1936
RADIO DATA BOOK

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RADIO NEWS AND SHORT WAVE RADIO

1936
RADIO DATA BOOK

Editor: Laurence M. Cockaday; Associate Editors: W. H. Holze, W. C. Dorf, J. M. Borst, J. H. Potts.

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Introduction

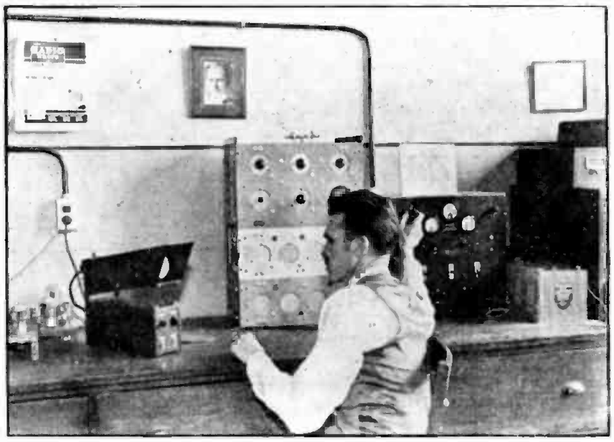
KEEPING up-to-date on radio! That is the problem that every man interested in radio must face in these years of swift change and extraordinary development. Today it is not enough to have a fundamental knowledge of radio; one simply must have the latest information and data available, to understand the many new things as they are being unfolded in the radio laboratory — and to have a working knowledge of new applications, as they are being made in the field. Not a single month goes by without some important advance that changes the whole outlook of radio. This month it may be metal tubes, next month it may be an entirely new method of reception and a few months from now it may be perfected television.

It is the duty of everyone interested in radio—whether from an amateur's, an experimenter's, a serviceman's, or an engineer's viewpoint, whether one is in radio for a hobby or for business—to keep himself informed on what is going on so that he can do his work or conduct his experimentation along lines conforming with the radio trend. If this is not done, we soon fall into paths that lead to nowhere and our hardest efforts produce results that may be obsolete before we start.

That effort of keeping people informed in radio is the acknowledged duty of a radio editor, and is the main aim of your magazine, RADIO NEWS; also, it is the aim of this book to present to RADIO NEWS readers, in this accessible form, some of the newest and most important radio developments of the times through which we are passing.

A glance at the index page shows a detailed compilation on such developments as television, the advent of the metal tubes, the latest receivers for short-wave and broadcast-band reception, converters, antenna tuners, the newest data on servicing and P. A. equipment—how to use oscillators, cathode-ray tubes and amplifiers—as well as a wealth of interesting data for the radio experimenter. Also note that we have not forgotten the short-wave listener. There are: a Wavelength - Frequency Chart, a Mileage Chart, Station Lists and other DX aids that are simply indispensable to all short-wave and broadcast DX enthusiasts. Then again, in the amateur field, a number of transmitters are described, with data on antennas, transmitting tubes and receivers.

And so we present this 1936 Radio Data Book to our many thousands of radio friends who are looking to us for guidance and encouragement, a book enabling each to do better his small bit in making radio more helpful, more interesting, and more successful.



IN THE RADIO NEWS LAB.

Here is one corner of the large, well-equipped Radio News laboratory where countless pieces of radio apparatus are tested before being brought to the attention of our readers.

Laurence M. Cockaday
Editor, Radio News And Short Wave Radio

TELEVISION

Disk Vs. Cathode-Ray Systems

TELEVISION bids fair to bring an entirely new set of problems before the Federal Communications Commission, for at present a number of experimental stations are sending or propose to send their pictures on the 5- and 6-meter bands, the 10-meter band, the 170-meter band, etc. Then there is the problem of how television programs are to be sent to different parts of the country: over wires, what kind of wires or cables, etc. Not only is this the case, but two radically different types of scanning are being used; the cathode-ray tube and the revolving disk. Each of these systems claims manifest advantages and proponents of each state that theirs will be the system adopted as the official standard when the standardization of television receivers takes place, as it is sure to do within a short space of time.

The cathode-ray types of scanners, in which Philco, RCA and the Farnsworth group are interested represent one side of the story. The mechanical (or revolving disk) scanner, as represented by some of the independents, one of which, the Peck Television Corp., has produced excellent images on a large screen, in black and white as shown in Figure 1.

Figure 1

In order to simplify a discussion of the improvements in both of these systems let us divide this article into sub-heads.

Simplicity of Mechanism

Besides incorporating a more or less conventional radio receiver to produce the television signal, a television receiver must include a light source, a means of modulating the light in order to reproduce highlights and shadows, a scanner to spread the light over the screen or otherwise break it up into a two-dimensional picture, and a power-pack capable of supplying the voltage and current used by these units.

The cathode-ray system appears to be simpler, for in it we find a single tube performing the functions of light source, light modulator and scanner, while the disk system makes use of a three-inch disc driven by a small motor, a headlight bulb for light source, and a separate modulator cell. Carrying our inspection a step farther, we learn that the disc motor operates directly from the 110-volt light lines and that the light source used with the disc also draws its current from the ordinary power-pack of the set and that the light valve is modulated directly from the output of the standard push-pull amplifier which Peck's receiving circuit employs. On the other hand, as many as six additional tubes are used in the cathode-ray systems to afford scanning action with the cathode-ray tube and each of these six extra tubes employs its own oscillator coils, condensers, chokes, etc. A special power pack, including heavy-duty rectifiers, chokes, condensers and resistors is also required with the cathode-ray tube, which may use voltages up to 4000 or more. Figure 2 shows a laboratory experiment with a large cathode-ray tube.

Neither of these systems is quite as simple as the now obsolete system in which a tube of either the neon plate or neon crater type was used as combined light source and light modulator. This system has, however, been virtually abandoned because of deficiencies in the brilliance and size of the pictures it produced.

Simplicity of Operation

Tuning is unquestionably somewhat simpler in the cathode-ray system than in the disk system. In the former, it is merely necessary to tune in the signal, which is automatically synchronized by the extra 6-tube circuit. One additional control is necessary to establish synchronization in the disc system. In both systems, synchronization, once obtained, remains established as long as the set is tuned to a given station.

Freedom From Trouble

The two systems are about equal in freedom from problems of servicing. In the cathode-ray system, the scanning-light-source tube may require the aid of a service man every 1000-2000 hours, when replacement becomes necessary. This will be the case if the manufacturers decide to install it in a sealed unit because of the high voltages which it may require. Its associated tubes should be easily replaceable by the set owner.

Both light source and modulator tubes, operated at normal set voltage in the disc system, will be replaceable by the owner. The motor will be similar to that used in an electric clock—and as completely free from servicing problems.

The cost of the cathode-ray tube, with an estimated life of 1000-2000 hours, may probably be brought as low as $25 when in production, and its associated tubes should last as long as, and cost no more than, the ordinary receiving tubes which the set employs. The disc light source and modulator tubes will have a combined retail cost below $2, and a life of approximately 5000 hours.

Detail Available

Images reproduced by cathode-ray systems will be composed of about twice as many lines per frame as will those of the disc system, which uses 180-line images. As a result, perfect detail will be visible to an observer stationed about five feet from the cathode-ray set, or about ten feet from the disc system.

Size of Picture

Cathode-ray receivers thus far demonstrated have produced pictures about three inches square, though pictures up to nine inches square are claimed. While the Peck television receiver normally shows a 14-inch picture on its self-contained screen, pictures up to 3 ft. by 4 ft. square have been

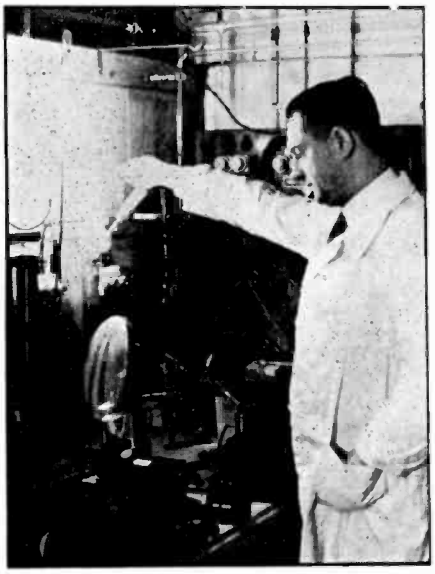


Figure 2

demonstrated when the screen is removed. The 14-inch Peck picture and the cathode-ray picture are of approximately equal brilliance; bright enough to be shown in a lighted room. The 4-foot picture is somewhat duller.

Number of Images Per Second

Both systems have shown 24 frames-per-second, the same as standard motion-picture film. It is said that one cathode-ray system is experimenting with 48 frames.

Program Material

No plans have as yet been made public by any television company relative to the actual material which will be broadcast. It is, however, logical to believe that motion-picture producers will enter into television agreements; that outstanding radio programs will be televised; and that portable transmitters will be used to broadcast public meetings, sports events and similar occurrences of public interest. Obviously, this material will be equally available for owners of either type of apparatus.

Adaptability

Should both systems be in general use, the problem of building receivers to receive both standards of images is encountered. Neither the cathode-ray nor the disk system will receive signals intended for reception by the other system unless certain adjustments are made. In the cathode-ray system it will probably be necessary to have the scanning oscillator re-calibrated in order to receive disk-type pictures. With the disk system a quick-demountable scanning wheel will be provided, to be snapped onto the motor shaft in order to receive the pictures intended for cathode-ray reception.

"Network" Possibilities

The problem of limited service area has been a major worry of all television concerns until very recently. According to proponents of the cathode-ray system, the maximum distance which can be traversed dependably, on the short wave which television will use, is about twenty miles. The Peck television station, VE9AK, in Montreal, Canada, has for the past several months been sending strong signals over a distance of 80 miles, with only a 300-watt antenna input.

A special high-frequency "coaxial" cable, suited to carrying television signals, will soon be under construction to link New York and Philadelphia.

Color of Picture

Cathode-ray tubes normally provide a picture which is in tones of apple green, though it is said a black and white tube is in the process of development. In the disk system, the picture is black and white, the same as the customary motion picture, which it closely resembles.

With two types of systems, each of which has certain advantages and each of which is capable of producing television images which should satisfy the most exacting critics, it would certainly seem that transmitters designed to serve cathode-ray receivers as well as those sending signals for the mechanical system should be given a place in the television spectrum. Even if there *is* some inconvenience or even chaos in using different systems with different details of transmission, they should be given a trial—and soon a definite "start" in television must be made.

A Canadian Television Station

TELEVISION is actually on the air daily over the Peck Television Corporation station, VE9AK, located in the Dominion Square Building, Montreal. And, Canadian radio manufacturers are preparing to put a low-cost radio-and-television receiver on the market.

It is not the "flickering" television such as has been broadcast formerly in America; both transmitter and receiver differ greatly from apparatus which has heretofore been shown. The transmitter uses an *entirely gearless* scanner and with a 300-watt antenna input is sending a strong signal *more than seventy miles* on the 5 to 6 meter channel. Twenty miles had previously been considered the practical limit for this 5-6 meter television prior to Peck's experiments. Figure 3 shows the control room of VE9AK. At the extreme left is the pick-up apparatus.

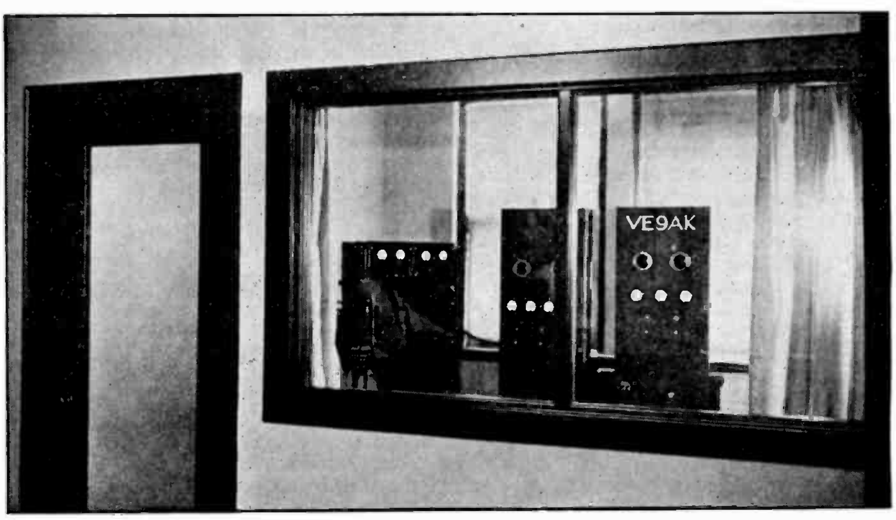
The receiver, too, is different. It projects a 14 inch by 16 inch picture on a screen with enough brilliance to be readily visible in a normally-lighted room. Its only elements which need replacement are a $1.50 light-valve tube and a 10-cent automobile headlight bulb (the light source). Both of these elements give 5000 hours service.

VE9AK was erected in the middle of May, 1935, as a 20-watt station. It then had a service radius of about ten miles. The power was gradually increased to 300 watts and the range for an R9 signal was increased to 75 miles easily.

The Reflector Antenna

The output of this new transmitter is fed into a single upright antenna—a small copper rod atop the Dominion Square Building, as shown in Figure 6. On three sides of this antenna are similar rods, tuned to the requisite frequency and placed ½-wavelength away. These are the reflectors, each collecting the energy radiated into its quadrant and reflecting it back to the antenna proper. By adjusting the length of the reflector rods, their resonance and therefore their efficiency may be controlled, so that it is possible to tune them in such a way that signals can still be heard on the "dead" sides of the antenna as well as along the path of the beam. In this manner, it is possible for the one transmitter

Figure 3



to serve two areas: the area immediately surrounding the transmitter (in this case the city of Montreal), and the area traversed by the beam, which at present lies between Montreal and the outskirts of Trois Rivieres, Quebec.

At the side of the antenna from which the beam emanates, two upright metal rods are arranged. These, however, are placed in line at correct distances from the antenna and consequently act, not as reflectors, but as "electrical lenses," for their effect is to *concentrate* the beam along the predetermined course, and to keep it from spreading.

The receiving antenna for these waves is also an upright rod.

