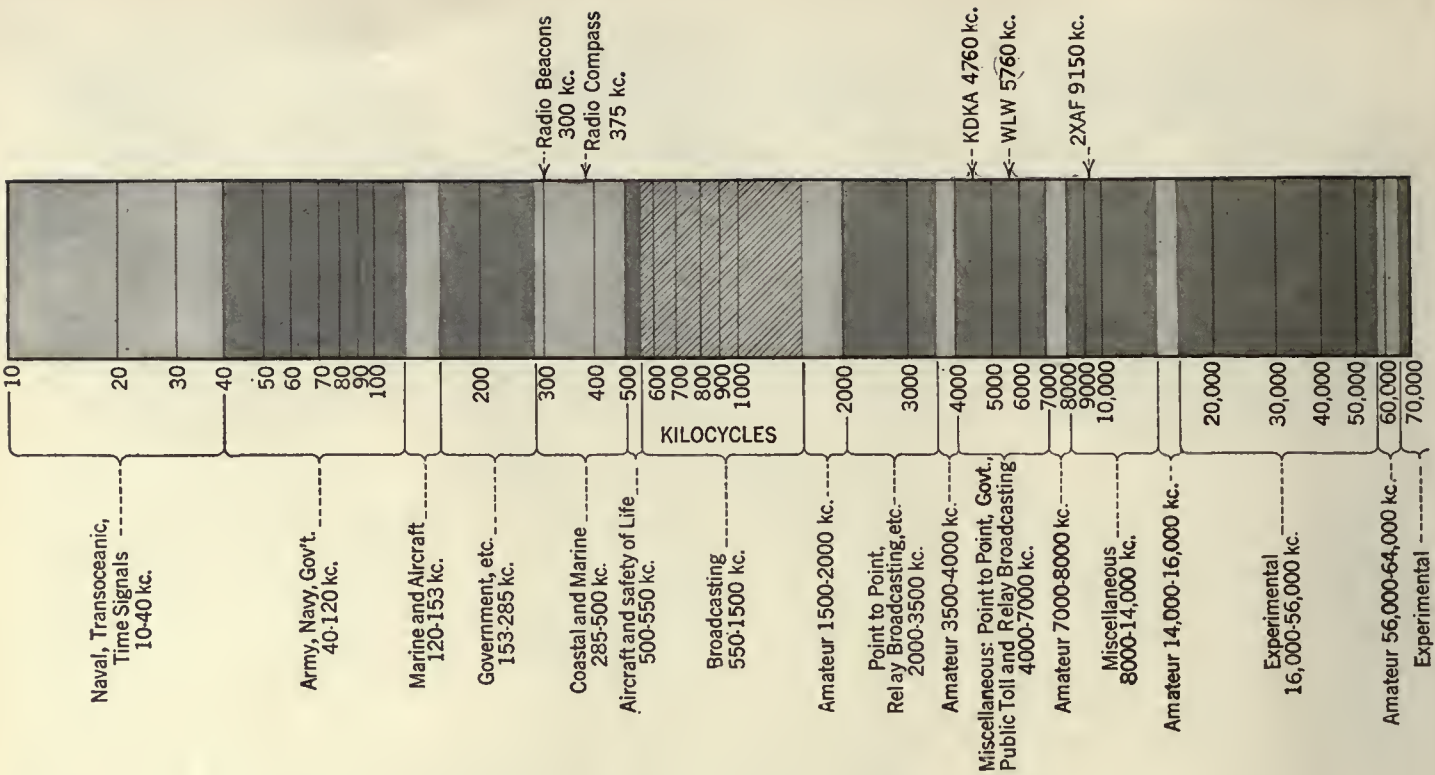


FROM TEN TO SEVENTY-THOUSAND KILOCYCLES

This diagram shows very clearly how the frequency spectrum between these two widely separated points is divided. and a very good idea of the comparative width of the band set aside for broadcasting may be had

Why Not Try the Short Waves?

