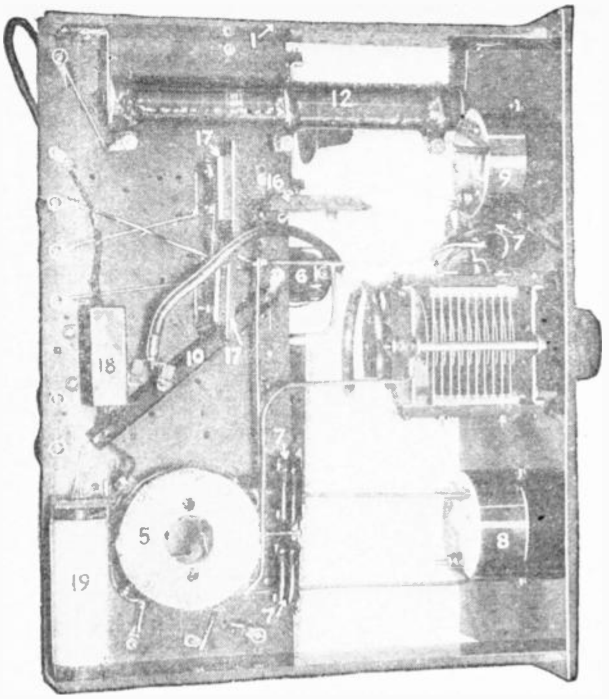
With the aid of the photographs, which indicate the general layout and mode of assembly and the numbered parts which in addition have their respective values noted also, it should prove comparatively simple to prepare, assemble and wire the parts into a complete whole.

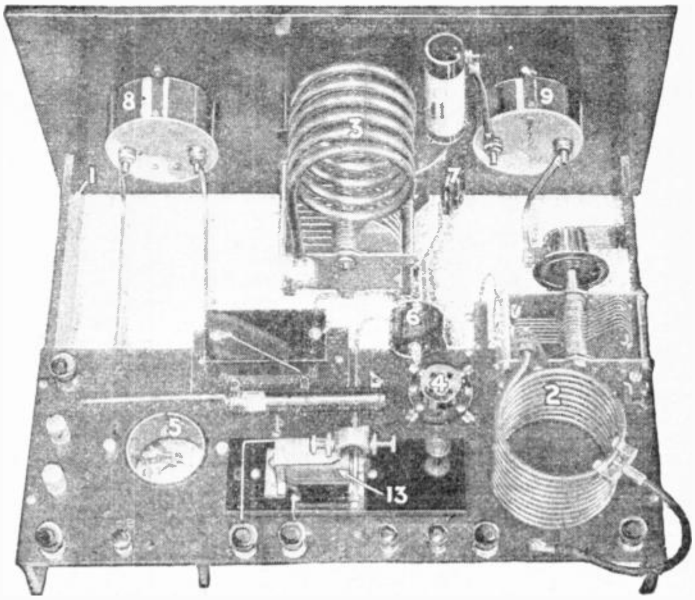
In a following issue will be presented photographically the layout of the power amplifier unit, the assembly of the transmitter as a whole, and the general information concerning its construction.

This 200-watt crystal controlled station has been on the air for six months and is widely known for its steady, clear signal.

With it Mr. Spangenberg has contacted amateurs in most every part of the globe, particularly New Zealand, South Africa, India and many points in Europe.

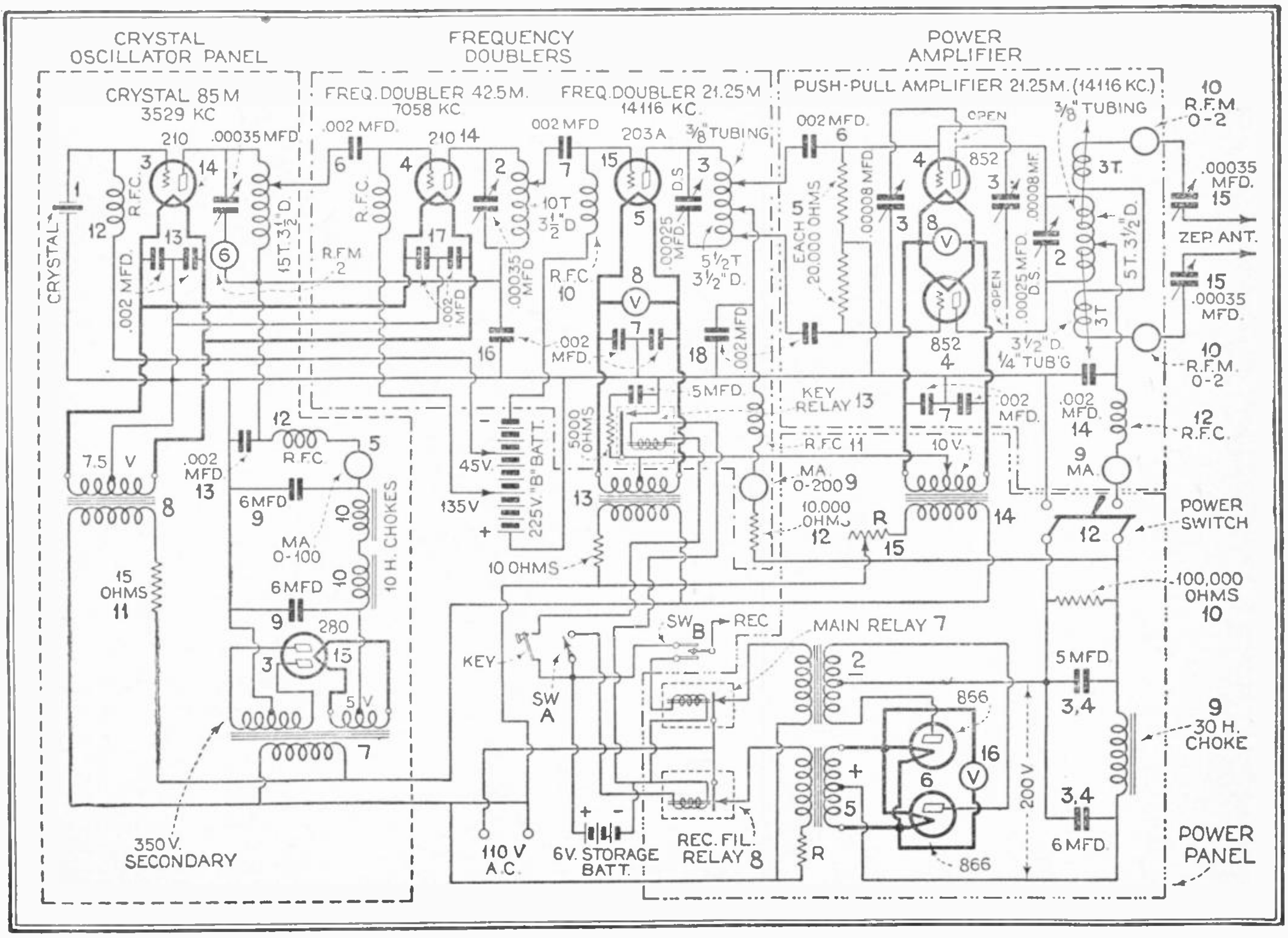
The transmitter is operated under the call letters W2MB.

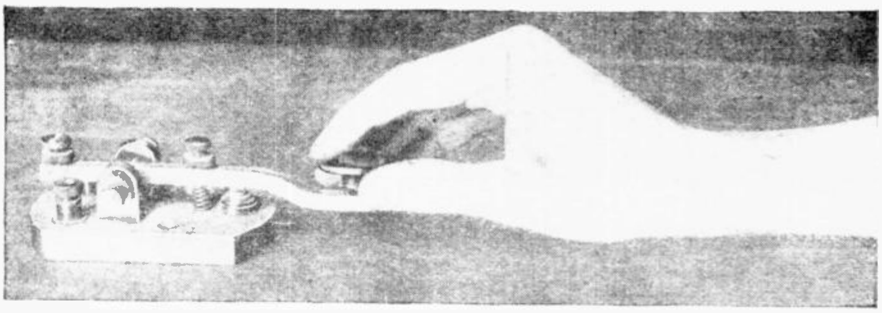




In Pictures and Diagram

SHORT WAVE TRANSMITTER





Breaking into Amateur Transmitting

By Lieut. William H. Wenstrom, U. S. A.

ON page 34 we traced at some length the absorbing story of Amateur Radio; we now consider some of the practical problems which confront an entrant into the transmitting fraternity. First of all, let us forget any lingering hostility which we may feel towards code—the dot and dash signals of radio telegraph stations. Once fairly learned, code is not at all the stupid, meaningless collection of symbols that it appears to outsiders. Ruling out machine and "bug" sending, an unbelievable amount of personality trickles through the sending of an individual, however measured he may strive to make it. We can easily classify experts and dubs—can even recognize quickly an operator with whom we have talked before. No two humans are exactly alike, and tricks of spacing and tempo mark an individual as surely as his manner of parting his hair. Strange as it may seem, it is almost as hard to keep the emotions out of code as out of the voice; timidity and anger both have their dot-dash rhythms.

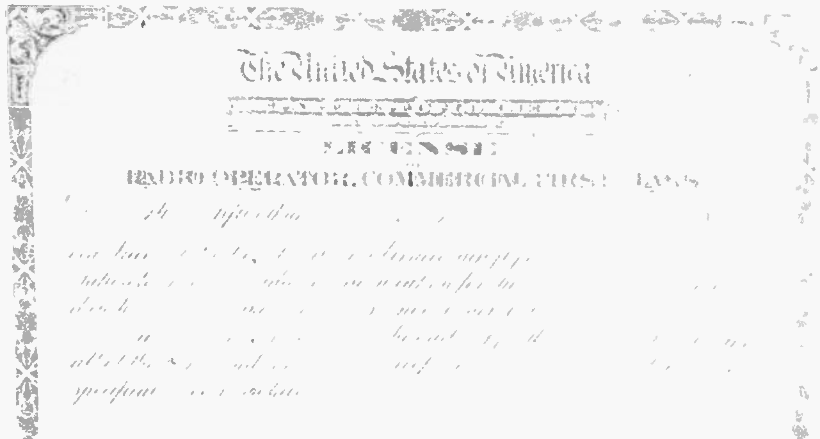
Manners and consideration for others, or the lack of them, are as evident on the air as they are on the road. We have all blessed the driver who put out his hand a few seconds before he turned, or realized our momentum along a highway well enough to refrain from crawling out of a side street directly in front of us. And we have all cursed the man who turned directly in front of us with little if any warning, or passed us in a burst of speed only to slow down immediately. The latter individual's counterpart on the air is characterized by a sputtering, wobbly note, too-rapid and unintelligible sending, and scarcely anything to say except "hows mi sigs? rpt my sig strength—pse send card—cul gb." When we come back with "hr msg air transport emergency," he greets us with a profound silence only to be broken by a sputtering "cq" for somebody else. But this type is fortunately a very small minority—else all cars would be wrecked and all transmitters gathering cobwebs. By means of abbreviations two good operators can talk in code almost as fast as they could by telephone. The system is a sort of homemade shorthand wherein unnecessary letters, particularly vowels, are omitted. Weather is wx, press is px, repeat is rpt, thanks is tnx or tks, your is ur, very is vy, please is pse; and so on, ad libitum.

Another distinctive pleasure of transmitting is that two-way communication requires far more skill than receiving. When skill entails work, distasteful to many of us, this statement may seem rather paradoxical; nevertheless, it is a fact, amply proved by observation. The devotees of chess would scarely consider checkers; a hunting horseman has no taste for ambling through the park on a tame nag; good sailormen would be bored to death on a motorboat. The transmitting operator has not only his receiver to think of; the transmitter must be turned on and adjusted for frequency, output, efficiency and steadiness. The wily distant station must be sought among the channels like an elusive deer in the forest, and when it is found, no hunter's trigger finger could be more smoothly certain than the hand that throws the switches and taps the key.

Another advantage of transmitting is greater control over the phenomena, to borrow a phrase from the laboratory. Reception is likely to degenerate at times into a sort of watchful waiting, but the owner of a transmitter can always start something. A well-remembered incident at W2CX occurred during the ill-fated Atlantic flight of Nungesser and Coli. W2CX hopped into the well filled 40 meter conversational puddle with a long CQ and "Any news of Atlantic fliers?" This innocent inquiry was apparently interpreted as a statement preceding the broadcast of important news, for immediately half the stations in New York and New England were heard frantically calling W2CX.

Then, too, phone receiving is somewhat limited in its scope, for broadcast transmitters have a tendency to congregate around the large cities of the world. They seldom go to sea, or essay the air, or take themselves off into remote jungles. But the amateur and experimental code sta-

The Department of Commerce of the U. S. Government issues to all who satisfactorily pass the required tests a license similar to Lieut. Wenstrom's, shown here



The United States of America

LICENSE

RADIO OPERATOR, COMMERCIAL FIRST CLASS

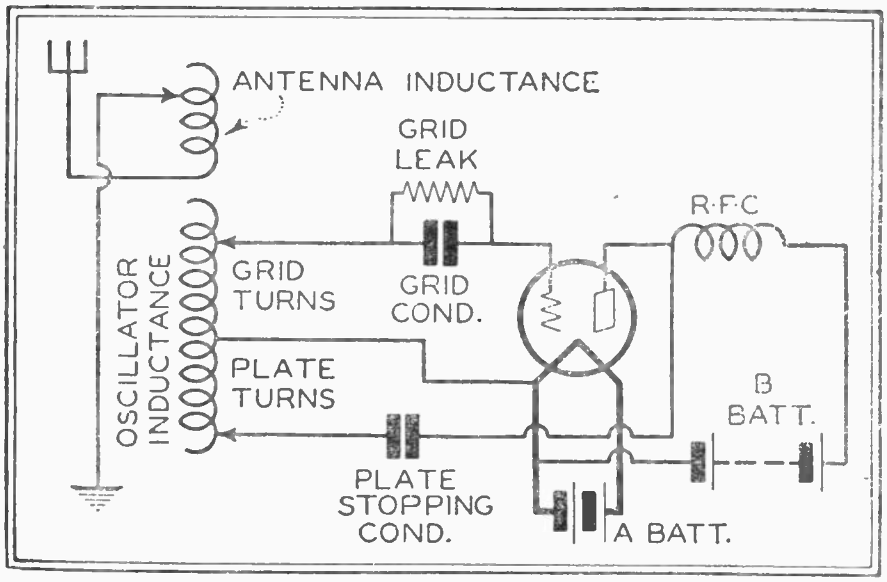


Fig. 1. One requirement of the Government test is to draw the circuit diagram of the transmitter you intend to use

tions are everywhere. Another W2CX red letter occasion was an evening chat with a courteous Englishman up in Cameroons, French Equatorial Africa. It consisted mostly of questions from New York and answers from Cameroons. "Are you on the coast or up in the jungle?—about 100 miles from coast. Is it pretty hot there?—very warm all year round. Are there any lions around there?—lots of game here, both big and small." If the answer had been "there is a big lion looking in the window and roaring now," we would probably have believed it.

Atlantic flights and roaring lions are all very well in their way, but let us get down to business. Several weeks at least before he starts actual transmitting the new operator should have completed the installation of a short wave receiver, both for code practice and for familiarity with the various amateur bands. Just what kind of receiver this is does not particularly matter, so long as it meets certain fundamental requirements. . The first of these is ability to go smoothly in- to and out of oscillation at any frequency within the receiver's range. (A grid biasing potentiometer, as used in the Portable Receiver described on pages 13, 14 and 15, is useful here.) Secondly, the amateur band corresponding to any particular coil should be well spread out along the center of the tuning dial. The extreme fulfillment of this requirement is the "traffic tuner" which spreads a single amateur band over the whole dial. Somewhat the same delicacy of tuning with better all around coverage may be gained by connecting a midget condenser (cut down to one stator and one rotor) in parallel with the regular tuning condenser of about 140 m. m. f., as shown in Fig. 1. Another requirement is the ability to change wave-bands quickly, and still another is some form of arm rest for tuning, as shown in the photograph. Distant high frequency stations cannot be snapped in with the casual dial twist that does for broadcast tuning.

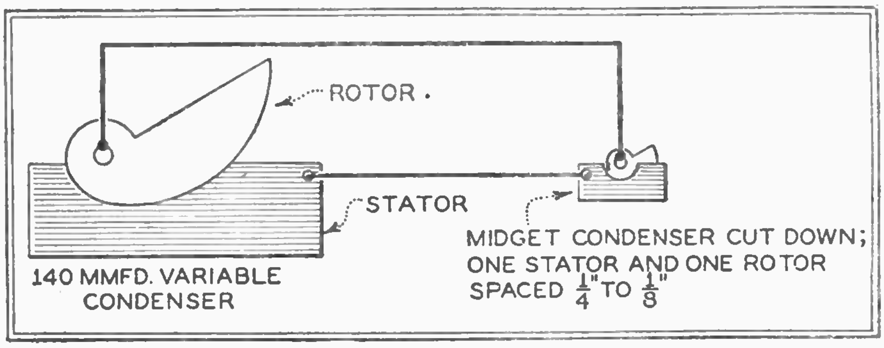


Fig. 2. To obtain a high degree of fine or vernier tuning action, a small condenser may be shunted across the main tuning capacity

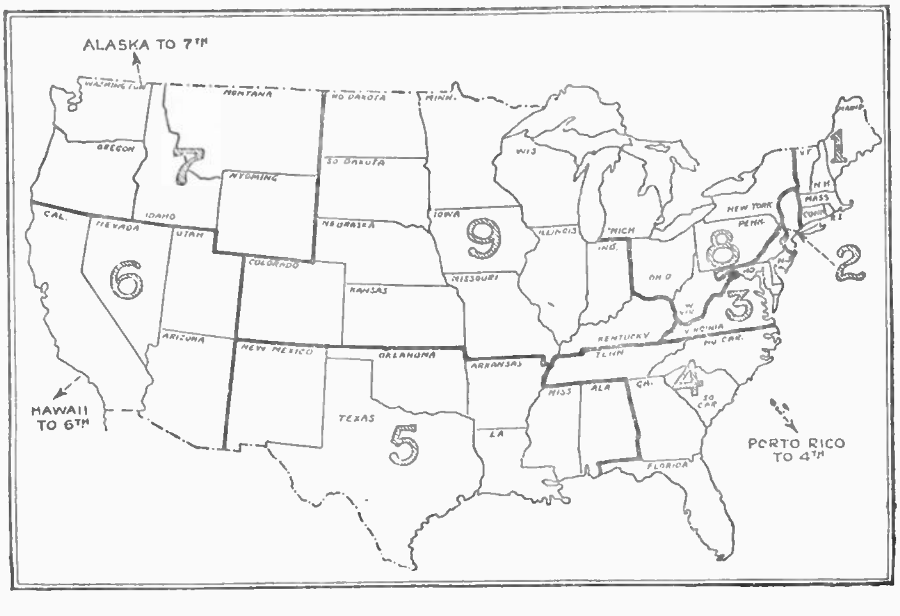
Most recent short wave receivers employ a screen-grid radio frequency amplifier tube, and this is satisfactory for rapid two way work (though scarcely necessary with a long outdoor antenna) if no extra tuning controls are added. For searching a band quickly the receiver must be strictly single control (have only one tuned circuit). This does not include the oscillation control, which requires only occasional adjustment.

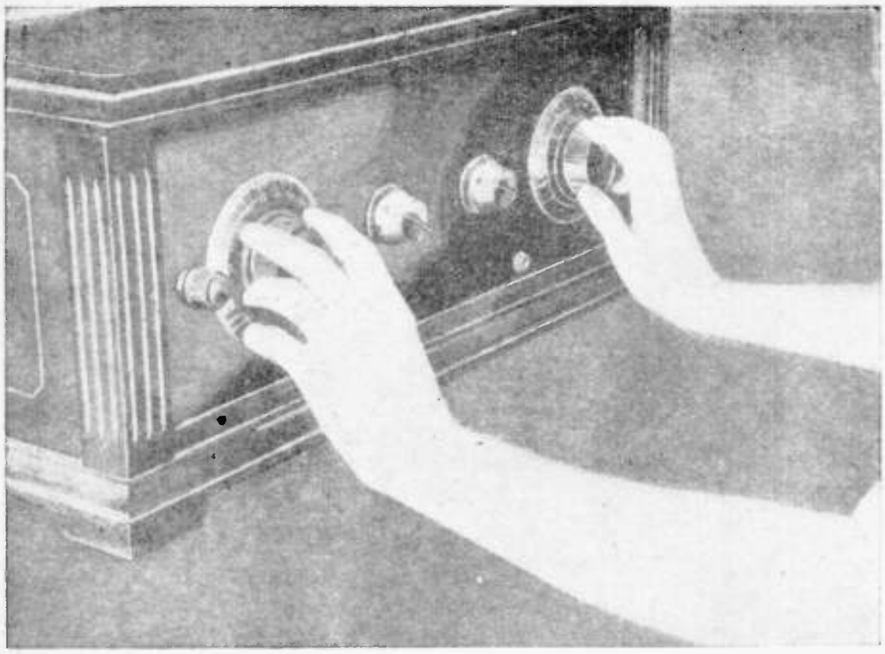
There are now so many good short wave receivers available that anyone may easily buy or build one. The four commercials—Silver-Marshall, National, Pilot, and Aero—are well designed and dependable. Then there is Samuel Egert's "S-W Four" described in the August issue, of which the detector unit and one audio stage would do very well for amateur work. A general discussion of 1929 amateur receiving requirements appeared in QST for November, 1928. For anyone who wants the utmost simplicity and ease of construction combined with creditable performance, the writer's "Cornet Receiver" described in Radio Broadcast for April, 1928, should prove useful. This set is still in use at W2CX, for nothing in the way of all-around code and phone performance by any newer design has inclined us to discard it.

Code Practice

The greatest bugbear in the way of becoming an operator is undoubtedly mastering the code. There is no absolutely

Fig. 3. The United States is divided into nine districts, as shown, to facilitate control and regulation of amateur transmitting activities





A firm, substantial rest for the forearms is an absolute necessity for distance tuning

painless way of learning it, or of doing anything else which requires mental effort and concentration. But the process will be easier if two cardinal principles are borne in mind. First, learn each letter as a single unit of sound, rather than as an aggregation of dots and dashes; second, do not hesitate over missed letters but go on to the next. It is much simpler, for example, to write "x" instantly when we hear a "Dah-dit-dit-dah" sound, than to think "dah-dit-dit-dah—let's see, that's dash-dot-dot-dash, and as I remember it, x looked about like that." Therefore eliminate any visual images of "x," such as —··—; the jump from ear to fingers is naturally much quicker than dragging in the visual part of the brain as well. Until you can write down each letter reasonably soon after the sound is heard, it is advisable to have someone send slowly to you on a buzzer, or to use a teleplex or omnigraph. After your speed begins to pick up a little, the short wave receiver offers a more varied and interesting field for practice. It is usually possible to find in one of the bands an amateur sending at a speed you can copy, and sometimes the highpower commercials are slowed down as low as ten words a minute under poor transmission conditions. Along with reception it is well to practice keying. As shown in the photo-

(*Continued on page 89*)

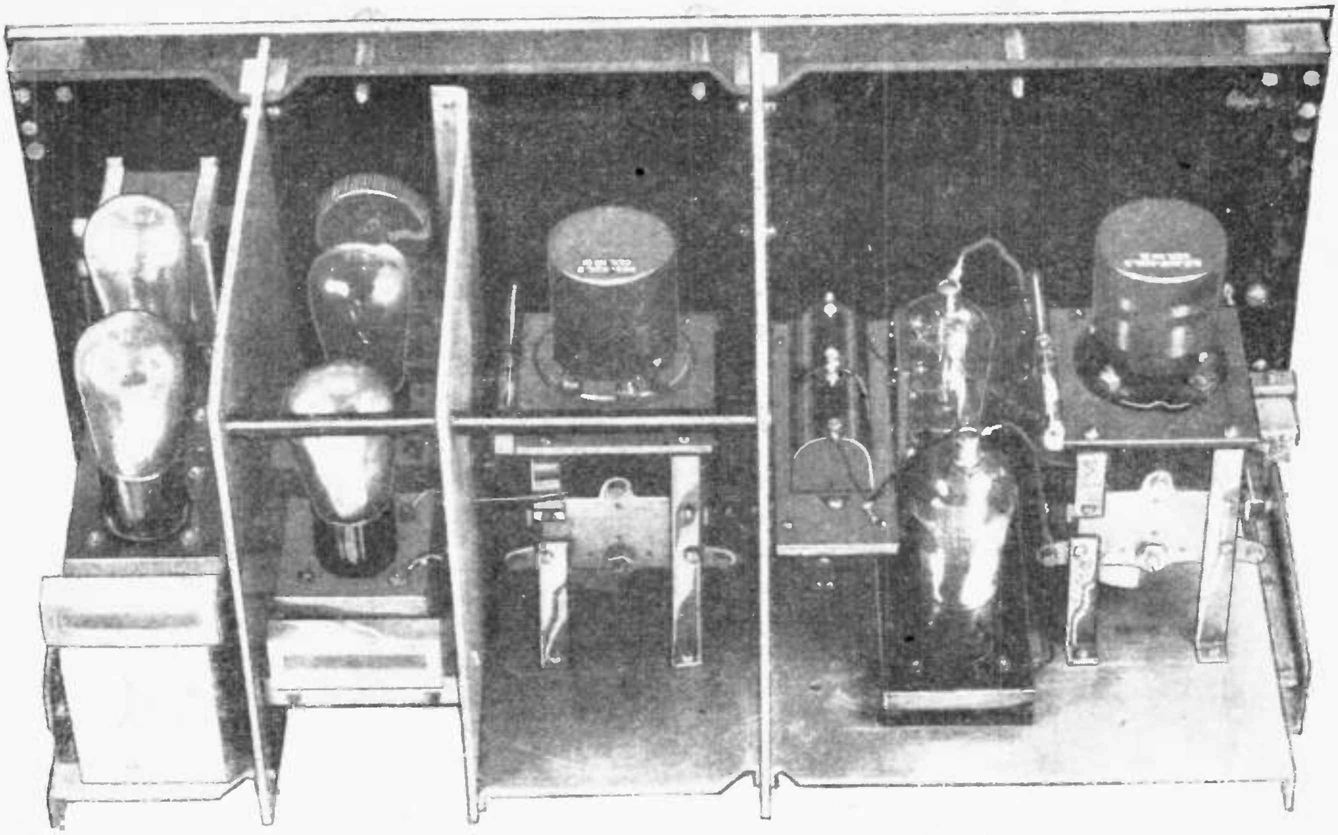
THE GENERAL SERVICE CODE

A dit dah
B dah dit dit dit
C dah dit dah dit
E dit
F dit dit dah dit
G dah dah dit
H dit dit dit dit
I dit dit
J dit dah dah dah
K dah dit dah
L dit dah dit dit
M dah dah
N dah dit
O dah dah dah
P dit dah dah dit
Q dah dah dit dah
R dit dah dit
S dit dit dit
T dah
U dit dit dah
V dit dit dit dah
W dit dah dah
X dah dit dit dah
Y dah dit dah dah
Z dah dah dit dit
1 dit dah dah dah dah
2 dit dit dah dah dah
3 dit dit dit dah dah
4 dit dit dit dit dah
5 dit dit dit dit dit
6 dah dit dit dit dit
7 dah dah dit dit dit
8 dah dah dah dit dit
9 dah dah dah dah dit

Time or duration relations:
dah is three times as long as dit
intra-letter space same length as dit
inter-letter space same length as dah
inter-word space two or three times as long as dah

Your station license, when issued, will authorize you to begin your transmitting career


UNITED STATES OF AMERICA
FEDERAL RADIO COMMISSION
AMATEUR RADIO STATION LICENSE



A rear view of the assembled receiver used in Mr. Marshall's tests

Some Experiments on Ultra-High Frequencies

By THOMAS A. MARSHALL

BACK in 1925, when 12 meters or thereabouts was considered the shortest wavelength on which transmission of signals could be obtained, a radio theory was advanced, perhaps as a relief to those who had ambitions to talk to Mars and other heavenly bodies, that since the waves shorter than 12 meters could not possibly be used successfully over the earth, they could be used for interplanetary communications. This supposition was offered as it appeared that these short waves would be capable of piercing our atmosphere as well as that of other planets. It was also believed that the course of the interplanetary wave on leaving the earth would be strongly influenced by the electrons coming from the sun and would be diverted directly toward the sun, where it would reach an electron density of more than 100,000 per cubic centimeter, which would cause total reflection. The wave might then be reflected toward Mars or other planets. Many prominent scientists, however, did not agree with this theory, and believed that satisfactory transmission could be obtained on these ultra-short wavelengths. They said "Time will tell."

TO the many experimenters who have been delving into the mysteries and behavior of transmission and reception on the extremely short wavelengths Mr. Marshall's observations as outlined here will be of distinct interest.

Mr. Marshall, formerly connected with the U. S. Naval Research Laboratory at Bellevue, D. C., and recently with the U. S. Battle Fleet in southern waters, has over a period of nine months made the observations which form the basis for the article presented herewith. His work in this field has undoubtedly provided him with much authoritative information and we are pleased to present to our readers his theories, together with a description of the receiver he used in his work.

From personal observations, it appears that time *has* told. The writer has just completed a long series of observations concerning actual reception at fundamental and second harmonic frequencies of signals being transmitted by a host of stations now operating on short wavelengths, the results of which seem to indicate that it is entirely practicable to utilize the band of 13 to 7.5 meters for transmission purposes on our own planet. By the use of his own type of receiver, he has received excellent signals from Washington, D. C., on wavelengths as low as 7.5 meters, at a distance of 2,000 miles.

The dotted line in Fig. 1 shows the skip distance effect as expounded by Dr. Hulbert in one of his lectures. It would indicate that a wavelength of 15 meters jumps over the earth approximately 1,400 miles and that a 10-meter wave is totally reflected. The heavy line indicates the skip distance as observed by the writer, as compared with that obtained by Dr. Hulbert in his investigations along these lines.

The data for extending Dr. Hulbert's curve were obtained by observations made over a period of nine months. There appears to be no longer any doubt that there does exist another favorable series of wavelengths below 13 meters, suitable and adaptable for long-distance signalling. From 6,600 to 23,000 kilocycles, which is the present band in use, there is a band 16,400 kilocycles. From observations made, it appears that this band may be increased from 23,000 kilocycles to 40,000 kilocycles, which is 17,000 kilocycles in width, thus doubling the width of the high-frequency band.

Since the absorption of extremely short wavelengths is negligible in the Kennelly-Heaviside layer, and the skip distance is long, as shown in Fig. 1, strong signals should be received from stations located at great distances. The line (A) in Fig. 2 shows the possible angle of radiation from a certain type of antenna adjusted to 25 meters. The primary skip distance depends entirely on the angle of radiation and the height of the Kennelly-Heaviside layer. It is possible, by employing plane antennæ and reflectors, to concentrate the antenna radiation at an angle most advantageous for reception at a given distance. For extreme distances it would be possible to control the radiation angle to increase the skip distance, and thus increase the signal strength from three to four times at the receiving station. The line B shows how the radiation angle may be changed so as to reach point D on the earth. Note that the 40° angle would give strong signals at C and diminish in strength toward D. Radiation angle B would skip over position C and produce strong signals at position D.

The conventional type of receiving circuit as developed in the past has been incapable of giving high amplification in the short-wave bands due to the relatively low input impedance of the circuit and to the low L C ratio. The low impedance is due to the relatively high grid-to-filament capacity. This may be further explained as follows: this type of circuit, due to the high inter-electrode capacity, reduces the number of grid and plate turns of inductance for a given wavelength. The high inter-electrode capacity also limits the number of turns for feedback purposes, causing the circuit to be a poor oscillator.

The receiver circuit shown diagrammatically in Fig. 3 has many advantages over the single-circuit receiver in that it is especially suitable and adaptable for reception of wavelengths down as low as 3 meters. This type of receiver functions on push-pull principles in the radio-frequency stage and detector stage, making it possible to obtain very stable oscillations over the entire range. In fact, the receiver oscillates and performs as well at 5 meters as at 50 meters. In this circuit, the inter-electrode tube capacities are reduced: first, by use of the four-element tube which, in effect, tends to reduce the effective grid-to-plate capacity, which is effective on the input grid circuit; second, by using two split condensers having two halves which are in series across the inductance system; third, by connecting the two tubes so that each grid-to-filament capacity is across one of the series sections. Thus, the effective tube capacity upon the tuned circuit is halved, which in turn permits a higher L C ratio for the short wavelengths and reduces the grid conductance, thereby increasing the amplification manyfold. Due to the foregoing reasons, the circuit permits more turns of inductance for the plate and grid circuits at a given wavelength. The increased number of turns increases the input impedance, which increases the signal voltage, thus increasing the signal strength. Another feature in providing a greater number of turns in both grid and plate circuits is the increased feedback properties which are so desirable on short wavelengths in order to obtain stable oscillations.

Another commendable feature in the push-pull radio-frequency amplifier is the perfect neutralization of feedback conditions within the tubes. This is accomplished by connecting the tubes so as to balance each other, thus providing a perfect balance regardless of the wavelength. It is not possible to accomplish a perfect balance on all bands in a single-tube circuit. A slight feedback in a radio-frequency amplifier is desirable in order to overcome circuit resistance and increase selectivity. It will be noted that it is possible to accomplish this feature in the circuit as shown in Fig. 3. The radio-frequency stage should be balanced to a certain degree so as to reduce interaction with the detector circuit which means no detuning effect taking place when the radio-frequency stage is tuned to resonance with the detector circuit.

The detector circuit also has another distinct advantage over the conventional single-tube circuit for voice reception of about two to one, resulting from a change in plate current from two tubes instead of one, with a given impulse.

The push-pull circuit as shown in Fig. 3 has perfect electrical symmetry of the input circuit, which is so essential for loop reception. In a single-tube circuit, one side of the loop is connected to the grid while the other side is connected to the filament which is common to all the battery circuits, resulting in a very high

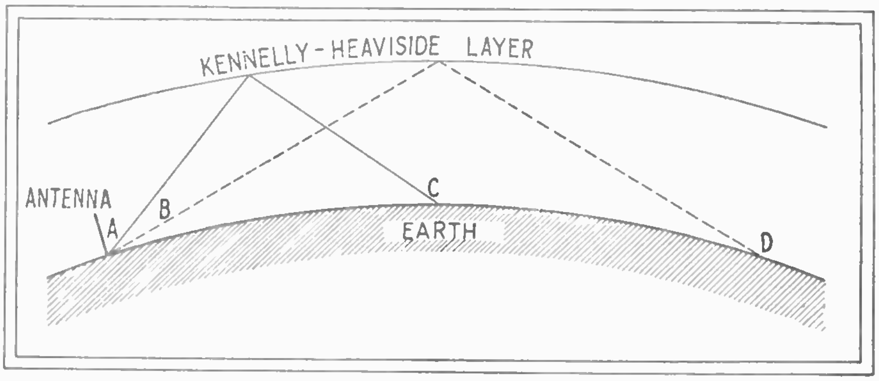


Fig. 2—Illustrating the "skip-distance" effect, as explained in the text

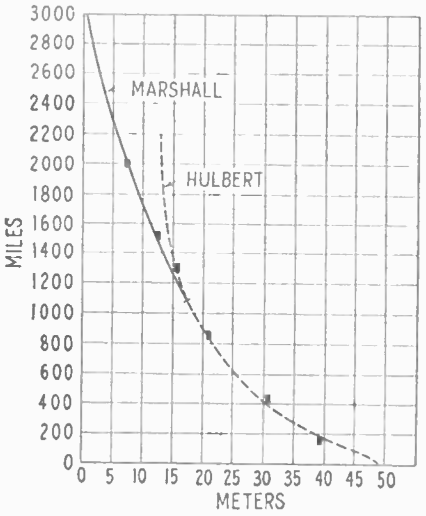
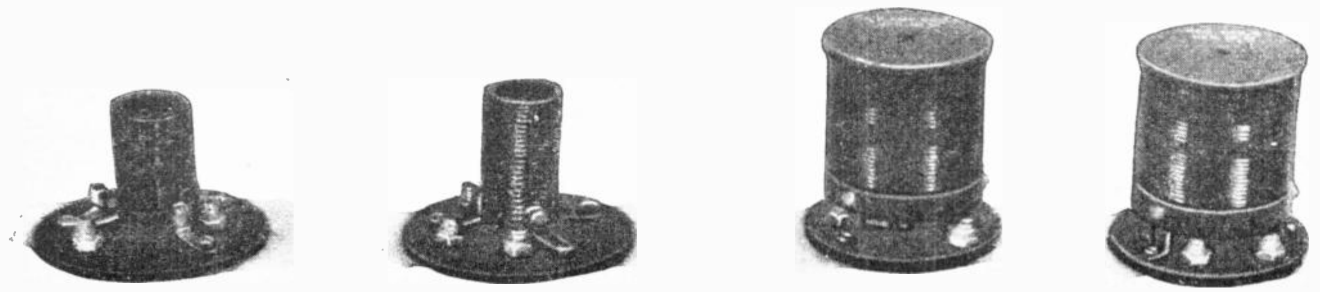
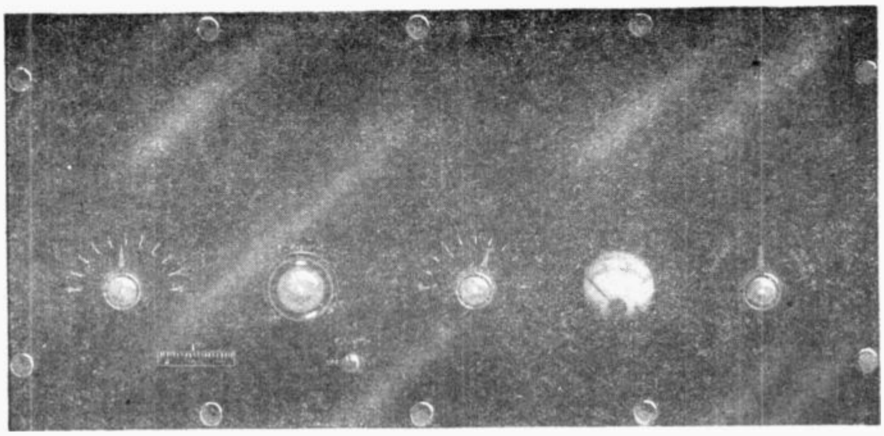


Fig. 1—A comparison of the wave bands previously accepted as the lowest practicable for radio communication, with those on which these experiments were carried out

Plug-in coils used by the author





A panel view of the completed receiver

ground capacity. This causes dissymmetry in the electrical properties of the loop system. The unbalanced condition of such a loop system brings about a certain degree of antenna effect, causing the zone of silence or minimum signal not to be present while rotating the loop. In order to minimize interference, it is essential that the loop have zero minimum signal.