The Receiving Apparatus

A diagram of the receiving apparatus which will soon be commercially available in Canada is shown in Figure 4. There are two features of the commercial job which will be of interest to every radio-minded reader.

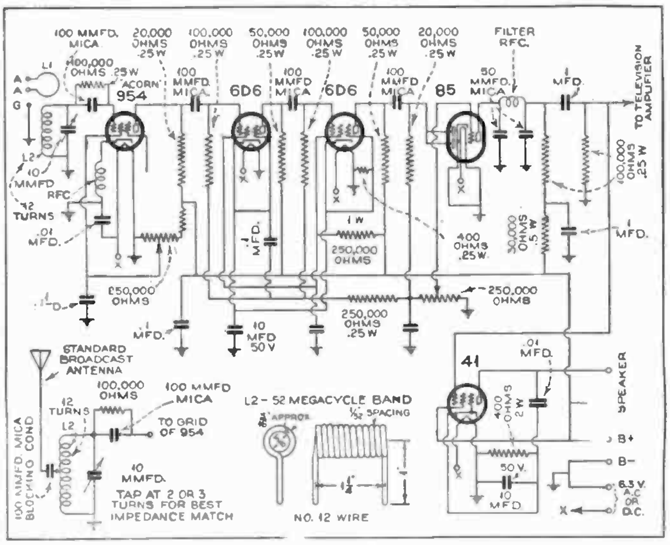


Figure 4

First, the cabinet is entirely different from the earlier odd-appearing television receivers which have been produced in the past. With the top closed, it looks like any handsome console radio receiver. But when television images are being received, the top of the cabinet is lifted, like the lid of a phono-radio combination, and the 14-inch by 16-inch ground-glass screen, upon which the picture is reproduced, automatically swings into place. This screen is removable, however, so that a larger picture, up to five feet wide, may be projected onto the wall.

Second, the same cabinet that contains the television receiver equipment also houses an all-wave radio broadcast receiver and high-fidelity loudspeaking system.

VE9AK uses films and is now opening negotiations with the leading producers to make comedies, animated cartoons, features, shorts and musicals available on the air. This, it is expected, will give the "looker-in" the greatest stars of the screen as ordinary entertainment.

New Wide-Frequency-Range Cable

THE recent announcement by Bell Laboratories, of the so-called "coaxial" cables for transmission of wide frequency-range signals from one point to another, has been of more than passing interest to telephone men and television experimenters alike. An experimental circuit is soon to be set up between New York and Philadelphia, using a double coaxial cable for further research work.

Although the idea of coaxial circuits has been investigated mathematically and by physicists theoretically for almost a century,

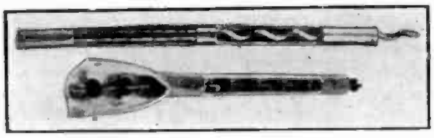
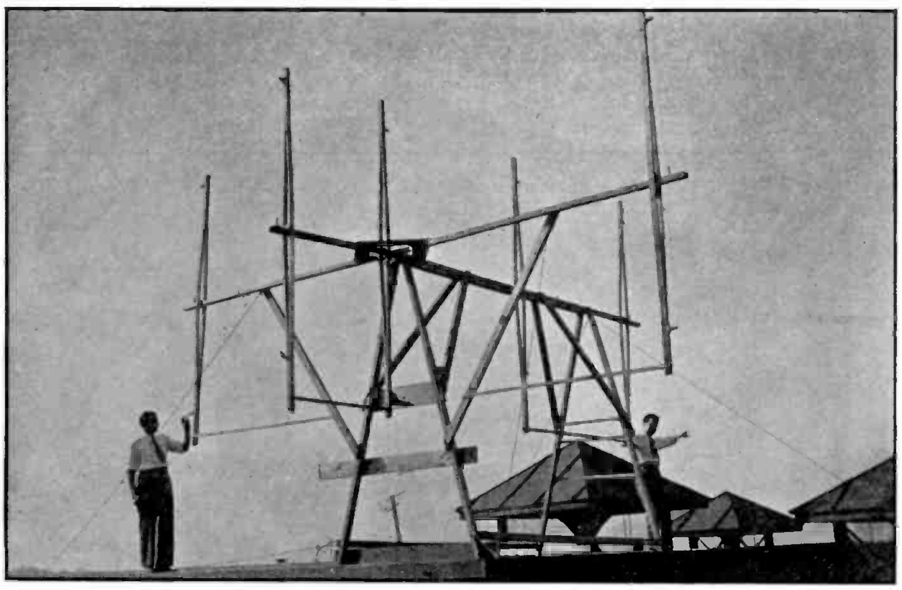


Figure 5

this is the first time that the idea will be given a practical long-distance trial. The cable itself is really a solid conducting rod, supported at intervals at the center of a conducting tube, that acts as the return path. The first experimental line (two miles long) was installed by A. L. Richey at a test station near Phoenixville, Pennsylvania. The outside tube in this case was 2½ inches in diameter with a smaller tube inside and a copper wire inside that. This was a "double" coaxial cable. The new New York-Philadelphia cable will contain, inside its outer lead sheath, two separate tubes each containing a conductor. Each one of these lines is capable of carrying frequencies of a band width of the order of a million cycles. Such a coaxial line requires successive amplifiers to take care of attenuation spaced at distances of about each ten miles. The amplifiers themselves are fully automatic and amplify all frequencies at the same time. The amount of gain necessary (which varies with the temperature) is automatic and a "feedback" principle in the tubes controls the gain and permits high stability and freedom from noise and distortion. This feedback principle is the reverse of that used in radio receivers some years ago.

Figure 6



A 1,000,000-cycle line such as this will carry over 200 voice conversations at the same time, without interference. All of these signals pass through the amplifier (power for which is sent at 60 cycles over the same line). The separate voice signals are modulated on to different frequency channels (up to 1020 kc.) by multiple oscillators and the separate channels are selected at the receiving end by quartz crystal filters.

The coaxial line is also well adapted for transmitting the extremely-broad frequency bands required by television. The new cable may become a means of transmitting television programs from one part of the country to another if the actual maintenace costs do not run too high. Figure 5 shows two types of coaxial cables.

METAL TUBES

Description and Characteristics

THE vacuum tube ascended one more step in the ladder of its evolution and now has lost all resemblance to its ancestor, the incandescent lamp. The General Electric Company, recently introduced the latest of all vacuum-tube development —the all-metal tube. Besides providing an efficient shield for the tube, the metal shell makes possible a sturdier construction, with better heat radiation, lower internal capacities and a more economical manufacture.

The new tubes, as shown in Figure 8, are smaller than the equivalent glass tubes. At present, ten different types have been made, including a power rectifier, a triode output tube similar to the 45, a variable-mu pentode, a pentagrid tube, a hexode, a small triode and a duo-diode. This latter tube is a new type, containing two cathodes and two diode plates. It is shown at the extreme right of Figure 8. The height of the tube (above the base) is ⅝ inch.

These tubes have an entirely new socket arrangement, which is an enormous improvement over the present one. All types, regardless of the number of prongs, will fit the same 8-contact socket. The pins are all of the same size and are placed at regular intervals. In the center is a larger pin, fitted with a "key." A bottom view of the base of Type 6A8 is shown in Figure 7.

In order to insert a tube into its socket, it is necessary only to insert this center pin into its hole first, then rotate the tube until the key finds its groove, when the tube can be pushed down. This can be done in the dark; it is no longer necessary to find the big prongs and the big holes and bring them into line. All tubes have one more contact pin than the corresponding glass-envelope tubes. This pin is connected to the shield and the corresponding socket contact should be grounded.

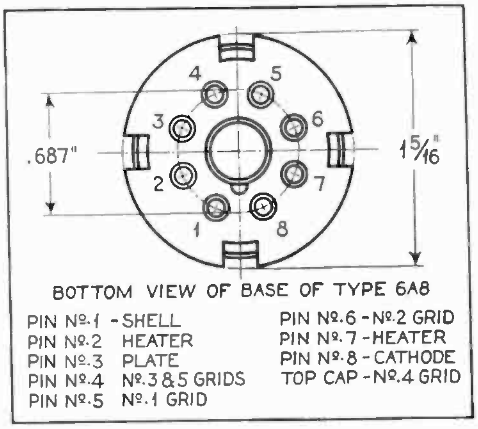


Figure 7

The metal envelope is a more efficient radiator of heat than glass. The construction of the tube has been greatly simplified due to the elimination of the "stem." The leads come up through the bottom end-plate and make shorter, sturdier supports possible. This helps to minimize microphonism and reduces the internal capacity. In fact, the tubes will oscillate at higher frequencies than their corresponding glass-envelope types.

The construction of the tube, as shown in Figure 9, is simpler and different from the method now employed. The shell is made of iron 1/50 inch thick. The construction is started with the bottom end plate; it looks somewhat like the cover of a salt shaker. In order to bring the leads through this plate, small eyelets of a special alloy are welded into the holes. This alloy, "Fernico," consisting of iron, nickel and cobalt, has the same expansion coefficient as glass; it was developed especially for the metal tube. A small glass bead with a wire passing through it is fused into the eyelet. The entire cylinder (forming the tube) is welded into the end-plate by a very heavy electric current, around 20,000 amperes, flowing only 1/20 of a second. This time is sufficient to weld the tube all around. A thyratron controls the timing in this process. After pumping, the tubes are sealed electrically.

In order to "clean-up" the tube, the usual high-frequency inductor coil cannot be used because of the metal shell. Instead, the tube is simply heated to red heat by means of a gas flame.

Metal tubes have been on the market in Europe for some time. The "Catkin" tube, made in England, is of a different construction; its envelope constitutes the anode and is therefore at high potential. A second shield is then necessary to safeguard against shocks or shorts. These new American tubes are constructed differently and are considered a great improvement; the outside shell is the shield and is at ground potential. No further tube shield is required; moreover, the shielding is much more efficient, due to closer spacing between the shield and the elements.

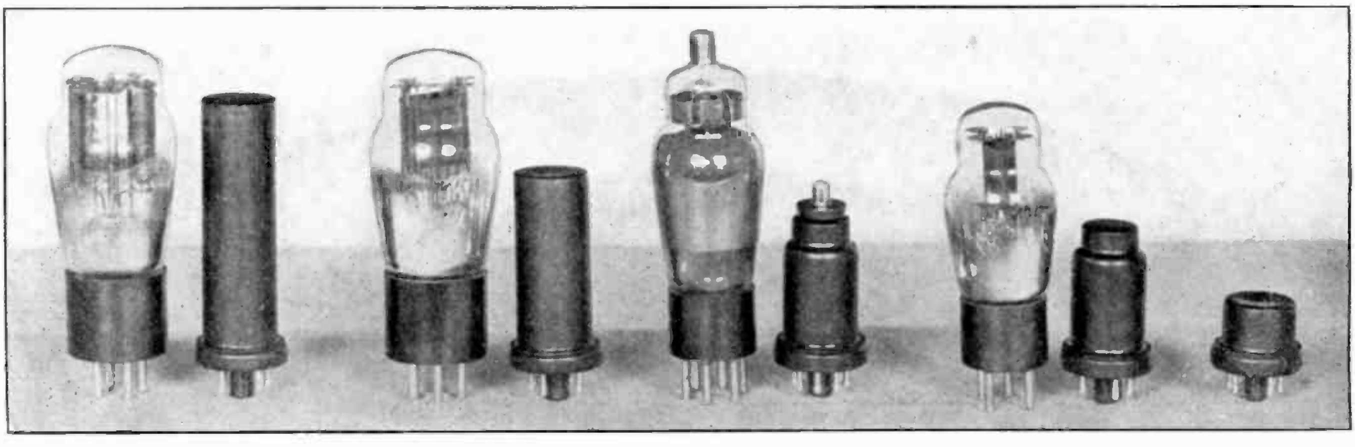
The tubes, the first standard American all-metal tubes, are not interchangeable with present glass tubes, due to the different construction of the socket. The ten types now planned for production all have 6.3-volt filaments.

The following are the tentative characteristics of these metal tubes as supplied by the RCA Manufacturing Company:

5Z4
Full-Wave High-Vacuum Rectifier

The 5Z4 is a full-wave rectifying tube of the metal type intended for use in d-c power-supply devices which operate from the a-c supply line.

Figure 8



Tentative Characteristics

Heater Voltage	5.0 Volts
Heater Current	2.0 Amperes
A-C Plate Voltage Per Plate (RMS)	400 max. Volts
Peak Inverse Voltage	1100 max. Volts
D-C Output Current	125 max. Milliamperes
Maximum Overall Length	5-1/8"
Maximum Diameter	1-5/16"
Base	Small Octal 5-Pin

6A8

Pentagrid Converter

The 6A8 is a multi-electrode vacuum tube of the metal type designed to perform simultaneously the functions of a mixer (first detector) tube and of an oscillator tube in superheterodyne circuits. Through the use of this type, the independent control of each function is made possible within a single tube.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Base	Small Octal 8-Pin

As Frequency Converter

Plate Voltage	250 max. Volts
Screen (Grids No. 3 and No. 5) Voltage	100 max. Volts
Anode-Grid (Grid No. 2) Voltage	200 max. Volts
Anode-Grid (Grid No. 2) Voltage Supply**	250 max. Volts
Control Grid (Grid No. 4) Voltage	-3 min. Volts
Total Cathode Current	14 max. Milliamperes
Typical Operation:	
Plate Voltage	250 Volts
Screen Voltage	100 Volts
Anode-Grid Voltage	250* Volts
Control Grid Voltage (Minimum)	-3 Volts
Oscillator Grid (Grid No. 1) Resistor	50000 Ohms
Plate Current	3.3 Milliamperes
Screen Current	3.2 Milliamperes
Anode-Grid Current	4.0 Milliamperes
Oscillator Grid Current	0.5 Milliamperes

* This is an Anode-Grid Supply voltage applied through 20000-ohm voltage-dropping resistor.
** Anode-grid voltages in excess of 200 volts require use of 20000-ohm voltage-dropping resistor.