In Which the Appetite of the Broadcast Listener Is Whetted—A Receiver for Exploring the Nether Regions of the Wavelength Spectrum, Where a Real Taste of Internationalism Is Possible

By KEITH HENNEY

Director of the Laboratory

OUT of a total number of frequencies available for radio communication amounting to some 60 million, the broadcasting band occupies only one million—a very small band indeed. What goes on in the other bands has been, until recently, a closed book to the vast majority of listeners because of the language used there—the International Morse code. Now, however, there are at least three American broadcasting stations using voice and music to modulate waves in these vast open spaces outside of our familiar broadcasting band, so that adventuring into the other 59 million frequencies is not too devoid of interest.

For many months the General Electric Company has put programs into the ether experimentally on a wavelength of 32.79 (9150 kc.) meters, and the 63-meter (4760 kc.) signals of the Westinghouse station KDKA are already too well known to need introduction. Recently WLW at Cincinnati has been using a band at 52 meters (5750 kc.) for rebroadcasting their regular programs and, according to reports, a 30-meter (9990-kc.) station operated in Eindthoven, Holland, can be heard during the early evening hours in the United States. Also, as this is being written (July) a station near Quebec is testing on approximately 32 meters (9380 kc.) and signing cs.

Here are five landmarks for which anyone equipped with a short-wave set can go seeking. Fortunately, it is possible to build a receiver for the high frequencies in a very simple manner indeed, and with removable coils one can cover the entire range from below about ten meters (30,000 kc.) to something beyond the broadcasting band, thereby opening up a vast expanse of receiving territory unfamiliar to the average listener, and filled with interesting goings-on.

The usual short-wave receiver uses only two tubes since headphone reception is the rule. The first tube is a detector, which may be made to oscillate, or not, as the operator desires, and the second tube is used in a transformer-coupled amplifier. If loud speaker signals are desired it is only necessary to provide an additional stage, preferably equipped with a power tube.

FREQUENCIES AVAILABLE FOR AMATEUR USE

AMATEURS in the United States operate in bands set aside for their use as shown in the table below. Other interesting services carried on the high frequencies are given in the box on page 291:

METERS	KILOCYCLES	WIDTH KC.
0.7477–0.7496	401,000–400,000	1000
4.96 –5.35	64,000–56,000	8000
18.7 –21.4	16,000–14,000	2000
37.5 –42.8	8000–7000	1000
75.0 –85.7	4000–3500	500
150.0 –200.0	2000–1500	500

The illustration forming the heading of this article shows the part of the spectrum that broadcasting utilizes and also gives an idea of the many services which take place in the other parts of this spectrum. Above the broadcasting frequencies come the many-tongued bands filled with amateur transmitters. In the United States, for example, there are several sections in which amateurs may operate, that immediately above our broadcasting section (or below if we think in meters), then another at 3750 kilocycles, or 80 meters, one at 7500 kilocycles or 40 meters, and still others at 15,000 and 60,000 kilocycles, or 20 and 5 meters respectively.

Communications take place on these higher frequency bands that would be considered miraculous on lower frequencies. For example, on February 20th, 1927, the following stations were heard at 2 EJ, one of the stations operated by RADIO BROADCAST Laboratory, on or below the so-called 40-meter (7500-kc.) band:

EST	STATION	LOCATION
3:35 P. M.	NL 4 X	West Indies
	G 5 XY	England
3:50 "	FO A 3B	South Africa
3:55 "	G 5 XY	England
4:00 "	EK 4 UAH	Germany
4:07 "	OA 5 WH	Australia
4:20 "	F 8 IB	France
6:25 "	SB 1 AR	Brazil
6:35 "	NQ 5 AZ	Cuba

Thus, in a space of one hour and a half, it was

Coil No.	Wave-length Range Meters	Kilocycle Range	Secondary, L_2				Tickler, L_3		
			Total Turns	Length of Winding Inches	Size Wire	Insulation	Total Turns	Size Wire	Insulation
1	15-28	19,990-10 710	3	$\frac{5}{32}$	18	Enamel	2*	26	d.s.c.
2	30-52	9994-5766	8	$\frac{17}{32}$	18	Enamel	4*	26	d.s.c.
3	57½-111	5260-2701	19	$\frac{9}{16}$	18	Enamel	6*	26	d.s.c.
4	119-228	2399-1199	40	$1\frac{1}{2}$	22	d.s.c.	15*	26	d.s.c.
5	235-550	1276-545	81	$1\frac{1}{2}$*	26	d.s.c.	21*	26	d.s.c.