Taking up in detail a description of the circuit shown schematically in Fig. 3, L and L1 are wound on a bakelite form and have fixed relationship to one another. C and C6 are Cardwell .00025 mfd. variable condensers having the stators split; which is accomplished by cutting the bus bar connections at the center. C1, C2, C7 and VS are .0001 mfd. condensers.

C10 and C11 are plates ½ inch in diameter and are arranged so as to be variable in capacity. These condensers should be permanently secured between the tubes and have the top plates soldered to a brass screw which may be turned by using a wooden screwdriver while making final adjustments. C3 is a 1 mfd. condenser. R1 and R2 are 1 megohm grid leaks. R3 is a 100-ohm variable rheostat.

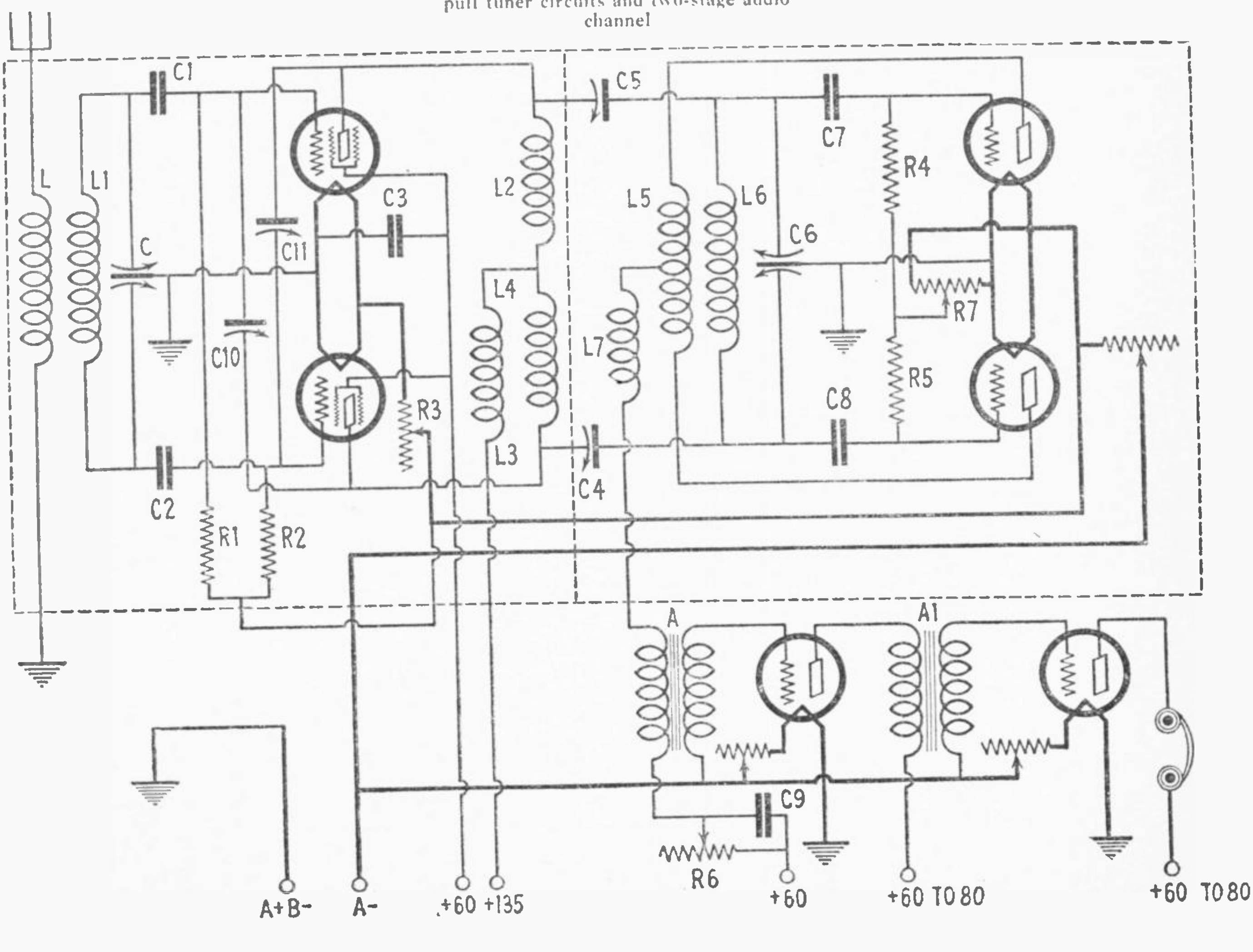
L2 and L3 are secured to the inside of the shield and are mounted horizontally about 3½ inches from coils L and L1. L4 is mounted vertically and directly underneath the junction of L2 and L3. C4 and C5 are 30 mmfds. each. L5 is the tickler coil and is coupled to L6. Both coils are wound on a bakelite form with fixed relationship to one another. L2, L3, L4 and L7 are Sampson 250 millihenry radio-frequency choke coils. R4 and R5 are ½ megohm grid leaks R7 is a 400-ohm potentiometer. R6 is a 100,000-ohm variable resistor. C9 is a 2 mfd. condenser. A and A1 are 5:1 ratio audio transformers.

The shields are made of 3/16-inch aluminum in order to reduce microphonic noise. The tubes and coils should be arranged symmetrically as shown in the diagram. All battery leads should extend directly through the aluminum subpanel. The audio stages should be shielded from the other circuits, as shown.

After the circuit has been placed in commission, the radio frequency stage should be detuned and the detector stage set into oscillations by varying R6, which should be set at a point where the detector circuit is just barely oscillating. R7 should be adjusted until the detector will go in and out of oscillation without "hangover" effect. This will be observed by varying R6, which controls regeneration in the detector circuit. The radio-frequency stage should be brought near

(*Continued on page* 94)

Fig. 3
Circuit diagram, showing the push-pull tuner circuits and two-stage audio channel

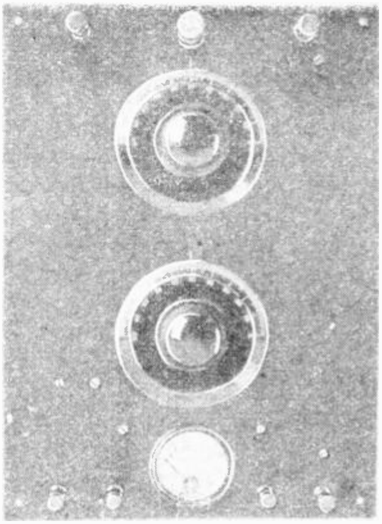


A Short Wave Transmitter

that fits the

Average Home and Purse

By Lieut. William H. Wenstrom



Front of transmitter panel. For neatness and compactness all parts are mounted directly on a 10 by 14 bakelite panel

ON pages 46 and 47 we touched on the elementary knowledge required of a transmitting operator; in this article we survey a more specific problem—the design and construction of a short-wave transmitter that will fit into the average home. Too often has enthusiasm for radio and electricity blossomed forth in a rambling and apparently endless maze of wiring, fascinating perhaps to the enthusiast when he can remember in more lucid moments which wire goes where, but decidedly inconvenient for those who happen to share the same house. Loose wires running more or less at random with occasional sparks, short circuits and other fireworks; oddly assorted pieces of radio apparatus crowding over tables and shelves until they do battle for space with the very necessaries of existence; chemical rectifiers crouching in dark corners ready on the slightest provocation to sputter electrolyte over nearby rugs—these sights have turned away many potential transmitting operators, to say nothing of innumerable fathers and wives whose vetoes were final. Needless to say, in this year of grace, these things are not necessary in transmitting, any more than they are in receiving. It is possible to arrange the apparatus so that it intrudes very little on the other interests of life. But before we consider placement, let us come to some decisions as to what the equipment itself will be.

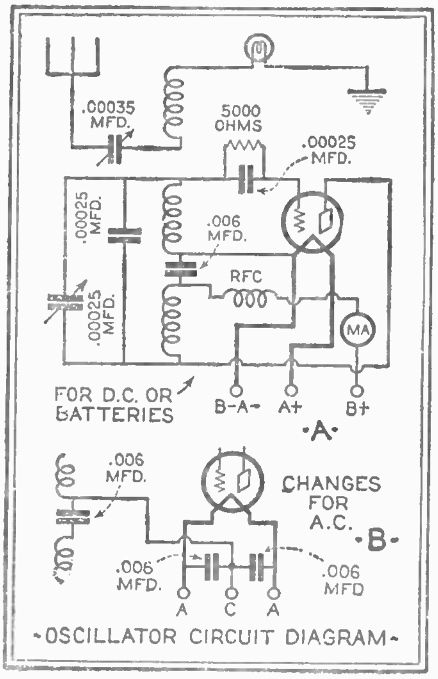


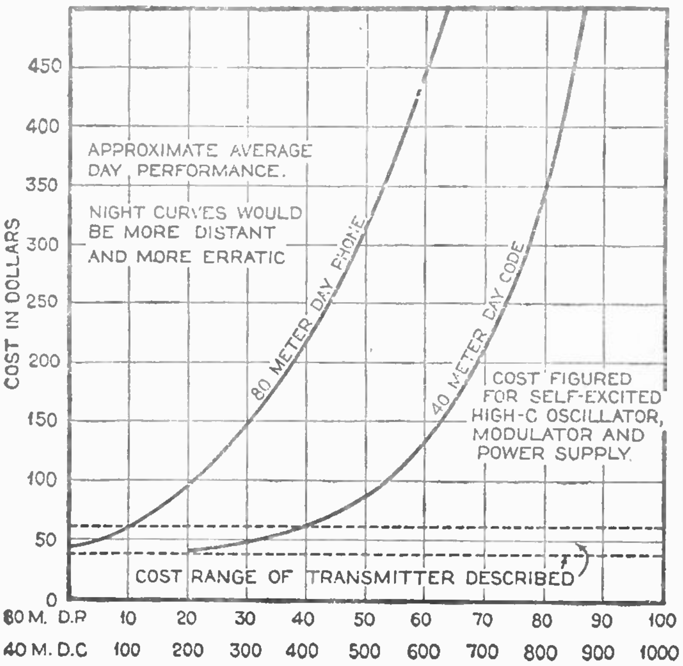
Fig. 2

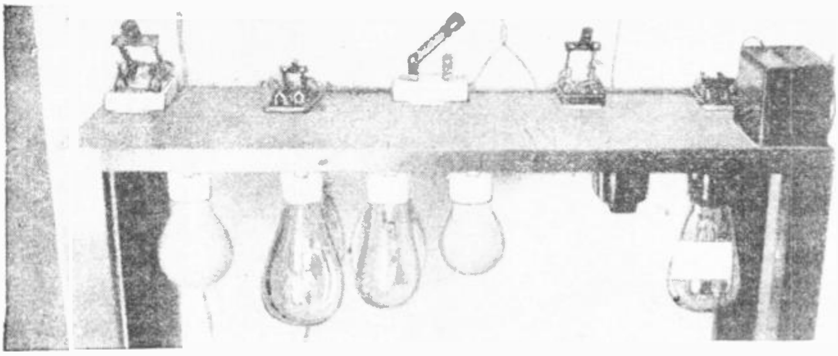
General Design

The first question is quite properly one of cost. A man buying an automobile does not take demonstrations indiscriminately in Fords and Cadillacs; he usually has a fairly definite idea of the amount he can invest and the results he expects in return. It might be well to approach radio transmitting with something of the same level-headed attitude. The curves in Fig. 1 give a fair average idea of the performance to be expected from various investments in transmitting apparatus, assuming the same general design in each case and current mail order prices. By performance we mean a clear, steady signal, readable at the given distance under average operating conditions. The shape of the curves is interesting. As in all other branches of human activity more money, representing as it does accumulated man-power of the past, produces more results. But we notice that around fifty dollars a slight increase in money means a considerable increase in performance; while above the "knee" of the curve, say around two hundred dollars, relatively great money increases cause little change in performance. Most of us are not ready to invest all our resources in a transmitter to the exclusion of such necessaries as food and transportation, so that we would probably in any case hold the expense below a hundred dollars. But in addition, for all such who are not millionaires, the curves have a message of cheer; they show conclusively that for around fifty dollars we can get the most miles per dollar—the highest actual value from our investment. This is because parts and accessories cost about the same for a UX-210 as they do for a UX-112A. For these reasons the transmitter here described is held within very reasonable limits; and if the cost seems at all high, it must be remembered that the estimates are for average prices on complete equipment: oscillator, modulator, tubes, power supply.

The next consideration is the choice of transmitting circuits. Anyone will admit that crystal control and master oscillator—power amplifier circuits will in general produce steadier signals than self-excited oscillators. But by using high capacities across the tube elements and loose antenna coupling (or detun-

Fig. 1





Close-up of local control switches, lamp bank and modulator. The upper side of the top shelf may well be used for local control transmitter switches, while its under side and lower shelf carry the modulator parts, batteries and transformers

If you have always hankered to "get into the amateur game," this article by Lieut. Wenstrom will be exactly your meat.

The amateur transmitting set does not require a lot of loose or trailing wires and a generally unfinished looking ensemble. Nor does the outfit require that the furniture be moved out, or the attic ripped to pieces, in order to install it.

ing the antenna if coupling is fixed) the self-excited oscillator signals can be made steady enough for practical purposes.

There are several oscillator circuits, notable among them being the Hartley, Colpitts and tuned grid-tuned plate. The last is efficient and popular, but requires two tank circuit controls for tuning. The Colpitts is ideal for any one band, and was used in the portable transmitter described in this manual, page 9. The Hartley, economical of apparatus and long the old stand-by, has had movable inductance clips in its usual form, but in this series Hartley design we do away with the clips and lead in the plate supply at a point of low radio-frequency potential. All coils for any one wave-band plug in as a complete unit; and the tank capacity, directly across the grid and plate, is variable only between 250 and 500 mmfd. This condenser is, in effect, a single control for changing the oscillator wavelength, though for actual transmission the antenna is tuned as well.

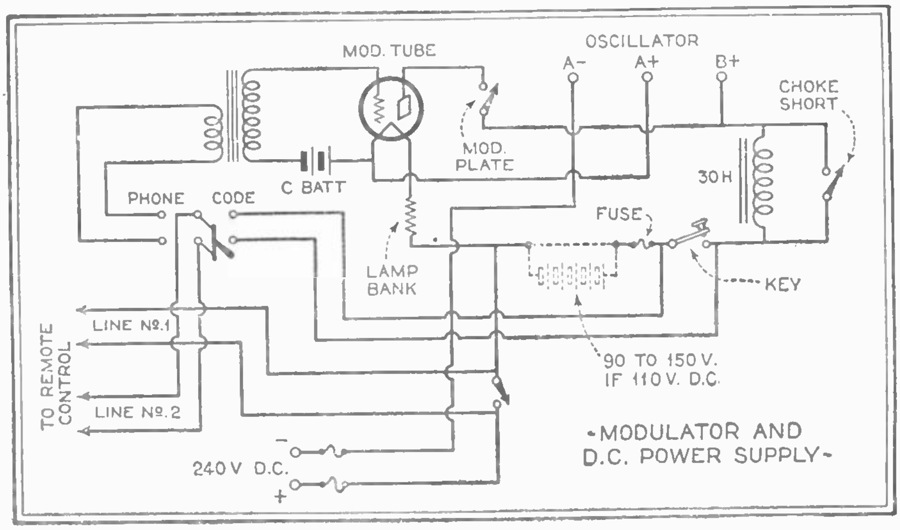
For some reason radio telephone does not appeal greatly to most amateurs. There is even some resentment at times against phones in the 80 meter band, usually when the latter are operating below their allotted sub-band. But while code with its far greater range and certainty will always remain the major interest, phone has its uses, such as talking to nearby friends or experimenting with voice transmission. A Heising modulation system, as good in principle as that of a broadcasting station, means only another tube, a choke, a transformer and a microphone; and we include it in this design so that our transmitter, simple though it is, will realize the fullest usefulness.

General Arrangement

After the determination of the transmitting circuits, we come to the problem of constructing and mounting them. Probably the most common arrangement places the transmitter, either panel or breadboard mounted, on one or two tables with the receiver and controls, while the power supply reposes on the floor. Though this scheme does make an imposing display of equipment, it usually monopolizes most of the space of one room, making it practically useless for anything else and very difficult to clean. Such profusion of apparatus is justifiable enough in an electrical laboratory, but it is out of proportion in the home.

It might seem at first that the solution is to be found in the other extreme—a transmitter, or both the transmitter and receiver, built into a console worthy in

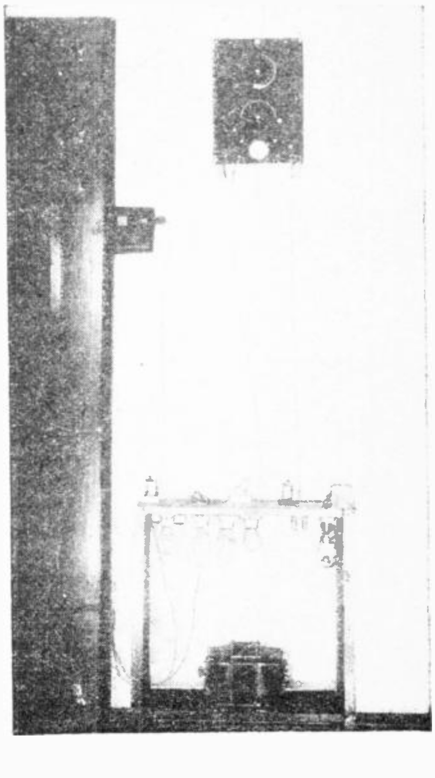
Fig. 3



appearance to take its place in living room or study. But at the start this conception entails serious difficulties. Some form of arm rest is a practical necessity for continued key work, and scarcely less so for the delicate and rapid receiver tuning which two-way communication demands. In these respects at least, the time-honored table is right in principle. Another possibility would be to mount the transmitter and receiver in a well-finished cabinet based on a living room table. This project breaks down because we must have a key and several control switches screwed tightly to the table for effective work. And both of these arrangements have other drawbacks, surmountable only at great sacrifice of efficiency. A transmitter cannot be crowded into any available space like a receiver, in which the relative placing of apparatus means little. The fields surrounding the transmitter are so much more intense that losses would be prohibitive; and the transmitter must be readily approachable for testing, measuring wavelength, or observing plate color—problems which never arise in the case of a receiver. In addition the antenna leads must be short, reasonably straight, and away from walls or other partial conductors.

Our reasoning thus seems to lead to an impasse, but there is a way out of the difficulty—remote control. We will take

The transmitter panel is held out from the bedroom wall by four wooden sticks; the whole being hung by two wires. The modulator and power supply is placed under the transmitter



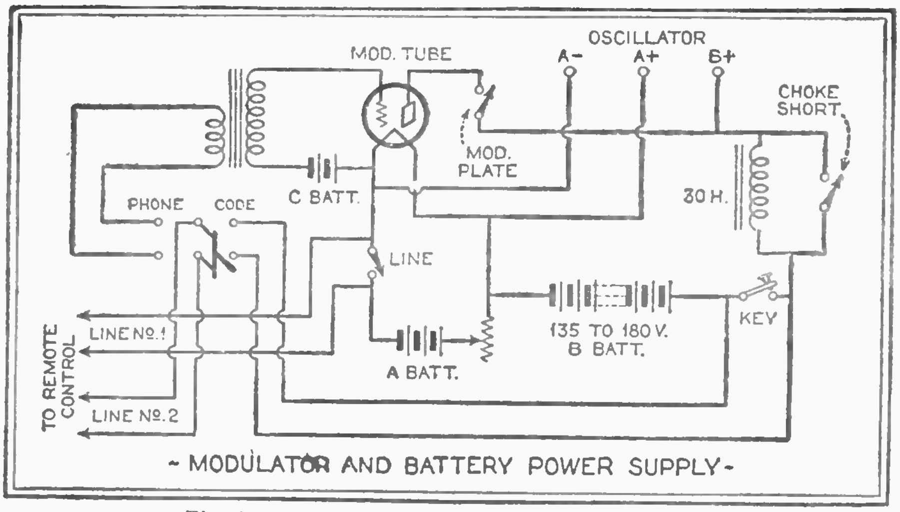
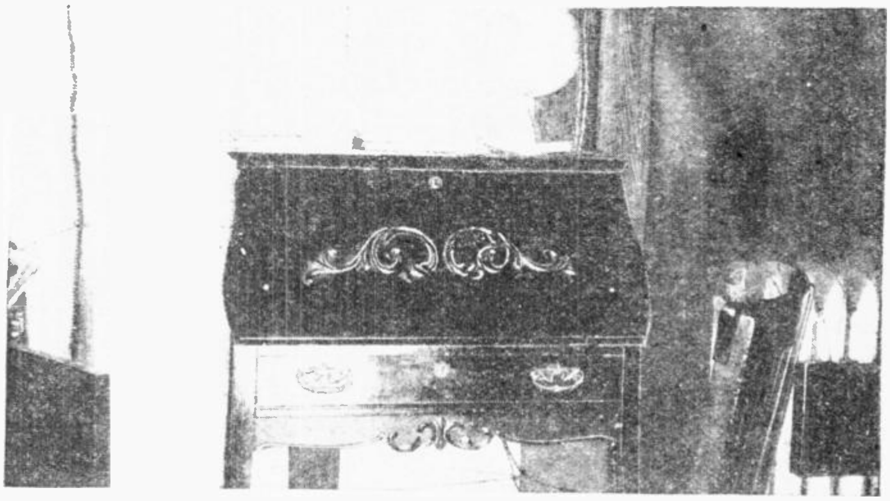


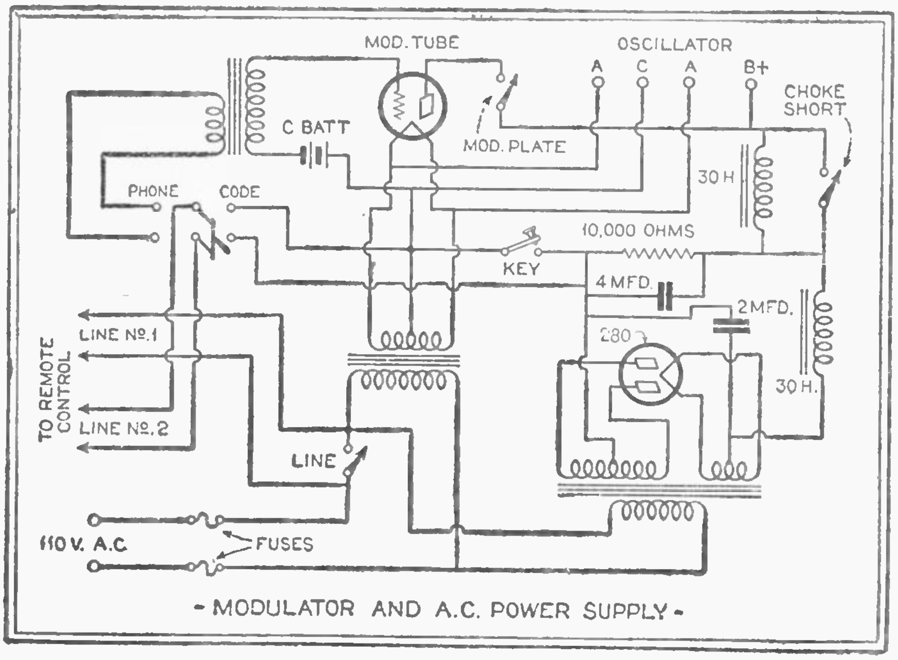
Fig. 4

this transmitter which is so particular about its field space and its antenna connections, and put it where all its whims can be indulged—high up on the wall of a spare bedroom or a covered back porch. For neatness and compactness all parts are mounted directly on a 10" x 14" bakelite panel, held out from the wall by four wooden sticks, one inch square and one foot long, the whole being hung by two wires and hooks for ready removal. The modulator and power supply can be placed anywhere the constructor likes—down cellar if there is one, but in the writer's installation they are mounted on a two-shelf affair similar to a small bookcase, directly under the transmitter. As the latter is well up towards the ceiling, the modulator and power supply unit covers very little additional horizontal area. The upper side of the top shelf may well be used for "local control" transmitter switches, while its under side and the lower shelf carry the modulator parts, batteries and transformers. The placing of the receiver and controls is the best of all. Waiving all claims to originality, we might say that the idea was suggested to us four years ago by 5AKY, Mr. W. F. Kitchens of El Paso. It is nothing more than mounting the receiver, key, microphone, transmitter remote control switches, "Q" signal chart and all other devices which the operator needs immediately before him, in a small folding desk. With the front down, the necessary writing, keying and tuning table is at hand; with it up, the casual visitor sees only an ordinary desk. And even if the experimenter likes to show friends his transmitting equipment, how much more startling is this display in its suddeness, like the presto change act of a magician! If all these advantages were not enough, remote control has others. Throwing switches on the transmitter itself, keying on the same table, and moving about in the vicinity—all are likely to produce vibration of the transmitter parts or changes in its field detrimental to steadiness of signal. It will work best when off by itself with no one puttering around it or jarring it. Then too, with a low power set thirty feet or more from the receiver the latter can be used (without antenna) for listening to one's own signal. And break-in, the ideal form of telegraph operation, is easy.



Remote control desk in living room—closed. The casual visitor sees only an ordinary desk

Fig. 5



Transmitter Construction

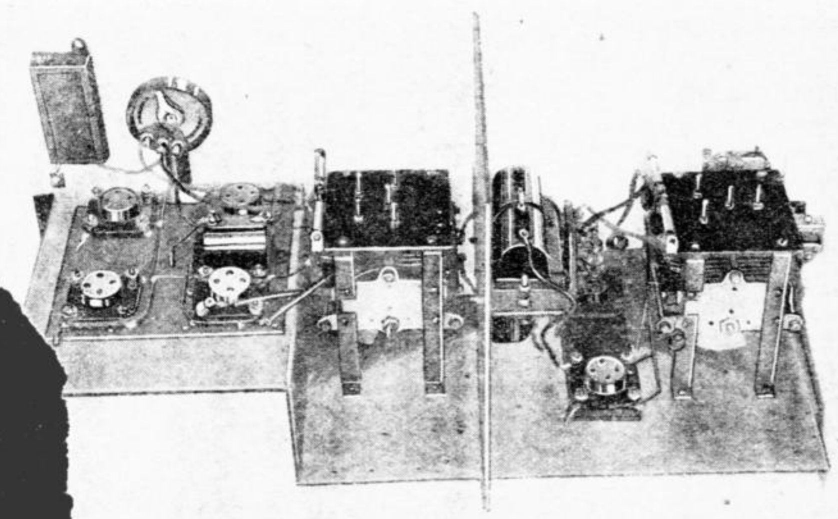
The whole transmitter assembly is based on a 10" x 14" bakelite panel, one fourth inch thick. The photographs and panel drilling diagram, Fig. 7, clearly indicate the layout and placement of parts. Experimenters may wish to vary the arrangement, but the design has been carefully worked out for greatest electrical efficiency, convenience and neatness, and may well be exactly followed. The controls and indicators are mounted along the panel center line. At the bottom is the milliameter, a fairly expensive instrument, but an absolute necessity, as it protects an equally expensive tube and tells many things about the transmitter operation as well. Next are the tank circuit tuning condenser (which happens to be double spaced), controlling the oscillator wavelength, and the antenna tuning condenser. These are old style Cardwells, obtainable very cheaply at many stores, and as good electrically and mechanically as anyone could want. It will be noted that a fixed condenser is shunted directly across the tank circuit tuning condenser. By thus always keeping the total tank capacity high, we achieve an absolutely steady signal.

Push-Pull
Wave Tuner Circuit

d Pointers on the Construction of this Unique Receiver

By Thomas A. Marshall

vith
...



ne inside of the Marshall re- looks. The metal base is spe- med as shown, with a com- ll to shield the r.f. tuner ne detector circuit

...
-pull
rical
input
direc-
...
eri-
cir
...g with."

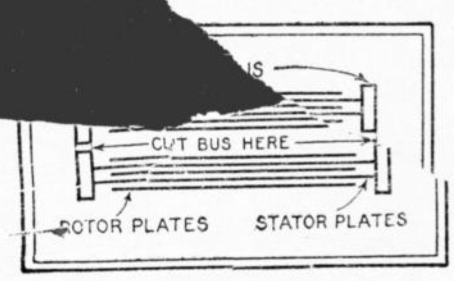
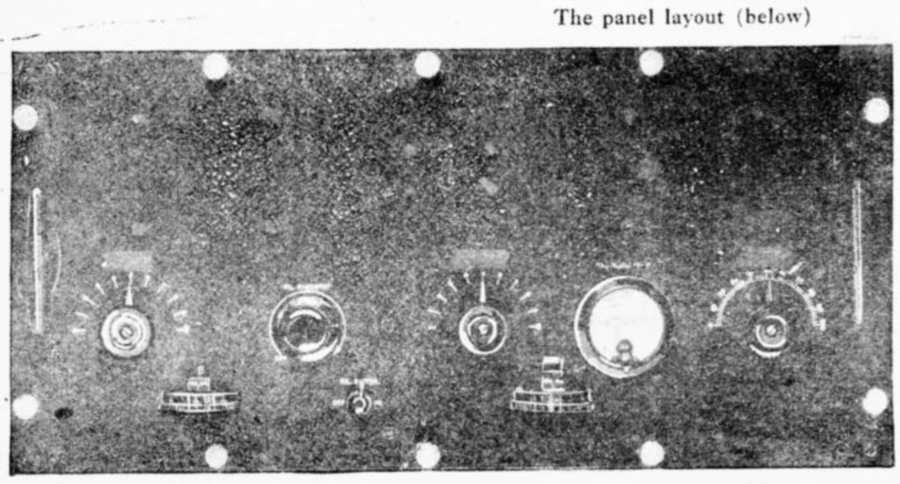


Fig. 1—Making one condenser do the work of two. In the push-pull circuit the stator sections of the tuning condensers are altered as shown

The panel layout (below)



MANY readers have written to me for additional information on the Marshall push-pull receiver, as described in RADIO NEWS, for July, 1929. For this reason, I have prepared the following diagrams, etc., which will enable the reader to construct this receiver, which will give really wonderful results and please the most exacting radio experimenter. The receiver will enable the radio constructor and experimenter to explore the short-wave band from 7 to 125 meters. More and mo. experimenting is being conducted o. these short-wavelengths. Of course at present there are not many broadcast ations within this band, but to my mind the time is not far distant when broadcasting stations will be using the short wavelengths extensively.

General Considerations

In order to obtain selectivity and sensitivity, it is necessary to completely shield the r. f. stage and the detector circuit. The arrangement of the shielded compartments (see photograph) is such as to produce a satisfactory over-all shielding and to obtain proper neutralization of the r.f. stage. The shielding recommended should be 3-16" in thickness, in order to eliminate all microphonic noise.

It will be noticed that subpanel wiring is used. This results in a neat appearance and at the same time greatly increases the shielding effect.

Plug-in coils are used in each of the tuned circuits, arranged so as to cover a definite wavelength range. L, L1, L6

At the top of the panel is the antenna current indicating bulb. Here we have a chance to spend over ten dollars for a radio-frequency ammeter, but on the whole the bulb does just about as well.

The exact antenna current is not very important in short-wave operation anyway, and the bulb resistance is low compared to the total antenna resistance. If one wishes the last ounce of signal strength, the bulb can be shorted by a switch. The bulb size will vary with the power used. For the average set a 12 volt 3cp auto bulb, with a normal current of .3 amps., a cold resistance of 6 ohms, and a white-hot resistance of 40 ohms, is the best size. For battery sets a 6 volt pilot bulb, as used in the Portable Transmitter, would be better; higher voltage a. c. installations will require a 6 volt 3 cp auto bulb (normal current .6 amp., cold resistance 2 ohms, hot resistance 10 ohms).

We have now accounted for all the major parts except the tube and the coils. The tube socket is mounted on the right

For the 40 meter band: antenna coil 5 turns; plate coil 3 turns; grid coil 3 turns. The 20 meter band could be reached, if desired, with a smaller fixed tank capacity, a plate coil of 2 turns and a grid coil of 1 or 2 turns, but it is best to begin with the lower-frequency bands. No filament voltmeter is included in the transmitter, as this voltage can be checked with a portable meter, and usually remains fairly constant.

The following parts went to make up the writer's transmitter:

1 Cardwell variable condenser, 350 mmfd.
1 Cardwell variable condenser, 250 mmfd.
2 Sangamo fixed condensers, 250 mmfd.
1 Sangamo fixed condenser, 6000 mmfd.
1 Benjamin spring socket.
1 Weston milliameter, No. 506, 0-200.
1 Ward Leonard resistor, 5000 ohms.
2 Dials, 4" bakelite, plain.
1 RFC (100 turns No. 28 on ½" dowell).
1 Socket and bulb, auto.

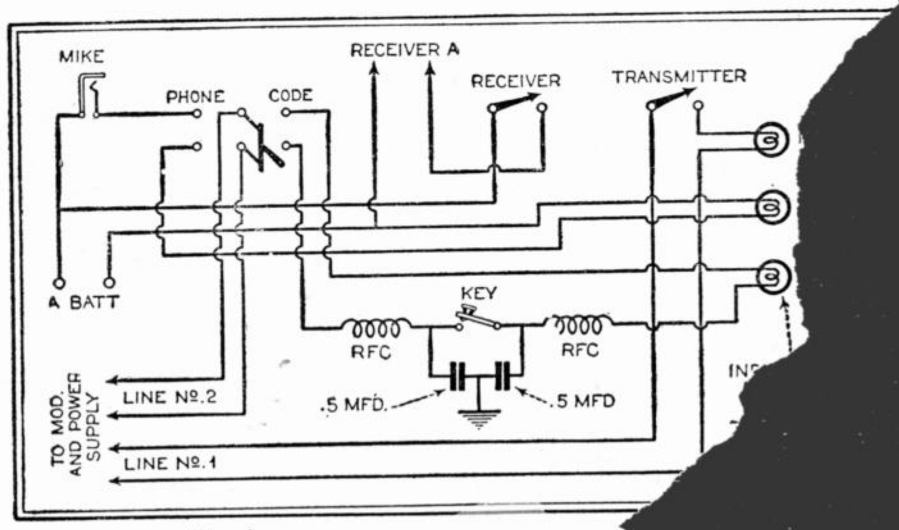
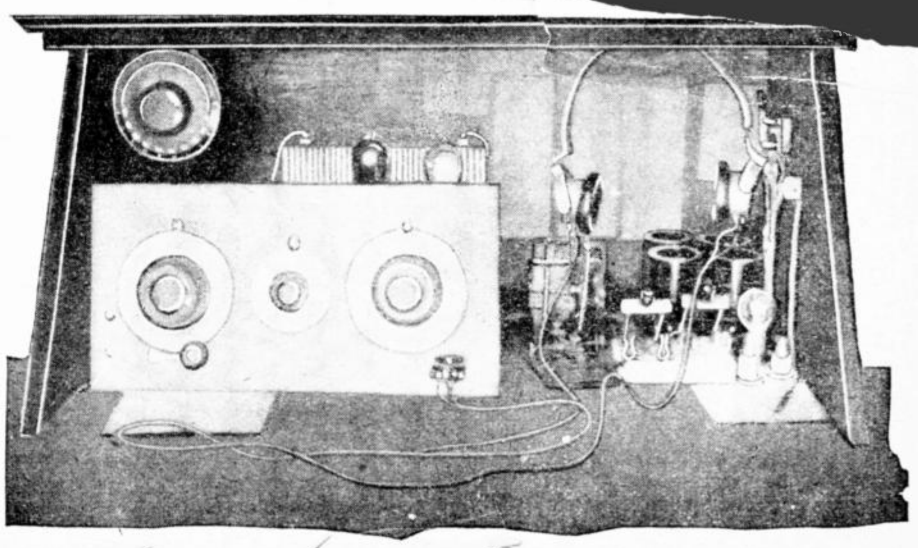


Fig. 6

of the condensers (viewed from back of panel), far enough out to clear the rotors. It happens to be an old style spring socket so that all types of transmitting tubes will fit it, but a new push-in socket would do just as well. The plug-in coils are worthy of some note. Manufactured transmitter coils are available, but none of these proved adaptable to this circuit and general design, adopted after a process of elimination. The coils are therefore easily and cheaply homemade from ⅛" copper tubing, first pulled out straight and polished, then wound tightly and tied overnight on a bottle or other form, then looped at the terminals and screwed to the strip by the beautiful little General Radio plugs, obtainable directly from that company at Cambridge, Mass. In a similar strip permanently mounted back of the front panel is a corresponding line of G. R. jacks (all three strips are drilled together), so that the coil assembly for one wave-band plugs in as a complete unit in practically one motion. The strips are 3-16" hard rubber, and the coil diameter is 2½ inches. For the 80 meter band we use: antenna coil 10 turns; plate coil 7 turns; grid coil 7 turns.