Conversion Conductance	500 Micromhos
Control Grid Voltage, Approximate (Conversion conductance = 2 umhos)	-45 Volts

6C5

Detector Amplifier Triode

* This is an Anode-Grid Supply voltage applied type recommended for use as a detector, amplifier, or oscillator. This tube has a high mutual conductance together with a comparatively high amplification factor.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Plate Voltage	250 max. Volts
Grid Voltage °	-8 Volts
Plate Current	8 Milliamperes
Plate Resistance	10000 Ohms
Amplification Factor	20
Mutual Conductance	2000 Micromhos
Grid-Plate Capacitance *	1.8 mmfd.
Grid-Cathode Capacitance *	4 mmfd.
Plate-Cathode Capacitance *	13 mmfd.
Maximum Overall Length	2-5/8"
Maximum Diameter	1-5/16"
Base	Small Octal 6-Pin

° If a grid-coupling resistor is used, its maximum value should not exceed 1.0 megohm.
* With shell connected to cathode.

6D5

Power Amplifier Triode

The 6D5 is a power amplifier triode of the metal type intended for use as an output tube in radio receivers which operate from an a-c supply line.

Tentative Characteristics

Heater Voltage (a.c. or d.c.)	6.3 Volts
Heater Current	0.7 Ampere
Maximum Over All Length	3¼ in.
Maximum Diameter	1⅜ in.
Base	small 6-Pin

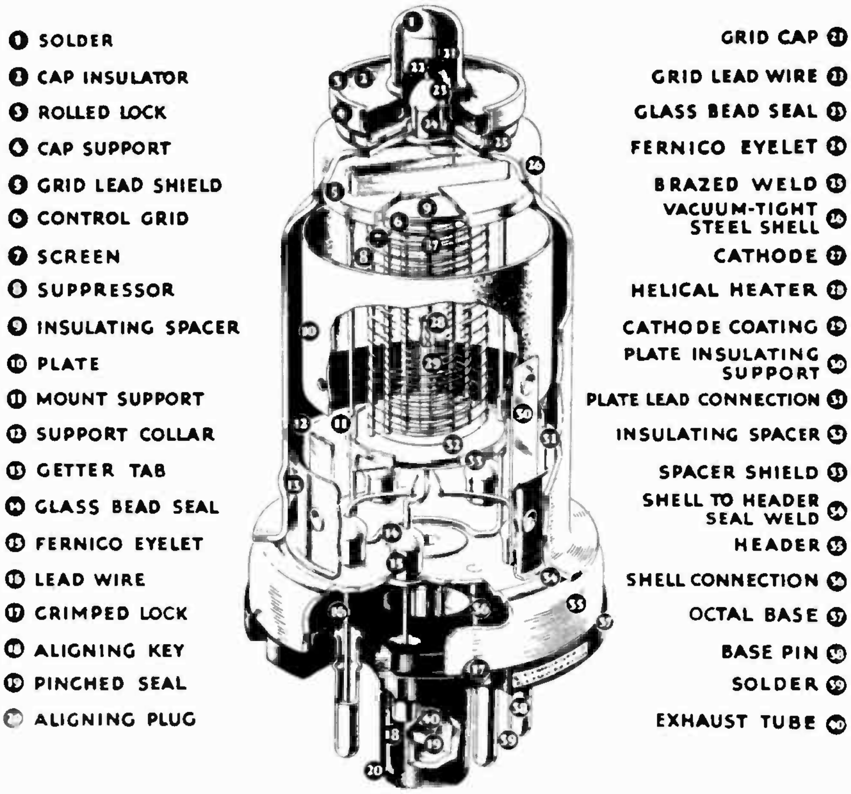


Figure 9 *Courtesy of RCA Mfg. Co.*

Internal Structure Of An All-Metal Radio Tube

As Single-Tube Class A Amplifier

Plate Voltage	275 max. Volts
Grid Voltage	-40 Volts
Plate Current	31 Ma.
Plate Resistance	2250 Volts
Amplification Factor	4.7
Mutual Conductance	2100 Micromhos
Load Resistance	7200 Ohms
Undistorted Power Output	1.4 Watts

As Push-Pull Class AB Amplifier (Two Tubes)

Plate Voltage	300 max. Volts
Grid Voltage (fixed bias)	-50 Volts
Plate Current (per tube)	23 Ma.
Load Resistance (Plate to plate)	5300 Ohms
Power Output	5 Watts

6F5

High-Mu Triode

The 6F5 is a high-mu triode of the metal type. It is particularly suitable for use in resistance-coupled amplifier circuits.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Plate Voltage	250 max. Volts
Grid Voltage	-2 Volts
Plate Current	0.9 Milliampere
Plate Resistance	66000 Ohms
Amplification Factor	100
Mutual Conductance	1500 Micromhos
Grid-Plate Capitance *	2 mmfd.
Grid-Cathode Capitance *	6 mmfd.
Plate-Cathode Capacitance *	12 mmfd.
Maximum Overall Length	3-1/8"
Maximum Diameter	1-5/16"
Cap	Miniature
Base	Small Octal 5-Pin

* With shell connected to cathode.

6F6

Power Amplifier Pentode

The 6F6 is a heater-cathode power-amplifier pentode of the metal type for use in the audio-output stage of a-c receivers. It is capable of giving large power output with a relatively small input voltage. Because of the heater-cathode construction, a uniformly low hum-level is attainable in power-amplifier design.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.7 Volts
Maximum Overall Length	3-1/4"
Maximum Diameter	1-5/16"
Base	Small Octal 7-Pin

Single-Tube Class A Amplifier

	Pentode Connection		*Triode Connection* (Screen tied to plate)
Plate Voltage	250	315 max.	250 max. Volts
Screen Voltage	250	315 max.	— Volts
Grid Voltage	-16.5	-22	-20 Volts
Plate Current	34	42	31 Milliamperes
Screen Current	6.5	8	— Milliamperes
Plate Resistance	80000°	75000°	2600 Ohms
Amplification Factor	200°	200°	7
Mutual Conductance	2500	2650	2700 Micromhos
Load Resistance	7000	7000	4000 Ohms
Total Harmonic Distortion	7	7	5 Per cent
Power Output	3	5	0.85 Watts

° Approximate.

6H6

Twin Diode

The 6H6 is a heater-cathode type of metal tube combining in one shell two diodes. Each diode has its own separate cathode and corresponding base pin. This arrangement offers flexibility in the design of circuits employing the 6H6 as a detector, a low-voltage low-current rectifier, or for the purpose of automatic volume control.

Tentative Characteristics

Heater Voltage	6.3 Volts
Heater Current	0.3 Ampere
Plate No. 1 to Plate No. 2 Capacitance *	0.02 mmfd.
A-C Plate Voltage per Plate (RMS)	100 max. Volts
D-C Output Current	2 max. Milliamperes
Maximum Overall Length	1-5/8"
Maximum Diameter	1-5/16"
Base	Small Octal 7-Pin

* With shell connected to cathode.

6J7

Triple-Grid Detector Amplifier

The 6J7 is a triple-grid type of metal tube recommended especially for service as a biased detector in radio receivers designed for its char-

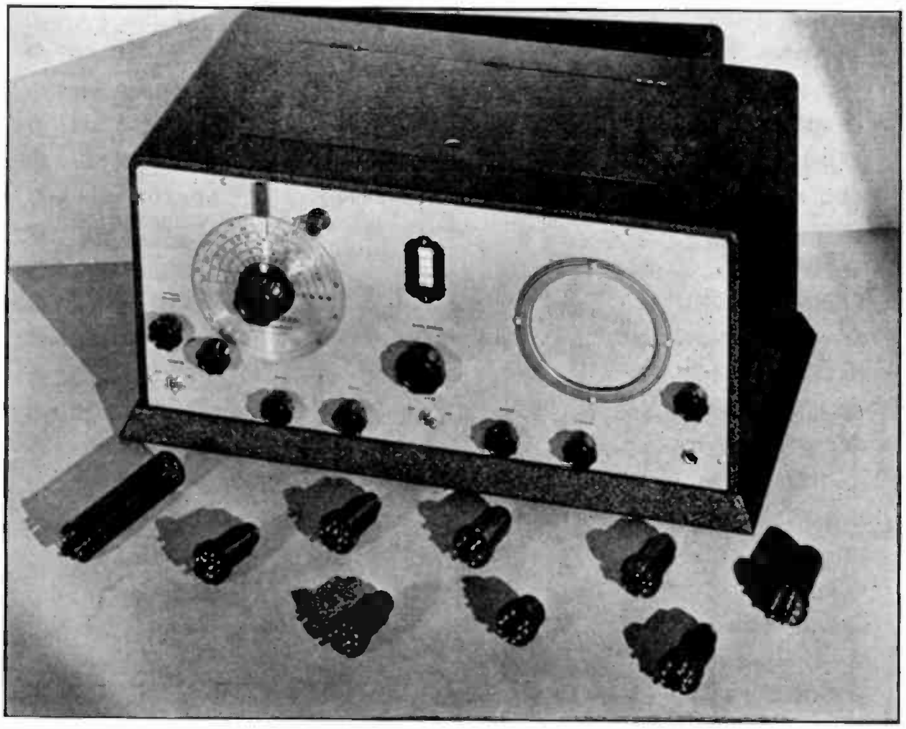


Figure 10

A Typical Metal Tube Receiver

acteristics. In such service, this tube is capable of delivering a large audio-frequency ouput voltage with relatively small input voltage. Other applications of the 6J7 include its use as a high-gain amplifier tube.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Plate Voltage	250 max. Volts
Screen (Grid No. 2) Voltage	100 ** Volts
Grid (Grid No. 1) Voltage	-3 Volts
Suppressor (Grid No. 3)	Connected to cathode at socket
Plate Current	2 Milliamperes
Screen Current	0.5 Milliampere
Plate Resistance Greater than	1.5 Megohms
Amplification Factor Greater than	1500
Mutual Conductance	1225 Micromhos
Grid Voltage (Approx.) ‖	-7 Volts
Grid-Plate Capacitance °	0.005 max. mmfd.
Input Capacitance °	7 mmfd.
Output Capacitance °	12 mmfd.
Maximum Overall Length	3-1/8"
Maximum Diameter	1-5/16"
Cap	Miniature
Base	Small Octal 7-Pin

* If a grid-coupling resistor is used, its maximum value should not exceed 1.0 megohm.
** Maximum Screen Volts = 125.
‖ For cathode current cut-off.
° With shell connected to cathode.

6K7

Triple-Grid Super-Control Amplifier

The 6K7 is a triple-grid super-control amplifier tube of the metal type recommended for service in the radio-frequency and intermediate-frequency stages of radio receivers designed for its characteristics. The ability of this tube to handle unusual signal voltages without cross-modulation and modulation distortion makes it adaptable to the r-f and i-f stages of receivers employing automatic volume control.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)		6.3 Volts
Heater Current		0.3 Ampere
Plate Voltage	250 max.	250 max. Volts
Screen (Grid No. 2) Voltage	100	125 max. Volts
Grid (Grid No. 1) Volt. (Min.)	-3	-3 Volts
Suppressor (Grid No. 3)	Connected to cathode at socket	
Plate Current	7.0	10.5 Milliamperes
Screen Current	1.7	2.6 Milliamperes
Plate Resistance	0.8	0.6 Megohm
Amplification Factor	1160	990
Mutual Conductance	1450	1650 Micromhos
Grid Voltage *	-42.5	-52.5 Volts
Grid-Plate Capacitance O		0.005 max. mmfd.
Input Capacitance O		7 mmfd.
Output Capacitance O		12 mmfd.
Maximum Overall Length		3-1/8"
Maximum Diameter		1-5/16"
Cap		Miniature
Base		Small Octal 7-Pin

* For mutual conductance = 2 micromhos.
O With shell connected to cathode.

6L7

Pentagrid Mixer Amplifier

The 6L7 is a multi-electrode vacuum tube of the metal type designed with two separate control grids shielded from each other. This design permits each control grid to act independently on the electron stream. This tube, therefore, is especially useful as a mixer in superheterodyne circuits having a separate oscillator stage, as well as in other applications where dual control is desirable in a single stage. The design of the tube is such that coupling effects between oscillator and signal circuits are made very small. This feature enables the 6L7 to give high gain in high-frequency circuits.

Tentative Characteristics

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Base	Small Octal 7-Pin

As Mixer

Plate Voltage	250 max. Volts
Screen (Grids No. 2 and No. 4) Voltage	150 max. Volts
Typical Operation:	
Heater Voltage	6.3 Volts
Plate Voltage	250‖ Volts
Screen Voltage	150‖ Volts
Signal-Grid (Grid No. 1) Voltage	-6 min. ‖ Volts
Oscillator-Grid (Grid No. 3) Voltage**	-15 Volts
Peak Oscillator Voltage Applied to Grid No. 3 (Minimum)	18 Volts
Plate Current	3.3 Milliamperes
Screen Current	8.3 Milliamperes
Plate Resistance Greater than	1 Megohm
Conversion Conductance	350 Micromhos
Signal-Grid (Grid No. 1) Voltage for Conver. Cond. of 5 Micromhos	-45 Volts

** The d-c resistance in oscillator-grid-No. 3 circuit should be limited to 50000 ohms.
‖ Recommended values for all-wave receivers.

As Amplifier

Heater Voltage	6.3 Volts
Plate Voltage	250 max. Volts
Screen (Grids No. 2 and No. 4) Voltage	100 max. Volts
Control Grid (Grid No. 1) Voltage	-3 min. Volts
Control Grid (Grid No. 3) Voltage	-3 Volts
Plate Current	5.3 Milliamperes
Screen Current	5.5 Milliamperes
Plate Resistance	0.8 Megohm
Mutual Conductance	1100 Micromhos
Mut. Cond. { -15 volts bias on Grid No. 1 / -15 volts bias on Grid No. 3 }	5 Micromhos

Typical Metal Tube Receivers

Atwater Kent 649

GETTING high-fidelity on DX from all over the world as well as on local signals is a worth-while feat on any set. To do this on a 9-tube set constructed in such a small space as this chassis takes up would be impossible without using the new metal tubes.

The circuit for this receiver is shown in the accompanying diagram, Figure 11. It employs a 6K7 metal tube in one stage of r. f. preselection, a 6A8 metal tube as a mixer-oscillator, two 6K7's in two i.f. stages, a 6H6 second detector tube followed by a 6C5 first-stage audio amplifier and two 6F6 push-pull pentode power tubes working directly into a loudspeaker through a coupling transformer.