*Close wound.

Note: Tuning condenser is 100 mmfd. Primary, L_1, consists of 10 turns, wound in a space of 9-32nds inch, of No. 22 cotton-covered wire, and is $2\frac{3}{4}$ inches in diameter. Secondary is 3 inches in diameter.

possible to listen-in on the whole world. At another time BZ 1 IB, a Brazilian Amateur, was heard talking to GMD, the Dyott Expedition. It would be possible to go on indefinitely with stories of long distances covered and interesting experiences, but the preceding paragraphs should give the uninitiated some idea of what can be expected in the short-wave provinces.

Kits of short-wave coils, condensers, etc., are now available from several manufacturers, and with these, receivers may be constructed. All of these receivers will radiate and can disturb near-by listeners, but with loose coupling to the antenna and an additional audio stage if necessary to make up for the decrease in signal strength, this radiation is reduced to a minimum.

In actual practice, the detector is on the point of oscillating when voice or music is being received, and when code signals are copied the detector is actually oscillating, but is near the point where oscillations are liable to cease. In these conditions the detector is most sensitive.

Attention is called to the two articles by Frank C. Jones, 6 AJF, on non-radiating short-wave receivers. Mr. Jones has made a substantial contribution toward the ideal receiver and the set described by him in RADIO BROADCAST in May, 1927, approaches very closely to a truly non-radiating receiver.

Each of the coils designed for the short-wave kits differs from the others, Silver-Marshall using a form similar to broadcast coils, Aero Products using spaced windings on slotted forms, REL supplying the familiar basketweave style, and those of Gross or Hammarlund consisting of spaced windings on a celluloid form.

WINOING THE COILS

FOR the experimenter who likes to make his own, the following description of coils similiar to the Aero inductances will be helpful. The number of turns for the various frequency bands to be covered is given in the table on this page.

An insulating tubing three inches in diameter can be used without introducing much loss. The tickler coil is, in each case, $2\frac{3}{4}$ inches in diameter and is made self-supporting by using collodion or some other binder. This coil is placed inside the secondary at a position near the grounded end of the coil and need not have a great deal of mechanical strength as it is protected by the secondary. The same primary is used for every coil and should be fastened on a hinge which makes it possible to vary the coupling as desired. This coil is made self supporting, is wound without spacing, and a binder is used to keep it in shape. It is wound with ten turns of No. 22 double silk-covered wire. The primary may be mounted on the sub-panel of the receiver. It will be found, in operation, that the setting of the coupling need not be changed very often and once adjusted properly may be left in a fixed position. Secondary coils Nos. 1, 2, and 3 are wound with No. 18 enameled wire spaced approximately the diameter of the wire. Secondary coil No. 4 is space wound with No. 22 double silk-covered wire, the dimensions of the coil being $1\frac{1}{2}$ inches by three inches. Coil No. 5, which covers the broadcast band, is wound with No. 26 double silk-covered wire and is not spaced. The coils are mounted on flat strips of bakelite, and four connections are brought out from each coil in the form of pins, mounted on the bakelite strips. The pins are designed to fit into corresponding slots in the sub-panel mounting. Three pins are spaced at one end of the bakelite strip with a fourth apart from the others, making it impossible to plug the coils in the wrong way. Almost any type of plug system having four contacts may be used. Suggestions have been made from time to time for using an old base of a vacuum tube and a tube socket for this purpose. If such a device is used care should be exercised to see that too much capacity is not introduced, otherwise the wavelength ranges will be considerably affected.

This covers the mechanical details of the coils. It is not necessary to go into details of the wiring of the receiver shown in Fig. 1 as most of our readers are familiar with this part of set building. It is important, however, especially in short-wave work, to make the grid lead very short and to keep all wires rigidly fixed in their respective positions. The actual order of wiring is not mandatory but it is suggested that the filament wires be completed first.