Below—a close-up view of the remote control apparatus, as installed within the ordinary writing desk. Note that the receiver occupies the lion's share of the space, and that there is no crowding of apparatus



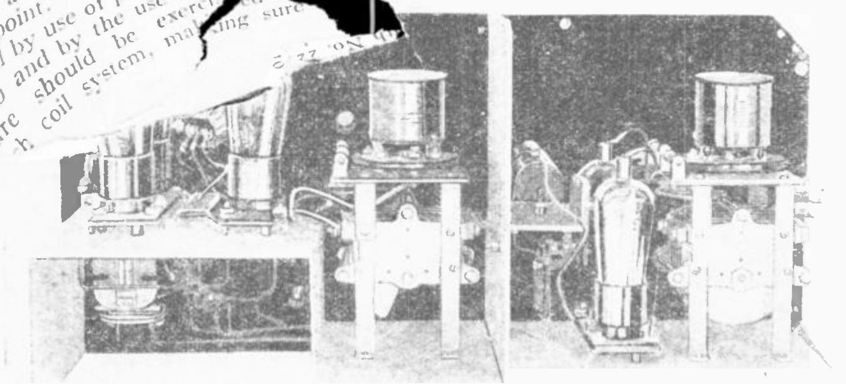
30 to
and circ
operates
audio
most peo
is much
principl
if a fe

COIL #	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
1										
2	38.1	41.7	43.3	45.3	47.5	50.3	53.6	57.3	60.5	62.0
3										
4										
5										
6										
7										
8										
9										
10										

Fig. 2—The preparation and use of a chart such as that shown facilitates greatly the tuning in of desired stations

... are wound upon bakelite forms, ... mmended from a lowloss ... losses are further re- ... r diameter-to-length ... aced windings. ... in winding ... that the

and L7 ... which are reco... The ... standpoint. ... duced by use of prope... ratio and by the use of s... Care should be exercised ... coil system, making sure



Practically every constructional detail is clearly indicated in the above photograph. Note that the specially formed metal base shields the audio channel and also serves as the base for the detector and audio amplifier tubes

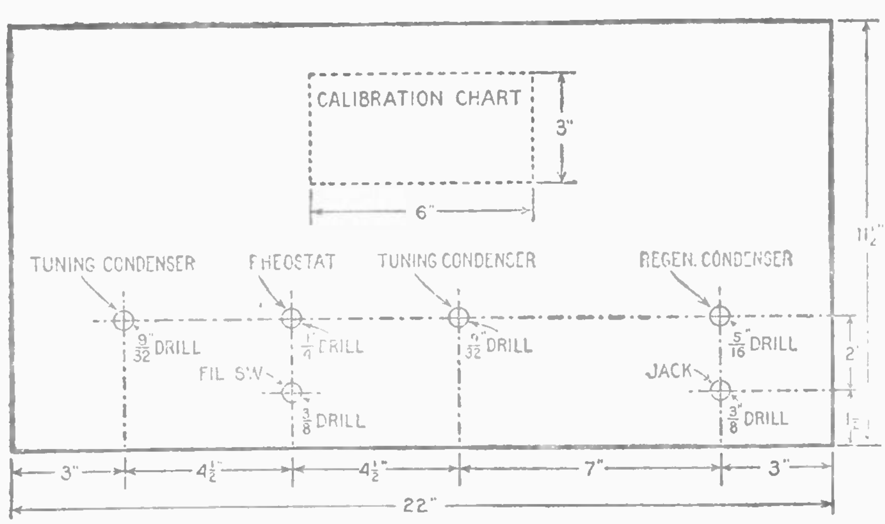
turns are wound exactly as specified in Table I.

Cardwell straight-line frequency condensers (type 169-E) are used in order that maximum ease in tuning may be experienced in the short-wave bands. These condensers are also recommended due to the arrangement of the stator plates which enable two condensers to be made from one. This is done by cutting the bus-bar at the center as shown in Fig. 1. The middle stator plate is removed, thus leaving four stator plates and six rotor plates. This combination makes possible two condensers with one common set of rotor plates. The total tuning capacity across the coil is approximately .0008 mfd. In order to tune short-wavelengths, it is necessary to use a high ratio vernier dial, such as a National VV. With the condensers bottom side up as shown, the coil mounts are secured to the condensers by means of support brackets as shown in the illustrations. The dial is so arranged as to read kilocycles, starting at the lowest value at the left, increasing as the dial is rotated. Fig. 2 shows arrangement of the chart for calibration of the coil systems. This is new to the tuning art and will be extremely valuable in locating short-wave stations.

Circuit Constants

C1, C2, C7 and C8 are Sangamo .0001 mfd. condensers. See Fig. 4. These condensers are mounted directly underneath the coil bases so as to reduce the length of the grid leads. R1 and R2 are 1 megohm grid leaks. R4 and R5 are ½ megohm grid leaks. Durham or Lynch metallized grid leaks are recommended. C3 is a 1 mfd. condenser. C12 is a 2 mfd. by-pass condenser. L2, L3, L4, and L5 are Sampson No. 125 r. f. choke coils. L2 and L3 are mounted on a stand as shown in Fig. 5 while L4 is mounted vertically and directly underneath the junction point of L2 and L3. C10 and C11 are neutralizing condensers. R6 is a Centralab 500,000 ohm variable resistor. V1 and V2 are UX222 shield grid tubes. V3 and V4 are UX201A tubes. It is not necessary to have matched tubes for this circuit since the grid coil has no center connection which enables the circuit to find its own electrical center. C4 and C5 are 50 micromicrofarad condensers. About 30 mmfds. should be used. Increased coupling will cause unstable oscillations within the detector circuit due to inter-action between the two stages. C9 is a 1 mfd. by-pass condenser. R7 is a 200 ohm potentiometer. R8 is a 10 ohm rheostat. R3 is a 20 ohm rheostat. R3 is adjusted to 3.3 volts on the UX222 tubes when R8 is adjusted for 5 volts on the detector tubes. A1 is a Thordarson 5-1 ratio audio transformer. A2 is a S. M. 256 transformer. This combination is recommended in order to obtain the best audio amplification. V5 is a UX112A tube. V6 is a UX171A tube.

Fig. 3—A drilling template for the parts employed and described by the author in the text



Oscillations are controlled by R6. This method of control permits maximum regeneration without changing the calibration of the receiver. R7 permits the proper adjustment for good detection. When the proper bias is used the detector should go in and out of oscillations without any "hang over" effect.

Operating Notes

After the filaments have been adjusted to the proper voltages, insert coil No. 3 in the detector circuit and adjust R7. It will be necessary to adjust R7 so as to cause the circuit to go in and out of oscillation. After this adjustment is perfected, set C4 and C5 at about 30 mmfds. and insert No. 3 r. f. stage coil. Adjust C10 and C11 to about ¾ inch apart. Tune the r. f. stage to resonance with the detector circuit. If the latter stops oscillating, detune the r. f. stage until the detector oscillates. Adjust C10 and C11 and tune the r. f. stage condenser until it is possible to set the detector stage at maximum regenerative point (just barely oscillating) and be able to pass through resonance with the r. f. stage without causing the detector to

Table I
Coil Winding Data

Coil No.	Wave Band	L	L1	L6	L7	Dia. in inches
1	80 125	10	41	8	41	2
2	75	6	21	6	21	2
3	40	4	12	6	12	2
4	30	4	7¾	4	7¾	2
5	22	3	5	4	5	2
6	18	2	3¾	3¾	3¾	2
7	12	2	4	4	4	1
8	10	2	3	4	3	1
9	8	2	2	4	2	1
10	7	2	2	4	2	¾

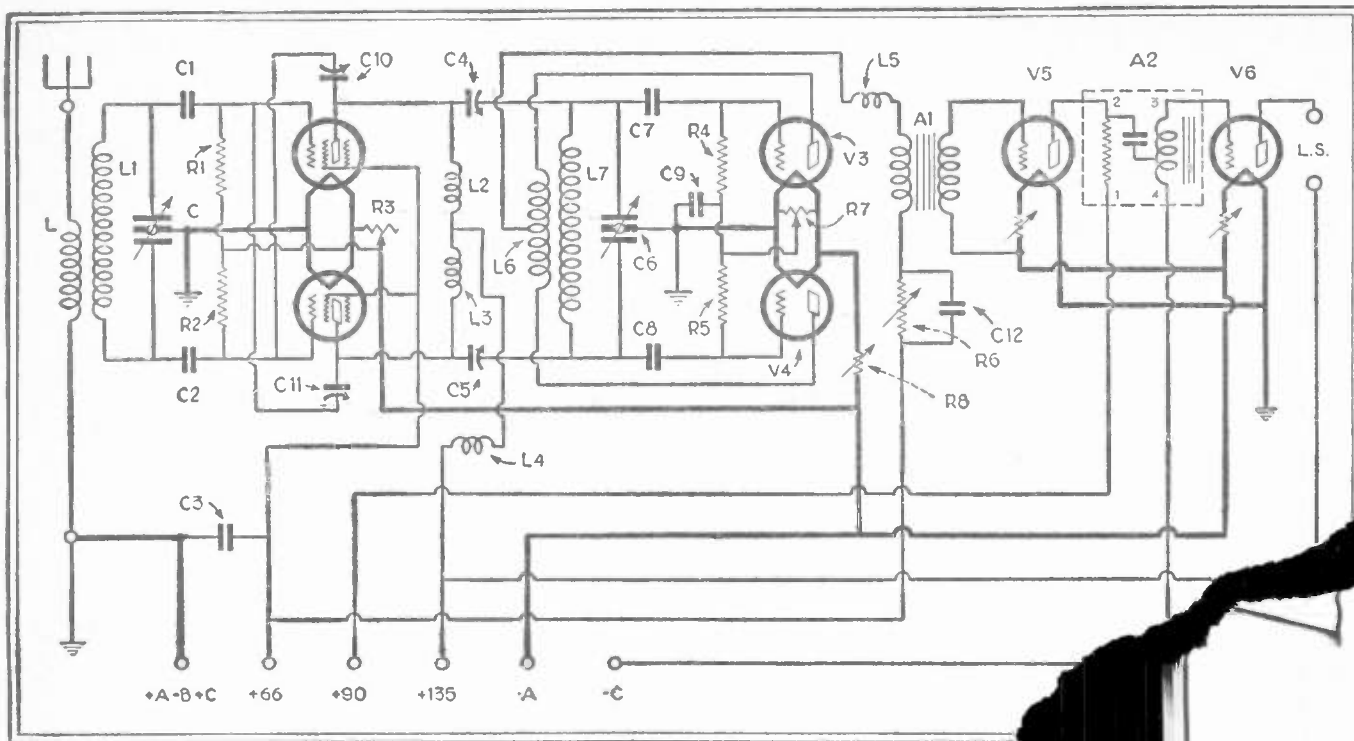


Fig. 4—The complete circuit diagram of Mr. Marshall's push-pull short-wave receiver. The coils L-L1 and L6-L7 are of the plug-in type, allowing change of tuning in the wavelength bands

stop oscillating. When R7, C4, C5, C10 and C11 are properly adjusted there should be no interaction between the detector circuit and the r. f. stage, when both circuits are tuned to resonance. If this condition is obtained, the circuit is ready for calibration.

Do not make any changes in C4, C5 C10, C11 or R7 after the coils are calibrated.

Grid and antenna coils No. 1 to No. 6 inc... w... coils N... wi... No. ... are wound 18 turns to the ... No. 22 ... enamel covered wire. Tickler ... No. 6 inclusive are wound ... covered wire. Coils close toget... with fields.

Press and Weather Reports on Short Waves

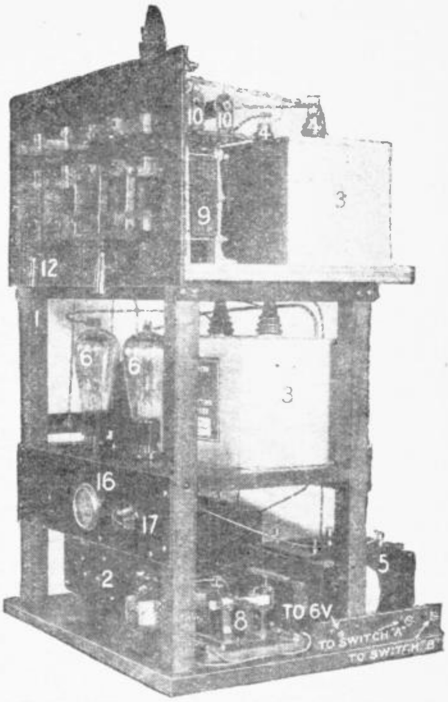
It will be noted that the time given for each station is GMT (Greenwich Mean Time). The local time for these broadcasts may easily be figured by simply subtracting the number of hours difference from GMT. For instance, U.S. Eastern Standard Time is five hours behind GMT, so that those in the New York area will receive the midnight chimes of Big Ben broadcast over G5SW at 7 P.M.

GMT	CALL	KC	WAVE	LOCATION
0100	DIH	19947	(15.04)	Königs Wunsterhausen, Germany
0100	GBR	8103	(37.15)	Rugby, England. British official press
0145	8ZW	12820	(23.4)	Shanghai, China. Weather and storm signals
0330	NPG	8350	(35.93)	San Francisco, Calif. Hydrographic reports
0400	XDA	7790	(38.5)	Mexico, D. F. Sends first in Spanish
0600	WHD	8250	(35.93)	New York City, U. S. A.
0605	W6XI	6730	(44.58)	Bolinas, Calif., U. S. A.
0700	NAA	8030	(37.36)	Arlington, Va., U. S. A. Navy press, simultaneous with NSS
0845	FVA	9677	(31)	Algiers, Algeria
0900	KUP	6335	(47.35)	San Francisco, Calif., U. S. A.
0945	FFZ1	10526	(28.5)	Koukaza, China. Weather reports
1000	NPG	8350	(35.93)	San Francisco, Calif., U. S. A. Press, sent as test messages to NPN, NPU
1130	FFZ1	10526	(28.5)	Algiers, Algeria. Same as at 0945
1200	NPN	8570	(35)	Guam
1800	NPO	16068	(18.67)	Cavite, Philippine Islands
2008	IDS	10156	(29.54)	Königs Wunsterhausen, Germany
2100	KUP	6335	(47.35)	San Francisco, Calif., U. S. A.
2145	LGN	8350	(35.93)	Bergen, Norway. To "CQ Norsk radiopresse"
2230	ZLW	5700	(52.63)	Wellington, New Zealand. Except Sunday.

Final Details for Completing

SPANGENBERG'S S-W TRANSMITTER

How to Build the Amplifier and Power Supply Unit for a 200-Watt "Ham" Transmitter



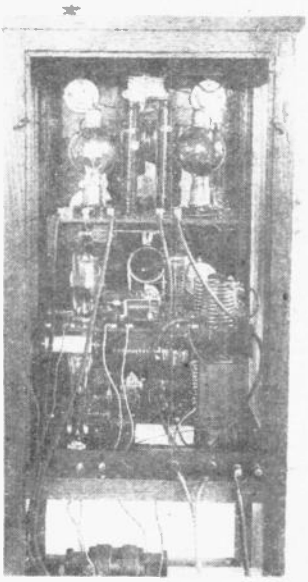
Above: The power supply unit, like the others of this transmitter, is built on the "deck" principle. Left: Here are the three units of the transmitter proper, in place in the supporting frame

THIS is the third and last installment of the story describing pictorially Lester Spangenberg's (W2MB) 200-watt short-wave crystal controlled "ham" transmitter.

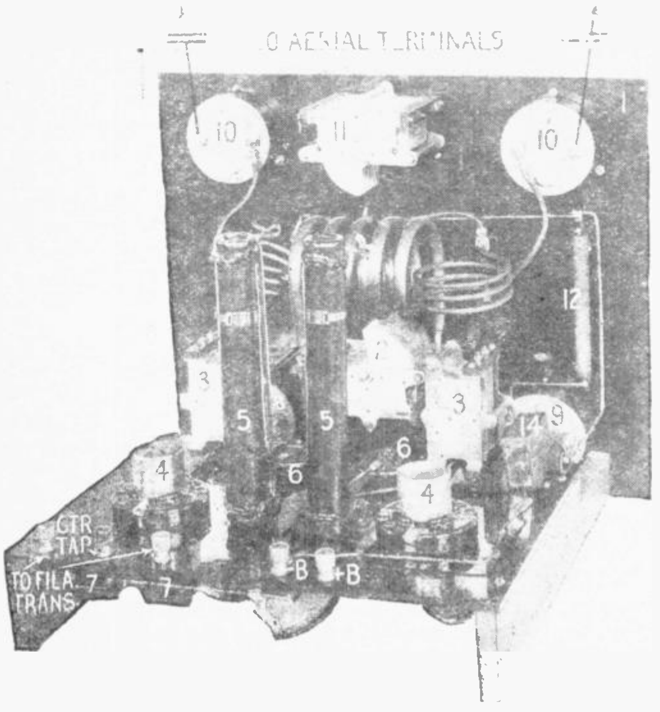
In the first part of the story, published in this issue of the Short-Wave Manual, page 20, the general layout or mode of assembly was described and illustrated. The second installment, appearing on page 44, described in detail the crystal oscillator and frequency-doublers and showed the circuit.

This time we deal with the power amplifier unit and the power supply device, thus completing the picture. It will be found helpful, in duplicating the construction of Mr. Spangenberg's transmitter, to refer frequently to the circuit diagram of the complete outfit, printed on page 44 in this manual.

Mr. Spangerberg has housed the three units—namely, the crystal oscillator, frequency doublers and power amplifier—in a special frame glassed in on three sides, the fourth being provided by the front panel. The power unit was built as an independent unit on its own supporting stand. This unit, unlike the transmitter proper, is not enclosed, but is rather open in construction to allow rapid dissipation of the heat generated by the rectifier tubes.



The power amplifier assembly details may be clearly observed from this illustration. The parts are numbered to jibe with the parts list and the circuit diagram appearing on page 643 of the January issue of RADIO NEWS



LIST OF PARTS—POWER UNIT

1 frame (1)
1 R. C. A. power transformer, 750 watts (2)
2 4 mfd. Flechtheim condensers, type TH400 (3)
6 Faradon 1 mfd. condensers (4)
1 5-volt transformer for filaments of UX866 tubes (5)
2 UX866 tubes and UX sockets (6)
1 power relay (7)
1 relay for filaments of UX866 tubes (8)
1 Acme radio-frequency choke, 30 henries, 150 mils. (9)
2 50,000-ohm resistance (to carry 30 mils) (10)
1 stand (11)
1 double-pole single-throw knife switch, for power leads (12)
1 Todd filament transformer, 10 volts (for UX203A) (13) (on bottom shelf of transmitter)
1 Acme filament transformer, 10 volts (for two UV852) (on bottom shelf of transmitter)
1 Allen Bradley primary resistance (radiostat) (15)
1 0-10 a.c. voltmeter for filament of UX866 tubes (16)
1 10-ohm rheostat for primary of UX866 filament transformer (17)
5 "C" batteries (45-volt size) (18)

PARTS LIST—POWER AMPLIFIER PANEL

1 frame complete (1)
1 Cardwell double-spaced .00025 mfd. condenser and dial with coil attached and two antenna coils at ends (2)
2 Cardwell two-plate condensers with knobs, as neutralizing capacity (3)
2 UX tube sockets (4)
2 Ward Leonard grid leaks (type 507-77), 20,000 ohms (5)
2 Sangamo .002 mfd. condensers (5,000-volt test) (6)
2 Sangamo .002 mfd. condenser (standard) (7)
1 Jewell a.c. voltmeter, 0-15 volts (8)
2 Jewell milliammeters, 0-500 mils. (9)
2 Jewell radio-frequency thermo-couple meters, 0-2 amps. (10)
1 Cardwell double-spaced .00025 mfd. condenser and dial (11)
1 radio-frequency choke, ½" diameter, 400 turns No. 28 d.c.c. wire (12)
2 UX852 tubes (13)
1 .002 mfd. high-voltage condenser (Faradon 5,000-volt test) (14)
2 .00035 mfd. variable condensers (used in series feed Zep. antenna) (15)
2 UX852 tubes (16)

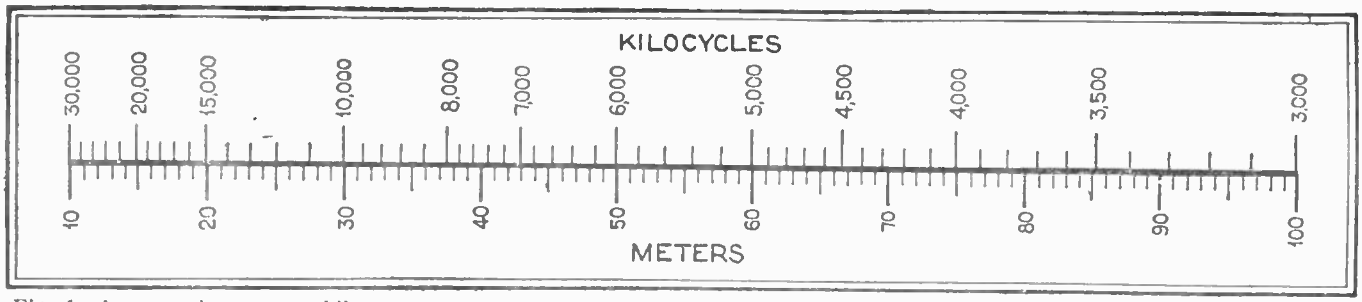


Fig. 1—A convenient meters-kilocycles conversion chart

Ready *for a* Short-Wave C*hat*

Putting the Home Transmitter on the Air

By Lieut. William H. Wenstrom

To those of our readers who have followed Lieut. Wenstrom's preceding articles, the present one is of particular interest because it carries on from the mere building of a practical short-wave transmitter (described on page 52 of this manual) to the actual job of putting it into operation.

If you have not read the earlier articles of this series, we can only say that you have missed something worth while—and there are more to follow, in succeeding issues of Radio News.

THE previous article covered the construction and preliminary tests of the Home Transmitter. This time we put it into actual use, and examine in addition some of the methods of short-wave operation. The subject is a large one, and it will be necessary at times to burrow rather deeply into technical intricacies. For this we ask the reader's indulgence; may the result be a sufficient foundation for practical work.

It will help somewhat in the first tests if we can locate in the same town, or a nearby one, another amateur who is willing to spend some time listening to our signals and working with us. If this is not possible, we can get along anyway, though it may take some time and patience to make the first outside contact. A new transmitter seems to suffer from inhibitions for a few days. The truth is that the signals are getting out, but we lose confidence when no one answers them. Then, one day, we hear our own call pounding in from somewhere below the horizon's rim. The ice is broken; the new transmitter has found itself.

First Results

We report here a few desultory tests with the writer's Home Transmitter, carried out under the difficulties of hot, humid summer weather, the interruption of travel, and the indolence of a vacation state of mind. The results are nothing out of the ordinary, but are good enough when we recollect that the plate voltage was around 200 and the output about 3 watts. All the tests were in the daytime, as the nights showed prohibitive static, if not actual thunder showers.

The 80-meter coil was tried out first, with the oscillator set at 78 meters. At about 5 p. m. we connected with W8AKD at Walton, New York, about 75 miles away. Both stations were QSA4 (which indicates readability through static, etc., rather than audibility)—very good, considering the maximum is QSA5. This station had a fine d.c. note and reported ours pure d.c. also. We held communication for about two hours without a break. W2CX changed wave up to 85 meters, with no change in signal strength at Walton. We also tried phone for a short time with the output around 2 watts. W8AKD could hear the words faintly, but could not understand them.

The next tests were with Lieut. Bullene, W2BEI, two miles away in Highland Falls. His low-powered transmitter, shown in the photograph, follows exactly the "home transmitter" design. Of course we had no difficulty in working code back and forth under any kind of atmospheric conditions. We used break-in practically all the time, and worked back and forth as quickly and smoothly as could be desired. Then we tried phone, each station using about 2 watts output. This of course did not give the superlative transmission of short-range code, but we understood practically every word that was spoken, and had no difficulty in raising each other with phone at scheduled times. The final test was "break-in phone," suitable only for short distance and low power. The two transmitting wavelengths must be separated as widely as the narrow phone band permits. We left both transmitters and receivers on continuously, the microphones in front of our mouths and the headphones on our ears. Of course one's own transmitter comes in fairly loud, but not loud enough to prevent hearing the other operator if he interrupts. When we finally got the system working, it gave all the speed and certainty of a commercial telephone call—with the advantage that it could be held by the hour, and no overcharge!

Two more 80-meter tests were made. At about noon we raised W2AFV on

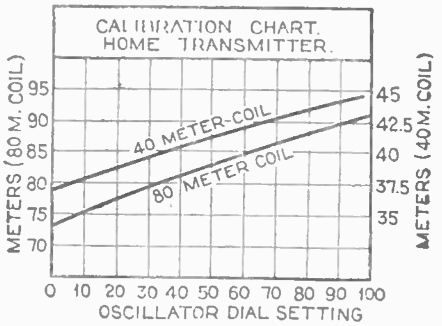


Fig. 3—Above, calibration curves for the author's transmitter. With such curves (plotted for the individual transmitter, of course) adjusting to any desired wave band is simplified

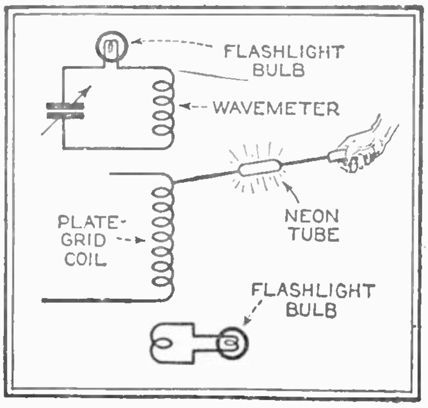


Fig. 2—The essential circuit for a home-made wave-meter is shown at the left

Staten Island, 60-odd miles distant. He reported our signals as QSA2 while his were QSA4, but he was using much more power, about 100 watts input. W2CX was near the bottom of the band on 78 meters. In a later test on the same wave we raised W1PF at Stamford, Conn. This was about 4 p. m. and both stations were QSA3. The static was very bad—several thunderstorms were growling in the distance.

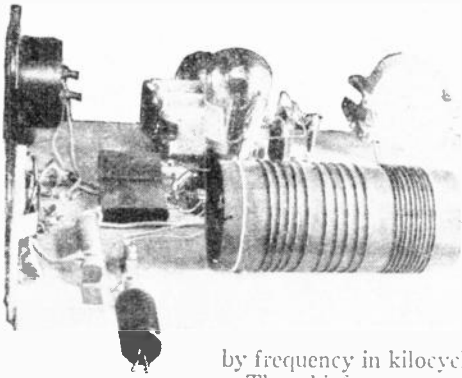
The first test with the 40-meter coil in place met better luck. At about 9:00 a. m., with the sun well up on its morning climb, we connected with W8ADS at Findlay, Ohio, 500 miles out. The output was still about 3 watts. Both stations were QSA4 and pure d.c., and except for some interference from broad raw a.c. notes, the communication was perfect. The day was bright and clear, with a high-pressure area overspreading the eastern half of the country. It is only fair to say that after this contact we spent the next hour calling without raising anybody; but such are the vagaries of low-power, short-wave transmission. Many complicated factors make wave transmission an exceptionaly interesting study which we hope to explore in a succeeding article. We shall report, also, some further tests with the home transmitter.

Preliminary Tests

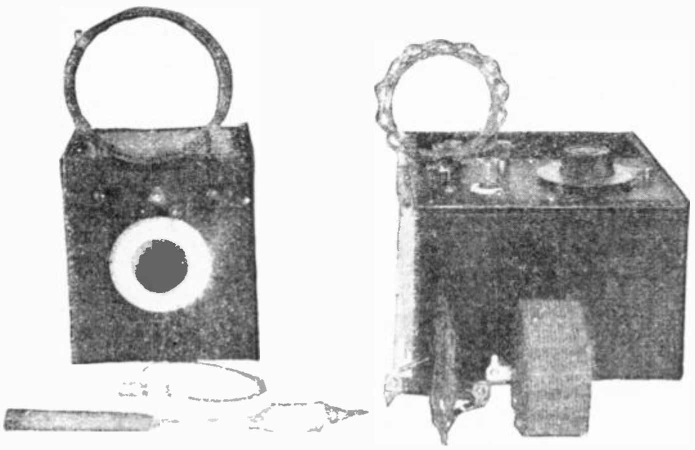
We assume that the transmitter has been completed, bench-tested for circuit continuity and oscillation, and installed in some convenient location near a window. The receiver has been long since installed in another room and has its own separate antenna; the remote control circuits are all in. The first transmitting antenna may be almost any single wire about a quarter-wavelength long, with either a conductive ground or a counterpoise.

It is easy enough, of course, to throw on the current and hope for the best, but there is far greater pleasure in running a small transmitter with some care and skill. For this reason voltmeters should be placed across the plate and filament circuits. It is also well to start with a high resistance in the plate circuit, which will cut down the voltage to about half normal value. With local control switches set for code, we turn on the filament current and, after allowing the tube a minute or two in which to warm up, the plate current. With the oscillator condenser set at the desired wavelength we tune the antenna circuit until the current-indicating bulb lights brightest. This very close resonance tends to make the signal unsteady, so that the best setting is about ⅔ maximum current, at which the effective coupling is decreased until antenna changes have little effect on the oscillator frequency.

In addition to watching the bulb and the meters, we should glance occasionally at the plate of the tube; it should never get hotter than a barely visible red, and at plate voltages below 300 no heating should be visible. The plate current of the UX210 runs from around 40 mils with antenna completely detuned up to 50 or 60 mils with antenna tuned to resonance. We should note all the voltage and current readings, making up a list similar to Table 1, which gives the actual performance of the writer's transmitter. If plate voltages over 300 are used, the grid leak value should be changed from 5,000 ohms to 10,000 ohms, so that plate currents will not be excessive.



At the right, the "breadboard" transmitter at W2BEI, using a 245 tube. This transmitter co-operated in many two-way tests with the author's home transmitter



At the left are shown a home-made and a commercial wavemeter, with flashlight bulb and neon tube oscillation indicators

We can estimate the output fairly well by calling it ⅓ of the input. It is well to try tuning the antenna at several settings of the oscillator condenser, noting the tuning differences. With the antenna disconnected, the oscillator condenser should go from 0 to 100 with only very small changes in plate current. The tests are repeated on all working wavelengths that the operator expects to use, and on 85 meters the tests are repeated with the switches set for phone. Here we need a milliameter in the modulator plate circuit, so that the grid bias can be adjusted for normal plate current. In addition, we whistle and talk into the microphone, checking for amplitude distortion in the same way we would with the last stage of an audio amplifier.

If at any time we can get no indication of antenna current, we test the plate-grid coil for oscillation by coupling to it a single turn of wire ending in a flashlight bulb, or touching it with one terminal of a sensitive neon tube (see Fig. 2). If the bulb lights or the neon tube glows, the tank circuit is oscillating; getting antenna current is a matter of adjusting the length of the antenna-counterpoise system.

Frequency Measurement and Monitoring

Two or three years ago various groups of radio engineers and operators decided to use kilocycles instead of meters in speaking of radio waves, and the announcements at that time indicated that anyone who breathed anything about "meters" or "wavelength" after a reasonable interval would be in the same class with Rip Van Winkle. The precise relation between them is expressed by the formula: wavelength in meters, multiplied by frequency in kilocycles, equals 299,796.

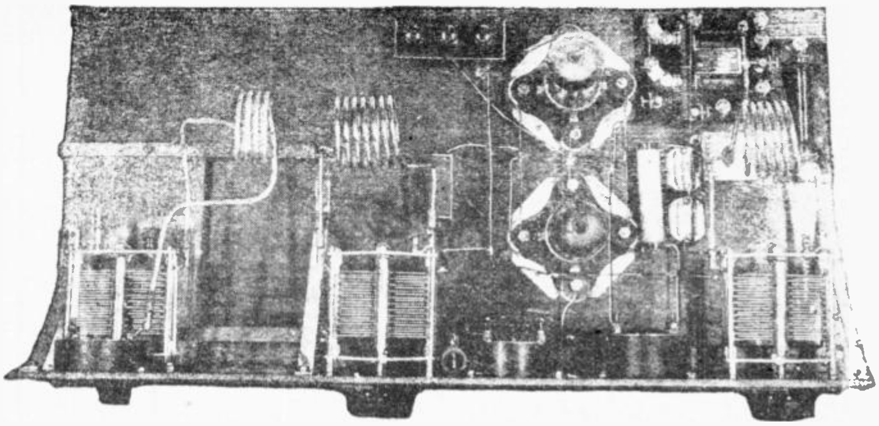
The chief argument for the kilocycle system is that it makes channel allotment and other technical calculations easier. Yet today practically all laymen, and some engineers as well, cling to the meter nomenclature. And it has some undoubted advantages. Wavelengths can be expressed conveniently in three digits, as 305, 45.5, 5.76; a wavelength of some meters is physically conceivable more readily than a frequency; antenna lengths can be more readily calculated; and there is a closer analogy with light rays. Because the meter system appeals to a far greater number of people, we use it in this article, but include (Fig. 1) a conversion chart of meters to kc.

We can measure roughly the wavelength of the transmitter by disconnecting the receiving antenna and listening to our own signal on the receiver. That is one great advantage of low-power combined with remote control—we can always check our signal on the receiver. Other arrangements would require a separate monitor, which is simply a low-amplification receiver, completely shielded in a metal case. If the 80-meter signal is too loud, we can pick up its harmonic with the receiver 40-meter coil. By listening to other amateurs we can get a fair idea of the extent of a band on the receiver dial, discounting the outer fourths. If we then tune our own transmitter until its signal falls within the inner half of the range of copied amateur signals, we are reasonably certain of being in the required band.

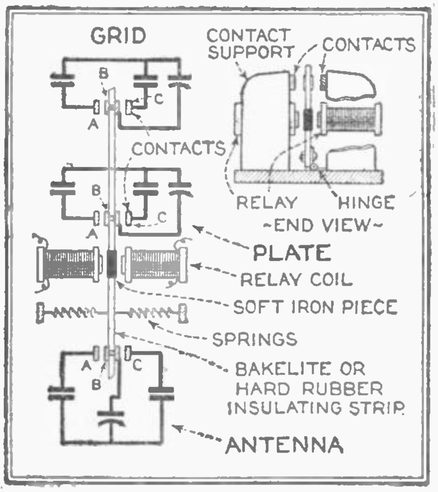
This matter of "monitoring" our signal with the receiver is very important. We can send a test each day before starting

(*Continued on page* 88)

If You Are About *to* Build a Short-Wave TRANSMITTER—



Looking down on the top of the Binneweg s.w. transmitter. The oscillator apparatus is to the right, while the slide-coupled antenna coil and condenser is at the extreme left



A simple electromagnet with contact-carrying strip provides the electrically operated means for quickly changing the transmitter's wavelength adjustment

TRANSMITTERS for use in the present amateur short-wave frequency-bands require special design and construction to obtain the desired sharp, "unmodulated" wave of constant frequency. Unless particular attention is given to the electrical design factors necessary for a modern transmitter, amateur operators will have difficulty in working other stations equipped with modern receiving apparatus. Present amateur short-wave receivers have reached such a high degree of perfection that poorly adjusted transmitters will not be heard properly or will be entirely lost in the medley of whistles and background noises, too well known to be elaborated upon.

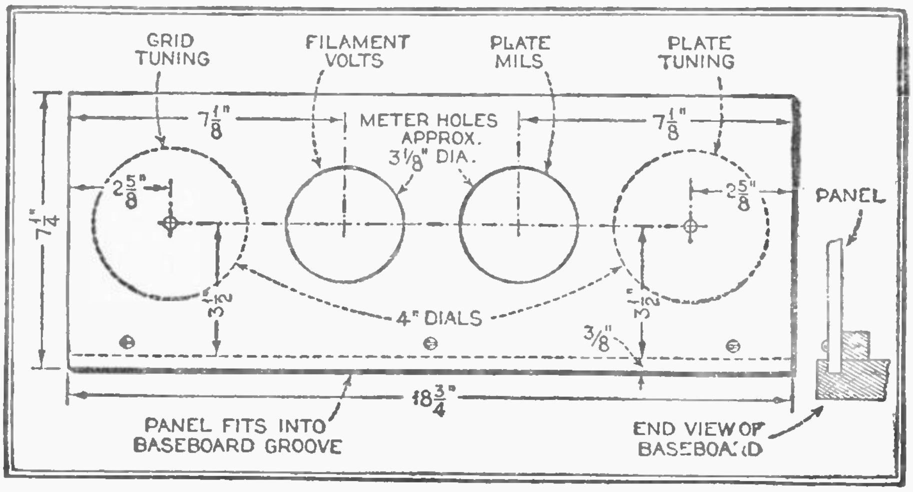
The 100-watt set illustrated will serve more as a target for the following general discussion, bearing on the design and construction of any short-wave transmitter. Amateur operators and other radio enthusiasts have too much native inventive ability to copy exactly any existing set. However, it is a good one to copy, for its electrical features are right and its mechanical construction is certainly pleasing to the eye.