Looking at the front panel of the receiver, the two upper controls near the dial are, left: combination "on-off" switch and sensitivity control, and right: the tuning knob. By pushing "down" on this latter control, a very nigh ratio non-backlash tuning is obtained. By pulling "up" on the control, a low ratio is obtained for fast tuning. Located between these two knobs is the shadow-tuning meter (which was found a great help in obtaining exact resonance even on the most distant stations as far away as Asia). The three bottom

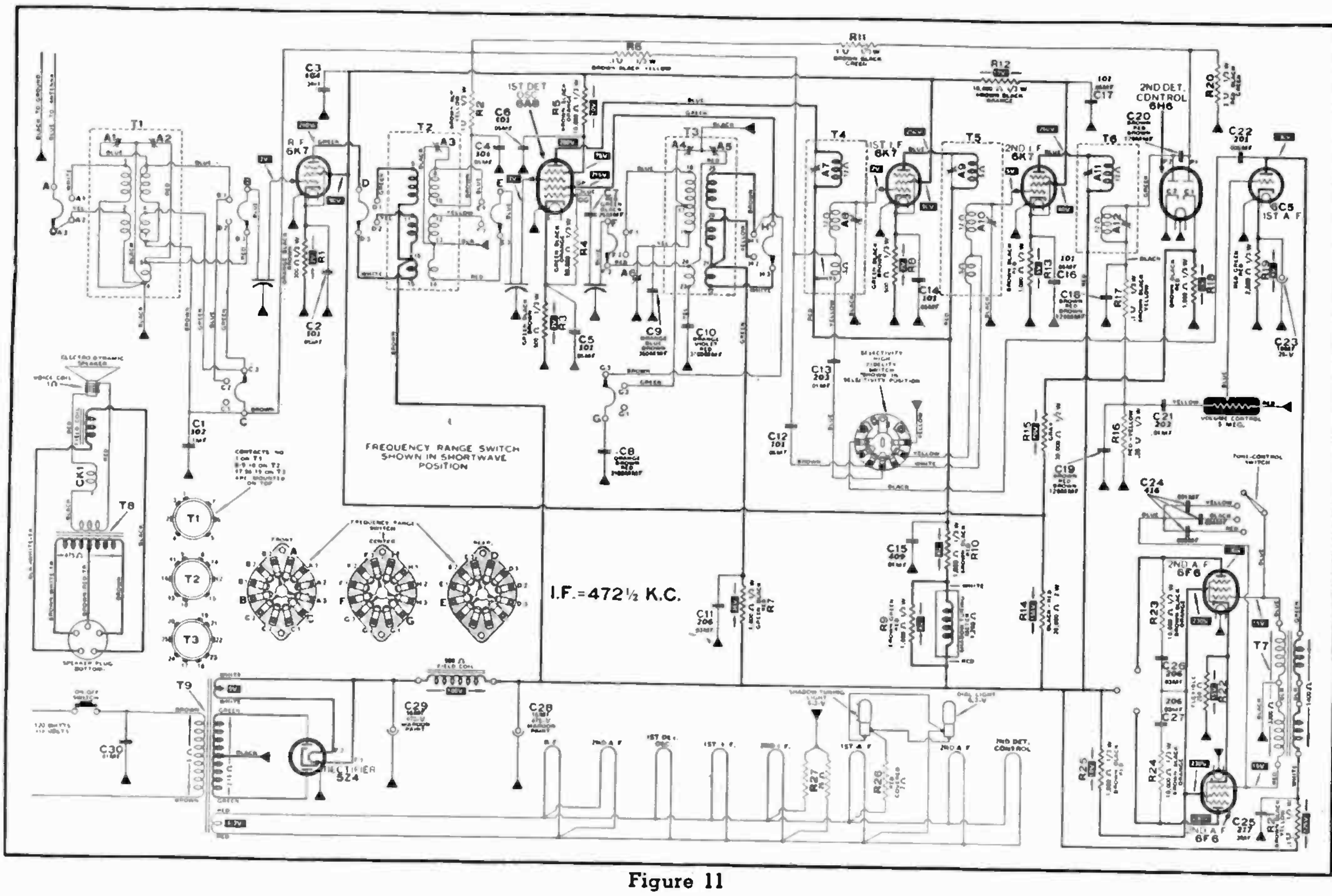


Figure 11

controls are, left to right: the 4-position tone control, the high-fidelity-sensitivity switch and the wave-change switch (which changes coils and moves up and down the proper dials). This set is mounted in a really beautiful chest-high console.

General Electric A-82

RECEPTION of short-wave broadcasts from every continent, including Australasia, was one of the highlights of recent RADIO NEWS tests on this new all-wave, 8-metal-tube receiver: The circuit is shown in Figure 12 and employs the following metal tubes: Two 6K7 triple-grid super-control amplifier tubes, one 6A8 pentagrid converter tube, one 6H6 duo-diode detector tube, one 6C5 triode amplifier tube, two 6F6 power pentode tubes and one 5Z4 rectifier tube.

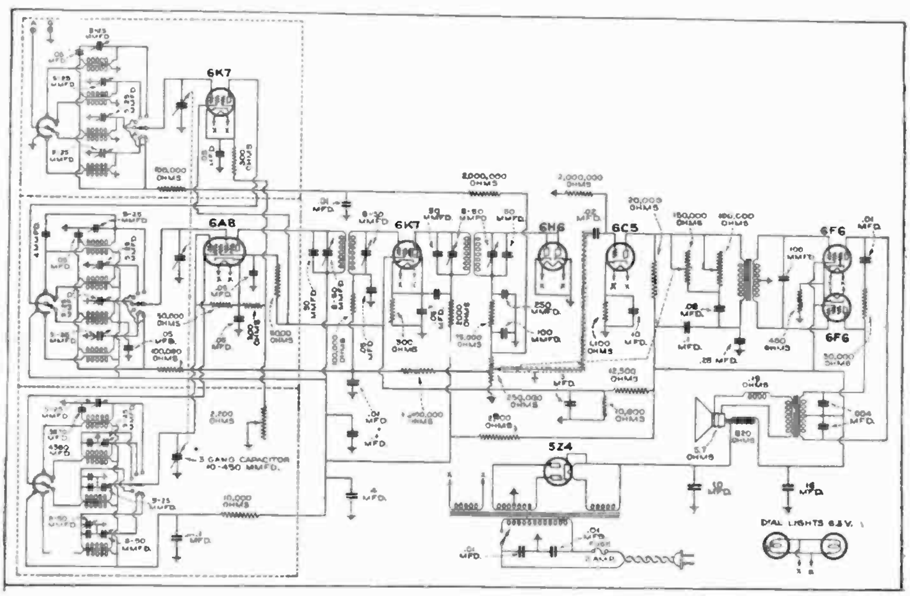
The wave-bands covered by the set are as follows: Band A, 140 to 410 kc.; Band B, 540 to 1750 kc.; Band C, 1750 to 6000 kc.; Band D, 6000 to 19,500 kc. It will be noted that the only part of the range not covered is from 410 kc. to 540 kc. which includes the intermediate frequency used, so that the set is capable of reception from 19,500 kc. to 140 kc. except for this small band (which has no particular interest to the listener, anyway).

Looking at the front of the receiver, the loudspeaker grille is at the top, with the linear tuning scale horizontal across the middle portion of the set, with the wave-changing knob at the left and the tuning knob at the right. This tuning knob is pushed "in" for high ratio, 55-1, and "out" for low ratio, 5½-1, for fast-tuning. The three lower knobs are, from left to right, the sensitivity control, the volume control and the combination "off-on" switch and volume control.

The receiver, taken as a whole is a remarkably efficient, beautifully toned receiver, with plenty of high frequencies so that long distance station announcements can be easily recognized.

The receiver should appeal to those who wish to literally step out all over the world to hear the short-wave stations clearly, and yet at a moment's notice switch over to the broadcast band for high-quality reception of local stations. This is also one of the first American receivers to incorporate a high wave band above the standard broadcast band including 2000 meters reception.

Figure 12



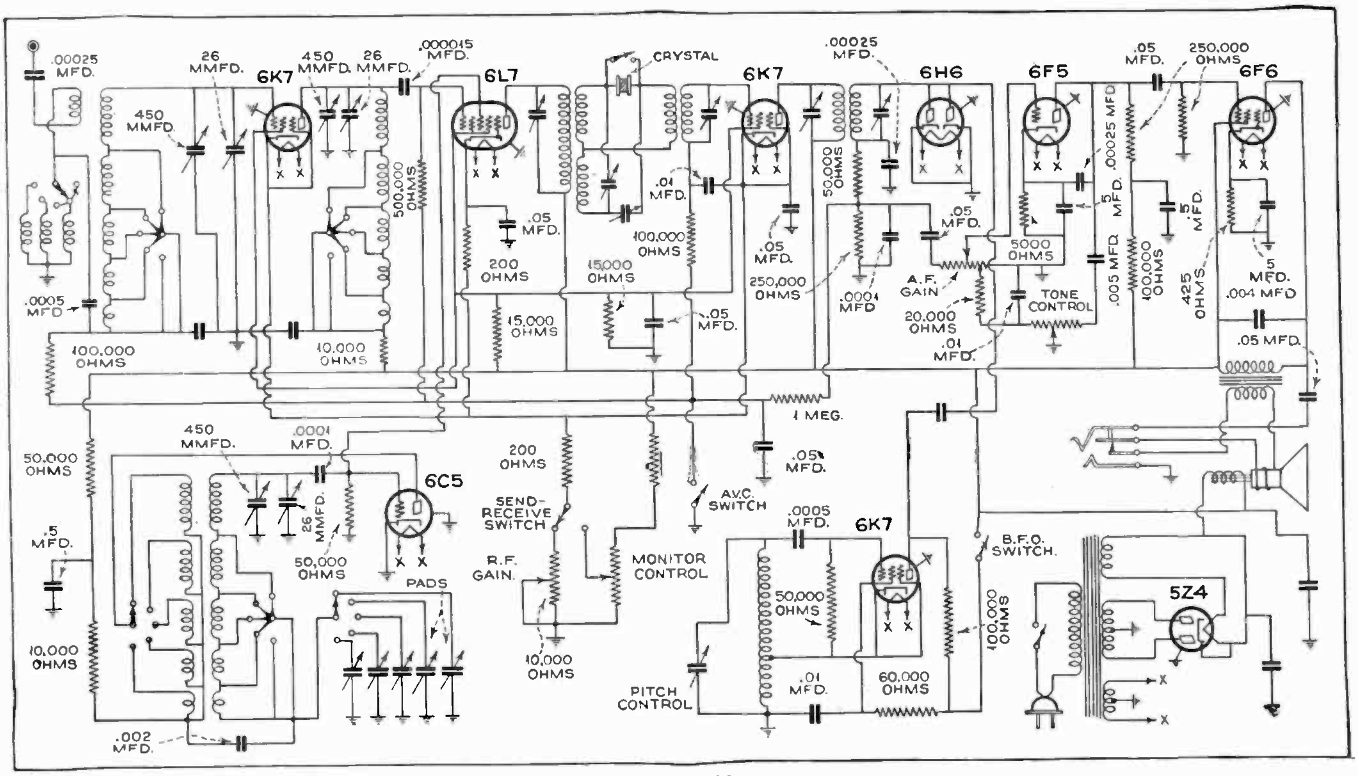


Figure 13

The Super Skyrider

THAT metal tubes will definitely provide better short-wave reception is the conviction of the Hallicrafter engineers. The metal tubes permit the elimination of tube shields, to which source engineers have long attributed a lot of the noise in short-wave receivers. The metal tubes also reduced inter-electrode capacities and gave the advantage of shorter leads, all of which afforded greater gain and fewer circuit complications.

The circuit diagram in Figure 13 shows that the new receiver uses metal tubes throughout as follows: a 6K7 in the r.f. pre-selector stage; 6L7 as first detector-mixer; a 6C5 as the oscillator; a 6K7 as the i.f. stage; a 6H6 as the second detector and avc tube; a 6K7 as the electron coupled beat oscillator; a 6F5 first audio, a 6F6 second audio and output tube and a 5Z4 rectifier. The 6L7 tube used here has no parallel in the glass tubes. The set and tubes are shown in Figure 10.

The crowded amateur bands demand a new order of selectivity. The special iron-core, intermediate-frequency system for this receiver answers this need adequately.

The new set uses six tuned circuits in its i.f. system, either with or without the crystal filter, where most crystal receivers use only four tuned circuits. True single-signal reception is assured by this arrangement.

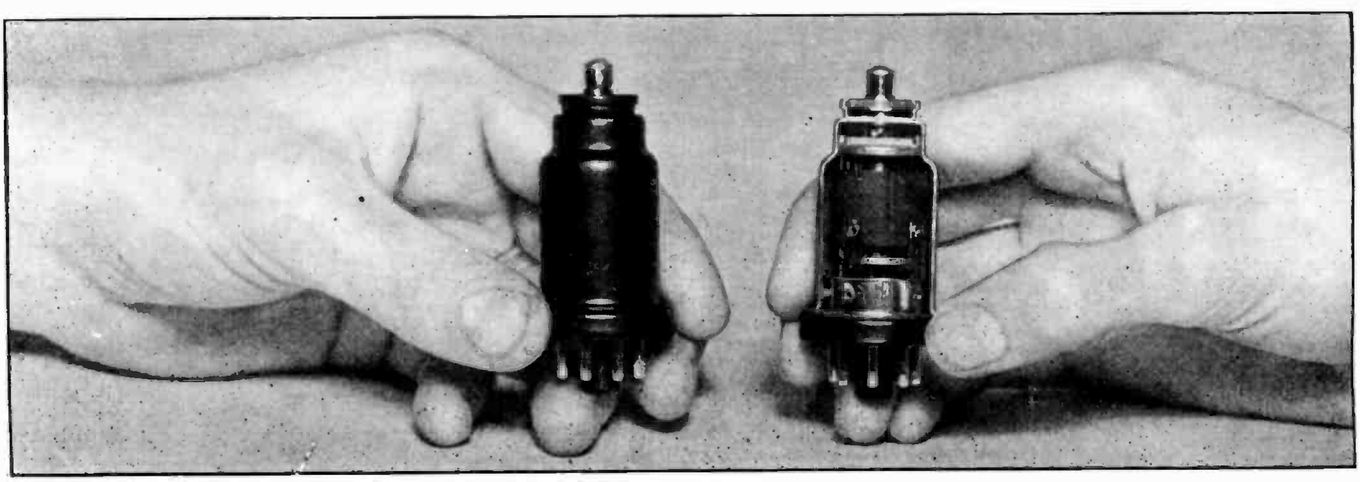
An efficient 5-band coverage from 7.5 to 550 meters (41,000 to 540 kc.) has been achieved. This high efficiency is also made possible through an antenna circuit that is (in each case) tuned to the low frequency end of each band. It is capacitively *and* inductively coupled to the grid and through this means uniform gain on all parts of all the bands is obtained. The crystal filter is controlled on the front panel by a switch and a phasing condenser. In addition there are r.f. gain and audio gain controls, the send-receive switch and the phone jack. The knobs, too, are distinctive and highly practical.