The circuit used for the several kits on the market is fundamentally the same. That used in the Aero kit is shown in Fig. 1. The Radio Engineering Laboratories kit consists of a complete set of parts, including panel, wire, transformer, coils, etc., and lists at $36. Silver-

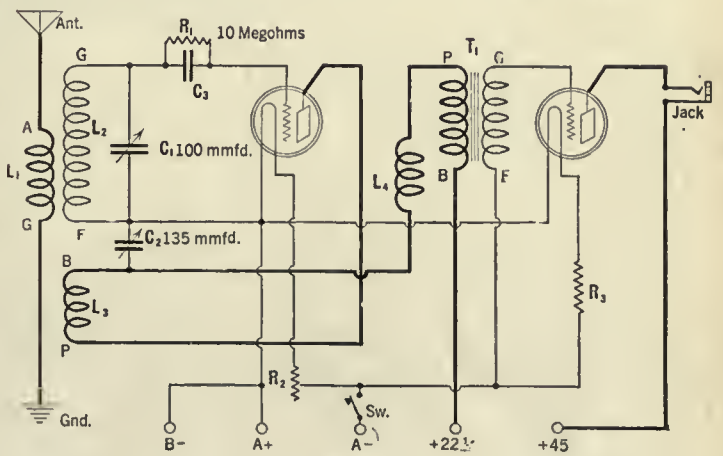


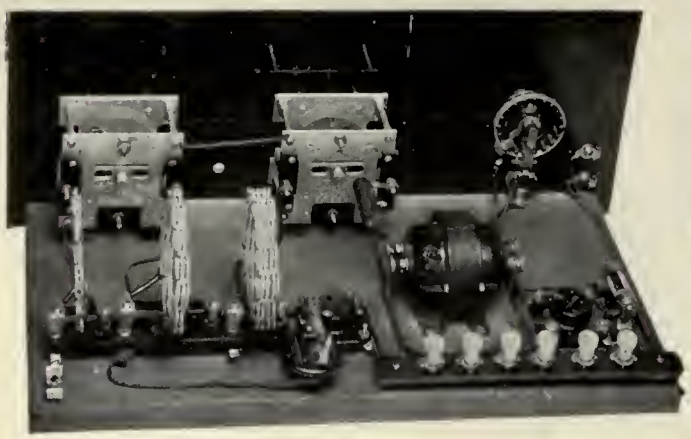
FIG. 1

The circuit diagram of the Aero short-wave receiver

How the Higher Frequencies Are Allocated

AN IDEA of what goes on in the higher frequency bands may be gleaned from the following table, which shows how the various frequencies were divided up by the Fourth National Radio Conference:

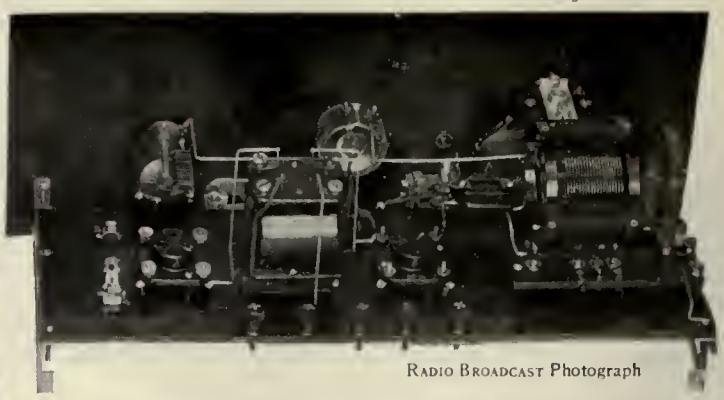
Kilocycles	Meters	Service
500-550	600-545	Aircraft and fixed safety of life stations.
550-1500	545-200	Broadcasting only.
1500-2000	200-150	Amateur only.
2000-2250	150-133	Point to point.
2250-2300	133-130	Aircraft only.
2300-2750	130-109	Mobile and Government mobile only.
2750-2850	109-105	Relay Broadcasting only.
2850-3500	105-85.7	Public toll service, Government mobile, and point-to-point communication by electric power supply utilities, and point-to-point and multiple-address message service by press organizations, only.
3500-4000	85.7-75.0	Amateur, Army mobile, naval aircraft, and naval vessels working aircraft, only.
4000-4525	75.0-66.3	Public toll service, mobile, Government point to point, and point-to-point public utilities.
4525-5000	66.3-60.0	Relay broadcasting only.
5000-5500	60.0-54.5	Public toll service only.
5500-5700	54.5-52.6	Relay broadcasting only.
5700-7000	52.6-42.8	Point to point only.
7000-8000	42.8-37.5	Amateur and Army mobile only.
8000-9050	37.5-33.1	Public toll service, mobile, Government point to point, and point-to-point public utilities.
9050-10,000	33.1-30.0	Relay broadcasting only.
10,000-11,000	30.0-27.3	Public toll service only.
11,000-11,400	27.3-26.3	Relay broadcasting only.
11,400-14,000	26.3-21.4	Public service, mobile, and Government point to point.
14,000-16,000	21.4-18.7	Amateur only.
16,000-18,100	18.7-16.6	Public toll service, mobile and Government point to point.
18,100-56,000	16.6-5.35	Experimental.
56,000-64,000	5.35-4.69	Amateur.
64,000-400,000	4.69-0.7496	Experimental.
400,000-401,000	0.7496-0.7477	Amateur.



RADIO BROADCAST Photograph

MADE IN THE LABORATORY

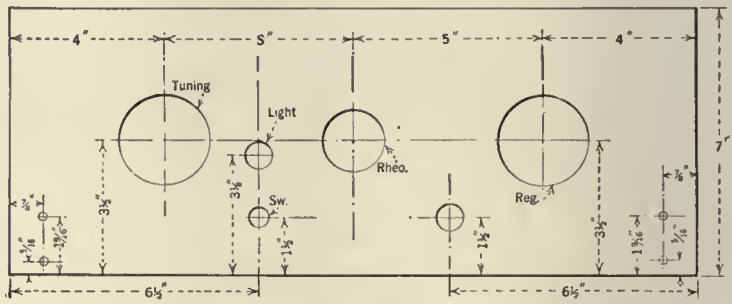
The short-wave receiver here shown employs REL coils, National condensers, X-L binding posts, etc. The circuit is basically the same as that shown in Fig. 1



RADIO BROADCAST Photograph

THE RECEIVER DESCRIBED IN THIS ARTICLE

The parts list and panel layout for this particular receiver are given on this page while the circuit diagram appears as Fig. 1, on page 291



PANEL LAYOUT OF THE SHORT-WAVE RECEIVER

Marshall's kit includes coils, coil socket, and three condensers and lists at $23.00. Other kits of coils are sold by the Aero Products Company as indicated on the list of parts in this article, and that sold by J. Gross which lists at $27.90. Aero also stocks a short-wave drilled and engraved foundation unit listing at $5.75.

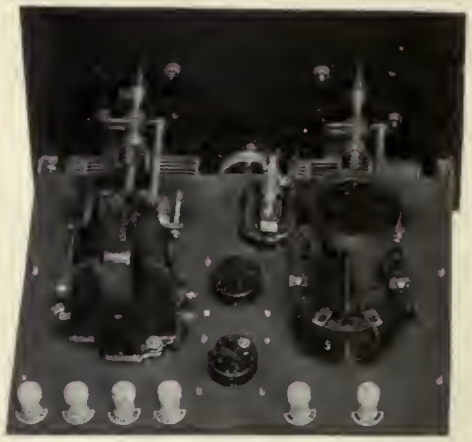
THE ANTENNA

THE antenna used with these receivers may be of practically any type, long or short. A long outside antenna will naturally give the better ox results, though the coupling between the primary and secondary coil will have to be reduced or perhaps a series condenser inserted in the lead-in, if it is found that the set refuses to oscillate over a certain band. This is probably due to absorption by the antenna. A little experimenting with the coupling or perhaps changing the antenna length or position will usually remedy this.