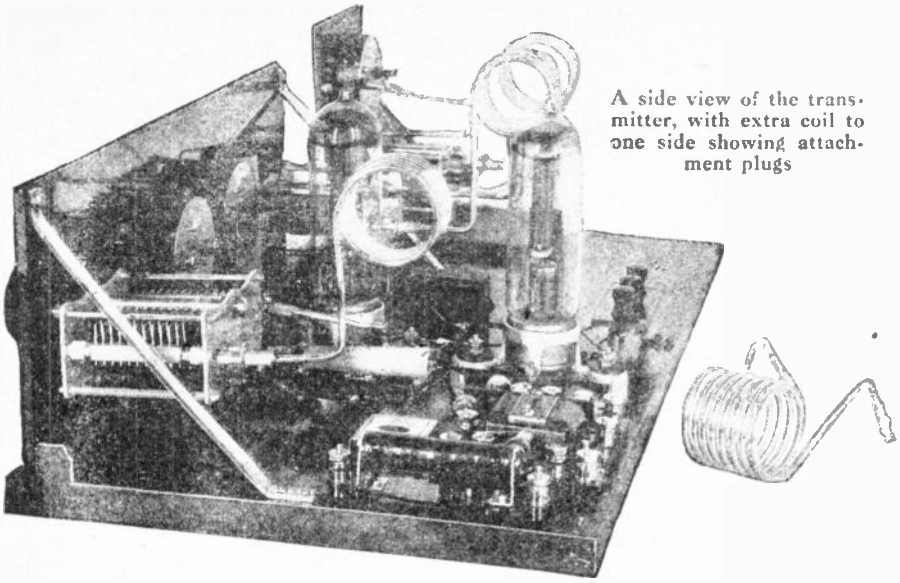
This set can easily be adapted for use with two 7½-watt tubes instead of the 50-watt size in the set by slight circuit changes. Smaller sockets and lower plate and filament voltages are necessary. For the smaller tubes, blocking condensers of about .0002 mfd. will serve for general short-wave use.

There are several important factors which must be considered in any design. It is well known that a high ratio of capacity-to-inductance will stabilize the emitted frequency; but this should not be carried to extremes, as the circulating currents become large and the efficiency falls off rapidly. Moreover, the best value of this ratio will depend upon the tube employed. In this set 43-plate condensers, having, originally, a capacity of .001 mfd. maximum, were double-spaced, giving a final maximum close to .0002 mfd., as the number of plates is halved and the spacing is doubled. These condensers are quite efficient. Although W. E. tubes are shown in the illustrations, R. C. A. 50-watt tubes were also employed, giving good results.

Another important consideration is the size of blocking condensers used. In the usual Hartley oscillating circuit, the blocking condensers are in series with the grid-plate capacity, the resultant capacity being in shunt with the oscillating circuit. This shunt arrangement carries a fraction of the oscillating current of the main "tank," this fraction depending upon the relative sizes. It is an advantage to limit the current through the tube, as this capacity does not compare in efficiency with the tank condenser. The power lost in the resistance of the distributed circuit also constitutes a waste. The blocking condensers cannot be made too small, as the tubes will not oscillate. These remarks apply also to the tuned plate-tuned grid circuit, but only the plate circuit carries the heavy currents. The correct size for blocking condensers depends, among other things, upon the tube used and the circuit constants. In the 100-watt set illustrated, the size of condensers used

This sketch shows the layout of the instruments on the main panel of the Binneweg transmitter





A side view of the transmitter, with extra coil to one side showing attachment plugs

Read These Design and Constructional Hints

By A. Binneweg, Jr.

INSTEAD of describing in detail how to build the short-wave transmitter which is illustrated here, Mr. Binneweg, a "ham" well known to the amateur transmitting fraternity, has used it as the basis for a discussion of good design and construction of transmitters in general, and points out the salient features which should be considered.

For those who wish to duplicate Mr. Binneweg's construction the several photographs will convey quite satisfactorily the constructional features which make this particular transmitter one of simple design yet of sure, dependable long-distance operation.

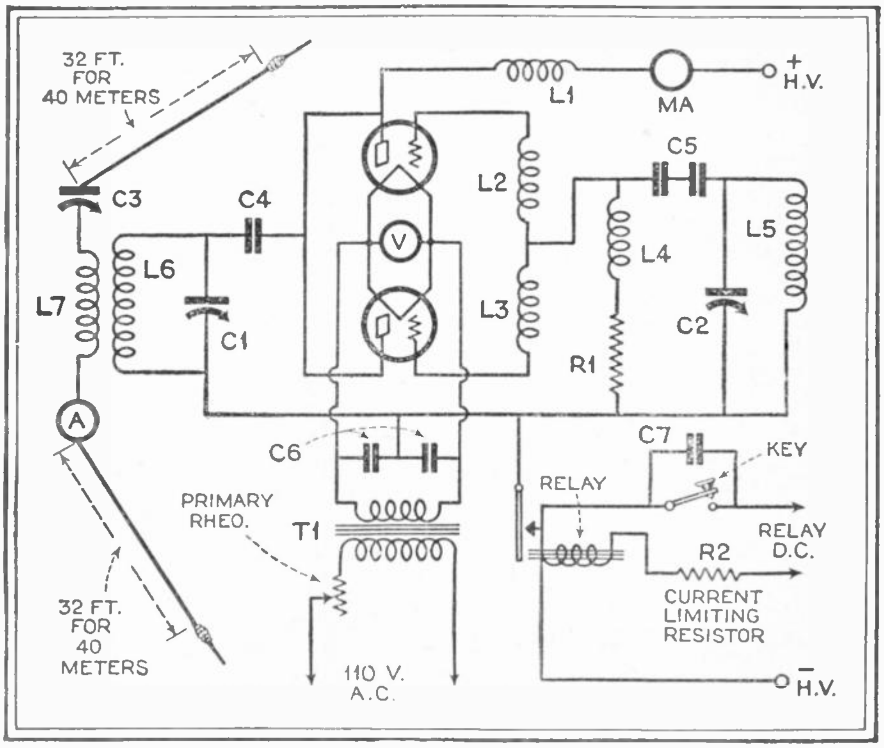
for blocking is .0006 mfd., this value being obtained from a high-voltage tapped block, especially made for this purpose. It is important in a high-power oscillator that the condensers should stand up under the relatively high voltages used. The grid condensers are not subjected to such high voltages. In this set two good mica condensers of double the required capacity, connected in series, were used. Further details on circuit values can be found also in the List of Parts.

Few pay much attention to the design of the r.f. choke. In this set the choke, L1, is subjected to high voltages and was, accordingly, constructed with great care. If the choke is not considered of importance, note the difference in output when a good one is replaced by another of indifferent construction!

A coil, due to its inductance and distributed capacitance, will have a natural period similar to a wavetrap, or parallel circuit, in which the inductance and capacity are connected in parallel and considered as "lumped" in the coil and in the condenser. Such an arrangement has a high impedance with respect to the external "lines," and thus effectively blocks r.f. currents of the frequency to which it is tuned. One would not, however, use an impedance having a high value of capacity for the circulating currents would be high and the losses quite large. A single-layer winding has comparatively small capacity and will serve for the purpose. There may be opinions to the contrary as to the use of a choke at its natural period, but experimenters who have worked on the problem recommend this procedure, as no better method is at present at hand.

Winding the Choke

To resonate such a choke to the desired frequency is not a simple matter with limited laboratory facilities, but the most convenient way is to start winding wire on a ½-inch form and continue a few turns at a time until the natural period is obtained. This can be tested by placing the choke near a small auxiliary oscillator; a good dip of the grid-meter will indicate the natural frequency. The natural period thus found, however, will change somewhat when the choke is placed in the oscillator, the amount of change depending upon the factors of construction and constants, so that no exact specifications can be given. The choke used in the 100-watt set operated effectively; it consists of about 200 turns of No. 30 d.c.c. wire on a ½-inch bakelite tube. The grid chokes, L2, L3, and L4, are not so important, but can be made similar to the plate choke.

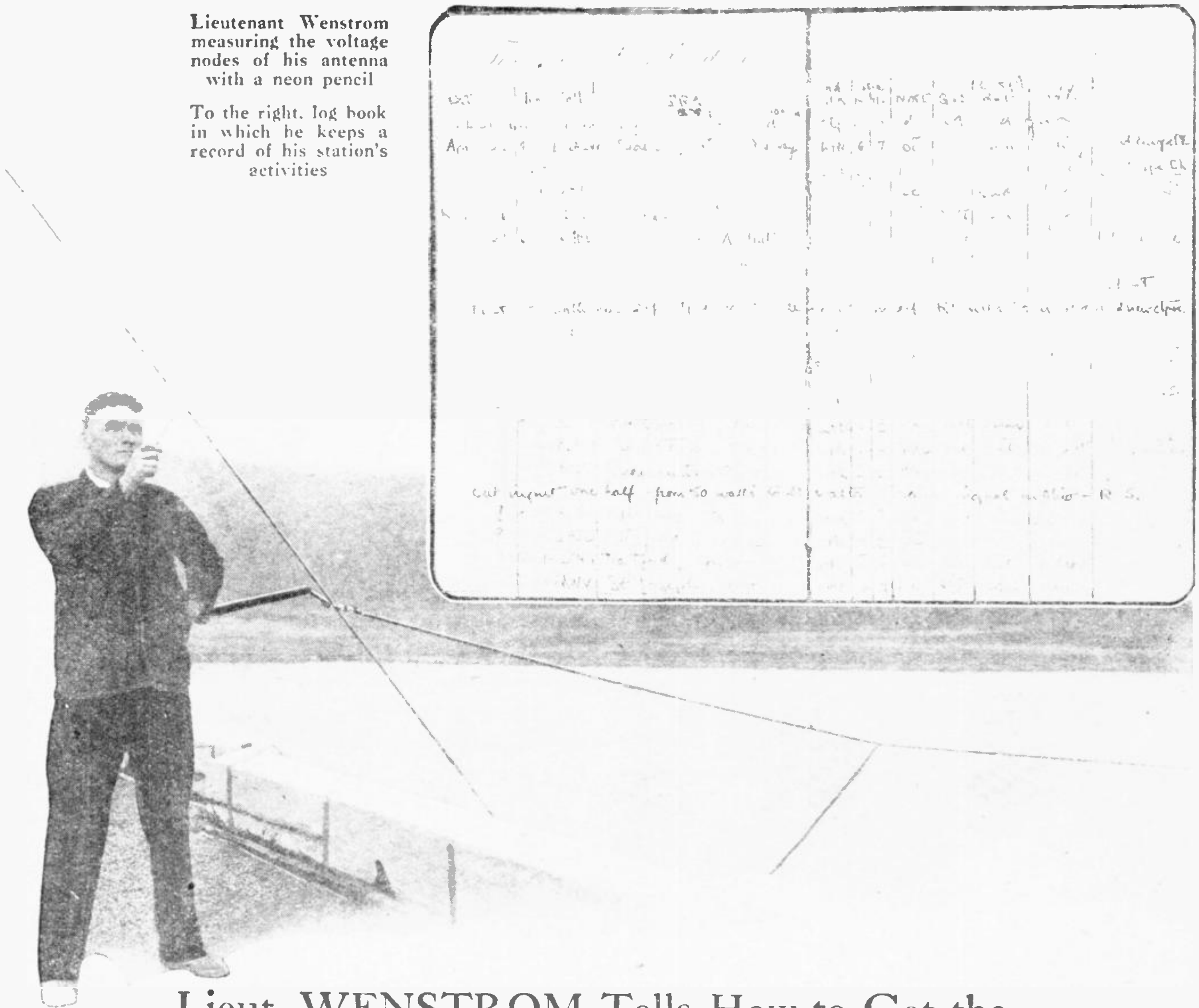


The complete circuit of the s.w. transmitter. Note the antenna-counterpoise dimensions required for best operation

(Continued on page 92)

Lieutenant Wenstrom measuring the voltage nodes of his antenna with a neon pencil

To the right, log book in which he keeps a record of his station's activities



Lieut. WENSTROM Tells How to Get the MOST *from your* Short-Wave Transmitter

DO you know whether your antenna is functioning at its full measure of efficiency? What sort of counterpoise do you employ?

DO you follow the standard form of "raising" a fellow amateur or does any old method satisfy you? Are your messages concise and complete or are you a "rag chewer"?

DO you keep a log of your station's activities? Have you noted any changes made in the transmitter, the antenna or other parts of your installation?

Read what Mr. Wenstrom has to say about these points.

ON page 60 we described some of the salient features of amateur procedure, particularly the methods of raising another station and the routine reports which characterize the first part of a two-way contact. Often the two operators discover enough in common for a protracted air chat; and many friendships—local, inter-sectional or even international, are thus formed. But there is another phase of amateur operating which appeals particularly to the more skilful and experienced operators who have run through the early DX thrills enough to feel the need of solid accomplishment, and that is traffic handling. We can here only indicate the general form of message procedure.

Messages

A message should be arranged and sent in the following form:

HR MSG NR7 FM BOSTON MASS W1AA NOV 10
TO RADIO WGZZ GLENDALE CALIF
HOW ABOUT A SCHEDULE NEXT MONTH QUESTION
SIG BOB SMITH

The dash signal (— · · · —) is sent after preamble, address and text; and the signal AR indicates the end of the

Every amateur is interested in receiving confirmation of communication with far distant stations. These cards are only a few of those received by Lieut. Wenstrom, shown below, at his transmitter

message. If the entire message is received correctly, the receiving operator sends "NR7 R"; or he may call for repeats by sending "?WA" (word after), "?WB" (word before), "?AA" (all after), "?AB" (all before). "RPT NR7" or "RPT MSG" would call for a total repetition.

An Amusing Instance

Once there was an amateur traveling on a commercial liner, and checking with a short-wave receiver the signals of an amateur friend ashore. Wishing at the least possible expense to let the shore friend know that all his transmissions had been received well, the sea passenger filed a commercial radiogram of which the text was simply "R." The ship operator obligingly fired the message at a commercial shore station, which promptly came back "RPT TEXT." The ship sent "R." "R URSELF," replied the shore station, "HW ABT THE TEXT?" "TEXT R," said the ship. "NO TEXT NOT R," from the shore station. And so, as Briggs would say, far into the night.

Telephone operation closely parallels code operation, with a few exceptions, such as "come in, please," for the code "K." The procedure is not as standardized as code, and varies a good deal with the individual. The procedure, here given, while not exhaustive, is enough to start with. Other details will be learned on the air, but it must be remembered that many amateurs operate incorrectly, and as in any other group activity, success depends largely on teamwork. For full information about traffic handling, see the American Radio Relay League's pamphlet, "Rules and Regulations of the Communications Department."

Foreign Countries

In the example calls above we used W as the beginning letter, signifying that the stations were within the continental limits of the United States. The beginning letter for our territories and colonies is K. Similarly, the amateur calls of each nation begin with definite letters, listed in Table 1. With this it is possible to determine at once the particular foreign country from which a received signal is coming. For the last four countries the old intermediates are given, as the new amateur call letters are not yet known.

"QSL" cards are simply postcards on which are printed some details of one's station. Seven typical foreign cards are shown in the photograph. As a rule, cards should be exchanged with a foreign station actually worked. Answering cards from foreign receiving stations or domestic stations is something for the individual to decide, but few operators feel that it is necessary.

Further Tests

The Home Transmitter tests reported last month were all conducted with plate voltages around 200. In some further tests we added a 100-volt booster unit to the plate supply. It consists of four 24-volt storage "B" batteries, mounted on a board with the charging bulb and switch. This practically doubles the output, and brings the performance, detailed in Table 2, up to that of an a.c. power supply installation. The 12-volt antenna indicating bulb is replaced by one rated at 6 volts, 3 c.p.; this has a normal current

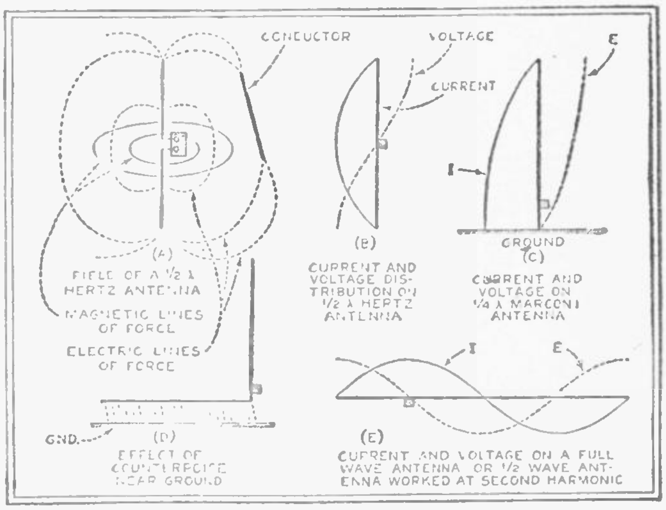


Fig. 1—At A is shown a ½λ Hertz antenna, with the absorption effect of a nearby conductor indicator. B shows the voltage and current distribution of this type of antenna, while in C the same is indicated for a ¼λ Marconi antenna. With the latter a counterpoise, as shown in D, may be used. E shows the voltage and current distribution of a full-wave antenna worked at its second harmonic

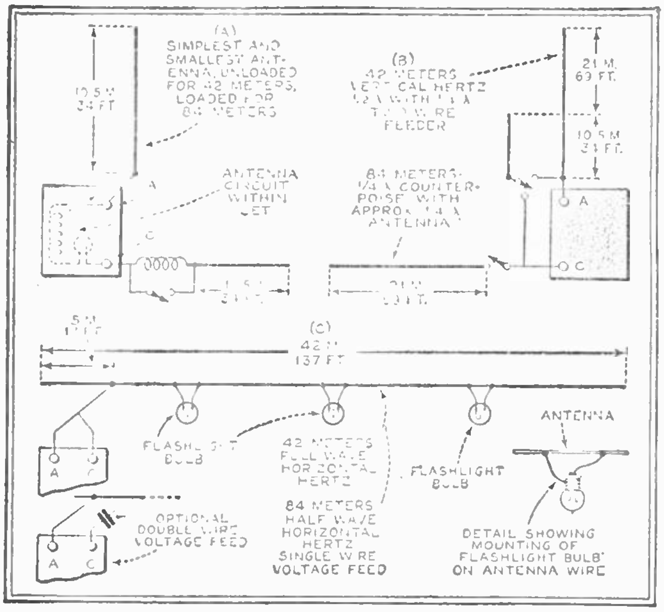


Fig. 2—These diagrams illustrate the various systems of r.f. transmission or "feeder" lines which are in general use in short-wave transmission work

of .6 amps, a cold resistance of 1.7 ohms, and a white-hot resistance of 10 ohms. We also use a grid leak of 10,000 to 15,000 ohms.

On the first test with the voltage booster we heard VE3BO sending out a CQ, and called him on 41.2 meters. He came back immediately, and reported our signals R5 and QSA3, pure d.c. tone and steady. His location was Toronto, Ontario, about 300 miles away. This was an excellent contact, without interference or repeats—a rather rare occurrence in the crowded 40-meter band. We next raised W3UX at Berwyn, Pa., about 150 miles away. This station was using "break-in," so that we could talk rapidly back and forth despite a good deal of interference. Our signal was R5 QSA5, and steady in frequency.

In another test soon after midnight we tuned the transmitter to 77 meters. The static at W2CX was very bad, and the other stations reported it heavy also. We first raised W3ADX at Allentown, Pa., not far for that time of night. The next contact was better—W9ANQ at Waukeegan, Ill., 700 miles out. Considering the output power of about 5 watts, we should not expect much greater distance than this in the 80-meter band. The third contact was W8DMS at Detroit, Mich., distant 500 miles. Each of the QSO's lasted about half an hour, and each new station was raised with surprising promptness for a low-power set.

Some further tests were made with the 40-meter coil. At about 8 a.m. we raised W9GCO of Angola, Ind., 600 miles out, who reported "pure d.c. and QSA3." The next morningg W4ADF at Moultrie, Ga., 900 miles to the south, reported "pure d.c. QSA3 steady." One or two other uncertain contacts were made, but the signal had become unsteady due to the varied wobbles of the obsolete 240-volt d.c. lighting circuit, now in its last gasp before conversion to a modern a.c. system. This is a local fault, however, and not a general one; when tested with all battery power, the transmitter sounded like crystal control, as did the same circuit at W2BEI with a.c. supply. There is no reason why builders of the Home Transmitter should not eclipse the performance here recorded and get 40-meter distance up to 2,000 or 3,000 miles in late night or early morning, particularly later on in the fall and winter. International communication on the 40-meter band has lately been almost at a standstill for several reasons. The one narrow band for all nations has greatly increased the difficulties, particularly for low-power sets; English amateurs report some difficulty in raising even the Continent. Many foreign nations have been slow in licensing their amateurs under the international agreement which went into effect last January. The transmission conditions for 40-meter work have been very unfavorable throughout the summer. The last two difficulties, of course, should clear up by the middle of this winter.

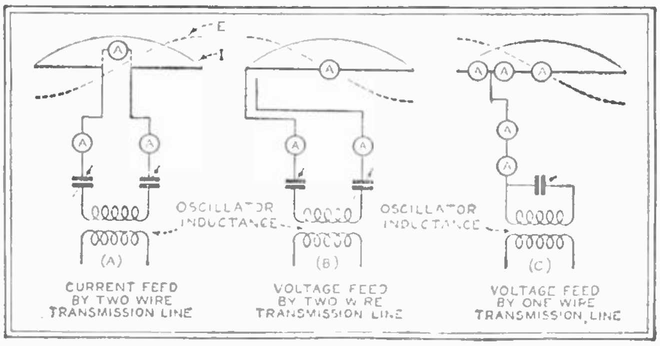


Fig. 3—Three types of short-wave transmitting antenna which will work satisfactorily on 42 meters or from 83 to 85 meters. A is a ¼λ antenna, B a vertical antenna with 2-wire feed, and C a horizontal Hertz, ½λ for 84-85 meters or full-wave for 42 meters

Antenna Design

Circuit designers are prone to claim superior results for their sets. We hear statements such as "this transmitter covers extreme ranges with a small input," or "in this location the Colpitts circuit has been found much better than the Hartley, which will not work at all." The truth is that the efficiency of most properly designed oscillator circuits is about the same regardless of type; for a given input they all deliver about the same radio-frequency power to the antenna. Granted an oscillator of average efficiency, then the greatest element in transmitting success is the antenna. Of course, things like location and weather have a great deal to do with it, but over these things we have no control. Within certain limits of space, cost and trouble, we can arrange our antenna to suit ourselves.

From the standpoint of electrical efficiency only, the simplest and most efficient arrangement would be to hang a single wire ½ wavelength (λ) long from a balloon several miles above the earth's surface, and to cut in our transmitter at the center of it. Our receiver, our power supply wiring, even ourselves, would all have to be absent from this picture of electrical efficiency—a limitation which makes it somewhat impractical of attainment. Such a system, shown in Fig. 1A, is called a ½λ Hertz antenna, because Hertz used it to radiate electric oscillations long before radio had any practical significance. In order to construct transmitting antennas it is necessary to know something of the principles which govern them. The writer could simply say "cut this wire a certain length, and stretch it thus." But this is not the way to approach transmitting; one must have some idea of what it is all about. If we look at the antenna of Fig. 1A for a very small instant of time, we shall find that the center oscillator is charging the top wire to one polarity and the opposite wire to the opposite polarity. As in the case of a condenser, therefore, an electric strain exists between the two halves of the antenna; or it creates an electric field, shown by the dotted lines. Within the limits of the frequency and the antenna capacity a momentary current actually flows vertically in the wires and this of course sets up a magnetic field, represented by the horizontal circles. The two fields should not be thought of as separate entities, but as components of the electric field as a whole. At each change of current caused by the oscillator this field builds up, and with the next current change part of it collapses into the antenna again. But part of it does not have time to collapse before the next current change forces it outward again, and this part, spreading ever outward into infinite space at the enormous speed of light, is called the radiation field—the only useful field for communication purposes.

Absorption Effects

Now let us assume that a conductor is brought near an antenna; we can see from the figure that, coming within the electric field and having currents induced within it, it will seriously distort the field and absorb a great deal of energy. That is why we projected the ideal balloon-hung antenna above—to get it away from absorbers of energy. In actual practice, of course, we fall far short of the ideal—note the W2CX antenna in the photograph, surrounded by other wires.

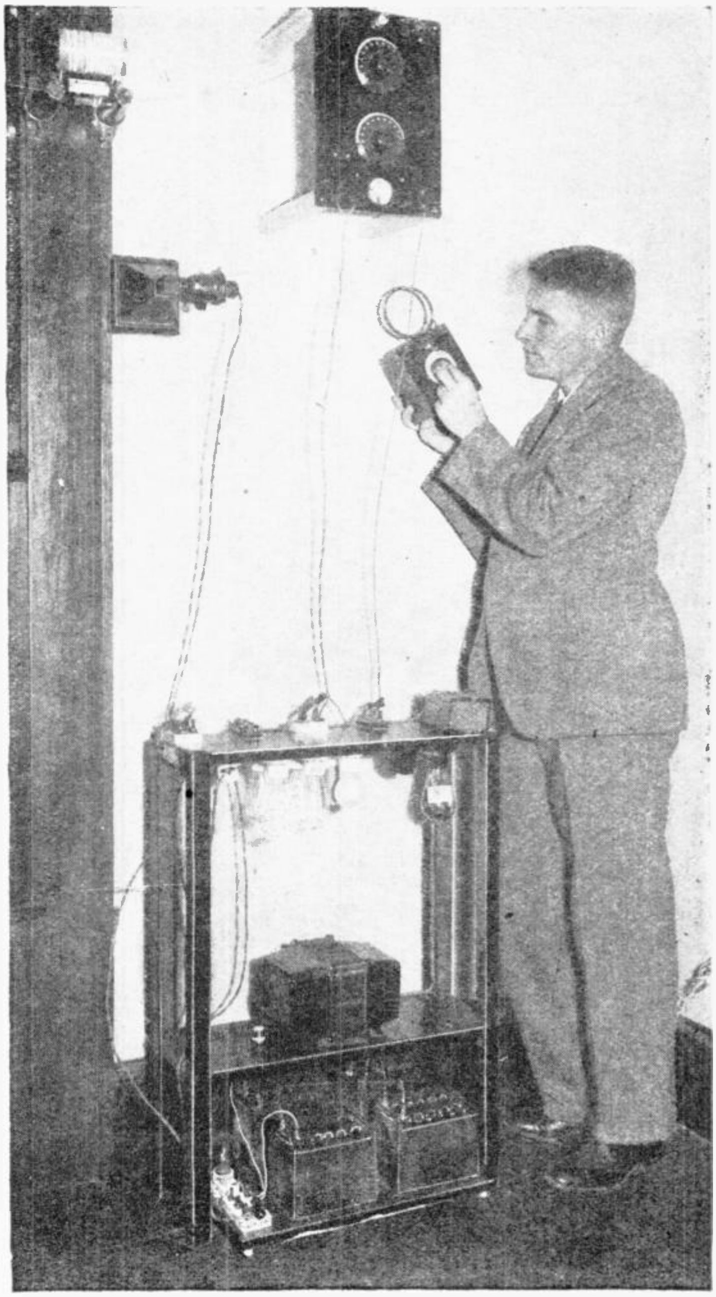
Antenna Currents and Voltages

We have said that under the urging of the oscillator, potentials and currents momentarily exist in the antenna; let us see how these elements are distributed. Fig. 1B shows the same ½λ Hertz antenna, and the distance away from it of the solid and dotted curves at any point gives an idea of the relative amplitude of current and voltage at that point. The current (solid line) is maximum at the center, and tapers off towards the ends. The voltage (dotted line) is minimum at the center and maximum at both ends. That means, for instance, that it is more important to keep the ends away from absorbers than the middle, for the high voltage at the ends may cause losses. It also means that if we wish to measure the antenna current, we should insert the meter at the center.

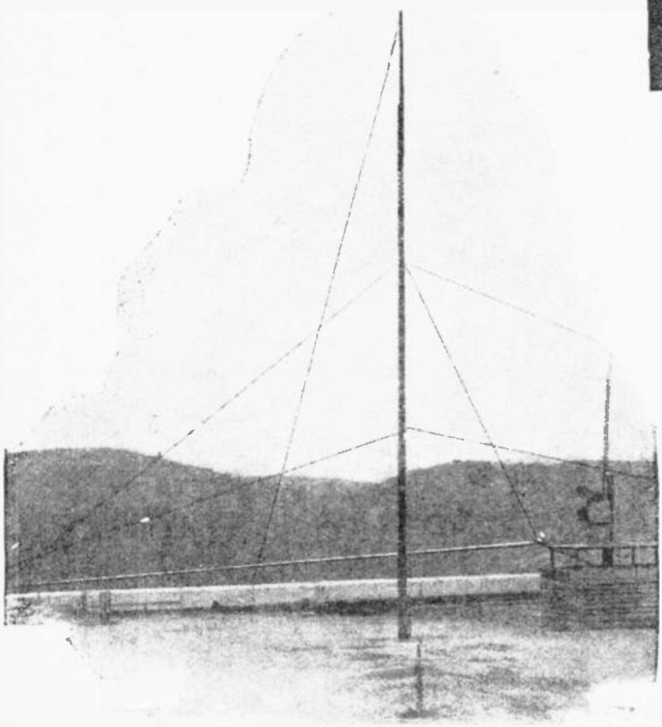
Fig. 1C shows a so-called Marconi antenna, in which the antenna proper is ¼ wavelength long (or loaded by a coil if less), and the ground (or water) takes the place of the bottom wire of the Hertz system. Where the ground conduction is good, this system is efficient; not so in the case of a high resistance ground, as on a dry desert. This very simple type of antenna was suggested last month as a starting point in transmission tests—the ground being a convenient water pipe or steam radiator. In the Marconi system we do not need to use a conductive ground: we can use a counterpoise (capacitative ground) instead. Such an arrangement is shown in Fig. 1D. It is readily seen that the system is equivalent to that of 1C with a condenser in the ground lead; it offers the advantage of low resistance by reaching directly a large ground surface. Either the antenna or the counterpoise, or both, may be bent instead of straight. The usual transmitting antenna is in effect a compromise between the two systems. The nearer it approaches the ground, the more it becomes a Marconi antenna; the higher up we get it, the more it approaches the ideal Hertz form. If the reader is interested in pursuing further the general theory of antennas, we suggest Morecroft's "Principles of Radio Communication," Chap. IX; or Lindenblad and Brown: "Main Considerations in Antenna Design," Proc. I. R. E. June, 1926.

Harmonic Operation

Going back to the antenna of 1B, we might liken it to a violin string which is plucked at the center. The string will then vibrate as shown by the solid current curve. By plucking the string in a certain manner, however, we can make it vibrate not as a whole, but in two halves, like the solid current curve of 1 E. (The truth is that it vibrates both as a whole and in parts, but let us neglect this.) The as-a-whole vibration is said to be its fundamental note; the half-and-half vibration is said to be its second harmonic. Similarly, we can have a full-wave Hertz antenna equivalent to two ½λ ones placed end to end. Call it a full-wave 40-meter antenna working at 40 meters, or a half-wave 80-meter antenna working at its second harmonic (40 meters); two ways of saying the same thing.



Checking the wavelength adjustment of your transmitter frequently insures efficient operation. The wavemeter tells you whether the transmitter is adjusted to work correctly with the antenna you have provided



Mast guy wires should be broken in electrical lengths by the use of insulators so as not to resonate with the antenna. Otherwise these guys will absorb some of the radiated energy

R.F. Transmission Lines

We have said that we wish if possible to get the antenna up in the air away from absorbers. It may be either vertical, slanting, or horizontal; the last position keeps both ends well away from the

(*Continued on page* 88)

A Complete A.C. Operated SHORT WAVE Receiver, With PUSH-PULL Output

By H. S. Knowles

ALTHOUGH a number of short-wave adaptors that have been intended for a. c. receivers have been announced at various times, to the best of our knowledge no complete a. c. short-wave receiver has been described. The problem of making such a receiver which is reasonably free from a. c. modulation when receiving short-wave phone signals (that is, in a non-oscillating condition) is only slightly more difficult than that of a standard broadcast receiver. The difference arises largely from the fact that power line and rectifier disturbances are more pronounced at high frequencies. The design of a full a. c. operated short-wave receiver, which may be operated in an oscillating condition and with a value of a. c. modulation which is sufficiently low to permit real DX reception, is a much more difficult one.

Five tubes Employed in A. C. Short-Wave Circuit

The receiver uses a choke-coupled screen-grid stage followed by a 227 detector and 227 first a. f. stage and a pair of 245 tubes arranged in a push-pull power outfit stage. An inspection of the schematic wiring diagram in Fig. 1 does not, as might be expected, disclose any unusual circuit arrangement. With the exception of the two chokes, which are in series with the plates of the 280 rectifier tube, the by-pass condensers from the heater circuit to ground and the .1 mfd. condenser, which is tied into one side of the line, the circuit is perfectly conventional. Experience with the circuit precautions necessary in high gain screen-grid tube circuits at broadcast frequencies have brought out the necessity of using a separate ground return for each circuit to which all of the returns for that particular circuit are connected. All of the leads are as short and direct as possible with the exception of the one to the regeneration condenser which was, however, laid out so the loop it formed did not introduce any a. c. hum. It will be noted that although the rotor is at ground potential, the return lead is run all the way from the midget condenser to the common ground of the detector circuit.

Receiver Employs Novel Design Features

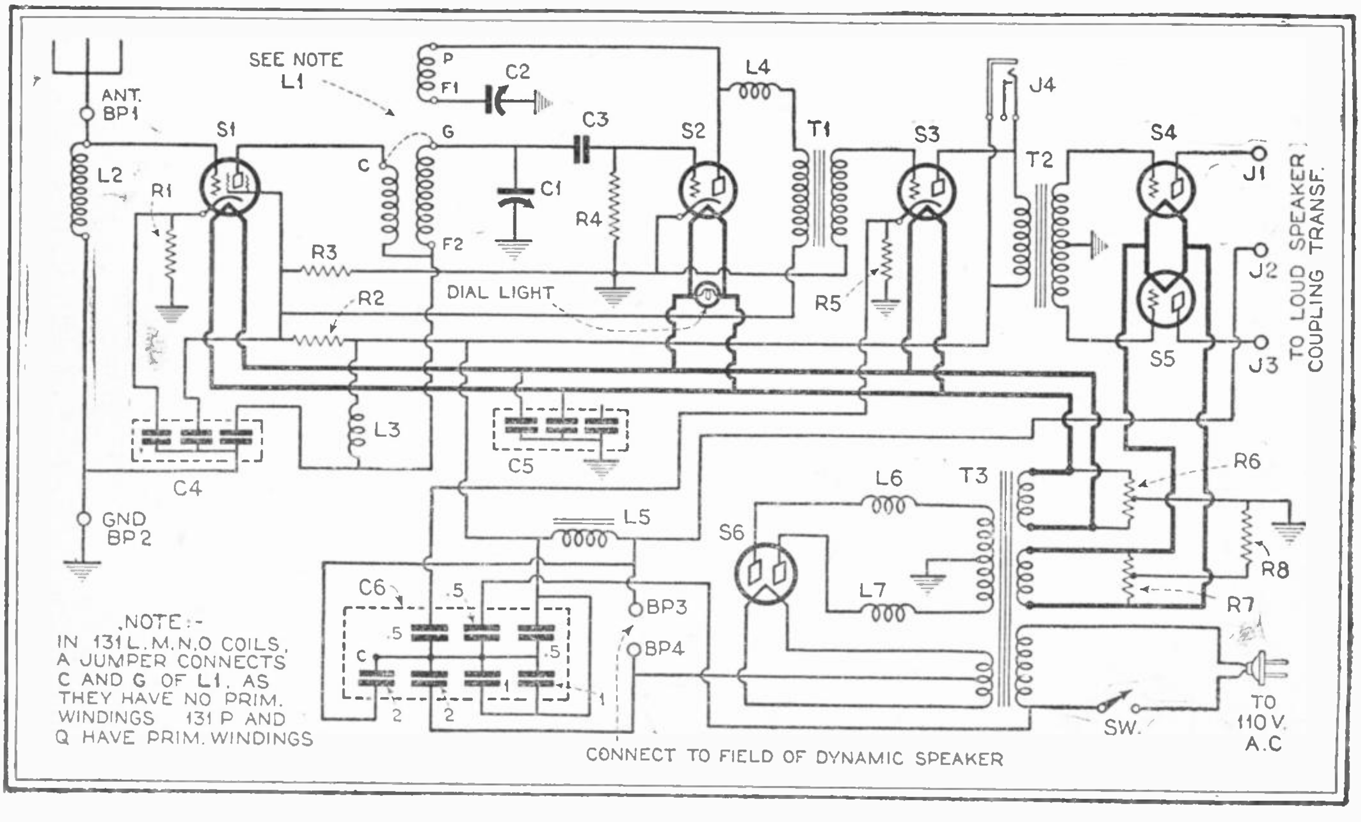
It was found that a large percentage of the interference from power line disturbances could be filtered out by placing radio-frequency chokes, which had a uniformly high impedence to the frequency range that the receiver covered, in series with the plate leads of the 280 tube.

The .1 mfd. condenser which is connected to the ungrounded side of the 110 volt a. c. line is the first condenser of what is, in fact, a complete r. f. and a. f. filter. The first condenser in the plate supply filter is the terminating condenser in the r. f. filter.

Stability in Operation Obtained By Choke Input

Although the possibility of using a tuned input to the 224 tube was considered, in order to improve the amplification, it was found that the greater amplification of this 224 tube resulted in quite a marked improvement over the usual d. c. receiver using the 222 tube with an untuned input. Although the effective grid-plate capacitance of the 222 tube is only .025 mmfd. this capacitance is very appreciable at the high frequencies at which a short-wave receiver is normally used.