The phone man, too, has a new "gadget" in the exclusive "low-boost" control that injects the desired amount of bass into phone reception, eliminating the "thinness" so characteristic in phone reception on communication receivers, generally.

Another feature of the new set is the duomicro-vernier band-spread system. Unequalled accuracy of logging is afforded by this system which combines electrical band spreading and micro-vernier tuning in an exclusive and distinctive dial.

THE OUTSIDE AND THE INSIDE

The new G. E. metal variable-mu pentode. The inside view shows the closer spacing and shorter leads.



SHORT WAVE RADIO

Reception Aids

HARDLY a day goes by but what some new drama of the ether is unfolded and it is this unexpected and dramatic interest that makes short-wave reception so exhilarating. Although we are not all privileged to "sail the seven seas," we can all be transported, at least for a time, far from the hum-drum realities of our everyday existence by sailing the ether lanes on our present-day short-wave radio receiver.

To get the most pleasure from your short-wave receiver, there are certain facts that should be kept in mind.

It is commonly known that short-wave stations do not operate at all hours, or every day. It is also well known that these stations change their wavelengths with the changing seasons, and some of the large stations use different frequencies at certain hours of the day. Short-wave broadcasting also covers only narrow bands within a wide wave spectrum which runs from 1500 to some 40, or even 50 thousand kilocycles, including thousands of separate channels. If it were not for the up-to-date and accurate World Short-Wave Timetable, published monthly in RADIO NEWS, all the best equipment in the world would be of very little use, as it would be like searching for a "needle in a hay-stack" to find out *when* the stations were operating, *where* they were located, and *upon what frequencies* they were operating.

Short-wave tuning is different from broadcast tuning. On the long waves we know almost when and where (on the dials) to find stations, for we grow accustomed to tuning them in day after day. But on a short-wave set we must search for the stations at first and then keep a record of the dial-reading in order to go back and get it later. It is not necessary to keep a written record always, as dial settings on a short-wave set soon get fixed in the mind just the same as on long waves. But you must search for the station at first, and to get it you must tune *when it is on the air!*

In running up and down the dials you might pass over a distant station dozens of times and never know it is a station unless you happen to stop right on the exact spot where the signal is located. Therefore, you must tune slowly. Short-wave stations are mostly experimental and change quite often. Be sure your station list is up to date and kept up to date or you will spend much time tuning for stations that are not on the air. Then, paying particular attention to the time each station is on the air, tune for it near where the local station was heard on the dial. For example, you can easily tune in W2XAF, New York, on 31.48 meters and station VK3ME is just a shade on the dials above it.

The Short-Wave Identification Charts, Figures 14, 15 and 16 will prove a great aid in identifying short-wave stations received. By listening to the announcement or identifying signals of short-wave stations and referring to the charts, it is possible to determine the call letters of the station to which you are listening. Also included are the names and addresses of the various stations for use in obtaining verifications.

Other aids to the short-wave fan in this chapter include a World "Alphabets" Chart which will enable you to translate foreign announcements, a Wavelength-Frequency Chart for converting meters into kilocycles (and vice versa) and a U. S. And World-Wide Mileage Chart which shows the air-line distances between most of the important cities of the world.

Verifying Short-Wave Calls

ONE of the incidental pleasures of long-distance reception, on either short-wave or broadcast bands, is obtaining written verifications from the foreign stations. Many of these "veris" are elaborate, multi-colored documents and are well-worth framing; even the simpler and less pretentious ones make good exhibits when you have company and want to show off your standing as a DX fan of international accomplishments.

Merely hearing a foreign station is only the first step in the process of getting a veri. You must appreciate the fact that writing to a foreign country is not like requesting a catalog from a nearby mail-order house. The first and most important rule is: WRITE PLAINLY! If at all possible, typewrite your letter or have someone else do it for you. At most of the radio stations in Europe, Asia and South America there is someone with at least a book knowledge of English.

Use plain white paper, and write on only one side of the sheet. Spell out the name of your town and state. To a person unfamiliar with domestic geography, N.Y., N.J., N.H. and N.M. all look somewhat alike.

If you can find the full street and city address of the foreign station in any of the published call lists, put it on your outgoing envelope. If you can't, the mere call letters or name of the station, the city and country are enough. Outside of the United States, practically all radio stations are government controlled, and the postal authorities know where to deliver anything mailed "radio." Of course, put your own name and full address, including "U.S.A." after the state, on the outside of the envelope.

A perfunctory report like "I heard your signals. Please send me a verification" is likely to bring back an equally meaningless acknowledgment (if any) that you won't even want to show to friends. Don't be afraid to go into details; the foreign stations like it. At one time, the French used to send short-wave listeners a five-page mimeographed questionnaire, in which they asked about everything except the condition of the DXer's teeth. Give as much "dope" as you have time for on the following topics: (1) Exact time of reception — specify Eastern, Central, Mountain or Pacific Time, or better still, Greenwich Time; (2) what you heard—names of selections or kind of music, exact time of announcements, talks, weather or news reports, etc.; (3) how long you listened to program; (4) comparative strength and clarity of signals, fading, extent of atmospherics, etc.; (5) weather conditions at the time—some listeners even give barometer readings; (6) type of receiving set—regenerative, t.r.f., or superhet; (7) length and direction of aerial; (8) entertainment value of program; (9) how signals compare generally with those of other stations in nearby countries.

Giving the station an idea of signal strength is a problem, as there is no standard of comparison and even two persons listening to the same program from the same loud speaker often cannot agree on any numerical value in the "R" or "QSA" scales. A better picture of receiving conditions is given if you say something like "Music clearly audible throughout a three-room apartment," or "Signals heard fifty feet from loud speaker standing in open window." The station engineers can then at least visualize your receiving conditions and get some real idea as to how the signals came through. Above all make your report truthful—don't exaggerate.

Information on point 9 is especially wel-

(*Continued on Page* 14)

Station Identification Chart

Figure 14

Call Letters	Address	Name	Announcement	Identifying Signals
CJRO, CJRX	James Richardson & Sons, Ltd., 155 Royal Alexandra Hotel, Winnipeg, Manitoba			Begins with "O Canada", Strikes 4 gongs
CNB	L'Inspecteur General, Directeur de L'Office des Postes, Rabat, Morocco	Radio-Maroc	"Ici Radio-Rabat dans Maroc"	Metronome between selections, finishes with "La Marseillaise"
COC	Short Wave Radio Station, COC, P.O. Box 98, Havana, Cuba		"Seh-O-Sch, Habana, Cooba." Sometimes in English	
COH	Calle B, No 2, Vedado, Havana, Cuba		"Estacion de onda Corta Seh-O-acha," Spanish and English	
CO9GC	P.O. Box 137, Santiago, Cuba	La Voz de Santiago de Cuba		
CO9WR	P.O. Box 85, Sancti Spiritus, Cuba	Radio Illimani	Announces in English and Spanish	Chimes somewhat like N. B. C.
CP5, CP6, CP7	Compania Radio Boliviana, Calle Socabaya 231, La Paz, Bolivia		"Radio Illimani"	
CQN	Postmaster General, Macao, Asia			
CR6AA	Caixa Postal 118, Lobito, Angola, Port. W. Africa			
CR7AA	Gremio dos Radiofilos da Colonia de Mozambique, Portguese, E. Africa	Radio Colonial	"Radio Lorenzo Marques"	
CT1AA	Av. Duque de Avila, 86 r/c, Lisbon, Portugal		"CT1AA, Radio Colonial"	3 cuckoo calls
CT1CT	Oscar G. Lomelino, Rua Gomes Freire 79, Lisbon, Portugal			
CT1GO	Portuguese Radio Club, Parede, Portugal			
CT2AJ	Ponta Delgada, Sao Miguel, Azores		"Aki say-tay-doix-ah-jhota, estacao emi-sora da Ponta Delgada, Sao Miguel, Azores." Also English announcements	Ends with Portuguese National Hymn
DFB	Reichspostzentralamt, Berlin, Germany			Three tone whistle at beginning of transmission: D, C, G.
DJA, DJB, DJC, DJD, DJN, DJQ	Reichsrundfunkgesellschaft, Haus des Rundfunks, Berlin-Charlottenburg, 9, Germany		"Dear Friends and listeners in North America," etc., German, English and Spanish spoken	Chimes—Eight notes of old German song, frequently repeated
EAQ	Station EAQ, Apartado Correos 951, Madrid, Spain		"Akee Ay-Ah-Coo Madrid Espana," Big Ben Chimes. Announces in Spanish and English	Ends with "Rachmaninoff's Prelude"
FIQA	Dept of Mail, Telegraph & Telephone, Tananarive, Madagascar		"Radio Tananarive."	Opens with "Ramona," ends with "Marseillaise"
FYA	Station Radio-Coloniale, 98 Bis. Boulevard Haussmann, Paris, (8e), France	Radio-Coloniale	"Ici Paree, Radio Coloniale," Does not use call letters	Chimes of French clock, quarter hours. Ends with "Marseillaise" and Bon soir Mesdames, Bon soir Mesdemoiselles, Bon soir Messieurs"
GSA, GSB, GSC, GSD, GSE, GSF, GSG, GSH	British Broadcasting Corp., Broadcasting House, London, W1, England		"This is London calling you"	Starts and Finishes with Big Ben's Gong. Sometimes "God Save the King"
G6RX	Mr. G. A. Struthers, Rugby Radio Station, Hillmorton, England			
HAS, HAT	A. Magyar Kir Posta, Kiserleti Allomasa, Gyali-ut 22, Budapest, IX, Hungary			
HBL-HBP	M. G. Gallarati, Information Section, League of Nations, Geneva, Switzerland	Radio Nations	"Radio Nations," Does not use call letters; speaks English, Spanish and French	
HB9AQ	Lausanne, Switzerland			
HB9B	Radio Club Basel, Postfach Basel 1, Switzerland	Radio Club Basel		Intermission: signal "z'Basel a myn Rhy."
HCJB	Radio Station HCJB, Casilla 691, Quito, Ecuador	La Voz de los Andes	"La Voz de los Andes"	Two tone chime, announces in Spanish and English
HC2ET	Radiodifusora HC2EP, Box 249, Guayaquil, Ecuador	El Telegrafo		
HC2RL	Dr. Roberto Levi, Box 759, Guayaquil, Ecuador	Quinta Piedad	"Hello, America," Announce in English and Spanish	Ecuadorian Anthem
HH2S	Mr. Armand Mallebranche, P. O. Box A-103, Port au Prince, Haiti			
HIH	La Voz del Higuamo, San Pedro de Macoris, Dominican Republic	La Voz del Higuamo	Spanish and English every half hour: "HIH Santo Domingo, operating on a frequency of 6818 kc."	
HIZ	Secretaria de Estado, De Trabajo y Comunicaciones, Santo Domingo, Dominican Republic			
HI1A	Rafael Western, Box 423, Santiago de los Caballeros, Dominican Republic	La Voz del Yaque	"La Voz del Yaque"	Plays "Anchors Aweigh" at start and finish of program
HI1J	P.O. Box 204, San Pedro de Macoris, Dominican Republic			
HI3C	La Voz del Rio Dulce, La Romana, Dominican Republic	La Voz del Rio Dulce		Chimes
HI4D	La Voz de Quisueya, Santo Domingo, D.R.			
HJ1ABB	Elias J. Pellet, Box 715, Barranquilla, Colombia	La Voz de Barranquilla	"La Voz de Barranquilla, Acha-hota-uno-ah-beh-beh," announces in Spanish and English and Spanish	Chimes like NBC
HJ1ABD	Sr. Ignacio de Villareal, Radio Station HJ1ABD, Cartagena, Colombia	Ondas de la Heroica		Three-note chimes
HJ1ABE	Sr. Jose M. Fuentes L. Apartado Postal 31, Cartagena, Colombia	La Voz de los Laboratorios "Fuentes"		Ends transmission with "Aloha Oe".
HJ1ABG	La Voz del Atlantico, Apartado 816, Barranquilla, Colombia	La Voz del Atlantico		
HJ1ABH	Sr. Sergio Martinez Aparicio, Cienaga, Colombia			
HJ2ABA	Pompilio Sanchez C., Tunja Boyaca, Colombia	La Voz del Pais	"La Voz del Pais"	
HJ3ABD	Colombia Broadcasting, Calle 16, No. 5-40, Bogota, Colombia	Ecos de Calle	"Atcha-Kah-Effeh'	Gong
HJ3ABH	La Voz de la Victor, Apartado 565, Bogota, Colombia	La Voz de la Victor		
HJ4ABA	Medellin, Colombia	Ecos de la Montana		
HJ4ABL HJ4ABB	Ecos del Occidente P.O. Box 79, Manizales, Colombia	Ecos del Occidente	"HJ4ABL" L as in Lady"	Four strokes on gong
HJ4ABC	Pereira, Colombia	La Voz de Pereira	"Estacion acha-hotah-quatro-ah-bay-say, La Voz de Pereira, Pereira, Colombia"	Chimes before Announcements
HJ4ABE	Cia. Radiodifusora de Medellin, Medellin, Colombia	La Voz de Antioquia	"Aqui la acha-hotah-quatro-ah-bay-ay en Medellin, Colombia." Also English announcements	