Another point which is important in making a set of this character oscillate evenly over the entire band is the grid leak. For best results a high-resistance leak should be used, say of 6–10 megohms. The detector tube should go in and out of oscillation easily when the regeneration condenser is varied. As seen from the circuit diagram the set may be grounded on the negative return (dotted lines) or not, according to which connection gives the better results. A little time spent in becoming familiar with the adjustments of the set will tend to insure better results and at the same time preclude unnecessary disappointments.

The variable condenser used for tuning the set illustrated in Fig. 1 is one of 100 micro-microfarad (0.0001-mfd.) capacity. While this condenser does not quite cover the entire bands it does spread out the available bands and makes tuning much easier. If it is desired to cover every wavelength over the full range a small shunt condenser may be placed across the main condenser and be operated with a switch. A straight frequency-line condenser is used for tuning. The regeneration control condenser may be of any type as this control is not at all critical.

A list of parts for this Aero receiver, shown diagramatically in Fig. 1, made in the Laboratory, and used at 2 GY, is given below, and panel and sub-panel layouts are shown in Figs. 2 and 3.



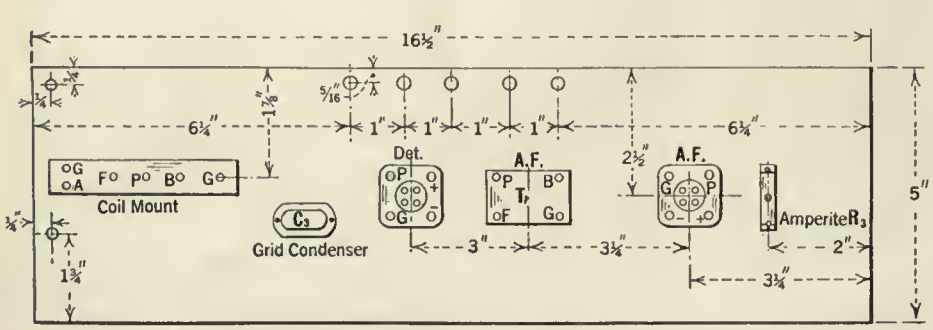
RADIO BROADCAST Photograph

ANOTHER SHORT-WAVE RECEIVER

Silver-Marshall parts form the basis of this efficient and compact receiver

LIST OF PARTS

L_1, L_2, L_3—Short-Wave Kit Consisting of Coils Nos. 1, 2, and 3 with Primary and Plug-In Mounting, Aero Products Company (15-111m.)	$12.50
L_2—Coils Nos. 4 and 5, Aero Products Company (119-550 m.)	8.00
L_4—Silver-Marshall Short-Wave Choke	.60
C_1—Hammarlund Variable Condenser, 100 Mmfd.	4.25
C_2—Precise Variable Condenser, 135 Mmfd.	2.00
C_3—Sangamo 0.0001-Mfd. Grid Condenser with Mounting	.40
R_1—Grid Leak, 10 Megohms	.50
R_2—Frost 20-Ohm Rheostat	.50
R_3—Amperite and Mounting, 1–A	1.10
T_1—Samson 6:1 Audio Transformer	5.00
Two Benjamin Spring Sockets	1.50
Yaxley Single-Circuit Jack	.50
Yaxley Combination Switch and Pilot Light	.75
Two Benjamin Brackets	.70
Five Eby Binding Posts	.75
Two Karas Vernier Dials	7.00
Radion Hard Rubber Panel 7 x 18 x $\frac{3}{16}$ Inches	2.50
Radion Hard Rubber Sub-Panel 5 x $16\frac{1}{2}$ x $\frac{3}{16}$ Inches	1.65
Wire, Screws, Etc.	.50
TOTAL	$50.70



A SUB-PANEL LAYOUT OF THE RECEIVER

ACCESSORIES NEEDED

2 CX-301-A Type Tubes
1 45-Volt B Battery
Pair of Phones
Antenna and Ground Connections