At these high frequencies the 224 tube by virtue of its lower effective grid-plate



capacity permits about 2½ times the gain with the same stability. Even this extremely low value of effective grid-plate capacitance is high enough, however, so that there is no improvement in gain at the very high frequencies and the slight increase in selectivity which may be obtained under certain conditions is more than offset by the difficulty of tuning this extra circuit.

Although the alignment could be preserved between the two tuned circuits of one, or possibly two of the ranges covered, it is impossible to make the two circuits "track" with all of the sets of coils required to cover the range of from 17 to 650 or even 17 to 215 meters. There is also the added disadvantage of having to change two dissimilar coils instead of only one, for each range.

Condenser System of Regeneration Found Satisfactory

Although rheostat and potentiometer type regeneration controls were tried, these were rejected in favor of the conventional condenser method when it was found that the frequency variation with regeneration setting could be minimized, the "drag" in the control almost eliminated, and the a. c. modulation reduced to a lower value than was otherwise possible. The regeneration control is used as a volume control since in the reception of phone signals it was found that a sufficient change in gain could be effected. On very loud signals the speaker may be used in the first stage jack where a head set is normally used for DX. Because of the high selectivity of the receiver in the oscillating condition when used for the reception of CW and even ICW signals and due to the fact that broadcast stations are not placed on adjacent channels 10 kc. apart at high frequencies, the selectivity did not need to be increased above the values obtainable with a single tuned impedence-coupled stage below 200 meters (above 1500kc.). At broadcast frequencies the selectivity of a single tuned impedence stage is inadequate for local reception. In the two coils which cover the broadcast band an inductively coupled primary is used; the necessary change in circuit is taken care of by a jumper in the short-wave coils.

At broadcast frequencies the receiver may be used where moderate gain and selectivity are required.

(*Continued on page 77*)

Some Refinements for the S-W Four

PROOF of the fact that the S-W Four, the short-wave receiver described in the August issue of RADIO NEWS, is meeting with wide acclaim and popularity will be apparent from reading the letter which the editors of RADIO NEWS have received from the designer of the receiver, Mr. Samuel Egert.

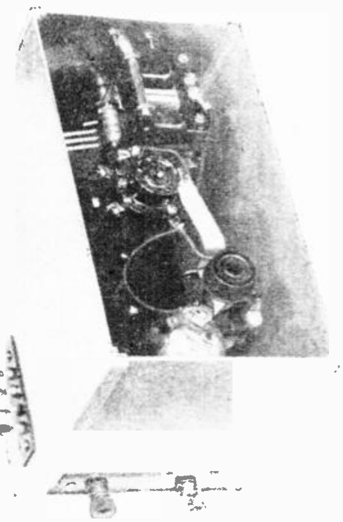
Questioned further, Mr. Egert has furnished us with additional information concerning the operation of the S-W Four, which undoubtedly will be of interest to readers of RADIO NEWS.

DEAR MR. EDITOR:

No doubt you have been interested in knowing the response which resulted from the publication of the article on the S-W Four, described in August RADIO NEWS. Interest in short waves has been increasing by leaps and bounds, and the S.W. Four has been another incentive for the radio fan to realize its possibilities. Almost everyone wanted to know of the possibilities of hearing Mr. Nicholson's voice direct from the Graf Zeppelin. The Columbia Broadcasting system distributed five of these sets along the Atlantic Coast, working on schedule time with Mr. Nicholson.

One item of interest is the inquiries that have been arriving. They have come from almost all over the world. I am sure that you can appreciate the worth of a short-wave set located in some part of deep Africa or in the frozen North where communication with human beings is an impossibility without the proper type of short-wave equipment. The interest shown from these distant parts, seems to be greater than that shown here in the United States. This is possibly due to the fact that men in foreign lands are in need of and want something which they believe will produce results.

We have made a series of experiments in various parts of the city and suburbs to determine the exact possibilities of this set working under these different conditions. We have found that reception on shortwaves in the city is far inferior to that in outlying sections. The steelwork that exists in the structure of urban buildings hampers the reception of short waves to a great degree; and the results obtained



both in reception and volume were greatly decreased when compared to results obtained in the suburbs. Another thing that we have found to our delight is the adaptability of this set to broadcast reception. Local stations come in with fine volume and most certainly afford as good entertainment as the most modern electric receiver. There is one more discovery we made while testing the receiver and that was its complete lack of hand capacity. This is probably due to the excellent shielding it employs. All in all we had a great time while checking the receiver. We stayed up two or three nights until about 4 in the morning and aside from the reception we received on short-wave broadcast, which included voice and music reception from France, England, Holland, Germany and Australia, we received code reception from every continent in the world, checking Byrd as well.

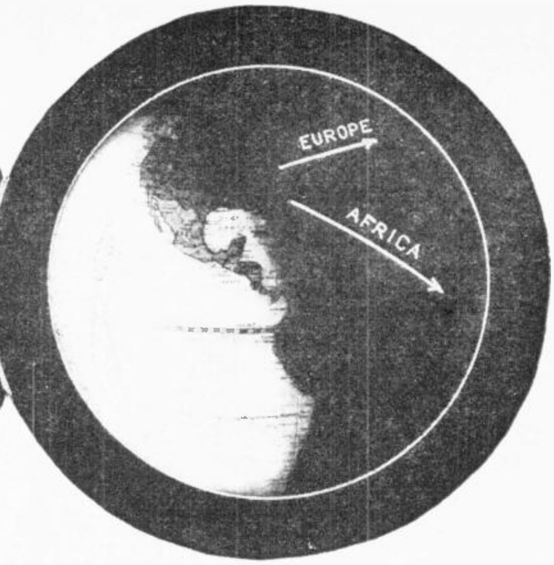
One rather serious criticism of the operation of the receiver was the way in which the dials tracked, or rather their lack of tracking. This was due to the difference in the characteristics of the two tuned circuits and the tubes to which they inputted. To overcome this tuning discrepancy the following remedy will prove quite satisfactory. Merely shunt across the first tuning condenser, a midget of the 3.2 mmfd. size. The accompanying photo shows how this is done. Then, with the midget adjusted, the main dials will read alike and will track together.

Here are a few reports from some of the people who have built the S-W Four: The first comment invariably is upon the ease with which one can construct the set. Most of the men who have built this set are not amateur radio operators who are interested in code, but who are vitally interested in ge ting good broadcast reception on sh waves. This is the first time that t ave owned a short-wave set, and ' ults they are obtaining are highly raging. Most of them have already succeeded in getting foreign broadcast reception on short waves, despite their unfamiliarity with a set of this type. This speaks well for the ease of tuning, which we have always claimed was one of the features of the receiver. We have also received a report from a gentleman in New York State, who is using a B-eliminator for his B supply with very fine results. We have tried the short-wave set with various B-eliminators at different times and have found that excellent results are obtained on some while very poor results are obtained on others. This, of course, is due to the efficiency of the eliminator. In other words, if one wants to use an eliminator, he must use a good one. One of our customers is employing a 210 tube in the last stage successfully.

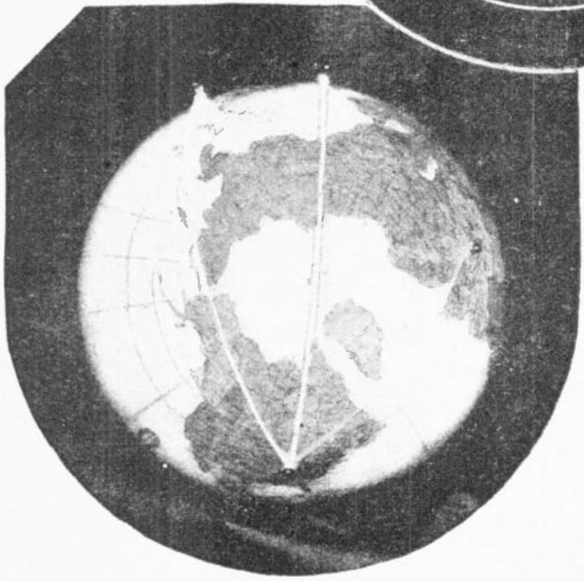
We have also had a number of comments as to the quietness of operation. As you know, we employed the use of seven by-pass condensers in the design. They seem to be functioning very well, as the quietness of operation depends on these by-pass condensers. Another thing

(*Continued on page 77*)

SUNRISE IN THE EASTERN U. S. Most favorable conditions for low-power communication with New Zealand and Australia. The earth's inclination corresponds to November or February



OVER THE TOP OF THE WORLD. If they follow the shortest (Great Circle) routes, signals from Chicago would shave Greenland to reach Central Europe, cut the Arctic Circle on the way to the Philippine Islands, and cross the North Pole on a direct line to India



SUNSET IN THE EASTERN U. S. Most favorable conditions for low-power communication with Europe and Africa. The earth's inclination corresponds to November or February

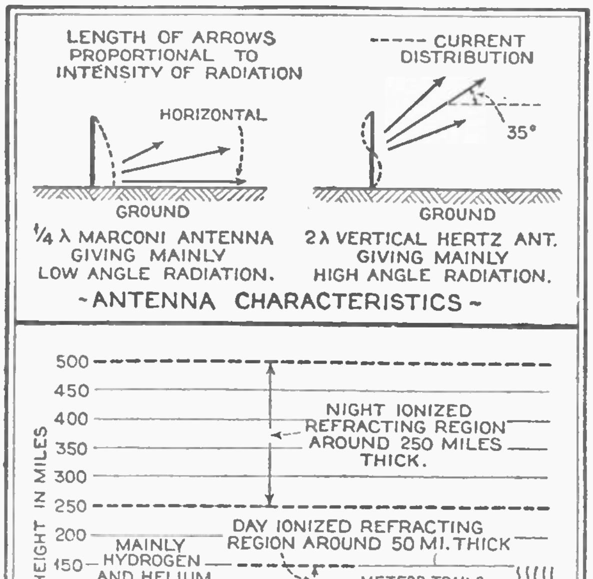
MORE on *Short-Wave*

The First Complete, Authentic planation of Long-Distance

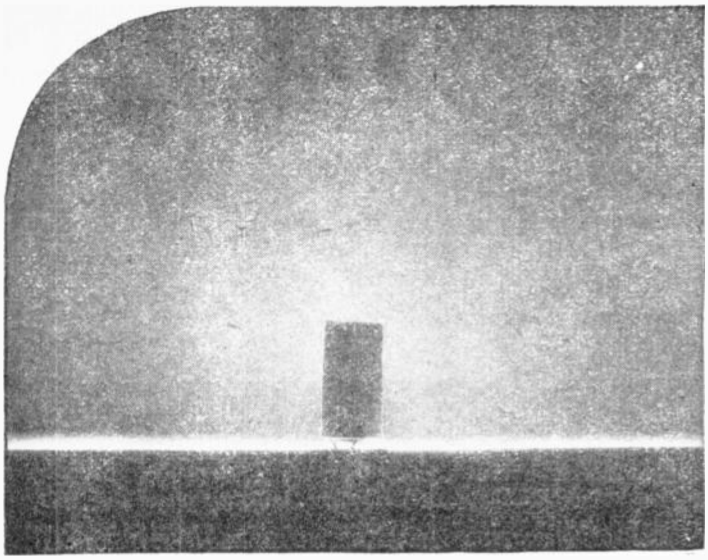
By Lieut. W.

IN the old days of long-wave supremacy an air of complacent finality pervaded radio transmission theory. This has, under the onslaught of the short waves with their worldwide range on low power, given way to a less comforting but more healthy uncertainty in which the radio engineer must consult the meteorologist and even the astronomer. The commercial companies seized quickly enough on the practical possibilities of the high-frequency El Dorado, with some possible benefit to mankind through the reduction of wireless rates; and for a time engineers were too preoccupied with what the short waves did to question how they did it. But now the tide has changed, and perhaps the greatest gift of the short waves to man will be in prodding him to further investigations outside the narrow ten-mile layer which he inhabits. Fortunately, the short waves provide a method as well as an incentive. If we set up a receiver near a powerful transmitter equipped to send a "jab" signal about 1/1000 of a second long, we can record, perhaps a thousandth of a second after the nearby shock has passed, an "echo" indicating that the wave has traveled some hundred miles up into the air, whence it was by some agency directed again downward towards the earth. And about one-seventh of a second later we may trace a second and much fainter echo, indicating that the wave has made in that brief fraction of time the complete circuit of the globe. How do these things happen?

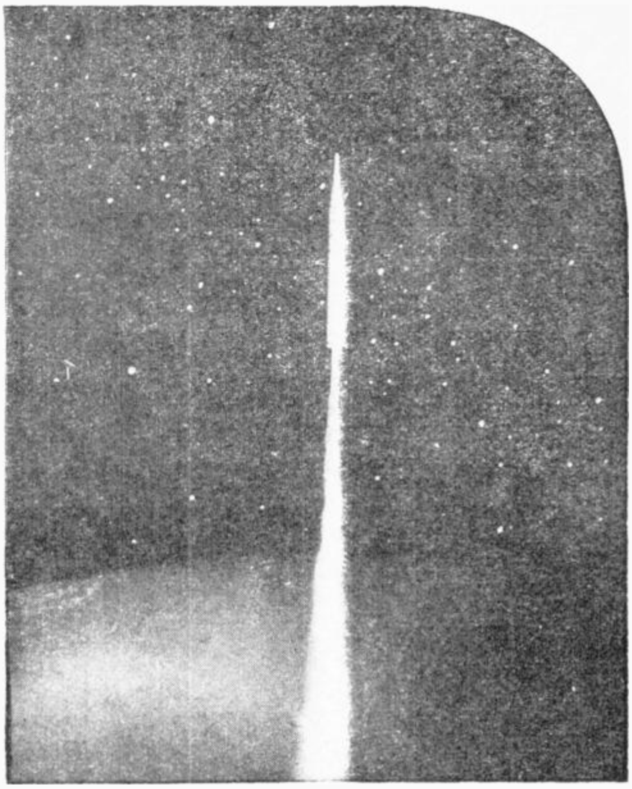
In attempting here a readable and non-mathematical explanation, we shall have recourse to many illustrations and analogies. Radio waves are almost exactly like light waves except in size, and their performance on a large scale can often be visualized by studying the performance of light waves on a small scale. If our language seems



At the top, Fig. 1 shows the radiation characteristics of two types of antenna, while Fig. 2 (below) indicates the relative heights attained by man and those attained by the night and day ionized regions



LIGHT FILAMENT ANALOGY OF A TRANSMITTING ANTENNA ABOVE CONDUCTING GROUND. The filament behind the screen radiates light in all directions. The "ground" absorbs some of the light, but reflects the rest of it to reinforce that coming directly from the filament



PROBABLE APPEARANCE OF THINGS IN THE IONIZED LAYER. The Goddard high-altitude rocket, only man-made contrivance capable of reaching these heights, zooming up from the earth dimly visible hundreds of miles below, gleams in the light of a blue-white sun, which blazes against a black sky filled with brilliant stars

LIGHT *Transmission*

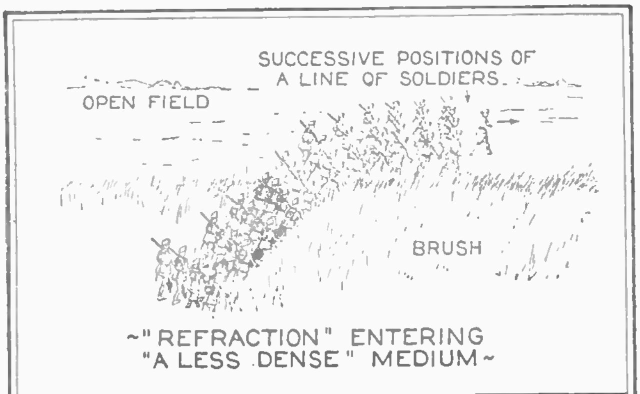
and Non-Mathematical Ex- Radio Transmission Theory

H. Wenstrom

at times a trifle abstruse, it is because the subject is more so; and if our facts and figures seem rather vague, it is because the foremost authorities of the present cannot yet find ground for exact agreement.

Antenna Radiation and Immediate Ground Reflection

Let us see first of all how the radio waves get away from the average antenna. We discussed at some length in a previous article the formation of the electromagnetic field about the antenna, and the fact that a part of this field speeds away in all directions. "In all directions" is not entirely correct, however, for the ground cuts off everything below the horizontal, absorbing some, reflecting some. As Morecroft has pointed out, an antenna over partly conducting earth is analogous to an incandescent filament over a partly reflecting surface. This is well shown in the photograph. The filament is behind the oblong pasteboard screen so that its glare will not fog the film, and the radiation of light into the surrounding smoky air can be clearly seen. The white paper "ground" cuts off practically all the downward radiation, reflecting a large percentage back up again into the air. If the horizontal surface were a mirror, we could see an inverted image of the filament below the real one; and in the same way if the ground below an antenna is a good conductor, there will be a well-defined virtual "image" of the antenna below the ground level. It is easily seen that if the ground is a good conductor (and hence a good reflector) the radiation is more efficient. For this reason big commercial stations are often



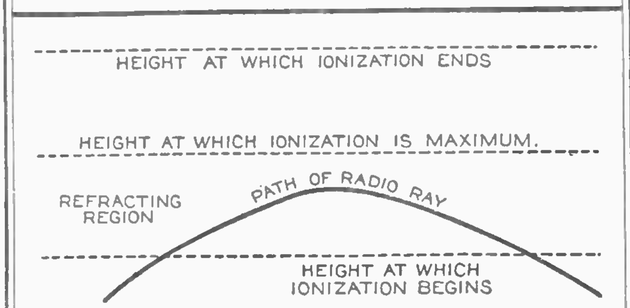
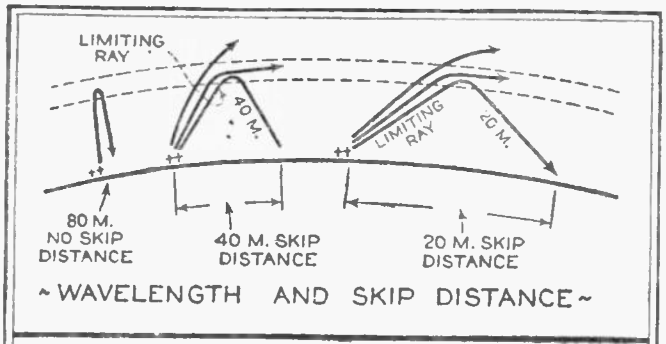
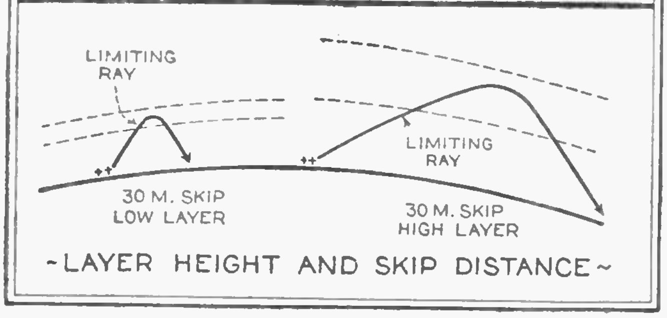


Fig. 3 (above) shows how the line changes direction to the right, because the soldiers on the left encounter the easier going first and for a short time walk faster than those on the right

Fig. 4 (below) illustrates how a radio ray is refracted due to the ionized layer.





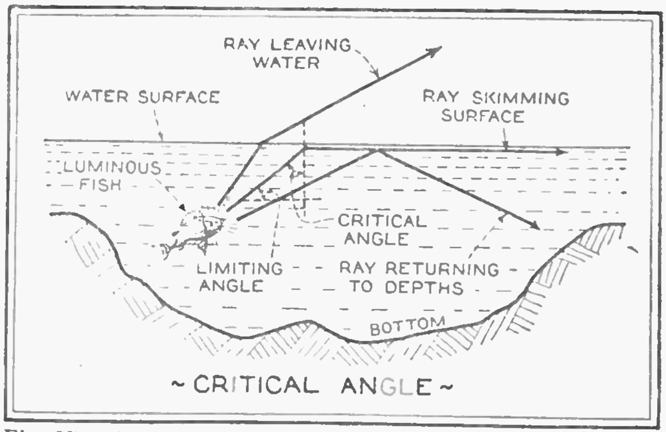


Fig. 5B (above, to the left)—For a given wavelength, as the layer rises, the skip distance increases

Fig. 5A (to the left)—For a given layer height (here pictured for a summer day), as the wavelength decreases, the skip distance increases

Fig. 5—A simple analogy depicting how rays of light from a luminous fish may, depending on the angle, be reflected from the surface or passed out into the air

located in salt marshes, and the ideal "ground" would be smooth sea water or large, flat metal serface. It might even be worth while to build such a surface, or to outline it with wires, beneath a short-wave transmitting antenna.

Even if the antenna is raised high above the earth, ground reflection and the "image" effect will still play some part in transmission. The present-day ceiling for an aircraft transmitter is less than eight miles, and this distance is small in comparison with long-range signal paths. Raising the transmitter in an airplane may, however, have an important effect on skip distance, as we shall see later.

KNOWING the conditions under which you work is half the job. It is no less true in short-wave transmission than in every-day walks of life.

If you want to raise a station in Europe or Africa, your efforts will not be as successful if the attempt is made, let us say, at sunrise, as they will be if made at sunset. Similarly efforts to contact Australia will be more successful when the sun is just up than at sunset. Reasons for such phenomena are clearly described and explained in this noteworthy contribution by Lieut. Wenstrom.

The publication of this manuscript makes available, for the first time, as far as we know, a simple, non-technical application of the intricacies and vagaries of the theory and principles of short-wave transmission.

It is one thing to pound the key of a short-wave transmitter and hope to high heaven that your signals are "getting out." It is another thing to understand intelligently the limitations under which such work is accomplished.

If you are interested in the "how and why" of short-wave transmission, read this article.

THE EDITORS.

Antenna Radiation Angles

We should recognize at this point that radiation patterns may differ widely for different types of antennæ—that is, one type of antenna may project most of its energy in a horizontal direction, while another may radiate chiefly at a steep angle. This is shown for two sample antennæ in Fig. 1. Horizontal radiation, and perhaps radiation for several degrees above the horizontal, may be absorbed by the earth. This absorption is less pronounced for short waves than for long ones; and therein, as we shall see, is the great advantage of short waves, that lower "rays" can be used.

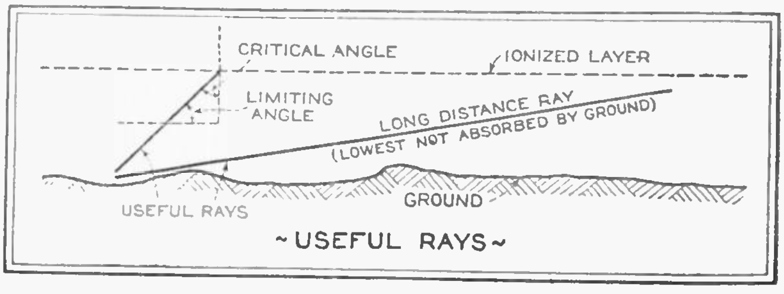
These effects are somewhat complicated by the fact that hills and buildings close to the transmitter may cast radio "shadows," and these shadows are sharper for short waves than for long. The same thing is true of light—the diffraction, or bending of light rays around a sharp edge, is greater for red than for violet. Even in sound the same principle holds. The sound of a cannon, fired on the opposite side of a hill or a large building, is muffled; the lower frequencies in the report, bending more easily around the obstruction than do the high ones, reach our ears in greater intensity.

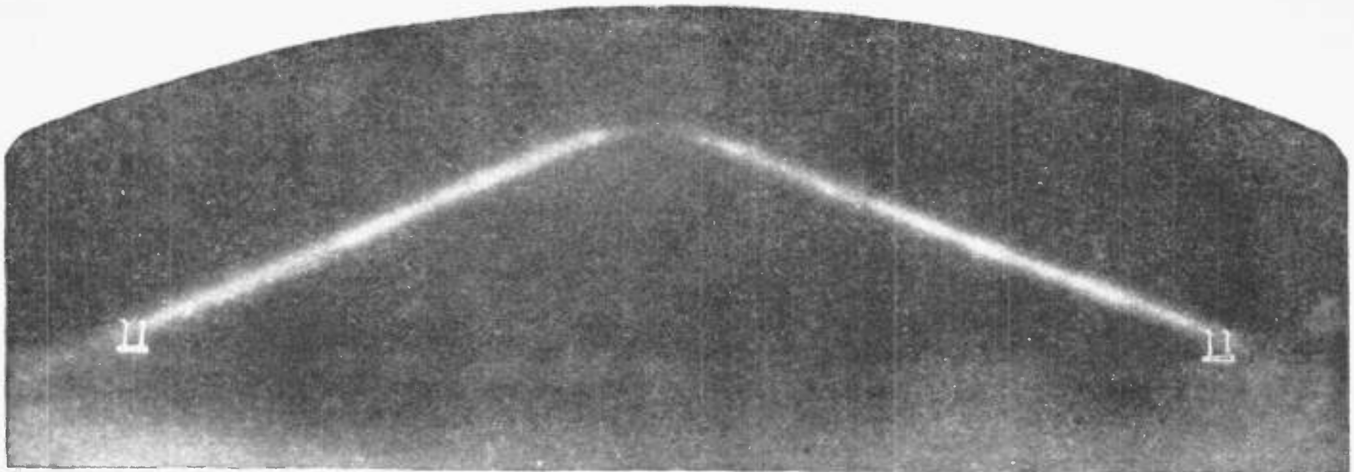
Before leaving the subject of antenna radiation angle, we might mention the possibilities of a horizontal parabolic reflector, arranged to throw a horizontal band of radio waves in a manner suggestive of a well-designed auto headlight. By moving the entire reflector system, it is possible to choose any maximum radiation angle at will. Such a reflector has been used by Meissner in Germany for 11-meter communication with Argentina.

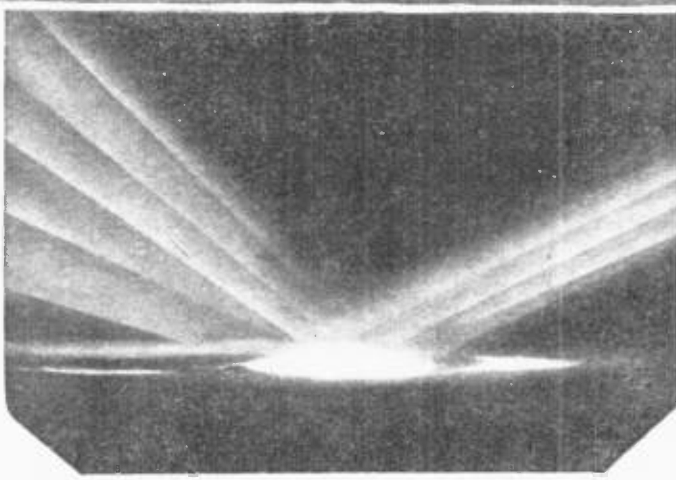
The Nature of the Ionized Region

The attempt to explain completely short-wave radio transmission has led to an intensive study of the nature of the earth's upper atmosphere. It was first thought that the upper air could act only as an absorber of radio waves, but as early as 1902 Kennelly, an American, and Heaviside, an En-

Fig. 6—All rays, between the limiting ray and the lowest ray not absorbed, return to earth







LIGHT BEAM ANALOGY OF GROUND-REFLECTED RADIO RAYS. When radio rays sloping downward from the ionized layer strike the ground, they are partly absorbed and partly reflected (generally with some diffusion)

LIGHT BEAM ANALOGY OF IONIZED LAYER EQUIVALENT REFLECTION. The light rays represent radio rays leaving the transmitter at high angle, to be "reflected" by the ionized layer down again to a distant receiver

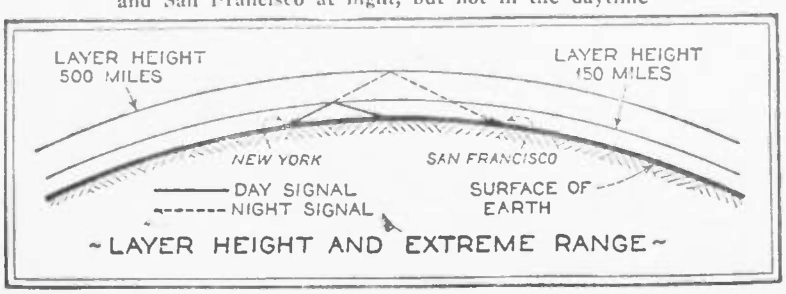
glishman, independently suggested that some reflective or refractive effect must be assumed to explain long-distance communication beyond the bulge of the earth. Since then the term "Kennelly-Heaviside Layer" has been used rather loosely by many writers to designate, sometimes a wide region, sometimes a definite surface or "shell." At the start we must realize that anything like a shell hundreds of miles above the earth's surface is the most monstrous impossibility, as extravagant as the solid sphere which the ancients believed to turn with the stars. There is absolutely nothing at these heights which would not be considered a very good vacuum at the earth's surface, and even at 30 miles, pressure has fallen to 1/1000 of its surface value.

Our knowledge of the upper atmosphere is far from final, because it has been arrived at largely by indirect means. The highest that a sounding balloon carrying meteorological instruments has ever ascended is about 20 miles—scarcely a beginning. But there are some indications of the height and nature of the upper air that anyone can notice. If we pass over the scattering of short light waves that makes the blue sky, or the transmission of long ones that makes the red sunset, the most common effect is the persistence of twilight after sunset and its appearance at dawn. This twilight is caused by the sun shining on the air high overhead, and the fact that it lasts about an hour indicates that the atmosphere up to a height of about forty miles is dense enough to scatter light. This gets us far above the range of the sounding balloon; other indications can carry us higher.

On clear, moonless nights we have all noticed "shooting stars" or meteors coursing swiftly across the heavens. They are specks of iron or rock, mostly smaller than pinheads, which approach the earth with velocities ranging from ten to fifty miles a second. They come originally from the break-up of comets by the sun's radiation pressure, and the comets themselves perhaps came from the Orion nebulous regions when the solar system was passing through them six or eight million years ago. Due to their high velocities, these meteors begin to glow with frictional heat in the rarefied gases a hundred or more miles above the ground, and they usually burn out above fifty miles. The prominent hydrogen and helium lines in their spectra indicate that the upper atmosphere consists largely of these gases. The photograph shows a meteor, and the pulsing light near the center of the trail apparently indicates successive explosions as the surface layers are enormously heated, vaporized and stripped away. As we shall see, radio signals themselves now furnish some of the best experimental evidence about the atmospheric heights.

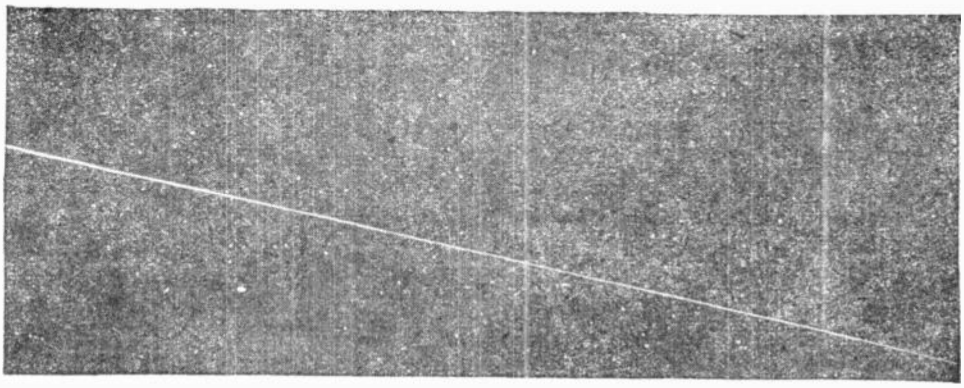
All these determinations are of course reachd indirectly, but they are in fair agreement. The only man-made device which gives much promise of carrying instruments to these heights is the Goddard rocket. A hypothetical observer rising with one of these would notice many strange phenomena. The pressure diminishes rapidly, the blue sky changes to violet, between 50 and 80 miles up the familiar nitrogen and oxygen give way to hydrogen and helium. The violet sky fades to black, planets and stars appear despite the sun, which has become bluer and more intense. Finally, at 500 miles, as pictured in the photograph, the sun shines brilliantly on the rocket and its trail, the sky is completely black and the stars very brilliant, and far below appears the dim bulge of the sunlit earth.

Fig. 7 shows why it is possible to transmit on 40 meters between New York and San Francisco at night, but not in the daytime



Having achieved a reasonable picture of the upper atmosphere, let us inquire more fully into the behavior of high-flung radio waves. When a diffuse gas is subjected to certain radiations, electrons are knocked out of some of its atoms, and wander about by themselves or attach themselves to complete atoms. The gas therefore contains three unusual things: free electrons, positive ions (atoms which have lost electrons), and negative ions (atoms which have picked up extra electrons); and under these conditions it is said to be ionized. It is the ionization of the upper air that makes possible the return to earth of upflung radio signals. The ionization, as we go upward, begins at about 20 or 30 miles, increases up to about 100 or

150 miles or possibly more, and thereafter does not increase and may decrease. The major cause of this ionization is the ultra-violet light from the sun, which of course strikes only the day-lit hemisphere. In addition, this stupendous energy-machine, of which we hope to say more in a later article, throws out at inconceivable speeds myriads of actual electrons (β particles) and many ions (α particles). These particles do not continue, like the ultra-violet, straight toward the daylit side of the earth, but many of them follow the lines of force of the earth's field and converge at the magnetic poles, whence they may migrate equatorward to some extent. The concentration of this form of ionization has striking visual proof in the aurora borealis and aurora australis, brilliant and colorful displays of diffused light which seems to radiate from the magnetic poles. But as a matter of fact the green (oxygen) line of the aurora is always present in the night sky even at the equator, and demands a supplementary explanation of night ionization. The probable cause is cosmic radiation—electro-magnetic waves about one ten-millionth as long as visible light waves—that appear to originate from the destruction of atoms in the great suns that we call the stars. In general, we can say that the ionized region is somewhat more intense and extends somewhat lower in the daytime, and is less intense and higher at night. It is also more intense and lower in summer than in winter.



Photograph courtesy Harvard College Observatory

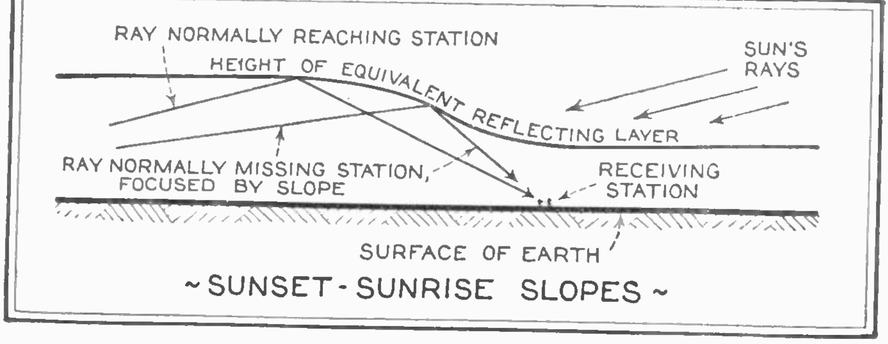
An actual photograph of a meteor trail. The meteor is coursing across the starlit heavens on a moonless night. Note the broken appearance of the center of the trail, probably caused by repeated explosions of the meteor's outer surface.

Refraction in the Ionized Region

We have said that ionization denotes the presence of electrons and two kinds of ions; in short-wave radio transmission the ions scarcely count, and the important thing is the number of free electrons per unit of space—the electron density. The effect of increasing electron density is to reduce the dielectric constant of space and, as the velocity of a radio wave is inversely proportional to this dielectric constant, to increase velocity above that in empty space. In other words, a radio "ray" (or beam reduced to negligible thinness for convenience of discussion) is entering a "less dense" or "lighter" medium when it enters an electron bank, just as a light ray enters a less dense medium in passing from water to air or from glass to air. Now a ray entering a less dense medium at an oblique angle will be bent out of its straight course, or refracted. This effect can best be visualized by the homely example of Fig. 3. A line of soldiers is moving slowly through some brush and high grass, and suddenly comes out obliquely into an open field where each soldier can walk faster. The soldiers on the left of the line, having the advantage of open ground first, will tend to get ahead of the others, and in an effort to straighten out the whole line will change direction somewhat to the right. The radio ray, entering a region of increasing electron density as shown in Fig. 4, behaves in exactly similar fashion; and having left the earth's surface on an upward slope, is bent downward again towards the ground. Any one ray is actually refracted into four different rays, but in the interests of simplicity we shall only consider one of these. You may ask, "How can one be so definite about something quite invisible so far above the ground?" The answer is that the general hypothesis is borne out by repeated experiments under several different methods, and the evidence is steadily accumulating.

Some years ago it was thought that the radio rays were reflected from the under surface of a fairly definite ionized (conducting) "layer," and this may occasionally occur. In the great majority of cases, however, the ray is refracted (bent traversing different mediums) rather than reflected (made to rebound by a surface that will neither absorb nor transmit it). Nevertheless, we often find it more convenient to discuss the phenomena and represent them graphically on a reflection basis. By "refracting layer" we mean the region where the ray begins to bend and where it starts downward. By "equivalent reflecting layer" we mean a hypothetical reflecting surface which would give the same downward-directing results as a given refracting layer. Sometimes we shall speak of one, sometimes of the other. It is only necessary to remember that the actual summit of a ray is, in general for short waves, about three-fourths as high as the "equivalent reflecting layer." The third photograph shows a light beam analogy of equivalent reflection. The light beam slopes upward from one of the miniature stations on the ground, strikes the "layer," and is reflected downward to the other ground station.