Station Identification Chart

Figure 15

Call Letters	*Address*	*Name*	*Announcement*	*Identifying Signals*
HJ4ABN	Manizales, Colombia	Ecos del Occidente	"Ecos del Occidente"	
HJ5ABC	R. Angulo Radiodifusora HJ5ABC, Cali, Colombia	La Voz de Colombia		
HJ5ABD	Cali, Colombia		"Achay-jay-sinko-ah-bay-day"	
HP5B	Estacion Miramar, Box 910, Panama City	The Voice of Panama	"Estacion Miramar," the voice of Panama	
HP5J	Sr. Manuel Diaz Doce, La Voz de Panama, HP5J Apartado 867, Panama City, Panama			
HRP1	Sr. Manuel Escoto, Radio Station HRP1, San Pedro Sula, Honduras	El Eco de Honduras en San Pedro Sula	Spanish and English	Music box will play the first note of National Hymn between selections. (in the near future)
HVJ	Station HVJ, Vatican City, Italy	Laudetur Jesus Christus		Clock's ticks in studio. Announcer begins with "Pronto, pronto, Radio Vatican," ends with "Laudetur Jesus Christus"
I2RO (2RO)	Ente Italiano Audizioni Radiofoniche, Via Montello No. 5, Rome, Italy	Prato Smeraldo	"Radio Roma Napoli." Lady announcer, sometimes a whole string of Italian cities; does not use complete call letters. During American hour from Rome a man announcer says "2R O, Rome"	
JES			"Osaki." Announcer speaks English and Japanese, announcer seems to be American	
JVH, JVM, etc.	Kokusai-Denwa Kaisha Ltd. Osaka Bldg., Kojimachiku, Tokyo, Japan		English and Japanese	Ends with Netional Anthem
JVR	Kemikawa Sending Station, Kemikawa-Cho, Chiba-Ken, Japan			3 gongs—2 gongs, 1 pause, 1 gong, 1 pause then 1 chime
LKJ1	Dept. of Commerce, Division of Radiotelegraphy, Oslo, Norway		"Broadcasting Oslo"	Interval signal: short series of musical notes
LSY	Transradio Internacional, San Martin 329, Buenos Aires, Argentina			Begins with xylophone notes E, E, G sharp, A
OAX4B	Messrs. Grellaud & Co. Apartado 1242, Lima, Peru		"Transmite la casa del auto" or, "Transmite la casa Grelland de Lima" or, "Transmite la estacion oh-ah-ekis-quatro-bay de Lima, etc."	
OAX4D	D. U. S. A., All-American Cables, Inc., 835, Lima, Peru	La Voz de Peru	"Radio D. U. S. A., La Voz de Peru." In Spanish and English	
OER2	Oesterr. Radioverkehrs, A. G., Johannesgasse 4b, Vienna, Austria		"Hallo Hier Radio Wien"	Metronome can be heard
ORP, ORK, ORG	Regie des Telegraphes et des Telephones. Direction des Radiocommunications, Brussels, Belgium	Belradio	"Ici Bruxelles I. N. R. emission speciales pour" la Congo par la station de Ruysselede	Finishes with "La Brabanconne"
OXY	Statsradiofonien, Heibergsgade 7, Copenhagen, Denmark			Chimes of the Town Hall clock at 6 p. m. EST
PCJ	Philips Radio, Emmasingel 29, Eindhoven, Holland			
PHI	PHOHI Studios, Hilversum, Holand		Announces in Dutch, Malay, German, French, English, Spanish and Portuguese. "Hallo, Hallo PHI, Holand," also "This is Huizen"	Signs off with Dutch National Hymn.
PLLJ	Middelbare Technische School, Oranjelaan 12, Dordrecht, Netherlands		Announcements in English, German and Dutch.	Begins with: cq "de PLLJ" in code.; ends with National Anthem and again the call in code
PLV, PMY, etc. Bandoeng Stations	Mr. H. van der Veen, Engineer in Charge, Java Wireless Stations, Bandoeng, Java, D. E. I.			PLV plays 3 records, starts calling on 4th record; PLF, PMC begin transmissions with 3 auto horn notes; F, D. C.
PRADO	Estacion Radiodifusora del Prado, Apartado de Correos 98, Riobamba, Ecuador	El Prado	"Estacion del PRADO, Riobamba, Ecuador." In Spanish and English	
PRA8	Radio Club de Pernambuco Avenida Cruz Cabuga 394 Recife, Brazil	"A Voz do Norte"		Chimes at 12:00, 7:00 and 8:00 p. m.
PRF5	International Radio Co. of Brazil, Rio de Janeiro, Brazil	La Presse Nacional	"Short-wave Station PRF5, F for Friday, Rrrio-de-Janeiro, Brazil"	3 chimes—announces in Portuguese, French, English, and Spanish
RW15	Far East Radio Station, Khabarovsk, Siberia			
RW59	Radio Centre, Solianka 12, Moscow USSR	Workers of the World	"Moscow Calling." Announces in German, French, Spanish, Hungarian, Swedish and English on different days of the week	Plays the "International" at beginning and end of transmissions
TFK, TFJ, TFL	Riksutvarp Islands, Box 547, Reykjavik, Iceland			
TGWA	Radiodifusora Nacional "TGW", Guatemala City, Guatemala			
TGX	M. A. Mejicano Novales, El Liberal Progresista, Guatemala City, Guatemala			Two tone high frequency signals
TIEP, TI2EP	E. Pinto Hernandez, Apartado de Correos 257, San Jose, Costa Rica	La Voz del Tropico	"La Voz del Tropico"	
TIGPH	"Alma Tica" San Jose, Costa Rica	"Alma Tica"		
TIPG Y12PG	Sr. Perry Girton, Costa Rica Radio and Broadcasting Station, Apartado 225, San Jose, Costa Rica		"This is Radio Station TIPG. Costa Rica. Costa Rica Broadcasting Station"	
TIRCC	Sr. Cespedes Marin, P. O. Box 1064, San Jose, Costa Rica	Radio emisora Catolica Costarricense, TIRCC		
TI4NRH	Amando Cespedes Marin, Heredia, Costa Rica	Sol Lucet Omnibus	English and Spanish spoken	Bugle calls and bird calls, finishes with March of Costa Rican Republic
VE9CA	Calgary, Alberta	Voice of the Prairie	"Voice of the Prairie"	
VE9CS	Radio Service Engineers, Ltd., 734 Davie Street, Vancouver, B. C., Canada			Sounds two bells between selections
VE9DR	Canadian Marconi Co., P. O. Box 1690, Montreal, Quebec, Canada			
VE9GW	R.R. No. 4, Bowmanville, Ont., Canada		"Canadian Radio Commission Station VE9GW at Bowmanville, Ontario, Canada"	4 strokes on gong at beginning of transmission
VE9HX	The Maritime Broadcasting Co., Ltd., Box 998, Halifax, Nova Scotia, Canada	The Key Station of the Maritimes		Call of laughing notes of kookaburra bird Finishes with "God Save The King"
VK2ME	Amalgamated Wireless (Australasia) Ltd., Box 2516 BB G. P. O., Sydney, Australia	The Voice of Australia	"Vee-K1-2ME, Sydney Amalgamated Wireless of Australia"	Has that "Empty hall" effect during announcements

Station Identification Chart

Figure 16

Call Letters	*Address*	*Name*	*Announcement*	*Identifying Signals*
VK3ME	Melbourne, Australia		"Vee-Ki-3-ME, Melbourne Amalgamated Wireless of Australia"	Begins with clock chimes
VK3LR	Postmaster-General's Dept., Treasury Gardens Melbourne C2, Victoria, Australia			
VK3ZX	Mr. G. C. Bryse, 501 Royal Parade, Rockville, N-2, Melbourne, Australia			
VPD	Amalgamated Wireless (Australasia) Ltd., Suva, Fiji	Radio Suva		
VPIA	Amalgamated Wireless Ltd., Suva, Fiji Islands		"Suva Radio calling"	Transmissions begin with "Song of the Islands" and end with "God Save The King"
VQ7LO	Cable and Wireless Ltd., P.O. Box 777, Nairobi, Kenya Colony, British East Africa			
VUB	Indian State Broadcasting Service, Irwin House, Sprott Road, Ballard Estate, Bombay, India			
WVD	c/o Alaska Telegraph System, Seattle, Washington			
W1XAL	World Wide Broadcasting Corp., 70 Brookline Ave., Boston, Massachusetts		"This is international S.W. Station W1XAL at Boston"	
W1XAZ	Radio Station W1XAZ, Bradford Hotel, Boston, Massachusetts		"Westinghouse Stations WBZ, WBZA and Short-Wave station W1XAZ"	
W2XAF-W2XAD	General Electric Co., Schenectady, N. Y.	The voice of electricity	"This is WGY and W2XAF," "or This is WGY and W2XAD"	Begins each program with a discharge of 10 million volts
W2XE	Columbia Broadcasting System, 485 Madison Avenue, New York City		"This is the Columbia Broadcasting System SW Experimental station W2XE"—in various languages	
W3XAU	WCAU Broadcasting Co., 1622 Chestnut Street, Philadelphia, Pa.		This is the Columbia Broadcasting System S.W. Station W3XAU at Philadelphia"	
W3XAL, W3XL	National Broadcasting Co., Rockefeller Plaza, New York City		"W3XAL, Bound Brook, New Jersey"	
W8XAL	Crosley Radio Corp., Cincinnati, Ohio	The Nation's Station	"The Nation's Station WLW and S.W Station W8XAL"	
W8XK	Westinghouse Elec. Mfg. Co., Hotel William Penn, Pittsburgh, Pa.		"This is Westinghouse Station KDKA and its S.W. complement, W8XK"	NBC chimes
W9XAA	The Voice of Labor, 665 Lake Shore Drive Chicago, Illinois	The Voice of Labor	"WCFL and W9XAA, The Voice of ot Labor"	
W9XF	National Broadcasting Co., Inc., Merchandise Mart, Chicago, Illinois		"W9XF, Chicago, 6100kc"	NBC chimes
XEBT	B. Sancristobal, Apartado 79-44, Mexico, D.F., Mexico	El Buen Tono	Announce in Spanish and English	Blowing of automobile horn—like very fast "cuckoo" calls, repeated twice, sometimes a siren. Sign off with Ave Maria
XECR	Ministry of Foreign Affairs, Mexico City, Mexico		"La estacion de onda corta, ekis-ay-say-erray"	
XECW	El Caballero Xantocam, Calle del Bajia 120, Mexico, D. F., Mexico			
XQAJ	80 Love Lane, Shanghai, China			
X2AH	"Foreign Club" Tijuana, B. C., Mexico			
YNLF	Sr. M. Le Franc, 206 Calle 15 de Septiembre, Managua, Nicaragua	La Voz de Nicaragua	"La Voz de Nicaragua"	
YN1GG	Managua, Nicargua.	La Voz de los Lagos		
YV2RC	Broadcasting Caracas, Apartado de Correos 290, Caracas, Venezuela	Broadcasting Caracas	"Ee-vay-dos-erray-seh broadcasting Caracas"	Chimes each quarter hour. Sign off with Venezuela Anthem
YV3RC	Caracas, Venezuela	Radiodifusora, Venezuela	Ee-vay-trays-erray-say	Plays bells on the hour. Two chimes, repeated, before announcement
YV5RMO	Sr. S. M. Vegas, Apartado de Correos 214, Maracaibo, Venezuela	Ecos del Caribe	"Ecos del Caribe"	Strikes gong before announcing
YV6RV	Valencia, Venezuela	La Voz de Carabobo	"La Voz de Carabobo, Ee-vay-sez-erray-vay"	Strikes gong before announcement
ZCK	P.O. Box 200, Hong Kong, China		"This is the Hong Kong Broadcasting Station Calling"	
ZFD	Town Clerk, St. George, Bermuda			
ZGE	The Malayan Amateur Society, Mercantile Bank Building, Kuala Lumpur, Federated Malay States		Announcements in English only	
ZHI	Radio Service Co. of Malaya, 2 Orchard Road, Singapore, Straits Settlements			Ends with "God Save The King"
ZHJ	Penang Wireless Society 40 Park Road, Georgetown, Penang, Straits Settlements			Opens with "God bless the Prince of Wales"
ZP10, ZP3AC	Avenida de Colombia 885 Asuncion, Paraguay	Rueda del Oeste	Announcements in Spanish	Begins with bugle call, ends with National Hymn.
ZTE	Malayan Amateur Society, Singapore, Malaya			
ZTJ	African Broadcasting Co., Ltd., Box 4559, Johannesburg, Union of South Africa			

Verifying S. W. Calls

(Continued from Page 11)

come to foreign stations, particularly the short-wavers. The politically embroiled countries of Europe are frankly out to develop world-wide audiences for their radio stations, as a means of putting over their own ideas and propaganda, and they are most anxious to learn how they are faring in the battle. If you send in regular reports, say at weekly or bi-weekly intervals, you are likely to be rewarded with beautiful photographs, engraved diplomas and even special stamps. More than one philatelist has taken up DX reception because of the valuable stamps the veris often bear!

The fact that the French stations naturally answer your letters in French, the Germans in German and the Italians in Italian merely makes the verifications more interesting. You expected them to read your English; why shouldn't they expect you to read their languages? Fortunately, the Russians write in neatly typed English! It is surprisingly easy to guess at most of the contents of these letters, even if you've forgotten what little French, German or Spanish you did assimilate at high school.