Fig. 8—Possible "focusing" of scattered rays on a receiving station. This theory explains strong signal of the British Chelmsford phone station in eastern U. S. just before sunset; the signal decreases as darkness comes on



Height and Extent of the Refracting Layer

When we speak of layer height and changes in that height, we do not mean that any definite and tangible thing has physically moved up or down. Rather do we mean that changes in the ionized region have made the particular layer which is refracting certain radio rays a higher one or a lower one. As a matter of fact, the effective layer height varies slightly with the inclination of a given ray; and varies considerably with wavelength, being perhaps twice as high on 20 meters as on 80 meters. But the great variations of layer height come with summer and winter, day and night. It is lower in summer, higher in winter; lower in the daytime, higher at night; intermediate for fall and spring, early morning and late afternoon; lowest on a summer day, highest on a winter night. The effective height under these various conditions is probably somewhat as follows: Summer day, 50-100 miles; summer night, 150-220 miles; fall or spring day, 80-150 miles; fall or spring night, 200-300 miles; winter day, 100-170 miles; winter night, 300-500 miles. Over the poles the layer is probably very low in summer due to perpetual daylight, and very high in the winter of continued darkness. As for the effects of layer height, a low layer discriminates against long waves in favor of short and ultra-short ones, while a high layer favors all waves that it bends down at all. Just how this works we shall see later. Below the refracting layer there may be an absorbing layer, which is very important for wavelengths

More Light on Short-Wave Transmission

By Lieut. William H. Wenstrom

around 214 meters, but negligible for waves under 100 meters.

Critical Angles and Limiting Angles

Let us suppose that the luminous fish of Fig. 5 wishes to signal to a companion fish over at the other side of the creek, and that some obstruction such as eel-grass prevents vision along a straight line between the two. By using reflection from the water-air surface, this particularly resourceful animal can still maintain communication. At rather large angles from the perpendicular this reflection will be possible, but as the ray increases in elevation there will come a time when it is not reflected downward at all, but passes up out of the water entirely, though somewhat refracted. There is one particular ray which follows a middle course and skims the water surface; this, or the one just below it which is the highest useful for fish communication, we might call the limiting ray. The angle which this ray makes with the vertical is the critical angle, 48.5° in the case of water and air; and the angle which it makes with the horizontal we may call the limiting angle. By the laws of reflection, the limiting ray descends at the same slope as it ascends, though the ray just above it would not descend at all.

An exactly similar effect takes place in the downward-bending of radio rays from the refracting (or equivalent reflecting) layer. As in our fish illustration where the angles are complementary, or add up to 90° the limiting ray returns to earth at its ascending inclination; the next higher ray does not bend downward at all but skims the layer; any rays still higher go off into space, useless for any communication upon the earth. The inclination of the limiting ray varies with wavelength and layer height; in general, limiting angles are lower for the shorter waves, and correspondingly lower for any wave as the layer rises. The following values of limiting angle, copied from Taylor, serve as examples; at an (equivalent reflecting) layer height of 100 miles, corresponding to a spring day, 54° for 40 meters and 18° for 20 meters; at 225 miles (summer night) 53° for 40 meters and 14° for 20 meters; at 500 miles (winter night) 52° for 40 meters and 0° for 20 meters. The limiting angle of 0° means, of course, that even the tangent or horizontal ray is above the limiting angle, and long distance communication is impossible. The shortest wavelength which can be used with a given layer height is often called the critical wavelength. This is around 25 meters for a 500 miles layer, 11 meters for a 100 mile layer, and for long distance 5 meter work the layer must be as low as 40 miles, a very rare summ-r day occurence.

Skip Distance

Having now attained a clear understanding of the limiting angle and the limiting ray, we can define skip distance very simply by saying that it is the distance to where the limiting ray first returns to earth, measured sometimes from the transmitter and sometimes from the limit of the ground wave, which at high frequencies only extends out 30 to 50 miles. At the same layer height skip distance increases as the wavelength decreases. This means that at certain times of day we can work a station on 42 meters, but not on 38 meters. For any given wavelength the skip distance increases as the layer rises; the limiting angle is lower, and a given ray can rise farther before bending downward. These relations are diagrammed in Fig. 5a and 5b. Some quantitative idea of actual skip distances is given by the following figures: Height of equivalent reflector 100 miles—no skip on 80 meters, 100 miles on 40 meters, 500 miles on 20 meters, and 1,000-2,000 miles on 10 meters. Layer height 225 miles—barely noticeable skip on 80 meters, 200 miles on 40 meters, 1,000 miles on 20 meters, 10-meter wave never returns. Layer height 500 miles—very short skip on 80 meters, 400 miles on 40 meters, 20 and 10 meter waves never return. An airplane short wave transmitter may not show any skip distance at all if rays below the horizontal cover all the ground which would normally be skipped. In general, for any middle-range as day brightens we can use shorter waves, as night approaches we must use longer waves.

Signals are often heard inside the skip distance, but this does not disprove the general law. They can be accounted for by the ground wave, or by the "throw-back" theory advanced by Taylor and Young. They noticed echoes at a Washington transmitter which seemed to come from the broken country in Labrador and the southwest, and some later throw-backs on 15 meters which came from the ocean. In both cases the size of ground and rough water slopes in relation to wavelength makes the theory plausible. We have been speaking so far of only one skip distance. As we shall see later, on very short waves there may be several skips outside the first.

Useful Rays

From our earlier consideration of ground absorption near the transmitter and the foregoing discussion of limiting rays, we can see that the rays useful for communication will be included between the limiting ray and the lowest ray not absorbed by the ground, as shown in Fig. 6, for all these rays return to earth. Higher rays will not return to earth, and lower rays will be absorbed. The height of the transmitter, the kind of ground and nearby hills all have their effect on the lowest useful ray. This ray is much lower for short waves than for long, but the limiting ray is also lower. In general, therefore, low angle radiation is most useful on short waves, high angle radiation on long ones.

Extreme Range on One Refraction

We have said that the lowest useful ray is lower for short waves than for long ones. This means that with one layer refraction it will travel farther along the earth's surface. It may be reflected up again and refracted down again several times, but each earth reflection certainly takes away energy, and *we may now state the great advantage of short waves: that by permitting the use of lower useful rays they get farther along the earth's surface on one refraction, or on few refractions and reflections, with less consequent loss of energy.* We therefore use for long range communication the shortest wave possible, and find in practice that the strongest signals are always just beyond the first skip distance.

A particular example of this principle is shown in Fig. 7, and indicates how the extreme range on one refraction is governed by the layer height. A station in New York wishes to work San Francisco on a winter day, but at a layer height of 150 miles the lowest useful ray will return to earth far short of California. We find, in fact, that around 800 miles is the limit for daytime low power work on 40 meters. But at night, the same ray can rise to a 500-mile layer, and on its first return to earth will be well out in California. And we find, in fact, that low power work with California on a winter night is easy. For simplicity some considerations have been left out of this example, but it correctly illustrates the principles.

There is one other possible effect which may greatly increase the range on one sky refraction. It is conceivable that the limiting ray, or the one just above it, does skim along the layer for a great distance, perhaps half way around the earth; and then, encountering somewhat different refracting conditions, bend down again towards the earth. While this effect may occur quite often in practice, the weight of scientific opinion and the accumulation of experimental evidence seem to indicate that it is the exception rather than the rule, and that most extreme long distance transmission depends on earth or water reflection.

Earth Absorption and Reflection

If we direct a brilliant and concentrated beam of light obliquely downward on a mirror, we can see in dusty or smoky air that the beam is reflected upward in practically unchanged form. If we substitute for the mirror a piece of white paper as shown in the photograph, the reflected beam is much less intense, and is spread out in all directions. With gray paper or a rougher surface both the diffusion and the absorption increase, and with black felt the absorption is practically complete. The same general effects are possible when a downward sloping radio ray strikes the earth's surface. Sea water is a fair conductor and, if not excessively roughened by storm, a good reflector of short-wave rays, corresponding perhaps to the mirror of our light example. Damp ground, fairly level or smoothly rolling, is probably a fair reflector corresponding to rough white paper. Ground that is very dry or very rough must be a poor reflector, absorbing nearly all the energy. Incidentally, the "roughness" of either water or ground depends on the wavelength, just as a metal light mirror is only a surface which has been polished to the point where the scratches are small in relation to the wavelength of the light. The effectiveness of ground reflection is more or less in debate, and some scientists maintain that most of the energy is absorbed or scattered. In thinking of long distance communication, however, it must be remembered that three-quarters of the earth's surface is covered by sea water. Some energy is undoubtedly lost, and short wave efficiency proves that few reflections are desirable, but a good deal of energy is probably reflected mirror-fashion under average conditions. When the ground reflects a downward sloping ray skyward, it is usually brought down again by ionized layer refraction at twice the distance of the first ground-strike from the transmitter, and may conceivably continue these ups and downs all the way around the world. In high power transmission "echoes" which have completed the 25,000-mile circuit sometimes appear at the receiver and spoil the signals.

Patterns of Recurring Signal Zones

We have said that there may be at certain times and on certain wavelengths skip distances beyond the first; let us follow out in a few examples the full pattern of transmission. Taylor has reduced the matter to a very complete series of graphs, and it is from these that most of our information comes. On 40 meters, for instance, with a layer height of 225 miles (summer night) the first skip extends out 200 miles from the transmitter. At this range the signal comes in strongly, and from here on it is continuous with no further skips, for the first re-refracted ground reflection comes down again before the single refractions have extended out to the lowest useful ray. With the layer at 500 miles (winter night), the first 40-meter skip extends out to 400 miles, and there are no further skips. But on 20 meters the story is somewhat different. With the 100-mile layer of a summer day the first skip extends out to 500 miles, with no skips thereafter. On a spring night, however, with the layer at 300 miles, we notice the typical ultra-short-wave pattern. The first skip extends out to 2,000 miles, where the signal comes in strongly and holds out to 3,000 miles. Between 3,000 miles and 4,250 miles is the second skip, after which the signal appears again to hold until 6,000 miles. A third skip comes between 6,000 miles and 6,400 miles, and beyond 6,400 miles the signal is continuous. Again, a 10-meter wave would have an infinite first skip unless the layers were at 60 miles or lower. With this rather unusual layer the 10-meter pattern would be marked by wide skips and narrow signal bands as far as the antipodes at least. On longer waves any station in the signal zones is reached by several rays traversing widely different paths, and this is true of short waves also beyond the first or second skip. The result is that patterns are less definite in fact than they are in theory.

Fading

Knowing the extremely tenuous nature of the ionized region and the complicated nature of ray refraction, we can readily understand the causes of fading, always more violent on the shorter waves. The primary cause is probably variation in the height of the refracting layer. Heising has found, by measuring the effective layer height continuously for fairly long periods during the night, that it rises and falls in cycles, each of which lasts around a quarter of an hour. The rising rate is something like six miles per minute—the speed of the very fastest racing airplane. The falling speed is much greater, probably around twenty miles per minute. In general, the layer height swings up and down in slow cadence, rising gradually and falling rapidly. In the daytime under the sun's ultra-violet radiation the layer is much steadier; and in the daytime also fading is far less pronounced. The most violent short-wave fading of all occurs at the outer edge of the skip distance. Here the ground-strike of the limiting ray may flutter back and forth, with the signal jumping between maximum and zero. There are other matters to be considered besides layer height. Relative numbers of electrons and ions, upper air absorption, height to which ionization extends—all may count, and of course play some part in determining the effective layer height. Phase difference between rays arriving by different paths is important—it causes much of the 50-100 mile fading in the broadcast band. Considering the medium and the conditions, we are lucky to find short wave transmission as steady as it is.

Slopes in Layer

So far we have been considering a layer of uniform height; in very long distance work such an ideal condition rarely exists. If the night layer is much higher than the day layer, and we know that it is, there must be well defined slopes at the sunset and sunrise lines. In order to visualize these slopes as they probably exist on the earth, it is only necessary to shine a spot light on a small globe. To show conditions at any particular date, we can look up the sun's declination in the Nautical Almanac, and tilt the globe so that the shadow line is the given number of degrees beyond (for + declination) or short of (for — declination) the North Pole. Two photographs accompanying show sunset and sunrise in the eastern United States for November or February. Taking into account the percentage of path in darkness, and the consequent high layer suited to few re-reflections, sunrise is probably the best time for amateur work on the 40-meter band with Australia and New Zealand. This is paraticularly so in the Western United States, for in addition to giving a favorable slope the sunlight in the east silences interfering signals from most of the American continent. We have in fact worked Australia from El Paso, Texas, with the sun an hour up in the sky.

For work with Europe and Africa, on the other hand, sunset is preferable. We have worked Belgium from West Point, New York, as much as an hour before sunset, taking advantage of the darkness over most of the path, minimum interference from the west, and the layer slope. It seems quite possible that the layer slope may focus several incoming rays, most of which would normally go to other regions, on a single receiver with considerable increase in signal strength. This theory has, so far as we know, been developed by no other writer, but it seems quite plausible on the basis of very meager data. Fig. 8 shows the effect on an equivalent reflection basis. We have noticed at West Point that the 25 meter phone signal of 5SW at Chemsford, England, increases noticeably about an hour before sunset, continues strong through sunset, and drops off rapidly with approaching darkness. It would be interesting to see if any other observations bear out this hypothesis.

As Taylor has pointed out, the daylight—darkness layer slope may have a considerable effect on the patterns of ultra-short waves. There exists what might be called a non-reciprocity of east and west transmission across the sunset line. Toward darkness all skips after the first tend to close up, making the signal zone practically continuous. Toward day light the second skip and possibly outer ones, tend to open out, making narrow signal zones separated by wide skips. With a given wave such as 20 meters, therefore, it may be possible to transmit from a western station to an eastern station, but not from the eastern station to the western station. Or to put it another way we can use a shorter wave for west-east work than for east-west work.

Conclusion

Radio is usually considered a narrow and highly specialized science—even a narrowing one—but it does not need to be. Its practical applications are as wide and varied as life itself. The ships on their lonely ocean wanderings talk unceasingly, sometimes of excitement and danger. And the lonelier airplanes are beginning to talk, too, while snug stations on ground and shore scatter weather warnings that all of sea and air must know—a hurricane in the Caribbean, or a blizzard in Greenland. Thus the thread runs, through shipping, aviation, meteorology—even geography becomes interesting when electric voices illumine the map.

In more tenuous but equally fascinating theory, ratio is also broad enough for a da Vinci. It is a form of electric activity, and though the larger principles may wear engaging disguises, they do not change. Tuning theory is the same for a broadcast receiver or a high-power transmission line that lights Boston from a Georgia waterfall. Electricity itself is but a part of physics. As we have seen, radio waves and light waves differ only in length; they both speed alike with incredible velocity, are reflected and refracted by suitable mediums, and show in some degree the same shadows and interference. And today we are interested

(*Continued on page 91*)

A Complete A. C. Operated Short-Wave Receiver

(*Continued from page 69*)

PARTS LIST

One Potter condenser block, No. 674C.
Two Potter by-pass condenser blocks, No. 30B.
One Polymet small moulded bakelite condenser, .00015 mfd.
Four A. C. sockets.
Three D. C. sockets.
Three Yaxley insulated tip-jacks, No. 422.
Two Yaxley center-tapped resistors, 40 ohm, No. 840C.
One on-off a. c. switch.
One Durham onewatt resistor, 2,000 ohm (White).
Two Durham two-watt resistors, 10,000 ohm (Green).
One Durham one-watt resistor, 2 megohm (Red).
One Carter resistor, 400 ohm, No. RU400.
One Carter closed circuit jack, No. 2A.
One Ohio carbon five-watt resistor, 800 ohm (Green).
One cord and plug.
Four moulded binding posts.
One set of hardware and hook-up wire.

AND THE FOLLOWING SILVER MARSHALL PARTS

One pierced metal chassis and power unit case, No. 721.
One Escutcheon, No. 812.
One illuminated drum dial (Right), No. 810R.
One variable condenser, .00014 mfd. No. 314.
One Midget condenser, .000075 mfd., No. 342B.
Four plug-in coils, 131L, 131M, 131N, 131O.
Two tube shields, No. 636.
One audio transformer, No. 260U.
One push-pull input trans ormer, No. 270U.
One power transformer, No. 336U.
Two R. F. chokes, No. 275.
Three R. F. chokes, No. 277.
One filter choke, No. 338.
Two wood knobs, No. 817.

Some Refinement for the Short-Wave Four

(*Continued from page 69*)

that has been commented on is the application of the removable caps to replace the various coils. We mentioned the advantage of these caps in the August article and it appears that in the application of the short-wave receiver they are an important item.

Very truly yours,
SAMUEL EGERT,
of Wireless Egert, Eng. Co., N. Y. C.

* * *

Making the Dials Read Alike

Recapitulating the suggestions in Mr. Egert's letter, for improving the receiver, first, it is simple to overcome the lack of similarity in the dial readings for both of the tuned circuits. The disparity in the dial readings was due to the difference in the characteristics of the two tuned circuits and the tubes to which they inputted. To overcome this tuning discrepancy the following remedy will prove useful. Merely shunt across the first tuning condenser a midget of the 32 mmfd size. The accompanying photograph shows how this addition has been made.

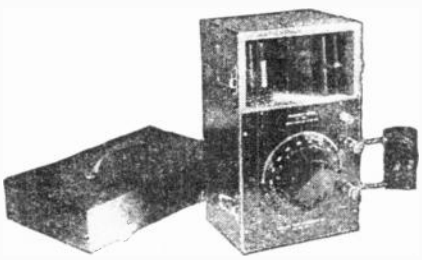
Screen-Grid Volume Control

The variable resistance, R5, which was incorporated in the original receiver as a control of regeneration, has to some extent been used also as a volume control but sometimes with a sacrifice in selectivity and sensitivity. Therefore the addition of the screen-grid volume control is advisable, especially where it is desired to cut down volume from a nearby local short-wave transmitter. Simply connect the center arm of a 100,000 ohm potentiometer to the screen-grid of the first tube and the two outer terminals one to B—, the other to B+ 45 battery terminal.

The Short-Wave Wavemeter

In tuning short-wave sets it is almost invariably the case that the exact frequency to which the set is tuned is unknown, and when the listener wants to get a certain station the frequency of which he knows, the best that he can do is to tune his set and say, "It ought to be somewhere around here." While this condition is practically universal at the present time, there is no reason for its continuance, for a short-wave frequency meter with the numerous coils calibrated in terms of wavelength or frequency can very easily be employed to determine the dial position of the desired station. The photograph accompanying shows a wavemeter which has been designed by Wireless Egert Engineering, Inc., 179 Greenwich Street, New York.

This wavemeter is mounted in a beauti-



fully finished solid walnut cabinet, and is arranged and wired so that it may be used either for transmitters or receivers. When used with a transmitter the meter is loosely coupled to the oscillator; the bulb in the wavemeter will indicate resonance as the tuning is varied. When used with a receiver, the "click" method is used. The instrument is now available complete with tested coils. A full set of curves is also included, each meter having been separately calibrated.

Some Facts About Volume Control

(*Continued from page 33*)

turns on and off the filament current. It will be noted that this resistor is of the potentiometer type. That is, it has a connection for both ends of the resistor. One outer terminal and the center-arm contact is connected directly across the antenna primary coil, while the outer terminal is connected to the antenna. Fig. 4

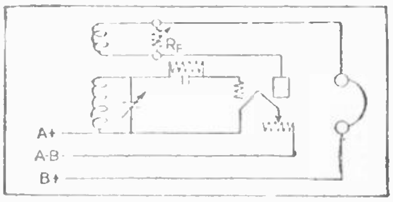


Fig. 5—A resistance shunt for regeneration control

shows the connection of a variable resistance across the secondary of an audio-frequency transformer. This is the type of volume control which is not to be recommended for broadcast circuits where there is need for a very high order of tone quality. In short-wave code receivers this type of volume control is quite satisfactory, since it does not materially affect the quality of the received signal which usually is of one frequency or tone.

Resistors have been used not only to

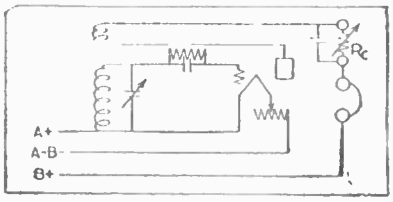


Fig. 6—A series-resistance regeneration control

control volume in receivers, but also to regulate regeneration in detector circuits. Fig. 5 shows a variable resistance shunted across the tickler coil of a detector circuit and in such position effectively controls the amount of regeneration which is obtainable from this circuit. In Fig. 6 is shown another detector circuit wherein the variable resistance for the control of regeneration, instead of being shunted across the coil, is connected in series at one side of this coil. Note that the volume control here is shunted with a fixed

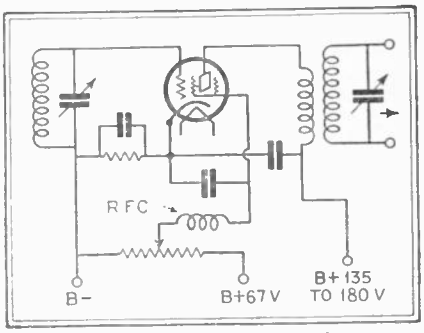


Fig. 7—Potentiometer control of screen-grid voltage for volume control

condenser. This condenser should be of the order of about 1 mfd. so that it will readily by-pass the radio-frequency current which flows in this part of the circuit.

In short-wave work we are dealing with a different set of conditions than that which exists in broadcasting receivers. First, the signals received are of a much higher frequency. Second, in some instances we are not so much concerned with the tone quality of the received signals, especially where it has to do with the reception of code signals. Third, the circuits which we use are much more simple than those which are used in broadcasting receivers.

Screen-grid tubes have come into use prominently as radio-frequency amplifiers for short-wave receiver circuits and the problem of control of volume has been simplified with their use, since it is quite easy to incorporate in the circuit a suitable potentiometer of high enough resistance value (50,000 or 100,000 ohms) so that the voltage which is applied to the screen-grid element of this tube is varied from about zero volts to the full value, or namely, about 45 to 67 volts. The circuit for such a radio-frequency amplifier is shown in Fig. 7. Resistors of the variable or fixed type are widely used as coupling mediums between the antenna circuit and the grid or input circuit of an r.f. amplifier; the amplifier

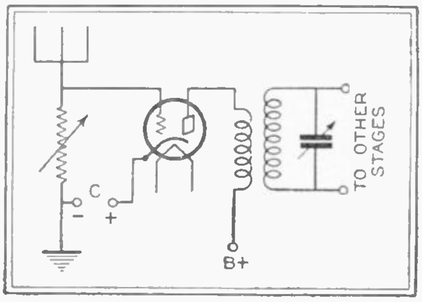


Fig. 8—Placing the volume control in the antenna circuit

as a whole acting as a coupling stage between the antenna and the regular tuned stages of radio-frequency amplification. The circuit for such a system is shown in Fig. 8.

Many of the systems as described for use in broadcast receivers are also applicable to the reception of signals on short wavelengths and require perhaps a bit more careful experimentation, before proper results are obtained, than for broadcast reception.

Putting the Portables Through Their Paces

(*Continued from page 25*)

were no pronounced hills and no trees; the mystery was apparently due to some freak of ground conductivity, in spite of the fact that we used counterpoises instead of conductive grounds.

But if things are not understood, so much more are they a challenge to the inquisitive mind. The greatest scientific joy is in treading a pathway not beaten too level by the feet of countless predecessors; in finding perhaps some few grains, however trifling, of universal truth.

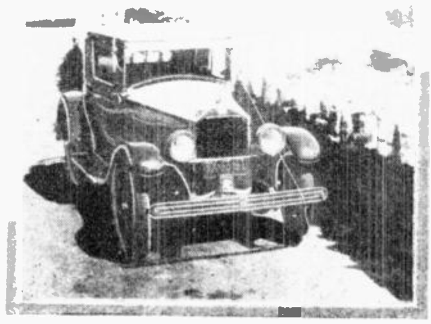
Portable Short Wave Transmitter

(*Continued from page 12*)

In a permanent location it is inconvenient to talk into a hand microphone. A "studio" pick-up which will transmit sounds that originate anywhere in the room is already in the possession of most experimenters. It is nothing more or less than a cone speaker, and its terminals are connected to the input of the speech amplifier. This arrangement makes the loudspeaker work backwards, or convert sound energy into electrical energy.

The speech amplifier is merely a two stage audio amplifier using fairly good transformers and almost any sort of tubes. It may be the audio part of the Portable Multiwave Receiver. As shown in the diagram, Fig. 4, the speech amplifier output goes through an ordinary transformer to the grids of the modulator tubes.

The modulator tubes are preferably the same type as the oscillator. One modulator tube works quite well. Two in parallel work very well indeed. Four would be still better, but a rather unnecessary and expensive refinement. The reason for more than one modulator tube

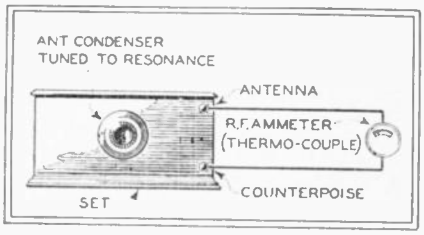


The antenna erected and ready for use

is apparent when we recall how Heising modulation works. As far as audio frequency is concerned, the total current supplied to both oscillator and modulator is held quite constant by the choke, L6. The modulator, in accordance with the audio frequency voltages impressed on its grid, draws more or less current—acts as a variable resistance across the oscillator plate-filament. For complete modulation this variable resistance should equal the fixed resistance of the oscillator plate-filament. At normal grid bias, four modulator tubes in parallel draw about the same plate current as one oscillator.

Results

While this transmitter is conservatively rated at two and twenty miles with a 171 and five and fifty miles with a UX-210, much greater distances are often covered. When the outfit was first set up at West Point, fifty miles north of New York City, a 210 was used with a 300-volt storage battery for plate supply. The location—in mountainous country—was none too good, and the late spring weather was thoroughly bad. In addition, the set was a rugged portable rather than a low-loss wonder resting mainly on air. In spite of these things we worked stations in Brooklyn, N. Y. (50 miles); Oneta, N. Y. (120 miles); Pottstown, Pa. (120 miles); Auburn, N. Y. (200 miles); and Greenburg, Pa. (300 miles). Heising phone was audible at a couple of hundred



Circuit used in obtaining the oscillator output table shown at the beginning of this article

miles, but no verbatim phone reception was logged beyond Newburgh, ten miles away.

Then a 171 replaced the 210 for a few days' test, and the plate voltage was cut down to 100. The input was 2.7 watts, and the estimated output 1 watt. With this rather Lilliputian power we worked Newburgh easily enough; Riverside, N. J. (120 miles); Watertown, Mass. (175 miles); and actually disturbed the daylight ether at Limo, Ohio, 500 miles out—not bad for the 80-meter band. The 1 watt phone was heard weakly a hundred miles distant, but was not checked word for word beyond a receiver in Highland Falls, two miles away. In order to see how far the phone comedy would go, we put a UX-201A in the socket and cut the B battery to 40 volts. Highland Falls still got most of our conversation.

Its laboratory tests finished, the portable was at last ready for field and highway, lake and river. It was installed on the package rest behind the seat of a coupe, and fed by the car battery and a 90-volt B battery. We then drove to an open place in the hills three-quarters of a mile from the receiving operator, and put up the umbrella antenna. Every word went through without difficulty, even when we started the car and drove slowly along the road.

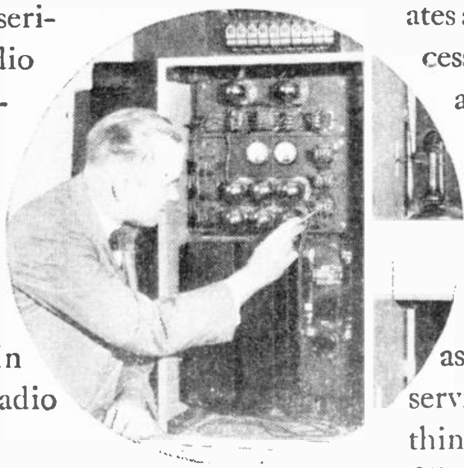
The next test was on the Hudson River. The transmitter, an A battery, a 90-volt B battery and the umbrella antenna were crowded into a small rowboat. On most seagoing craft the radio installations are inadequate, but this one may be truly said to have been overradioed. Our phone signals were continuously understandable at West Point up to two miles, when both the strength and good nature of the rowers gave out. At the same time, Newburgh, at eight miles, copied our code and heard the phone.

As a final test of portability, the set

RADIO NEEDS YOU

Let RCA Institutes show you the way to SUCCESS in this fast-growing industry

REACH out for a big-pay job in Radio... Tie-up to the fastest-growing industry in the world today... See for yourself what other men have done... You, too, can do the same! Hundreds of fellows just like you are now earning from $2,000 to $25,000 a year in RADIO. J. H. Barron, Radio Inspector of the U. S. Department of Commerce says that a most serious shortage in trained Radio men exists right now. Thousands of trained men are needed. Broadcasting stations, manufacturing plants, retail and wholesale dealers, as well as ships at sea and planes in the air, require trained Radio men.



Radio Mechanics earn up to $4,800 a year.

Learn Radio at Home... RCA Institutes Will Train You for Success!

RCA sets the standards for the entire radio industry. The RCA Institutes Home Laboratory Training Course gives you the real, inside, practical training in Radio, quicker than you could obtain it in any other way. It's easy to learn at home in your spare time. You get your lessons and criticisms direct from RCA... the very source of radio achievement... the vast world-wide organization that has made Radio what it is today... that sponsors every lesson in this course.

RCA Graduates Find it Easy to Fill Good Radio Jobs

There has been a radio job for practically every graduate of RCA Institutes. Graduates are actually *Trained* for Success because they learn radio by actual experience with the RCA Institutes famous outlay of apparatus given to every student of this course. You learn to solve every radio problem such as repairing, installing, and servicing fine sets. Here is everything you need know in order to fill a well-paid position in Radio.

Send for this Free Book "Radio... the Field of Unlimited Opportunity"

Read these 40 fascinating pages, each one packed with pictures and text that tell you everything you want to know about the many brilliant opportunities in Radio and about RCA Institutes, the world's oldest and largest radio training organization. Tune in on Radio. Send for this free book today and speed up your earning capacity!

Clip this Coupon NOW!

RCA INSTITUTES, INC.

Formerly Radio Institute of America

SPONSORED BY RCA

RCA INSTITUTES, Inc.
Dept. SWM-1, 326 Broadway, New York

Gentlemen: Please send me your FREE 40-page book which illustrates the brilliant opportunities in Radio and describes your laboratory-method of instruction at home!

Name ______________________________

Address ____________________________

Portable S-W Transmitter

(*Continued from page 78*)

(provided this time with a 135-volt B battery) was placed in the car along with the receiver and driven seventy odd miles to Garden City. We expected on arrival to find all the nuts loose and half the tubes broken, but no such thing happened; both the transmitter and the receiver worked perfectly at the end of the trip. We did some satisfactory two-way code and phone work up to two miles with 2GY, Radio Broadcast's station, and with 2VM at Mitchel Field. Then we drove south to Long Beach, and set up close by the restless Atlantic. At about ten miles we worked perfect communication for an hour with 2GY, using code at first and then, to our surprise, phone.

So much for the story of the 80 meter portable transmitter—a long story, perhaps, but not without a certain amount of meat. The set will not raise Australia in the small hours, nor will it pump every last microwatt of energy into the antenna. But after banging around in a boat or car it will do its modest two and twenty without complaining. And that, after all, is what a portable is for.

Wenstrom's Multiwave Receiver

(*Continued from page 15*)

below the panel top. Some bus bar is used to steady the coil socket and, the series fixed condenser is held by bus bar just behind it. The shorting switch S, of the midget knife type, is screwed directly into this condenser. At the top center of the panel are the antenna and ground binding posts. The dials are mounted on the front of the panel, and the right one, controlling the tuning condenser, is a vernier.

In the center section and 8½ inches below the panel top is mounted the gang socket. Few if any radio stores carry it in stock. It is the "Frost No. 616 3-gang shock absorber socket for UV-199 tubes," and can be obtained from Herbert H. Frost, Inc., Elkhart, Indiana. In the middle of the center section is the voltmeter, to the right is the rheostat, and to the left the potentiometer. The grid leak is behind the extreme left of the panel, and the grid condenser is held by bus bar just above the tube socket. The radio frequency choke is held by bus bar just under the socket. The three phone jacks are placed one at each end of the gang socket and one just under its center.

The two audio transformers occupy most of the bottom section. Old style Amertrans were chosen for their high gain, small size and light weight and also because they happen to be on hand. Others of good make may naturally be substituted. Between the transformers is the filament switch; and below it is the external A battery jack, to which fahnestock clips for the internal A battery are soldered. All the other internal binding posts (fahnestock clips) are bolted to the bottom edge of the panel, and the two outside ones are also external posts. Behind the panel outside the transformers are the plate and grid by-pass condensers for the power tube, and its grid biasing resistance is held by bus bar below the left transformer. All wiring should be done in definite steps: first the filament circuits, then the various grid and plate circuits in order.

The carrying box is built of ½ inch white pine, nailed together with brads, reinforced with brass corners, and fitted with a suitcase handle. The lumber is cut as follows: 1 piece 12" x 14" (back), 2 pieces 6" x 13" (sides), 2 pieces 6½" x 12" (top and bottom), one piece 12" x 13" (front). The front is fastened to the rest of the box by snap catches, and when in place completely covers the panel. The back of the panel is held 1⅜" behind the inside of the front cover by two thin wooden stops at the bottom, and at the top by wing nuts on two bolts set in iron angles. The two B batteries are at the back bottom corners of the box, and the two A batteries are against the center of the back. All batteries are held in place by brass angles. Two plug-in coils are clipped into the back top corners. The entire carrying box is finished with walnut varnish stain. The phones could be crammed between the panel and the front cover, but few users will care to give them or the panel this sort of punishment.

Operation

When the set is completed, it should be thoroughly tested in the workshop before any outside work is attempted. The operation and calibration of this receiver is practically the same as that of any standard regenerative circuit. First of all, connect the internal A battery for a test of the filament circuit and controls. Then connect the internal B battery and test each coil for even oscillation throughout its range. At this stage a few signals should be heard on the 40-meter coil without antenna or ground. Next plug in the external A battery and again test the filament controls. Finally, with antenna and ground connected, test each coil for actual reception and calibrate it.

To test the power tube connections, remove the two jumpers, change the 199 in the last socket to a 120, and plug a small cone speaker into the last jack. Then connect the external B-C battery and tune in a strong signal, which should be reproduced with good quality at comfortable room volume. When any trouble develops the jack system comes in handy, for one can immediately localize the fault in detector, first stage or second stage circuits. There follows a complete list of parts used in the set. Other parts, electrically and mechanically similar, may be used, but their dimensions should be carefully checked against the available space.

LIST OF PARTS

C1—Cardwell old type 350 mmfd. variable condenser;
C2—Sangamo 250 mmfd. fixed condenser;
C3—Cardwell old type 500 mmfd. variable condenser;
C4—Sangamo 150 mmfd. fixed condenser;
C5—Sangamo .5 mfd. by-pass condenser;
C6—Sangamo 1 mfd. by-pass condenser;
L1, L2 and L3—see coil table;
L4—Silver-Marshall r.f. choke, type 275;
R1—Tobe tipon grid leak, 6 meg. (label removed);
R2—Carter midget potentiometer, 400 ohm;
R3—DeJur rheostat, 30 ohm;
R4—Ward Leonard vitrohm resistance, small size, 3,500 ohm;
1—Frost 3-gang socket (see text);
1—Silver-Marshall coil socket, type 515;
1—Hoyt midget voltmeter, type 541, 0-4 volts;
1—General Radio dial, type 302, 2¾" vernier;
1—General Radio dial, type 310, 2¾" plain;
2—Amertran transformers, type AF-6, 5-1;
1—Jack, open circuit;
2—Jack, double circuit;
1—Jack, filament lighting;
1—Filament switch, small push type;
4—Eby binding posts, large;
7—Fahnestock clips;
1—Grid leak mounting;
1—Bakelite panel, ¼" x 11" x 13" (see text);
1—Carrying box, complete with batteries (see text).

Portable Results

Recently some rather interesting tests were made with this receiver near West Point, 50 miles north of New York City. They extended over two or three evenings. There was no attempt to drag in extreme distance or to invoke the powers of the listener's imagination; we wanted simply to find out what the set would do under average conditions. As some signals had been heard accidentally in the laboratory while testing the set without antenna or ground, on the first test the two-inch coil in the set was the only pick-up. The set was placed on the high concrete wall of an athletic stadium up in the hills. On the broadcast coil, WEAF was tuned in intelligibly by zero beat. With the 80-meter coil in place KDKA came in quite distinctly on 62 meters, and amateur code came through from Connecticut and Pennsylvania. Then the 40-meter coil was plugged in, and brought in amateur code from New Jersey, Pennsylvania, New Hampshire, Virginia, North Carolina, Ohio and Indiana.