More and more the foreign stations are realizing the good-will value of a verification in the language of the person who sent in a report, and many veris do come

MOSCOW, U.S.S.R.	43	83	76	90	11	78	71	46	50	41	57	59	55	72	16	15	10	70	10	34	21	46	59	39	66	22	13	103	10	51	25	22	15	63	62	52	46	60	38
KHABAROVSK, U.S.S.R.	29	113	58	57	49	99	108	57	42	14	83	69	10	85	51	52	47	40	48	31	53	9	41	67	66	63	50	66	44	25	60	57	52	91	82	58	60	51	
LOS ANGELES, U.S.A.	23	61	93	74	62	48	63	22	11	65	35	23	56	35	55	57	58	25	62	81	63	54	89	97	16	59	56	66	54	73	56	58	59	99	36	16	25		
NEW YORK, U.S.A.	33	53	118	99	42	40	48	4	25	73	25	13	38	29	34	36	40	50	43	79	42	67	101	74	22	36	36	89	31	85	33	36	39	77	22	9			
ST. LOUIS, U.S.A.	29	55	108	90	49	41	52	7	17	72	26	13	45	28	42	44	47	41	51	82	51	63	99	83	14	45	44	80	43	82	42	44	47	86	25				
CARACAS, VENEZUELA	54	31	108	95	54	19	28	25	42	95	6	14	52	11	46	47	52	60	55	96	52	88	121	71	23	41	49	81	52	106	40	43	49	63					
CAPETOWN, SOUTH AFRICA	104	42	54	68	56	53	38	81	101	79	65	77	61	66	59	57	59	115	56	59	52	91	59	25	85	49	60	70	63	74	53	53	51						
GENEVA, SWITZERLAND	49	68	87	105	5	63	56	39	51	57	55	50	7	60	4	3	5	77	6	47	4	61	72	38	60	11	4	118	9	66	9	6							
MADRID, SPAIN	51	62	91	110	11	57	50	37	52	62	49	46	13	54	8	6	11	78	12	53	8	67	77	39	56	5	9	124	15	73	3								
LISBON, PORTUGAL	51	59	94	113	14	54	47	35	51	66	46	43	15	51	9	9	14	78	15	56	12	70	81	40	54	4	12	120	17	75									
MANILA, P.I.	53	110	32	39	61	117	111	81	65	12	107	94	60	107	67	67	62	53	61	22	61	18	17	58	88	76	64	52	60										
OSLO, NORWAY	40	76	87	99	8	68	64	36	45	50	57	49	3	62	7	8	5	78	9	45	12	53	69	44	57	20	5	110											
WELLINGTON, NEW ZEALAND	73	61	32	44	113	67	72	87	72	62	75	78	112	69	118	118	113	47	112	71	115	58	46	84	68	118	116												
HUIZEN, NETHERLANDS	44	71	88	103	5	65	59	37	48	54	55	49	3	60	3	3	4	72	7	47	8	58	72	41	58	14													
RABAT, MOROCCO	55	58	92	112	15	52	46	38	54	67	47	45	17	52	12	11	16	81	16	56	12	72	79	38	56														
MEXICO CITY	38	46	100	80	63	33	58	21	25	70	20	11	59	19	56	57	61	38	64	96	62	70	103	92															
NAIROBI, KENYA	82	64	55	75	37	71	55	75	89	58	76	81	42	79	42	40	39	50	36	38	38	70	49																
BANDOENG, JAVA	36	93	18	32	67	107	95	98	82	36	121	110	69	118	74	73	68	66	66	25	69	36																	
TOKIO, JAPAN	35	114	50	48	57	103	117	64	47	12	88	74	55	89	60	60	56	38	56	32	61																		
ROME, ITALY	52	69	83	101	5	65	57	44	55	56	58	54	9	63	9	7	7	80	5	45																			
CALCUTTA, INDIA	58	102	42	57	43	108	92	77	70	20	102	92	43	106	49	49	44	70	41																				
BUDAPEST, HUNGARY	49	73	81	99	2	69	61	44	52	51	61	55	6	66	9	7	4	76																					
HONOLULU, HAWAII	28	75	68	51	76	66	82	46	27	50	57	48	71	55	72	74	72																						
BERLIN, GERMANY	45	73	85	101	3	68	61	40	49	51	58	52	2	63	6	5																							
PARIS, FRANCE	47	68	89	105	6	62	56	37	49	56	54	48	6	58	2																								
LONDON, ENGLAND	45	69	91	106	9	61	58	35	47	55	53	46	6	57																									
QUITO, ECUADOR	56	22	99	83	63	14	29	31	43	99	5	16	63																										
COPENHAGEN, DENMARK	43	74	85	99	5	68	62	39	47	50	58	51																											
HAVANA, CUBA	40	43	110	90	54	29	42	15	28	83	14																												
BOGOTA, COLOMBIA	55	29	98	88	59	15	28	28	42	98																													
NANKING, CHINA	43	122	44	50	51	112	112	70	56																														
VANCOUVER, CANADA	13	70	92	78	52	70	69	21																															
TORONTO, CANADA	29	56	113	96	43	52	52																																
RIO DE JANEIRO, BRAZIL	81	12	83	72	61	16																																	
LA PAZ, BOLIVIA	69	13	90	80	68																																		
VIENNA, AUSTRIA	48	73	83	99																																			
SYDNEY, AUSTRALIA	73	72	20																																				
PERTH, AUSTRALIA	83	76																																					
BUENOS AIRES, ARGENTINA	83																																						
ANCHORAGE, ALASKA																																							

WINNIPEG, MAN.																													
WASHINGTON, D.C.																													126
VANCOUVER, B.C.																												238	118
TULSA, OKLA.																											165	106	96
ST. LOUIS, MO.																										36	179	174	86
SAN FRANCISCO, CAL.																									174	146	81	244	152
SALT LAKE CITY, UTAH																								60	116	92	81	185	96
RALEIGH, N.C.																							183	240	64	97	243	23	136
PORTLAND, ORE.																						239	64	54	173	154	26	236	123
PITTSBURGH, PA.																					218	33	167	227	56	92	220	19	107
PIEDRAS NEGRAS, MEX.																				144	170	138	107	142	91	59	168	154	150
PHOENIX, ARIZ.																			86	183	102	190	51	66	126	93	124	198	138
NEW YORK, N.Y.																		215	173	32	246	44	197	258	188	223	246	21	126
NEW ORLEANS, LA.																	119	132	65	93	207	77	144	193	60	55	220	98	144
MONTREAL, QUE.																141	38	220	189	48	236	73	195	255	98	134	232	39	115
MINNEAPOLIS, MINN.															96	106	102	130	121	74	144	100	99	159	46	63	145	93	39
MIAMI, FLA.														152	143	68	112	200	128	103	272	70	210	261	108	119	283	94	192
MEMPHIS, TENN.													88	70	113	36	197	126	76	67	186	64	125	180	25	34	195	77	110
LOS ANGELES, CAL.												161	237	153	247	169	247	37	113	214	83	224	57	34	159	127	108	230	154
HELENA, MONT.											93	140	227	91	184	166	194	92	140	166	52	188	41	81	124	110	55	185	73
FORT WORTH, TEX.										124	122	45	115	88	155	47	141	86	35	111	162	109	99	146	57	26	177	122	121
DETROIT, MICH.									103	145	198	46	118	54	53	96	49	169	137	21	197	52	149	209	46	81	198	40	86
DES MOINES, IA.								54	66	98	144	49	135	24	104	84	103	115	99	72	148	91	95	155	79	48	153	90	61
DENVER, COL.							61	116	66	124	83	88	174	70	163	109	163	59	82	132	99	147	37	95	79	55	112	149	81
CLEVELAND, O.						123	51	54	106	159	206	64	111	64	49	94	40	176	140	11	208	43	157	218	50	86	208	30	86
CINCINNATI, O.					23	109	51	24	84	151	190	42	87	60	71	72	58	158	118	26	199	40	145	204	32	66	203	40	98
CHICAGO, ILL.				25	32	92	31	24	83	128	175	49	120	35	75	184	72	140	117	41	177	64	126	185	21	60	179	60	73
BOSTON, MASS.			84	74	54	177	115	61	158	205	260	164	128	153	144	137	18	229	191	49	255	61	210	270	104	140	226	55	130
ATLANTA, GA.		94	59	38	56	121	75	60	75	173	195	33	61	92	100	43	76	160	103	53	218	35	159	214	47	67	226	55	131
ALBUQUERQUE, N.M.	127	196	112	124	142	33	83	136	56	86	67	161	170	98	187	103	181	33	57	149	112	157	50	90	93	59	130	165	114

Figure 17

through in English, even if the phrasing is ludicrous in places, and the genders are somewhat mixed. The acknowledgments from certain of the Central American stations in particular are actually scream provoking. But remember the writers of these letters are oftentimes going to a great deal of trouble in trying to use English *for your convenience and benefit.*

No matter what else you put into your outgoing envelope, you must be sure to include return postage. Now, for years, radio writers have been telling American listeners to send International Postal-Reply Coupons, which cost nine cents apiece and are good in countries belonging to the Postal Union, but even postoffices in large cities do not always have them in stock. Besides, some important countries, the Soviet Republics, for instance, are not members of the Union. It is a nuisance anyway to convert these coupons into stamps.

To simplify matters in this regard, the International DXer's Alliance has inaugurated a unique Postage Stamp Exchange, through which listeners can obtain genuine stamps of all countries at cost, plus a service charge of one cent, which is cheap enough. Thus in writing for verifications, the listener first purchases a stamp of the country from which the veri is requested, and encloses this with his report. At the other end, the station manager has only to stick this stamp on his own envelope, without going to the bother of converting postal coupons. This is a great idea and many DXers will undoubtedly avail themselves of the service.

The Stamp Exchange, which is directed by R. W. Schofield (an Official RADIO NEWS L.P.O. for Montana), carries stamps of 65 countries. Readers desiring information should address inquiries as follows: I.D.A. Stamp Exchange, 300 Evans Avenue, Missoula, Montana, U. S. A. This exchange was originally intended only for members of the International DXer's Alliance, but was recently extended to all.

U. S. & World-Wide Mileage Chart

TO determine mileage between any two of the listed cities of the world, first find these two cities on the top triangle of the world chart (Figure 17). Follow the horizontal column across the chart from the upper city, and the vertical column up from the lower city. The box at which these two columns intersect shows the required mileage in hundreds. The same method applies to the U. S. chart (lower triangle) except that mileages are shown in tens.

All mileages show the shortest (great circle) paths between points.

Just for an example, suppose you live in New York City and hear a station in Tokyo. By glancing at the mileage chart, following the horizontal column next to New York across until it bisects the vertical column up from Tokyo, you find the distance to be 6,700 miles.

World "Alphabets" Chart

(*see Page* 16)

THE World "Alphabets" Chart, Figure 18 is arranged for the purpose of assisting the radio DX listener in recognizing quickly the spoken call letters of foreign broadcasting stations. They must, therefore, be simple, and easy of recognition. All diacritical marks have been omitted. This means that a few of the letters are somewhat unscientifically represented, their true sounds being only approximately given. These are the letters with no true representation in English spelling. The alphabets are *not* for the purpose of learning to pronounce the letters, but to help recognize them.

The seven columns give the alphabet and first ten numbers in English, German, French, Italian, Portuguese, Spanish and Dutch, respectively. All pronunciations are given as they sound when spelled in English. The numerals are given in the original language with pronunciation (in parenthesis) as they would sound in English pronunciation.

ENGLISH ALPHABET	GERMAN PRONUNCIATION	FRENCH PRONUNCIATION	ITALIAN PRONUNCIATION	PORTUGUESE PRONUNCIATION	SPANISH PRONUNCIATION	DUTCH PRONUNCIATION
a	ah	ah	ah	ah	ah	ah
b	bay	bay	bay	beh	beh	bay
c	tsay	say	chay	seh	seh	say
d	day	day	dee	deh	deh	day
e	ay	ay	ay	eh	eh (as in mate)	ay
f	eff	ef	effa	effeh	effeh	eff
g	gay	zay (z like s in pleasure)	ge (as in genus)	zhay	heh	ghay
h	hah	ash	ahk-kah	a-gah (er-gah)	acha	hah
i	ee	ee	ee (as i in machine)	ee	ee	ee (as y in pretty)
j	yot (yah)	zee (z like s in pleasure)		zhota	hota	ja (yay)
k	kah	kah	kappa	kah	kah	kah
l	ell	el	ella	elleh	elleh	el
m	em	em	emma	emmeh	emmeh	em
n	en	en	enna	enneh	enneh	en
o	oh	oh!	o (as in toll)	o (as in for)	o (shorter than o in oh)	oah (as in woah)
p	pay	pay	pay	peh	peh	pay
q	koo	keeu	koo	keh	koo	keeu
r	err	air (aer)	erra	err (airr)	erreh	err
s	ess	ess	essa	esseh	esseh	es
t	tay	tay	tay	teh	teh	tay
u	oo	eeu	oo	oo	oo	eeu
v	fow (as in found)	vay	vay	veh	veh	vay
w	vay	dooble-vay	doppio-vay	veh-dobrado	dobleh-veh	way
x	iks	eeks	iks	sheeze	ekis	iks
y	ipsilon	ee-grec	e-greco	ipsilon or e-gray-goo	ee-gre-eh-ga	aai
z	tset	zett	dzay-ta	zeh	theta	zett
1	ein (as in wine)	un (uhn)	uno	un	uno	een (ayn)
2	zwei (zwy)	deux (like di in dirt)	due (e as a in ate)	dous	dos	twee (tway)
3	drei (dry)	troix (trwa)	tre (e as a in ate)	trez	tres (trace)	drie (dree)
4	vier (feer)	quatre (katr)	quatro	quatro	cuatro (quatro)	vier (veer)
5	fünf (feeunf)	cinq (sank)	cinque (chinq-que)	cinco (sinko)	cinco (sinko)	vijf (vaif)
6	sechs (zex)	six (seess)	sei (seh as e in men)	seis (e as in ell)	seis	zes
7	sieben (zeeben)	sept (set)	sette (setteh)	sete (e as in set)	siete (sieteh)	zeven (zaven)
8	acht (ahcht)	huit (weet)	otto (first o as in ought)	oito (o as in on)	ocho	acht (ahcht)
9	neun (noin)	neuf (nerf)	nove (noveh)	nove (noveh)	nueve (nueveh)	negen (nayghen
10	zehn (tsayn)	dix (dees)	dieci (diechi)	dez (e as in set)	diez (deeis)	tien (teen with short e)

Figure 18

Wavelength-Frequency Chart

(*see Page* 17)

THE chart in Figure 19 permits the instantaneous determination of the frequency corresponding to any wavelength—or the wavelength equivalent of any frequency throughout the entire radio spectrum.