The set was next driven in a car to a location close to the first one, beside a reservoir in the hills. The car was the counterpoise, and the single wire antenna was strung out on a slight upward incline to a nearby wall. On the broadcast coil WEAF, WJZ and WOR of the New York area, as well as WGY of Schenectady and WOKO of Beacon, came through with faint loud speaker volume. KDKA of Pittsburgh, WGIP of Hartford, WCAM of Camden and WCAP of Asbury Park were also heard, along with WNYC, WMCA, WGBS, WPCH and WABC of the New York area. On the 80-meter coil KDKA was up to fair loudspeaker volume; code amateur signals came in from Massachusetts, Delaware, Pennsylvania, Michigan, and Prince Edward Island, Canada; amateur phones in Pennsylvania and Long Island were clearly understood. The 40-meter coil was somewhat of a surprise. Amateur code signals came in from all over the United States; from Quebec, Ontario and British Columbia; from Mexico and Ger-

Wenstrom's Multiwave Receiver

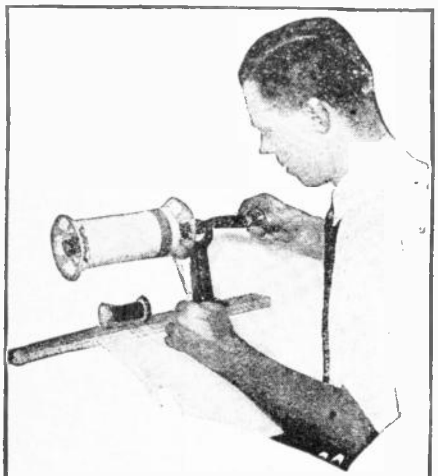
(*Continued from page 80*)

many; and from Cameroons and Liberia in Africa and a Portuguese ship. But this is not spectacular when we remember the carrying power of short waves, and particularly the carrying power of code.

The next test was made with the wave coil antenna to see what could be done with the car in motion. Of course there was some ignition noise, but on the broadcast coil it was not loud enough to obscure speech. On the 80 meter coil it was worse, so that only loud signals came through; and on the 40 meter coil it was very hard to hear anything but ignition noise. On the broadcast coil we tuned in WGL, a thousand watt station 50 miles away. Then the car was started, and at 20 miles per hour WGL still came through with a clearly understood weather report. After a few minutes of this, the local weather turned to distinctly overcast in the form of a tree limb which knocked the antenna off the car, but we put it back on and continued the test long enough to show that there is nothing difficult about broadcast reception in a moving car. Some interesting shadow effects can be visualized by noting the signal changes in hilly country.

The final test was made in a rowboat on the Hudson for a half hour in the late afternoon. The umbrella antenna was used, along with a small copper plate in the water for ground. WEAF, which in this vicinity might be called "Old Faithful," again came through with weak loud-speaker volume. WOR, WJZ, WABC and WNYC of the New York area came in clearly, as did WGY at Schenectady and W1CP at Bridgeport. The short wave coils were not used in this test, but on the small antenna they would undoubtedly have done better than the broadcast coil.

These tests seem quite pleasing when we remember the simplicity of the set. Simple though it is, a more reliable and versatile receiver would be hard to find.



Better home-wound coils can be made when using some sort of winding jig, as shown. There is better chance of duplicating coils for matching purposes than if they were hand wound

Short-Wave Stations of the World

(*Continued from page 43*)

KC	Station	
19740	GZO	Stonecutters Radio, Hong Kong, China
		M. R. T. Co., Guam
19780	WTF	Firestone, Akron, Ohio
19780	WMU	Southern Rdo. Corp., Linden, N. J.
	DGA	Nauen, Germany
		Rdo. Corp. of America
19800	WOG	Nairobi, Kenya, Br. E. Africa
19820	WMI	A. T. & T. Co., Deal Beach, N. J.
19860		Nauen, Germany
19867	W2XV	Rdo. Eng. Labs., L. I., N. Y.
19900	LP4	Buenos Aires, Argentina
19940	GLS	Ongar, England
19947	DIH	Konigs Wusterhausen, Germany
19987	CFA, CGA, CJA	—Drummondville, P. Q., Can.
19988	K1XR	Manila, P. I.
20000		Drummondville, P. Q., Can.
		Glace Bay, Nova Scotia
	LCM	Stavanger, Norway
	GLS	Ongar, England
	GKS	Dollis Hill, England
	IR2	Rome, Italy
20020	DFI	Nauen, Germany
20060	DGX	Nauen, Germany
20080		Nauen, Germany
20085		U. S. Govt.
20100	WQY	R. C. A., Rocky Point, N. Y.
20125		U. S. Govt.
20140		Nauen, Germany
20150		U. S. Govt.
20180	WQK	R. C. A., Rocky Point, N. Y.
		Konigs Wusterhausen, Germany
20200	VQA	Jesselton, Bermuda
20220	DGW	Nauen, Germany
20225		U. S. Govt.
20230	DIG	Konigs Wusterhausen, Germany
20260	WQQ	R. C. A., Rocky Point, N. Y.
20300		M. R. T. Co., Sayville, N. Y.
20312	DIF	Konigs Wusterhausen, Germany
20330	GYC	Horsea, Portsmouth, England
20400		U. S. Govt.
20400		Nauen, Germany
20420	DGB	Nauen, Germany
20500	DGQ	Nauen, Germany
20500	IR2	Rome, Italy
20580		Rio de Janeiro, Brazil
20620	W6XU	R. C. A., Bolinas, Calif.
20660	DGO	Nauen, Germany
20670	LP2	Monte Grande, Argentina
20700	FWX	Sainte Assise, France
20730		Konigs Wusterhausen, Germany
20740	DGP	Nauen, Germany
20780	KMM	R. C. A., Bolinas, Calif.
20820	KSS	R. C. A., Bolinas, Calif.
20860		Konigs Wusterhausen, Germany
20900	GZY	The Nore, Chatham, England
20900	LP3	Buenos Aires, Argentina
20960		Nauen, Germany
20966	FWX	Sainte Assise, France
20980	FWX	Sainte Assise, France
		M. R. T. Co., Sayville, N. Y.
21060	WND	A. T. & T. Co., Deal Beach, N. J.
21100	HSP	Bangkok, Siam
21100		Konigs Wusterhausen, Germany
21140	KAA	Manila, P. I.
21180	DGN	Nauen, Germany
21220	WQA	R. C. A., Rocky Point, N. Y.
21260	WBU	R. C. A., Rocky Point, N. Y.
21300	WQW	R. C. A., Rocky Point, N. Y.
21340	DGM	Nauen, Germany
21380		M. R. T. Co., Sayville, N. Y.
21420	WLO	A. T. & T. Co., Deal Beach, N. J.
21470		Buenos Aires, Argentina
21805	KFK, WFA to WFF	—Byrd Expedition
22050	CKA	Geizers Hill, Halifax, Nova Scotia, Can.
22520	DGE	Nauen, Germany
22600	DGF	Nauen, Germany
22625		U. S. Govt.
22660	KGQ	Robt. Dollar Co., San Francisco, Calif.
	KGR	Robt. Dollar Co., Seattle, Wash.
	KGS	Robt. Dollar Co., Honolulu, T. H.
	KGX	Robt. Dollar Co., Los Angeles, Calif.
	WGA	Robt. Dollar Co., New York City
22800	WKA	Westinghouse, E. Pittsburgh, Pa.
23075	ZBW	Victoria Peak, Hong Kong, China
23809	LSA	Monte Grande, Argentina
25680	W3XK	Jenkins Lab., Washington, D. C.
27270	GKP	Dollis Hill, England
27270	G5DH	Dollis Hill, England
	GKS	Dollis Hill, England
27550	DID	Konigs Wusterhausen, Germany
28000	(10.71m)	Limit of amateur 28,000 kc. band
28570	XQM	Yunnanfu, China
28874	DIC	Konigs Wusterhausen, Germany
30000	(10.00m)	Limit of amateur band 28,000 kc. band
34240	W1XAC	C. E. Mfg. Co., Providence, R. I.
	W2XBY	W. C. Van Brandt, Jersey City, N. J.
	W3XE	Radio Show, Baltimore, Md.
	W6XT	C. L. Watson & R. C. Gray, San Francisco
	W6XD	(Portable)
38885	DIB	Konigs Wusterhausen, Germany
39890	DIA	Konigs Wusterhausen, Germany
51360	W1XAC	C. E. Mfg. Co., Providence, R. I.
	W3XK	Jenkins Lab., Washington, D. C.
56000	(5.36m)	Limit of amateur 56,000 kc. band
60000	(5.0m)	Limit of amateur 56,000 kc. band

Hitting the High Spots with the A. C. Super Wasp

(*Continued from page 8*)

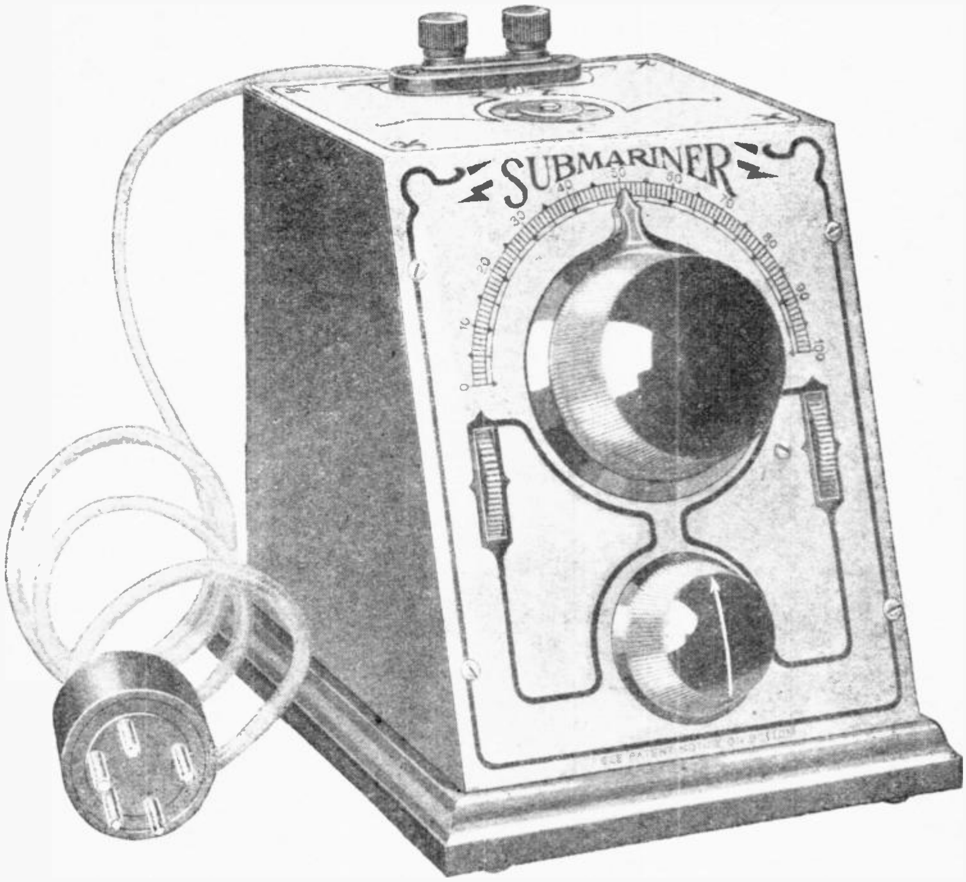
grid circuit at the starting point of oscillation. Just as the grid tends to change from the slight positive bias, which it normally has, to the negative value which the rectification gives it, it undergoes an oscillatory condition which causes a bad "squawk" when the plate voltage is fed through a transformer. But when the plate potential is supplied throuh a high resistance, such as .5 megohm, the effective plate voltage drops when this condition occurs and this decline immediately stops the oscillation or "squawk." The result is that the new A.C. Super-Wasp goes into r.f. oscillation in a very smooth manner, permitting perfect regeneration on even the weakest stations.

As the A.C. Super-Wasp is supplied in kit form, along with a full-size blue-print and detailed asembly directions, there is no necessity for giving instructions here.

In actual operation the A.C. Super-Wasp is slightly more sensitive than the now famous battery model, which has earned a marvelous reputation. While it would be foolish for anyone to say that reception of foreign stations is easy, it is safe to say that it is not difficult with the Super-Wasp, because the tuned r.f. stage actually amplifies, and obviates the necessity for critical regeneration control. The set, in New York, has brought in short-wave broadcast stations in England, Holland, Germany, Spain, Canada, Australia and British East Africa, with varying degrees of strength. Stations G5SW PCJ and W6XN come throug hon the loud speaker, sometimes exceptionally loud, sometimes so weak that the phones barely register. The set produces a million dollars' worth of thrills, and as a thrill maker it is presented to radio fans.

SHORT WAVE

With Your Present Receiver



THE SUBMARINER

attached to your present receiver, either AC or DC, will enable you to receive short-wave broadcasting or code. To attach requires but a moment and no changes are necessary to the receiver.

HIGHLY IMPROVED MODELS

The "Submariner" is the original short-wave adapter and has been sold for the past four years. In addition to the regular models, which can be used on older receivers, we have models which incorporate the "J" feature and allow them to be highly efficient on 1929 and 1930 receivers. The "Submariner" is a real substantial instrument, using a SHIELDED PANEL and CABINET, and a vernier dial with a ratio of 64 to 1. It uses a hum reducer for AC sets. The "Submariner" recommended for your set will compare in performance with any short-wave receiver and at about only half the price.

FOREIGN RECEPTION

Users of "Submariners" in America hear London, Holland, Germany, Australia and many other distant stations broadcasting. Code reception from any part of the world is also possible.

Mr. Philip Gruchy, of Angle Brook, Newfoundland, writes: "I was fortunate enough to bring in 3LO, Melbourne, Australia, on various occasions. If you would like a copy of my letter from 3LO, I will be glad to send you same."

ORDER TO-DAY

Will be sent prepaid in U. S. upon receipt of price or C. O. D. if $1.00 accompanies the order. For regular models, AC or DC (same appearance as above cut), the prices are: Fixed wave band, 16-32 meters, $17.50. Interchangeable coil, 14-150 meters, including three coils, $22.50. For "J" models, AC or DC (same appearance as above cut), which are recommended for 1929-1930 receivers, the prices are: Fixed wave band, 16-32 meters, $22.50. Interchangeable coil, 14-150 meters, including three coils, $27.50. Five-prong tube for AC receivers recommended for short waves, $2.50.

When ordering, please give name of set and the numbers on tubes or any other data available. Send order direct to

J-M-P MANUFACTURING CO., INC.

3334 Fond du Lac Avenue, Milwaukee, Wis., U. S. A.

Cable address, "Submariner"

The Thrills of Amateur Radio

(*Continued from page 38*)

shore even heard the note sputter as the antenna plunged into the water.

We might continue with the successful Pacific flight of the "Southern Cross," with the remarkable feat of one of Byrd's big monoplanes above Antarctica in maintaining two-way communication with W2UO, an amateur station in New York City. But these and scores of other instances are recent news, and we have seen enough to appreciate the paramount importance of the radio amateur in modern exploration. Let us turn to another amateur activity nearer home; less romantic, perhaps, but often more dangerous and exciting.

On September 17, 1926, hurricane warnings were broadcast up and down the Florida coast. Out in the Bahamas anchored yachts were reeling under a bombardment of cocoanuts blown about like rain, and at sea high-sided liners were hove to. At Miami that night the wind velocity swung ever upward—sixty miles an hour, eighty, one hundred. Buildings were crumbling into matchwood over their helpless tenants; enormous seas were sweeping over Miami Beach, on which the only refuge was the half-flooded concrete hotel. The next day, as the calm central eye of the storm passed, hundreds thought it was over, and were drowned in the sudden onrush of the east half of the storm. The terrific wind wiped out every telephone and telegraph line, every communication channel which had connected Miami with the outside world. In the cities of the South, where waited the potential forces of rescue, the only word from Miami was "wires down; no further news."

Then amateur radio, in the person of John V. Heish of Miami, stepped into the breach. The electric power was gone, but Heish improvised a transmitter with a UX-210 tube and a score of dry "B" batteries, and sent out an emergency call on 40 meters. He raised Gifford Grange in Jacksonville, and rushed through an official message from the county sheriff asking the Governor of Florida for immediate military aid. Throughout that first day the two stations kept an hourly schedule, handling Government and Red Cross messages, death messages, appeals for aid and news of safety. All over Florida and the entire South other amateur stations stood by, relayed messages, and did their part in the crisis.

The next great sectional disaster struck further westward. Through the spring of 1927 a series of floods occurred all along the Mississippi, inundating immense tracts of land, and driving nearly a million people from their homes and farms. Amateurs all along the great river stood watch hour after hour while flood conditions continued. 5SW in Hot Springs, Arkansas, gathered news for the city paper after wire communication went out. At Pine Bluff, in the heart of the flooded area, 5SI maintained contact with the Army Seventh Corps Area Headquarters at Omaha and handled all official army messages to and from Arkansas. In Louisiana and Mississippi several stations handled official relief and associated press traffic, and many more were standing by in readiness if wire lines failed.

Though the New England flood in November of the same year covered only a fraction of the area of the Mississippi flood, it was in some respects more concentrated and violent. The rainfall up and down western New England was around seven inches, and it is said that seven billion tons of water poured down from the skies on the Connecticut River watershed. George Wallstrom was at work in Montpelier on the afternoon of November 3rd and, realizing the danger of rising waters, started for his home transmitter. The water in the streets stopped his car; he continued on foot, but the depth and current soon forced him to take refuge for the night in a nearby house. The next morning he reached home by boat and met another amateur, Ralph H. Harris. They got one transmitter on the air immediately under auxiliary power, and raised Binghamton, New York, well outside the flood area. A few hours later, with the resumption of electric power, both stations began transmitting scores of official messages, news dispatches and assurances of personal safety. Three amateur expeditions took portable transmitters into the flooded area by automobile, freely sacrificing their time, property and safety in the common cause. Hundreds of permanent stations in the north Atlantic states kept watches night after night to expedite the flood traffic.

Perhaps the climax of wise preparation and intrepid devotion to duty on the part of amateur operators was reached in the Florida hurricane of 1928. The storm swept by the Virgin Islands and Porto Rico on the way, paralyzing two naval radio stations. Amateur transmitters, using the navy calls temporarily, at once got in touch with the mainland. In Palm Beach, Florida, two amateurs named Dana and Hollis prepared against the advancing destruction by gathering an emergency power supply of storage and dry "B" batteries and installing a transmitter in the Fire Station. They completed their final test transmissions under the shadow of the oncoming storm. Again along the Florida coast the wind rose to incredible velocities and began to crush houses, fell telegraph poles and lift solid blocks of stone bodily through the tormented air, while Hollis and Dana sat calmly at their instruments in constant touch with points beyond the storm area. Late in the afternoon their antenna blew away and their end of the building began to crumble. They moved the transmitter into the opposite end of the building, and strung a new antenna in a shower of bricks and roof tile. The next morning, while the wind shifted and the second half of the storm smote Palm Beach, they handled all sorts of emergency traffic that could find no other communication channel. Relief expeditions equipped with portable transmitters were on the way, but it was three whole days later when they were able to get into Palm Beach and relieve Hollis and Dana. During four days and nights one or the other had stayed almost continuously at the key, while other amateur stations all over the South relayed their messages to distant destinations.

Thus do the annals of amateur radio yield a broad and heroic story, of which we have here only sketched some of the highlights. Inspiring as it is to read this narrative written in fleeting signals through intangible space, how much more so, in whatever small degree, to help write it!

Today, amateurs are on a sound footing in every civilized country on the globe, and their operating bands and other privileges are recognized by international agreement. Many of our own operators have joined the Army Amateur Radio Net or the Naval Radio Reserve. In these days of propaganda, when the word "service" too often means simply self-glorification, to see a group of men who stand always ready in times of danger and disaster as a matter of course, with little to say about it either before or after, is both splendid and refreshing. And to join that group is more than merely to pursue a hobby.

The S. W. Four

(*Continued from page 32*)

this control properly only a small amount of actual experience is needed to master its sensitiveness.

COMPLETE PARTS LIST

1 S.-W.-Four foundation unit, comprising:

3 Alcoa shield cans, drilled;

3 bakelite sub-bases, drilled; brass posts for coil sockets, hardware, binding posts, pin plugs and jacks;

5 Aerovox fixed condensers, C3, C4, C5, C7, C9; .006 mfd.;

1 Aerovox fixed condenser, C6, .0001 mfd.;

1 Aerovox fixed condenser, C8, .002 mfd.;

R1, Yaxley fixed resistance, 5 ohms;

R2, Yaxley fixed resistance, 10 ohms;

R3, Aerovox grid leak, 3 megs.;

R6, Carter fixed resistance, 2 ohms;

R7, Aerovox grid resistor, 100,000 ohms;

ADDITIONAL PARTS REQUIRED

C1, C2, Cardwell taper-plate, variable condensers, type 167-E, .00015 mfd.;

R5, Carter Hi-ohm variable resistance, 100,000 ohms;

T1, T2, Amertran audio transformers, type AF-8;

L1, L2, eight S. W. Four plug-in coils (2 for each wave band);

V1, UX222 tube; V2, 112A tube; V3, 201A tube; V4, 112A or 171A tube;

Two National dials, type B;

Four Benjamin sockets;

Two De Jur 5-prong sockets (for coils);

One Yaxley battery switch, No. 10.


RADIO NEWS

A Short-Wave Transmitter

(*Continued from page 55*)

served. Just as an automobile engine must have three things to run: gas and air mixture reaching cylinder, ignition reaching cylinder, and low friction in moving parts; so must the Hartley oscillator have correct circuit arrangements (close coupling between grid and plate coil), filament and plate voltages tests with 80 meter coils almost any sort of an antenna may be used; a single wire forty to sixty feet long, in connection with a water-pipe ground, will do well enough. The rather extensive subject of efficient antennas for different wave bands, as well as frequency measurement, will be covered in a future article.

plate current. If 110 volt rather than 240 or 220 volt d. c. were used the connections would be the same, except that a 90 to 150 volt dry or storage B battery would be cut into the B+ lead as shown by the dotted lines, to give the necessary plate voltage of around 200. Where direct current is available, it offers a simple and easily installed method of running the transmitter. The large heat loss in the lamp bank cuts down efficiency, but even so, the expense of running the transmitter is quite small—around a cent an hour.

In many rural locations, and perhaps anywhere as a beginning, it may be advisable to run the transmitter from batteries. The connections for this form of supply are shown in Fig. 4. If the tubes are UX-112A and UX-171A the A battery is a single six volt storage unit, and the B battery should be about 135 volts of the heavy duty type. Of course these receiving tubes will not send out a very strong signal, but it should be readable enough up to 100 miles or so in daylight

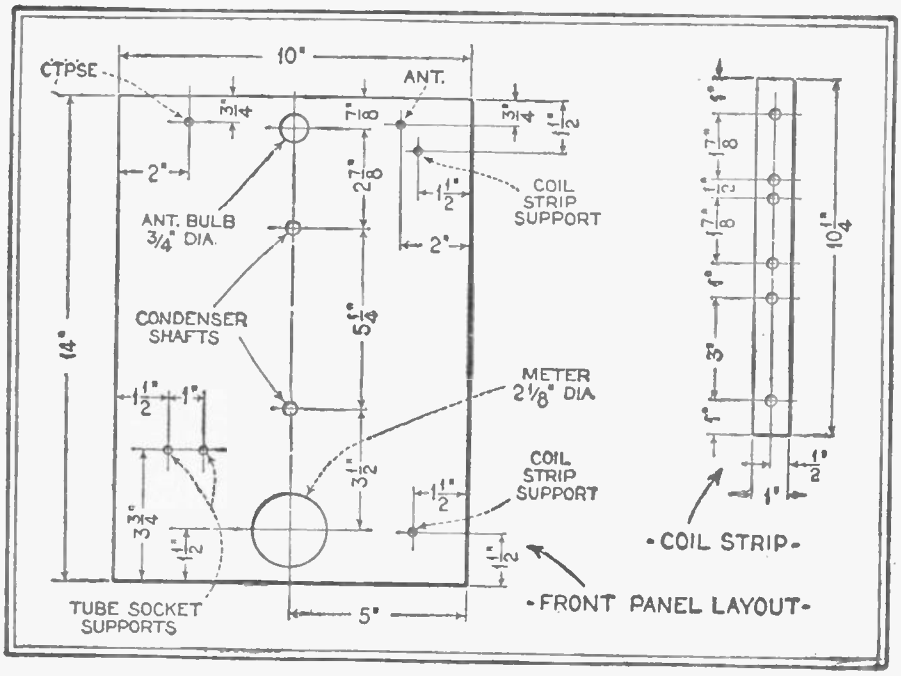
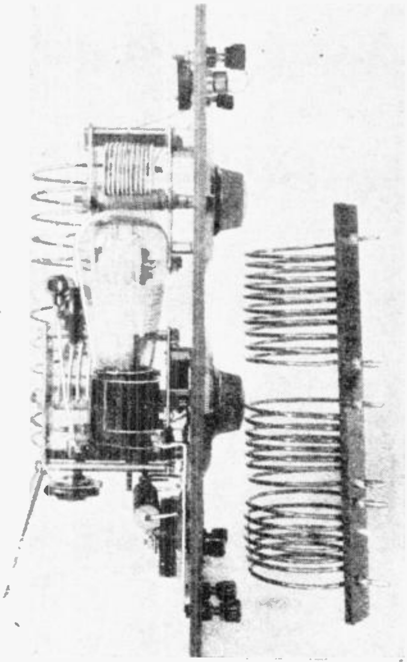


Fig. 7

reaching tube, and low resistance in tank ing the bulb will light. For the first few tests with the 80 meter coils almost any circuit. The fact of oscillation can be quickly checked by holding near the plate coil a single turn of wire terminating in a flashlight bulb; if the tube is oscillating the bulb will light. For the first few

Power Supply

In the photographs it will be noticed that a lamp bank appears prominently in the power supply. This is because the writer's lighting circuit happens to be 240 volts d. c., and all plate and filament voltages are obtained from this scource. The connections for this form of supply are shown in Fig. 3. The modulator and oscillator filaments are connected in series, with the oscillator at the minus end to give it the highest plate voltage as well as a slight increase in filament current due to the modulator



Right side view of the transmitter with the 40-meter coils inserted in the coil socket—80-meter coils leaning against dial

and a good deal further at night. Before long, however, the operator will wish the more certain results of the larger tubes. Then the A battery will be two six volts units in series, and the B battery voltage should be at least 180 volts, dry or storage. Of course dry B batteries are fairly expensive, and operating costs will probably run around ten cents per hour with the small tubes and over twenty-five cents per hour with the large ones; nevertheless, batteries are clean and simple to install, the initial investment is low, and some locations permit nothing else.

The third type of power supply, and probably by long odds the most popular one, is 110 volts a. c., diagrammed in

Remote control desk installed in the living room. Just to the right of the receiver is the key, the receiver filament switches and then the line switches and indicator bulbs

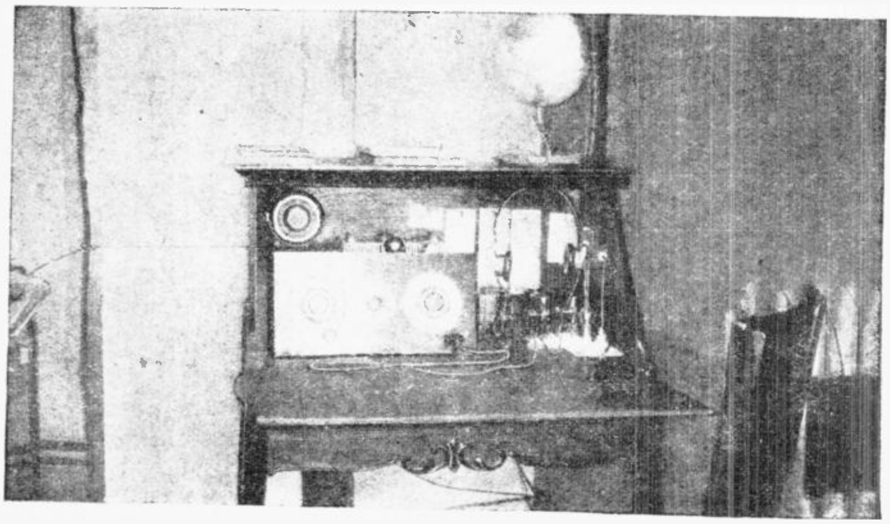
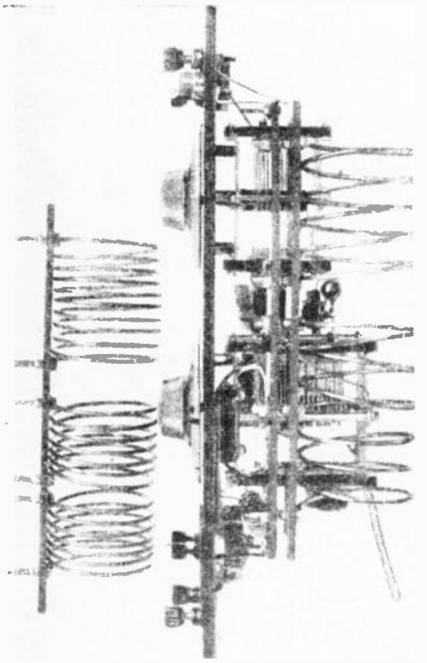


Fig. 5. A center tap and by-pass condenser must be added to the oscillator circuit, as noted in B, Fig. 2. The 7.5 volt filament transformer, perferably a separate one, is readily obtainable, and the remainder of the circuit is practically a B eliminator of the receiving type, using a UX-280 tube and a somewhat simplified filter. If desired, almost any manufactured B eliminator can be used here, or two UX-281's may be used with suitable transformers to put about 400 volts on the tubes. There is a ballast resistance of about 10,000 ohms across the filter output to draw some current when the key is up and reduce the load changes.

Modulator and Local Controls

The modulator proper takes up very little space on the under side of the top



Left side view of the transmitter with 40-meter coils inserted in the socket—the 80-meter coil is leaning against the dial

shelf of the modulator—power supply frame. It consists only of the tube, a spring Benjamin socket, and a Thordarson T—2357 microphone coupling transformer. (The microphone itself is a standard Frost one or the common telephone variety.) The 30 henry 80-150 mil. modulation choke, in this case the secondary of an old power transformer, is mounted on the bottom shelf. This also would be the place for batteries and a. c. transformers if used. The modulator circuits are included in the power supply diagrams of Fig. 3, 4 and 5. The "local controls," five switches mounted on the upper side of the top shelf of the frame, are used for turning the transmitter on and off during observation and adjustments, and for changing the circuits to code or phone operation. The left switch (line) turns on the power supply and lights the tube filaments, functions also performed by a similar switch at remote control over line No. 1. The second switch (code phone), in connection with a similar one at remote control, makes line No. 2 either a keying or a microphone circuit. The third switch (modulator plate) takes the plate voltage off the modulator tube during code operation. The fourth switch (key) acts as a local control key for testing, and remains closed during phone operation. The fifth switch (choke short) shorts the modulation choke during code transmission. To recount the switch line-up: for code, code-phone to code, modulator plate open, key open, choke short closed; for phone, code-phone to phone, modulator plate closed, key closed, choke short open. Though this switching seems a trifle complicated, it gives complete remote control of either code or phone with only four connecting wires.

Remote Controls and Receiver

In the remote control desk the receiver itself occupies the most prominent place. This may be any good design of short-wave receiver and needs no cabinet because of the closing desk. It is placed well back in the left hand part of the desk, with the B batteries behind it, and the A battery coming in through a cable.

The remote control circuits are shown in Fig. 6. Just to the right of the receiver is the key, of radio type with large contacts. The standard filter for eliminating key clicks in nearby receivers is a condenser across the key and a small audio choke in series with it, but when keying of necessity in the positive side of d. c. supply, this system has not proved of much value. For use with this transmitter we developed another scheme, consisting of two condensers across the key with center tap grounded and radio-frequency chokes in series with it. This suppresses the clicks to a point where they do not annoy broadcast listeners in the same building. In the desk the condensers and chokes are mounted just behind the key.

Next to the right is the receiver filament switch, separately mounted so that the receiver can be turned on and off without disturbing the tuning. The next switch turns the transmitter on and off over line No. 1. On the right of this switch are three indicating lights, one an auto headlight bulb showing transmitter on or off. In front of this are two small pilot bulbs, one in the key circuit to show oscillator plate current and the other in series with the microphone. These lights are of course much cheaper and more compact than meters, and they give a fair idea of what the transmitter is doing, besides acting as safety fuses. Up on the side of the desk wall are the microphone jack and a switch throwing either the key or the mike to line No. 2. For code transmission this switch is thrown to the key; and the operator, sitting before the receiver, closes the transmitter switch and taps the key. For phone transmission (the local control switches of course being changed) the DPDT switch is thrown to microphone and the microphone plugged into its jack. Then all the operator has to do is to close the transmitter switch and talk into the mike.

In General

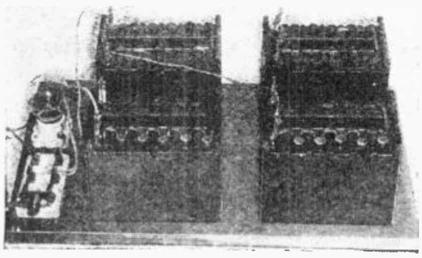
In another article we shall narrate some actual tests with this low power home transmitter, and touch in addition many details of short wave operation. In putting a new transmitter into service it is best to go slowly, testing each circuit separately before it becomes part of the whole. Small difficulties can then be ironed out as they arise, and they always do arise, even in the best design. But if performance is carefully watched at each stage—plate current, plate temperature, oscillation, r.f. output, etc.—getting "signs of life" out of a new transmitter will be found one of the most interesting experiences which radio offers.

In this description of a low power transmitter for the home many things have of necessity been discussed, and others perhaps more generally understood have been omitted. Detailed constructional information has been furnished as a guide for the beginner; and as solid data on a station that is neat but effective. An amateur station is of course an individual matter, and not to be fitted into any standardized mould. The experimenter, particularly, will wish to build his station in accordance with his own ideas. Let us hope at least that novice and old timer alike may find here some useful ideas of general design.

How to Get the Most From Your Short-Wave Transmitter

(*Continued from page 67*)

ground, and is to be preferred. Now, bearing in mind the current and voltage distribution on the antenna, let us put it within reason where we want it and get the excitation to it by a transmission line, or "feeder," just as the electric power company feeds our home lights over a line. One system of doing this is shown in Fig. 2A. The antenna is the same as that of Fig. 1B, with the set removed some distance and connected to it by a two-wire line. The system is called "current feed," because the line meets the antenna at a current maximum. Theoretically the current should be equal throughout the line—no standing waves, as shown by nodes of current and voltage, should exist on it. If these conditions are attained (by complicated tuning arrangements) the line may be of any length. But such perfection is beyond average amateur practice, and most of us can be content with a simpler method of getting practical results—making the line an even number of quarter-wavelengths long. This makes the standing waves "come out even," and as the two wires neutralize, they do not radiate. The great difficulty with all feeder systems is that the feeder refuses to be content with mere feeding, and tries to join the antenna in its function of radiation. The whole system may operate as a Marconi antenna, possibly on some harmonic of the fundamental frequency, with the filament transformer making a convenient ground. For this reason in all feeder experiments the filament circuit should be grounded, preferably through a thermoammeter of ample rating. If the ammeter shows current, something is wrong.



These storage "B's" boost the d.c. line voltage to about 350 volts

In Fig. 2B we have exactly the same antenna, this time "voltage fed." In other words, the line joins the antenna at a point of high voltage—the end. This has one advantage over the previous system—the antenna can be worked at harmonics without changing the type of feed—can be used, say, for both 80 and 40 meters. For the same reasons given above, the length of the feeder should be an odd number of quarter wavelengths. But as convenience and space usually limit it to less than $\frac{1}{4}\lambda$, this is not a serious handicap.

Two-wire lines have their advantages, but they are difficult to construct. In addition, due to the comparatively large surface and weight of spacing insulators, they are unwieldy in bad weather. Fig. 2C shows another voltage feed system, using only one wire. One side of the resonant secondary circuit at the set is connected directly to a high-voltage point on the antenna—it could be the end, but moving the feeder in a little way makes it less likely to radiate The feeder could also be connected directly to the oscillator circuit, but the intermediate tuned circuit provides smoother coupling control and causes less nearby interference. This system is easy to build, but hard to adjust, as the feeder has a strong tendency to become part of the radiating system. With the system in perfect adjustment, the feeder current should be equal throughout its length, the antenna current should be maximum at center and equal on the immediate opposite sides of the feeder connection. The adjustment difficulties are minimized by using a feeder less than $\frac{1}{4}\lambda$ in length. For further practical information on antenna systems and feeders the reader should see R. S. Kruse: "Feeding the Antenna," *QST*, July, 1926; and other articles in the same magazine for January and September, 1929.

TABLE 1

International Amateur Call Letters Commonly Heard in the United States

CM	Cuba	SM	Sweden
CT	Portugal	SP	Poland
CV	Roumania	UO	Austria
CW	Uruguay	VE	Canada
D	Germany	VK	Australia
EAR	Spain	VO	Newfoundland
F	France	W	United States of America
G	Great Britain		
HC	Ecuador	X	Mexico
K	U. S. Colonies	ZL	New Zealand
LA	Norway	ZS	Union of South Africa
OH	Finland		
ON	Belgium	AC	China
OZ	Denmark	AJ	Japan
PA	Netherlands	SC	Chile
PY	Brazil	EI	Italy
RX	Panama	EU	Russia
SA	Argentine		

The last six countries are listed with their old intermediates; their new amateur call letters are not yet known.

choice is more limited. Fig. 3 shows three antennas that will work from 83 to 85 meters, and also at 42 meters. By far the simplest is Antenna A—$\frac{1}{4}\lambda$ antenna and $\frac{1}{4}\lambda$ counterpoise at 42 meters. With the loading coil (25 turns of spaced No. 16 wire on $2\frac{1}{2}$-inch form) in, the antenna tunes through the whole 80-meter band. The actual A type antenna of W2CX is shown in the photograph, along with some of the nearby receiving antennas which do not help its efficiency. This design has the utmost simplicity and compactness, and is the best solution where one can only use a restricted portion of the roof. It is quite efficient on the 40-meter band, but less so on the 80-meter band.

TABLE 2

Home Transmitter Performance

Code or Phone	*Wave-length Meters*	*Plate Volts*	*Osc. Plate Mils.*	*Input Watts*	*Antenna Amps.*
CODE	85	330	55	18	.4
mod. choke shorted	77	330	55	18	.4
mod. plate disconnected	42	330	60	20	.3
PHONE mod. choke and plate in circuit	85	310	50	16	.3

Modulator grid bias -44 v.; plate current 50 mils.

84-82 *Meter Antennas*

Now that we have labored rather heavily through some of the principles and details of antenna design, let us apply them to our own problem. We wish to operate in both the 80-meter band and the 40-meter band. If we use two separate antennas, we may choose any of the types described above; if only one, our

Strictly speaking the antenna and counterpoise lead-ins should come into the house through pyrex bowls, or through the center of a window pane. But this raises the old question—who is living in the house, you or the transmitter? The W2CX lead-ins, shown in the photograph, are a compromise betwen electrical efficiency and convenience.

Antenna B calls for an overall height (or slanting length) of 100 feet, and of course something to support the high end. By changing two switches it is converted from a Marconi type with counterpoise for the 80-meter band to an elevated vertical Hertz, two-wire voltage fed, for the 40-meter band. This antenna has shown good results at W2WP. For those who have the facilities for installation, it will perform well. Due to the heavy current in the closed secondary circuit, the indicating bulb should be shorted out.

Antenna C is a horizontal Hertz, half-wave for 84-85 meters, and full-wave for 42 meters. Either single-wire or two-wire feed may be used. At the half and quarter points are flashlight bulbs, shunted around a few inches of the antenna wire, the drop across which at high current points will be sufficient to light the bulbs. When transmitting on 84 meters center bulb should light brighter than the others; when the wave is 42 meters the two outer bulbs should brighten up equally and the center bulb should go out. This may seem rather mysterious—to be lighting bulbs on a single dead-ended wire, but the reasons appear in Fig. 1.

The transmitting story is a long one. That is what makes it interesting—one can never say "I have built this and that, and I am through." We can only mention the ranges to be expected of the Home Transmitter. In the daytime we should do around a hundred miles in the 80-meter band and a few hundred on 42 meters. At night the 80-meter range spreads out to a thousand miles or so, while the 40-meter signals may on occasion travel several thousand. The reasons for these differences, one of the latest chapters in the radio art, are an interesting story which must be held over to next month. Here we are now, after a very respectable number of pages, scarcely beyond the end of the antenna. In the next article we shall journey out into space, to study the far-flung courses of the radio waves themselves.

Breaking Into Amateur Transmitting

(Continued from page 48)

graph, the key should be grasped lightly between the thumb, forefinger and middle finger; the other fingers take care of themselves. The round forearm muscle rests easily on the table; the whole arm is relaxed—motion is chiefly confined to the wrist and upper forearm. Another rule of sending, which could be adopted with benefit by many old timers, is: send slowly with regular spacing. Slow, even sending will get through a message much faster than a machine gun delivery which cannot be copied.

As all radio activities are controlled locally by the Supervisor of Radio, applications for the required operators and station licenses must be made to him. The supervisors are stationed at Boston (1st district), New York (2nd), Baltimore (3rd), Atlanta (4th), New Orleans (5th), San Francisco (6th), Seattle (7th), Detroit (8th), and Chicago (9th). The district boundaries on the map (Figure 2) show at a glance which district you are in. You must make formal application in writing for each license, and for the operator's license pass a code test at ten words per minute and a short theoretical examination as well. This examination usually includes diagramming and explaining the operation of your transmitter and receiver (see Figs. 3 and 4). Other electrical queries are usually combined with a few questions about radio law—for instance: No operator may divulge the contents of private messages he may copy; no one shall send out a false distress signal; amateurs must stay within their allotted bands and observe evening and Sunday morning silent hours when their transmission would interfere with other services. The two types of

(Continued on page 94)

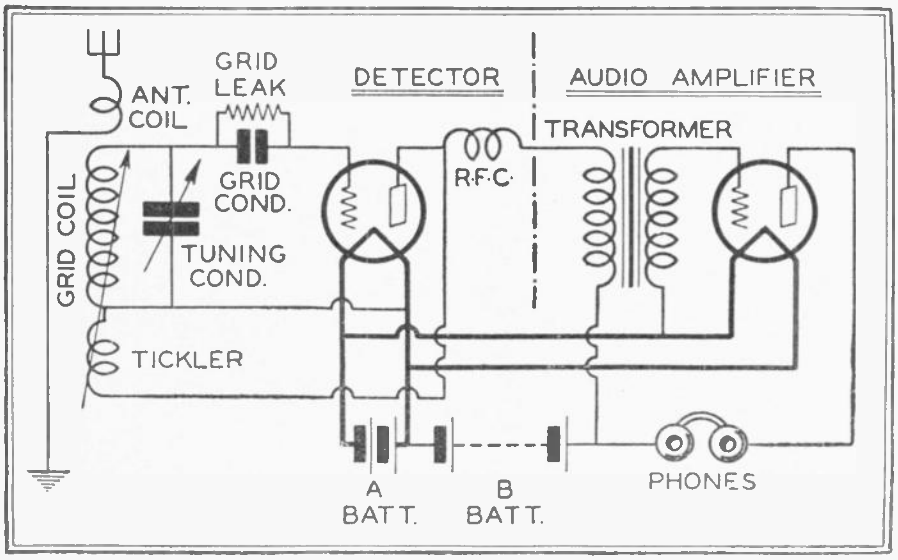


Fig. 4. Another requirement of the Government test is to draw the complete circuit details of your short-wave receiver

Ready For a Short-Wave Chat

(*Continued from page 61*)

communication, and assure ourselves that the signal is clean-cut and steady. We can also observe the effect of different circuit adjustments, different antenna tuning, etc., on the quality and intensity of our signal. The local intensity does not mean very much, however, as so many things enter into the transmission. When using the set for phone on 85 meters we can sit at the desk and talk into the transmitter, hearing our own words in the receiver headphones.

For more accurate frequency measurement we use a wavemeter. The coil is inductively coupled to the oscillator (holding wavemeter near transmitter is sufficient), and the condenser dial is tuned slowly until maximum current is indicated by the bulb, either flashlight or neon. Some of the commercial meters, such as General Radio and Aero, are excellent but a trifle expensive. The circuit, shown in Fig. 2, is simplicity itself, and a meter can be easily built from an old quickly adjusted to any desired wave by changing the oscillator condenser and retuning the antenna circuit. Variation in antenna tuning should not change the oscillator wavelength over 1%.

While the essential information for putting the home transmitter in operation has been indicated here, there are of course other things which space does not permit covering. A valuable source of information on this subject is the "Radio Amateurs' Handbook," published by the American Radio Relay League at Hartford, Conn., and also the articles by R. S. Kruse in *QST* from December, 1926, to March, 1927, entiled "How Our Tube Circuits Work."

Amateur Procedure

After all preliminary testing has been completed, and the operator has assured himself that his transmitter radiates a clean-cut, steady signal within one of the prescribed bands, it is time to "get out of

TABLE 1

Home Transmitter Performance

Code or Phone	*Wavelength Meters*	*Plate Voltage Volts*	*Osc. Plate Current Mils.*	*Input Watts*	*Antenna Current Amps.*
CODE	85	220	40	9	.20
Mod. choke shorted,	78	220	40	9	.20
mod. plate disconnected	42	220	45	10	.15
PHONE	85	190	33	6	.15
Mod. choke and plate in circuit	Modulator grid bias —22 v.; plate current 40 mils.				

These voltages approximate those of a battery-operated Home Transmitter. Grid leak 5,000 ohms. Oscillator UX210; modulator UX250. Filament voltage 7.5 volts d.c. Antenna —A type—detuned to ⅔ max. current for steady signal.

condenser, a flashlight bulb, and two rigidly wound, home-made coils. The flashlight bulb should be of the single cell, 1.2 volt type, as this is a low resistance bulb (.6 ohm cold and 2.4 ohms hot). The tuning with this bulb is much sharper than with a higher resistance bulb, but care must be used not to burn it out.

The home-made meter must be carefully calibrated from a standard one, by holding each in turn close to the receiver coil and noting the dial reading of each when they pull the receiver out of oscillation. As the receiver goes out of oscillation with a click and back again into it with another click, midway between these clicks on the receiver dial indicates the receiver wavelength corresponding to the wavelength at which the wavemeter is set. A curve is made up for the new wavemeter, showing dial settings plotted against wavelength or frequency.

With a calibrated wavemeter at hand, the transmitter can be calibrated in terms of oscillator condenser settings against wavelength. Such curves for the writer's transmitter are shown in Fig. 3. Fortunately enough, the main transmitting wave in each band, 85 and 42 meters, falls on the oscillator setting of 60, but such luck is unusual. While other home transmitters will show curves generally similar, each one should of course be individually calibrated. With this chart on the wall near at hand, the transmitter may be town"—ethereally speaking, of course; with low power and loose antenna coupling no physical move should be necessary. For the average location it is easier to begin with the 80-meter coil, as interference from distant stations is less. In sparsely settled country, however, such as parts of the West, the 40-meter coil offers the best chance of raising someone. The daytime is best for an air début, because the heavy traffic and interference at night tends to crowd out a weak, low-powered signal and the uncertain sending of a beginner. The simplest way to start is to locate with the receiver some other station sending "CQ." Each string of "CQ's" is followed by "de," and the distant station's call repeated two or three times.

When this sequence has been carried through a few times, the distant station sends "AR" or "K" and becomes silent. It is then our turn to switch on the transmitter and start sending his call perhaps five or ten times, followed by "de," and our own call two or three times. Switching on the receiver a moment, we listen to see whether he comes back; if not, we try again. If he does come back, he begins with our call, "de" and his own call, followed by whatever he has to say. In this process we have used the transmitter and receiver switches, but there was no need to touch the receiver tuning.

Using the other method of raising a station, we send out "CQ" three to five times, signing our own call two or three times. This whole sequence is repeated three times—no more. We then switch on the receiver, and "search" the band for an answering signal in the form of our own call. The tuning control must be moved slowly across the entire band, stopping long enough on each signal to recognize our own call if it is being sent. When we locate someone calling us, we answer him as soon as he stops sending. The standard inquiry call is "three times three," or "CQ" three times and one's call three times, all repeated three times. But as "CQ" catches attention and the call does not, it is usually better to send five "CQ's" and the call twice (three times on the last round). To send "CQ" more than five times running is a step toward becoming that premier nuisance of the amateur bands, the man whose fingers automatically repeat "CQ" *ad infinitum* while his mind is busy elsewhere, or dozing. Others get so tired of listening to his attention signal that they rarely wait for his call.

When contact is established one station usually says something like "GE OM QSA4 PDC hr at Boston, Mass. QRK? QRA?" (good evening, old man, your signals are moderately strong, pure d.c. note here at Boston; how do you receive me? —what is your location?), signing off with a short call. The other station, coming on with a short call, replies with "R" or "R OK" if everything was received perfectly, or "?" or "RPT" if something was missed, and gives the desired information. The chat then continues about anything of interest to the two operators—the weather, the transmitting conditions, the power in use, etc. Most of the "ama-

TABLE 2

Common Q Signals and Abbreviations

QRD	Where bound? Bound . . .
QRG	My frequency? Your freq. . . .
QRI	My tone bad?
QRK	How do you rec. me?
QRM	Interference
QRN	Static
QRQ	Send faster
QRS	Send slower
QRT	Stop sending
QRX	Stand by
QRU	Anything for me? Nothing
QRV	Are you ready? Ready
QSA	Signal readibility 1-5
QSB	My sig. strength vary? Your etc.
QSC	My signals swing out entirely? etc.
QSD	My keying bad? Your etc.
QSO	Can you communicate with?
QSP	Will you relay to?
QST	General call to all stations
QSQ	Send each word once
QSX	Does my frequency vary?
QSZ	Send each word twice
QTA	Cancel my last message
QTC	I have message(s) for you
QTR	What is your time? Time is . . .
C	Yes
N	No
UA	Do you agree?
K (or GA)	Go ahead
Q	Wait
R	Received
RPT (or ?)	Repeat
?WA	Word after
?WB	Word before
?AA	All after
?AB	All before

It will be noted that practically all the Q signals may be used either as a question or as an answer.

teur short-hand" as used above is easily guessable, as words are represented by a few of their consonants; and the rest is soon learned by listening to others. Signal strength is rated from a minimum readability of QSA1 to a maximum of QSA5. Some other "Q" signals in common use by commercial stations as well as amateurs are given in Table 2. A special amateur one is "QRAR?—Is your call book address correct?"; and "QRAR—My call book address is correct."

The government call book of American amateurs can be obtained from the Government Printing Office (Washington, D. C.) for twenty-five cents, and private interests publish quarterly an international call book costing a dollar. The signal "VE" is usually sent when beginning a transmission, and "VA" (or SK) is sent when signing off with a particular station. If the station is closing down and will not stand by for others, "CL" should also be sent. When signing off with another amateur it is courteous to send something like "HPE CUAGN VY 73 GB (hope to see you again, very best regards, good-bye)," although lengthy leave-takings can be and often are overdone. "73 GB" should really be sufficient.

With a small transmitter, and particularly with some form of remote control, the receiver may be left on while transmitting unless it is tuned very near the transmitting wave. This permits the use of "break-in," the fastest kind of two-way communication. We call another station, interspersing his call with "BK." As soon as he hears us he comes back, right through our sending, and of course we then stop and listen to him. If we miss any of his sending we simply send "BK," and he begins the word over. The transmitter and receiver switches remain closed; to send we merely press the key, and to receive we merely listen. Like two speakers face to face, either station can interrupt the other. This takes alertness and good operating—hence is more exciting and much faster than regular operation. Unfortunately, the percentage of stations equipped for break-in, and operators familiar with it, is none too great.

Every station should keep a log book. In this appears a more or less complete record of each transmission, including signal strength, static, etc. The notes may extend to the weather, the barometric pressure, or anything else in which the operator is interested. A cheap notebook can be ruled and labelled to the individual taste. The photograph shows a typical page from the W2CX log.

More Light on Short-Wave Transmission

(*Continued from page 76*)

less in the transmitters and receivers of which we know much, than in the actual transmission of which we know relatively little. The problem goes back to known physics, and forward to the unknown changes rung in the altitude of the northern lights by the distant yet all-powerful sun. Where will it end?

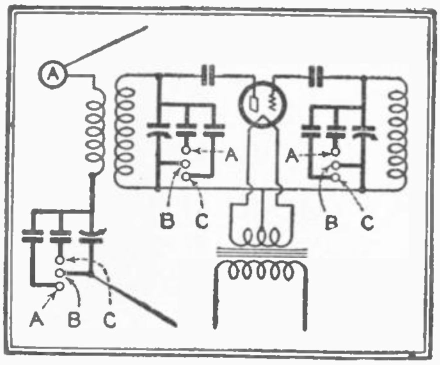
Building a Short-Wave Transmitter

(*Continued from page 63*)

In an oscillator it is possible that ultra-radio frequencies will be produced unless the small chokes, L2, L3, are connected in series with the grids. These parasitic oscillations may cause unnecessary heating and constitute a waste. A 20-turn winding on a ½-inch tube, tapped at the center and connected as in the diagram, Fig. 1, should effectively prevent any such possibility from becoming a reality.

Coupling the Antenna to the Oscillator

It is very important that the proper coupling between the oscillator and antenna be employed. Too little attention is given by the average fan to the coupling used. The method used in obtaining the proper coupling should be simple, so that it can be conveniently done, once

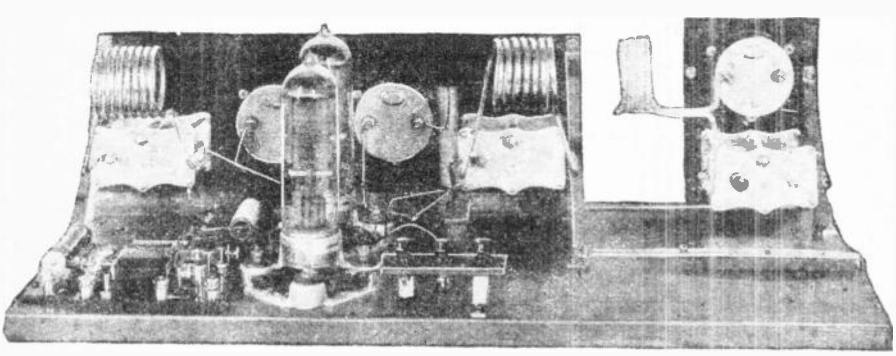


For quickly changing to other predetermined wavelengths, the circuit above is recommended by the author. Shunt condensers do the trick

for all, and the setting noted. If the coupling is too close, two frequencies are radiated and too much space in the spectrum is taken up in the already crowded bands. Use *loose* coupling; one sharp "peak" is then radiated. The proper value of coupling depends upon too many factors to give any general rules, but there is a simple method to tell when the desired result is obtained.

The following procedure would be followed in coupling the oscillator illustrated to its antenna. The antenna panel is first moved along the baseboard until antenna coil and plate coil are about ½ inch apart. The antenna is assumed connected to the antenna panel. With the coils close together, the antenna is tuned to resonance and the maximum antenna current is noted; this is, say, one ampere. Maintaining the antenna at resonance with the oscillator, by means of the antenna-series condenser, the coupling is loosened until the radiation has fallen to about 85% of its initial value, which, for the assumed maximum value of one ampere, would be .85 ampere. The signal is next studied by means of a well-shielded receiver, close at hand, or an ordinary receiver, with reliable operator, at some distance from the transmitter. The antenna condenser is then tuned first to one side of resonance (for example, tuned to a lower frequency than the oscillator) and then to the other, the "note" at each position is noted. If it is found that the note is much better on one side of resonance than on the other, the antenna is tuned to this "best" side and detuned by an amount such that the antenna current is 75% of the maximum reading first noted; this would give an antenna reading of .75 ampere. With a good oscillator and antenna, one can feel assured that with the proper coupling value, the emitted frequency will remain constant.

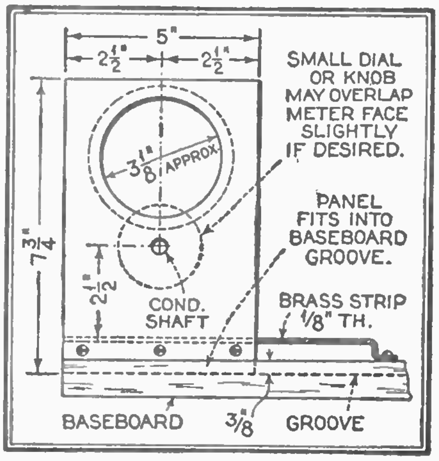
The method of coupling the plate and antenna coils in this oscillator is novel. The antenna coil, ammeter and series-condenser are all mounted on a small well-braced panel which slides along the baseboard. The panel itself extends somewhat below the top of the baseboard, fitting into a special groove running the length of the set. The main panel also fits into this groove, but is braced inside the set by a lengthwise piece to which it is screwed. Two pieces of strip brass are provided to hold the antenna panel rigidly in place and, in the rear strip, to two set-screws, so that, once the proper coupling is obtained, the screws may be tightened.



A rear view of the transmitter which clearly indicates how the sliding antenna coil-condenser is mounted

Often the proper adjustment of the coupling will improve the note as much as a whole section of filter. Although a battery or a d.c. generator is the ideal plate supply, well-rectified and filtered a.c. and proper adjustment of the set will give satisfactory results. Every precaution should be taken that the filament and plate voltages remain constant. Keying should be done in the negative plate supply lead to avoid shock in case the hand comes into contact with the key. Surprisingly good keying will result when large filament bypass condensers are used. Often a pair of 1 mfd. high voltage filter condensers, which have become useless for high voltage use, due to insulation breakdown, can be used across the filament leads for this purpose.

Some of the practical constructional details are of interest. The tuning condensers are constructed of 43-plate condensers by removing every other plate. The rotors are removed and every other plate in both rotor and stator can be driven out with a small screw-driver in some types of condensers. Before reassembling, the plug-in attachments for the coils are mounted in place, either by soldering or by screws through holes in the rear end-plates. The lock-nuts are readjusted to give the desired dial control.



Drilling details and layout dimensions for the antenna coil-condenser panel

Coils of the proper number of turns were cut from a long winding, consisting of about 20 ft. of ¼-inch copper tubing wound on a 2-inch wooden cylinder. The end of the tubing is fastened and the other end passes through a hole drilled in the cylinder; by rotating the cylinder the turns are wound tightly in place. The ends of the coils are bent to fit the plug-in attachments and are securely soldered to these. At 40 meters, 8 or 9 turns are used in each tuned circuit. The antenna coil consists of 5 turns from the same winding. A smaller number of turns can be used in the grid coil if desired; this allows a single size of plug-in coil to cover a given range, so that a smaller number of the various sizes need be constructed. All coils are interchangeable in either plate or grid circuits.

The chokes are supported by the heavy wire used in wiring the set. The wire passes through holes in the choke-tubing at the ends of the windings and the choke wire is soldered to these leads.

Hints on Operation for the Short-Wave Beginner

WHEN the receiver goes in and out of oscillation with a squawk, or a loud cluck, experiment with various grid leaks until you find the proper value which will allow the receiver to go into oscillation smoothly. Obstinate cases can be cured, generally, by reducing the detector plate voltage.

When wiring the receiver, always connect the rotor (movable) plates of the tuning and regeneration condensers to the filament return of the stage.

Power units, of both "A" and "B" types, are not recommended for use with short-wave receivers. A good "B" power unit is entirely satisfactory when used with a broadcast receiver; for the simple reason that, should a slight a.c. ripple be present in the speaker, it will not be noticed because of the volume of the reproduced signal. However, listening to a very weak signal with headphones is another matter; in this case a.c. ripples which would be inaudible in a broadcast receiver becomes literally roars in the phones. It should be remembered, also, that the broadcast receiver is, or should be, operated below the point of oscillation; this is quite a factor in keeping the a.c. ripple down to a minimum. In using a short-wave receiver, as the regeneration control is advanced, the ripple is amplified in direct proportion to the signal.

An efficient vernier dial must be used on the tuning condenser of a short-wave receiver. This refinement is not essential on the regeneration condenser; but tuning on the high frequencies is so critical that often signals are passed over without the operator being aware of their presence. This statement, also, emphasizes the necessity of slow and deliberate tuning, when a mere slight pressure on the knob of the dial may bring in a station.

It should be remembered that short-wave receivers can be logged—not quite as easily as the stabilized broadcast-wave receiver, but with a fair degree of reliability. After a station has been tuned in to the point where it is loudest, turn the regeneration dial to as low a point as it can be brought without losing the signal; when this has been reached, adjust the tuning condenser until the signal is loudest. At this dial reading the station may be logged, with some assurance of returning to it, when desired, with a minimum of "juggling."

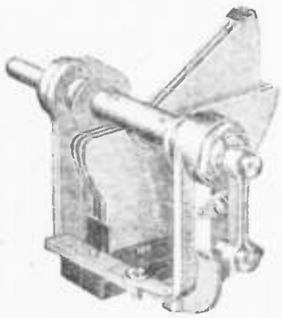
Transatlantics

THE following are the operating schedules of: G5SW, Chelmsford, England, 25.53 meters, 15,000 watts, 2 P. M. to 7 P. M. daily (Greenwich Mean Time) except Saturday and Sunday, and at irregular intervals, experimental transmissions from 7 P. M. to 9 P. M. All announcements are in English.

PCJ, Eindhoven, Holland, 31.4 meters, 27,000 watts, Thursday 1 P. M. to 3 P. M. and 6 P. M. to 10 P. M. Friday, 1 P. M. to 3 P. M. and 7 P. M. to 1 A. M. Saturday morning (Greenwich Mean Time). Announcements are made in six languages, according to the country to which the particular program is dedicated: Dutch, English, French, German, Spanish and Portuguese.

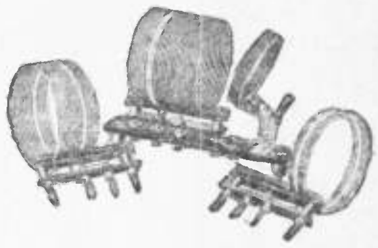
HAMMARLUND for "HAMS"

Short-Wave Condensers and Coils That Help You Travel Round the World



Short-Wave Condensers made in 5-, 7-, and 11-plate sizes especially for Short-Wave reception.

Hammarlund Condensers are Specified for the Radio News $50 Prize-Winning Receiver



Short-Wave Plug-in Coils. The standard set (illustrated) covers the 15-107 meter range with a .00014 mfd. condenser.

The same qualities that have given Hammarlund Products supremacy in the broadcast field are responsible for the success of Hammarlund Short-Wave receiving and transmitting devices.

Short-Wave *Receiving* CONDENSERS

Hammarlund Short-Wave Condensers have soldered, non-corrosive brass plates with tie-bars; minimum dielectric; aluminum alloy frame; non-shorting bronze pigtail; adjustable ball and cone bearings and a full-floating removable rotor shaft. Available in .0001 mfd., .00014 mfd. and .00025 mfd. sizes—with either the "Midline" or "SFL" tuning curve. $4.75 and $5.00.

HAMMARLUND SHORT-WAVE PRODUCTS Were Specified for the Following Receivers Featured by Radio News during 1929:

SPACE-CHARGE AUTODYNE

NEW YORK TIMES SHORT-WAVE RECEIVER

HAMMARLUND SHORT-WAVE CONVERTER-ADAPTOR

Short-Wave *Transmitting* CONDENSERS

Transmission over short-wave lengths is recognized as the most efficient medium for long-distance amateur communication. The very low losses and high quality of Hammarlund Transmitting Condensers are emphasized in this class of work where ordinary condensers are impossible. Tested to withstand very high potentials. Three sizes: .0001, .0002 and .0004 mfd.—$6, $7, and $10 respectively.

Short-Wave *Plug-In* COILS

Hammarlund Short-Wave Plug-in Coils are built around a special self-supporting space-wound coil material developed four years ago, and which has become standard for low resistance at very high frequencies.

These coils are wound with a definite space between turns and supported by a thin film of strong, efficient dielectric material. By firmly anchoring each turn of wire to the dielectric, short circuits are impossible.

Distributed capacity and resistance are at a minimum, making for extreme sensitivity and sharp tuning. To further minimize losses and to keep down the stray circuit capacity which limits the frequency range of each coil, the coil mounts and plug-in terminals have been widely spaced.

The standard SWT-3 coil set (pictured above) covers the 15-107 meter range with a .00014 mfd. condenser. There is ample overlap, making tuning very smooth over the entire wave-length range. Other coils are available which extend the range down to 8 meters and up to 215 meters. The primary coil is adjustable, and held in position by friction. Base and plug-in coils for the 20, 40 and 80 meter bands, $10.00. Base only, $3.00. Plug-in Coils for 20, 40 and 80 meter bands, $2.50 each. Plug-in Coil for 120 meter band, $3.00.

HAMMARLUND MANUFACTURING CO.,
424-438 W. 33rd Street, New York, N. Y.

Write for Folders

For Better Radio
Hammarlund
PRECISION
PRODUCTS

Write for Folders

The Transmitter Goes to Sea

The outfit has been given the acid test of actual use on board a yacht and in an amateur station and has worked, or been heard, in every continent when used in an amateur station. When used in the yacht, the meters were mounted upside down. All yachts seem to provide plenty of space for everything else but the radio equipment and operator, so it had to be mounted upside down on the ceiling to save space. This required also that the brass strips be made secure to keep the antenna apparatus in place. Some interesting practical results of tests on board a yacht will be given in a later paragraph for those interested or contemplating similar installations.

A transmitter is quite simple to get into operation. The wiring should first be checked; the high-voltage positive lead should be traced through the set to see that it does not touch anything connected directly or indirectly to filament. It is worth while also, for the plate milliammeter's sake, to test the plate condenser with a battery and phones before turning on the power. The antenna is as yet unconnected. First turn up the filaments to rated voltage, then press the key. Turn the grid condenser until the plate current drops to a minimum. The set should oscillate the first time. Measure the frequency with a frequency meter and adjust properly well within the desired amateur band by varying both condensers. If the grid and plate inductances are of the same size and the condensers of the same general construction, both condensers should be set approximately at the same dial-setting. The set is then coupled to the antenna as previously described.

The plate choke in the oscillator can be tested by using a wooden-handle screw-driver. Move the metal end along the choke; much sparking should result at the plate end of the choke, but little, if any, at the other end.

Remote Control Is Popular

Since separate receiving and transmitting antennas give best results, many amateurs operate the transmitter remote control so that the receiving apparatus is away from the immediate vicinity of the transmitter. The relay in the set is used for keying. Connections are as in Fig. 1. Although it is undesirable to extend the high-voltage leads in a powerful set for remote control, thus necessitating a relay, the 110-volt a.c. leads can be extended for turning the set on or off. In some cases it is possible to use a simple pull-chain socket with a long cord, connecting to the supply near the set, for simplified wiring. Some relays require a 20-ohm series resistor when operated on 110 volts d.c. A small storage-battery-operated one is suitable or even a revamped doorbell will serve. The 5 mfd. condenser across the key is to reduce sparking at the contacts, but this may not be found necessary in some cases.

Although the "open" type of construction appeals to visiting radio friends, the set can be placed in a cabinet if desired.

If no cabinet is used, a cloth should be thrown over the outfit when not in use to keep dust from lodging between the condenser plates or other places where it isn't so good.

All wiring is done with No. 10 wire (enameled) to prevent any possible vibration. The r.f. leads to grid and plate should be of the same length between tubes. The panel should consist preferably of ¼-inch stock. Nickeled braces, as in this set, certainly improve the appearance and strengthen the set greatly. These are fastened to the baseboard with two wood screws and to the panel with machine screws and nuts. The antenna condenser is provided with a small knob which overlaps the face of the meter slightly.

When the transmitter is used in a yacht, the antenna capacity changes so that every precaution must be taken so that the antenna has a minimum effect on the oscillation frequency. By adjusting the coupling as previously described, and employing "high-c" oscillator tanks, this is well taken care of. In "salt air" ordinary copper tubing inductances will corrode unless plated. The coils in the oscillator have been silverplated; this is not so very expensive and certainly adds to the appearance of the set. In motor-driven yachts especially, under certain conditions, the coils vibrate considerably, which may be undesirable. However, under other conditions, a slight vibration may be tolerable, as it tends toward a "modulation" on the emitted frequency, which is not so bad at sea. If vibration is severe, the best procedure is to fasten to each coil a piece of bakelite, extending this to the panel and securing it. This does not allow such rapid change of plug-in coils but steadies them. It is often sufficient to tie a piece of bakelite inside each coil with waxed cord.

Outside of the factors mentioned, the set works equally well in an amateur station or on board a yacht—either upside down or right side up. It is a 1930 set.

List of Parts

2 .0012 mfd. Sangamo fixed condensers —for grid C5.
1 R. C. A. tapped plate blocking condenser—C4 .0006 mfd. C1, C2, C3.
3 .0002 mfd. variable condensers—General Instrument Co.
2 50-watt sockets and tubes.
1 5000-ohm grid resistor—heavy duty, transmitting, R1.
1 filament voltmeter, 0/15 a.c. volts, Jewell V.
1 0/300 milliamperes d.c. meter, MA.
1 0/3 amp. antenna meter, high frequency, A.
1 filament transformer, with primary rheostat T. 10 V sec. for 50-watt tubes, 7 V sec. for "210" tubes.
1 center-tapped by-pass condenser, C6, .002 mfd. each section.
20 ft. 3/16 in. copper tubing for 40-meter band coils, L4, L5, L6.
8 plug-in atachments, "Ajax," and 2 for each extra coil.
1 Leach relay, keying, model 18, type S-3 (optional).
1 .5 mfd. Polymet fixed condenser (key contacts—optional), C7.
6 ft. ⅛ by ½ inch brass strip.
1 piece 3/16 by 1½ by 4 inch bakelite—post strip.
1 piece ¼ by 7¼ by 18¾ inch—main panel.
1 piece ¼ by 5 by 7¾ inch bakelite—antenna panel.
1 baseboard ⅞ by 13¾ by 28 inches—main baseboard.
1 baseboard ⅜ by 5 by 8¾ inches—antenna-panel baseboard.
1 200-ohm resistor (current limiting)—(optional) R2.
1 ft. ½-in. diam. bakelite tubing—for chokes.
60 ft. No. 30 wire for chokes L1, L2, L3, L4.
6 binding posts, large bakelite.
Panels, baseboard, strip brass, machine screws and nuts.

Breaking into Transmitting

(*Continued from page 89*)

licenses are illustrated in the photographs. Though the operator's license happens to be a first-class commercial one, for which a 20-word code test and a theoretical examination lasting several hours are required, the general form and wording of an amateur license is the same.

When a first-class receiver has been installed and when the operator is well on his (or her) way toward getting the necessary licenses, it will be time to think of building the transmitter. Here there may be a serious obstacle, usually human, in the form of a father, a wife, or perhaps some more distant yet equally insistent relative.

Some Experiments on Ultra-High Frequencies

(*Continued from page 51*)

resonance, and C10 and C11 adjusted until this stage may be tuned through resonance with the detector circuit without stopping the latter from oscillating. A maximum capacity of 30 micromicrofarads should be used in condensers C4 and C5 since condensers of great capacity will offer too much capacity coupling and will cause interaction between the two stages. After the two circuits are finally adjusted, it should be possible to place the detector on maximum regeneration point and then tune the radio-frequency stage through resonance without detuning or stopping the detector circuit from oscillating. The detector circuit should be calibrated and a careful curve drawn for each coil system. It will be found that the circuit will retain the calibration values indefinitely. Stations will come in at dial settings previously logged, thus avoiding "hunting" as experienced in other circuits. Variation of R6 does not affect the tuning. On the 6, 7 and 8-meter bands, it may be necessary to increase the detector voltage to approximately 60 volts in order to have full control of regeneration over the whole scale of each coil system.

It will be possible to receive certain stations on their second harmonic values. This, of course, cannot be possible where the skip distance takes places. WLL operates on 17,000 kilocycles and may be heard during daytime on 35,800 kilocycles. During daytime, the writer has received signals from the following:

Frequency	*Station*	*Location*
24,740	WQA	New York
26,350	NAT	New Orleans
26,400	RZ	Unknown
26,450	LSD	Buenos Aires
26,500	HJO	Colombia
26,540	FY	Syria
27,440	KLL	San Francisco
27,560	WGT	Porto Rico
27,740	WIY	New York
27,744	NKF	Washington
27,930	English Beam	Station
28,000	NKF	Washington
28,400	NKF	Washington
30,000	NKF	Washington
30,860	KEW	San Francisco
31,000	NKF	Washington
32,000	WIY	New York (*Rough note. Not a true harmonic.*)
32,120	NAA	Washington
32,300	NKF	Washington
32,700	NKF	Washington
34,000	NKF	Washington
35,000	WQC	New York
35,800	WLL	New York
35,910	NKF	Washington
36,040	KQJ	San Francisco
37,800	WDS	New York
38,500	NKF	Washington
40,000	NKF	Washington (*Not heard on all schedules.*)

NKF was received on fundamental frequencies, as given, while reception of other stations listed was accomplished on the second harmonic value of the main transmitting frequency. Tests from NKF were conducted at a distance of 2,000 miles, which gave good signal strength at 38,500 kilocycles, which shows that the skip distance played an important part for reception of the last-mentioned frequency.

An important feature was observed in reception of these stations—the steadiness of the signals. In fact, very little fading was ever observed.

The writer concludes by stating that the new receiver described in this article makes possible reception of frequencies from 23,000 to 40,000 kilocycles, which provides 1,700 available channels, each 10 kilocycles in width.

COIL DATA FOR THE PUSH-PULL RECEIVER

Coil No.	*Band in Meters*	*Turns Antenna*	*Turns Grid*	*Turns Grid Det*	*Turns Tickler*	*Dia.*
1	80	6	21	21	6	2
2	40	4	13	13	6	2
3	36	4	7¾	7¾	4	2
4	20	3	5	5	4	2
5	15	2	3¾	3	3⅔	2
6	12	2	4	4	4	1
7	10	2	3	3	4	1
8	8	2	2	2	4	1
9	6	2	2	2	4	¾

Grid and antenna coils from No. 1 to No. 5, inclusive, are wound 18 turns to the inch with No. 22 enamel-covered wire. Tickler coils are wound 4 turns to ⅛ inch with No. 27 enamel-covered wire. Coils No. 6 to No. 9, inclusive, use No. 22 double silk-covered wire for all coils. Wind the tickler coil close to the grid coil. For coils No. 8 and No. 9 space the tickler coil for each one so that the desired frequency range is obtained.

4 of the 40 Easy Ways to Make $3.00 an Hour In Your Spare Time in RADIO

THE four plans shown are but a sample of the many ways in which our members are making $3.00 an hour upwards, spare time and full time, *from the day they join the Association*. If you want to get into Radio, have a business of your own, make $50 to $75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the $600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.

Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean $50 to $75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. SWM-1 Chicago, Illinois

Below are a few of the reports from those now cashing in on the "40 Easy Ways"

Clears $3,000.00 Frank J. Deutch Pa.—"Since joining the Association I have cleared nearly $3,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow your easy ways of making money."

$1,100.00 in 6 Weeks J. R. Allen, Calif. — "Have done over $1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

$25.00 a Week Spare Time N. J. Friedrich, N. Y.—"I have averaged $25.00 a week for the last 7 months though I am not a graduate but just le[illegible]g."

Training Lands Him Job R. C. Kirk, N. C.—"Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below *now*. You'll always be glad you did.

Radio Training Association of America
Dept. SWM-1 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

Name ....

Address ....

City .... *State* ....