To find the frequency corresponding to any wavelength between 10.1 meters and 100 meters, or the wavelength equivalent of any frequency between 29,690 and 2,998, the chart may be read directly. Outside of this range the reading is made by shifting the decimal points. Thus, if one desires to find the frequency equivalent of 101 meters, for instance, shift the decimal point of the frequency one place to the left. This will show the frequency to be 2969 kc. If the frequency corresponding to 1010 meters is required, shift the wavelength decimal of the first item two places to the right and the frequency decimal two places in the opposite direction, and from this will be found that the required frequency is 296.9 kc.

In the same way, if the wavelength for a given frequency is desired, simply locate the frequency nearest to this value in the frequency column, moving the decimal point if necessary, and opposite it will be shown the corresponding wavelength, always shifting the decimal point in one column the same number of places (but in the opposite direction) as the point was shifted in the other column.

Where the frequency is known in terms of megacycles, its equivalent in kilocycles is found by simply adding three ciphers to the megacycle figure.

Formerly all short-wave enthusiasts thought in terms of wavelengths and receivers, if calibrated at all, were calibrated in wavelengths. Now, however, the trend is definitely toward the use of frequencies rather than wavelengths. Because of this the chart shown will prove very useful.

WAVELENGTH–FREQUENCY CHART

Figure 19

M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.
10.1	29,690	20.1	14,920	30.1	9,961	40.1	7,477	50.1	5,984	60.1	4,989	70.1	4,277	80.1	3,743	90.1	3,328
10.2	29,390	20.2	14,840	30.2	9,928	40.2	7,458	50.2	5,973	60.2	4,980	70.2	4,271	80.2	3,738	90.2	3,324
10.3	29,110	20.3	14,770	30.3	9,895	40.3	7,440	50.3	5,961	60.3	4,972	70.3	4,265	80.3	3,734	90.3	3,320
10.4	28,830	20.4	14,700	30.4	9,862	40.4	7,421	50.4	5,949	60.4	4,964	70.4	4,259	80.4	3,729	90.4	3,317
10.5	28,550	20.5	14,630	30.5	9,830	40.5	7,403	50.5	5,937	60.5	4,956	70.5	4,253	80.5	3,724	90.5	3,313
10.6	28,280	20.6	14,550	30.6	9,798	40.6	7,385	50.6	5,925	60.6	4,948	70.6	4,247	80.6	3,720	90.6	3,309
10.7	28,020	20.7	14,480	30.7	9,766	40.7	7,367	50.7	5,913	60.7	4,939	70.7	4,241	80.7	3,715	90.7	3,306
10.8	27,760	20.8	14,410	30.8	9,734	40.8	7,349	50.8	5,902	60.8	4,931	70.8	4,235	80.8	3,711	90.8	3,302
10.9	27,510	20.9	14,350	30.9	9,703	40.9	7,331	50.9	5,890	60.9	4,923	70.9	4,229	80.9	3,706	90.9	3,298
11.0	27,260	21.0	14,280	31.0	9,672	41.0	7,313	51.0	5,879	61.0	4,915	71.0	4,223	81.0	3,701	91.0	3,295
11.1	27,010	21.1	14,210	31.1	9,641	41.1	7,295	51.1	5,867	61.1	4,907	71.1	4,217	81.1	3,697	91.1	3,291
11.2	26,770	21.2	14,140	31.2	9,610	41.2	7,277	51.2	5,856	61.2	4,899	71.2	4,211	81.2	3,692	91.2	3,288
11.3	26,530	21.3	14,080	31.3	9,579	41.3	7,260	51.3	5,844	61.3	4,891	71.3	4,205	81.3	3,688	91.3	3,284
11.4	26,300	21.4	14,010	31.4	9,548	41.4	7,242	51.4	5,833	61.4	4,883	71.4	4,199	81.4	3,683	91.4	3,280
11.5	26,070	21.5	13,950	31.5	9,518	41.5	7,225	51.5	5,822	61.5	4,875	71.5	4,193	81.5	3,679	91.5	3,277
11.6	25,850	21.6	13,880	31.6	9,488	41.6	7,207	51.6	5,810	61.6	4,867	71.6	4,187	81.6	3,674	91.6	3,273
11.7	25,630	21.7	13,810	31.7	9,458	41.7	7,190	51.7	5,799	61.7	4,859	71.7	4,182	81.7	3,670	91.7	3,270
11.8	25,410	21.8	13,750	31.8	9,428	41.8	7,173	51.8	5,788	61.8	4,851	71.8	4,176	81.8	3,665	91.8	3,266
11.9	25,200	21.9	13,690	31.9	9,399	41.9	7,156	51.9	5,777	61.9	4,844	71.9	4,170	81.9	3,661	91.9	3,262
12.0	24,990	22.0	13,630	32.0	9,369	42.0	7,139	52.0	5,766	62.0	4,836	72.0	4,164	82.0	3,656	92.0	3,259
12.1	24,780	22.1	13,570	32.1	9,340	42.1	7,122	52.1	5,755	62.1	4,828	72.1	4,158	82.1	3,652	92.1	3,255
12.2	24,580	22.2	13,510	32.2	9,311	42.2	7,105	52.2	5,744	62.2	4,820	72.2	4,153	82.2	3,647	92.2	3,252
12.3	24,380	22.3	13,440	32.3	9,282	42.3	7,088	52.3	5,733	62.3	4,813	72.3	4,147	82.3	3,643	92.3	3,248
12.4	24,180	22.4	13,380	32.4	9,254	42.4	7,071	52.4	5,722	62.4	4,805	72.4	4,141	82.4	3,639	92.4	3,245
12.5	23,990	22.5	13,330	32.5	9,225	42.5	7,055	52.5	5,711	62.5	4,797	72.5	4,135	82.5	3,634	92.5	3,241
12.6	23,800	22.6	13,270	32.6	9,197	42.6	7,038	52.6	5,700	62.6	4,789	72.6	4,130	82.6	3,630	92.6	3,238
12.7	23,610	22.7	13,210	32.7	9,169	42.7	7,022	52.7	5,689	62.7	4,782	72.7	4,124	82.7	3,625	92.7	3,234
12.8	23,420	22.8	13,150	32.8	9,141	42.8	7,005	52.8	5,678	62.8	4,774	72.8	4,118	82.8	3,621	92.8	3,231
12.9	23,240	22.9	13,090	32.9	9,113	42.9	6,989	52.9	5,668	62.9	4,767	72.9	4,113	82.9	3,617	92.9	3,227
13.0	23,060	23.0	13,040	33.0	9,086	43.0	6,973	53.0	5,657	63.0	4,759	73.0	4,107	83.0	3,612	93.0	3,224
13.1	22,890	23.1	12,980	33.1	9,058	43.1	6,956	53.1	5,646	63.1	4,752	73.1	4,102	83.1	3,608	93.1	3,220
13.2	22,710	23.2	12,920	33.2	9,031	43.2	6,940	53.2	5,636	63.2	4,744	73.2	4,096	83.2	3,604	93.2	3,217
13.3	22,540	23.3	12,870	33.3	9,004	43.3	6,924	53.3	5,625	63.3	4,736	73.3	4,090	83.3	3,599	93.3	3,214
13.4	22,370	23.4	12,810	33.4	8,977	43.4	6,908	53.4	5,615	63.4	4,729	73.4	4,085	83.4	3,595	93.4	3,210
13.5	22,210	23.5	12,760	33.5	8,950	43.5	6,892	53.5	5,604	63.5	4,722	73.5	4,079	83.5	3,591	93.5	3,207
13.6	22,040	23.6	12,700	33.6	8,923	43.6	6,877	53.6	5,594	63.6	4,714	73.6	4,074	83.6	3,586	93.6	3,203
13.7	21,880	23.7	12,650	33.7	8,897	43.7	6,861	53.7	5,583	63.7	4,707	73.7	4,068	83.7	3,582	93.7	3,200
13.8	21,730	23.8	12,600	33.8	8,870	43.8	6,845	53.8	5,573	63.8	4,699	73.8	4,063	83.8	3,578	93.8	3,196
13.9	21,570	23.9	12,540	33.9	8,844	43.9	6,830	53.9	5,563	63.9	4,692	73.9	4,057	83.9	3,574	93.9	3,193
14.0	21,420	24.0	12,490	34.0	8,818	44.0	6,814	54.0	5,552	64.0	4,685	74.0	4,052	84.0	3,569	94.0	3,190
14.1	21,260	24.1	12,440	34.1	8,792	44.1	6,799	54.1	5,542	64.1	4,677	74.1	4,046	84.1	3,565	94.1	3,186
14.2	21,110	24.2	12,390	34.2	8,767	44.2	6,783	54.2	5,532	64.2	4,670	74.2	4,041	84.2	3,561	94.2	3,183
14.3	20,970	24.3	12,340	34.3	8,741	44.3	6,768	54.3	5,522	64.3	4,663	74.3	4,035	84.3	3,557	94.3	3,179
14.4	20,820	24.4	12,290	34.4	8,716	44.4	6,753	54.4	5,511	64.4	4,656	74.4	4,030	84.4	3,552	94.4	3,176
14.5	20,680	24.5	12,240	34.5	8,690	44.5	6,738	54.5	5,501	64.5	4,648	74.5	4,024	84.5	3,548	94.5	3,173
14.6	20,540	24.6	12,190	34.6	8,665	44.6	6,722	54.6	5,491	64.6	4,641	74.6	4,019	84.6	3,544	94.6	3,169
14.7	20,400	24.7	12,140	34.7	8,640	44.7	6,707	54.7	5,481	64.7	4,634	74.7	4,014	84.7	3,540	94.7	3,166
14.8	20,260	24.8	12,090	34.8	8,616	44.8	6,692	54.8	5,471	64.8	4,627	74.8	4,008	84.8	3,536	94.8	3,163
14.9	20,120	24.9	12,040	34.9	8,591	44.9	6,678	54.9	5,461	64.9	4,620	74.9	4,003	84.9	3,531	94.9	3,159
15.0	19,990	25.0	11,990	35.0	8,566	45.0	6,663	55.0	5,451	65.0	4,613	75.0	3,998	85.0	3,527	95.0	3,156
15.1	19,860	25.1	11,950	35.1	8,542	45.1	6,648	55.1	5,441	65.1	4,606	75.1	3,992	85.1	3,523	95.1	3,153
15.2	19,720	25.2	11,900	35.2	8,518	45.2	6,633	55.2	5,432	65.2	4,598	75.2	3,987	85.2	3,519	95.2	3,149
15.3	19,600	25.3	11,850	35.3	8,494	45.3	6,619	55.3	5,422	65.3	4,591	75.3	3,982	85.3	3,515	95.3	3,146
15.4	19,470	25.4	11,800	35.4	8,470	45.4	6,604	55.4	5,412	65.4	4,584	75.4	3,976	85.4	3,511	95.4	3,143
15.5	19,340	25.5	11,760	35.5	8,446	45.5	6,589	55.5	5,402	65.5	4,577	75.5	3,971	85.5	3,507	95.5	3,139
15.6	19,220	25.6	11,710	35.6	8,422	45.6	6,575	55.6	5,392	65.6	4,570	75.6	3,966	85.6	3,503	95.6	3,136
15.7	19,100	25.7	11,670	35.7	8,398	45.7	6,561	55.7	5,383	65.7	4,563	75.7	3,961	85.7	3,498	95.7	3,133
15.8	18,980	25.8	11,620	35.8	8,375	45.8	6,546	55.8	5,373	65.8	4,557	75.8	3,955	85.8	3,494	95.8	3,130
15.9	18,860	25.9	11,580	35.9	8,352	45.9	6,532	55.9	5,364	65.9	4,550	75.9	3,950	85.9	3,490	95.9	3,126
16.0	18,740	26.0	11,530	36.0	8,328	46.0	6,518	56.0	5,354	66.0	4,543	76.0	3,945	86.0	3,486	96.0	3,123
16.1	18,620	26.1	11,490	36.1	8,305	46.1	6,504	56.1	5,344	66.1	4,536	76.1	3,940	86.1	3,482	96.1	3,120
16.2	18,510	26.2	11,440	36.2	8,282	46.2	6,490	56.2	5,335	66.2	4,529	76.2	3,935	86.2	3,478	96.2	3,117
16.3	18,390	26.3	11,400	36.3	8,260	46.3	6,476	56.3	5,325	66.3	4,522	76.3	3,929	86.3	3,474	96.3	3,113
16.4	18,280	26.4	11,360	36.4	8,237	46.4	6,462	56.4	5,316	66.4	4,515	76.4	3,924	86.4	3,470	96.4	3,110
16.5	18,170	26.5	11,310	36.5	8,214	46.5	6,448	56.5	5,307	66.5	4,509	76.5	3,919	86.5	3,466	96.5	3,107
16.6	18,060	26.6	11,270	36.6	8,192	46.6	6,434	56.6	5,297	66.6	4,502	76.6	3,914	86.6	3,462	96.6	3,104
16.7	17,950	26.7	11,230	36.7	8,170	46.7	6,420	56.7	5,288	66.7	4,495	76.7	3,909	86.7	3,458	96.7	3,101
16.8	17,850	26.8	11,190	36.8	8,147	46.8	6,406	56.8	5,279	66.8	4,488	76.8	3,904	86.8	3,454	96.8	3,097
16.9	17,740	26.9	11,150	36.9	8,125	46.9	6,393	56.9	5,269	66.9	4,482	76.9	3,899	86.9	3,450	96.9	3,094
17.0	17,640	27.0	11,100	37.0	8,103	47.0	6,379	57.0	5,260	67.0	4,475	77.0	3,894	87.0	3,446	97.0	3,091
17.1	17,530	27.1	11,060	37.1	8,081	47.1	6,366	57.1	5,251	67.1	4,468	77.1	3,889	87.1	3,442	97.1	3,088
17.2	17,430	27.2	11,020	37.2	8,060	47.2	6,352	57.2	5,242	67.2	4,462	77.2	3,884	87.2	3,438	97.2	3,085
17.3	17,330	27.3	10,980	37.3	8,038	47.3	6,339	57.3	5,232	67.3	4,455	77.3	3,879	87.3	3,434	97.3	3,081
17.4	17,230	27.4	10,940	37.4	8,017	47.4	6,325	57.4	5,223	67.4	4,448	77.4	3,874	87.4	3,430	97.4	3,078
17.5	17,130	27.5	10,900	37.5	7,995	47.5	6,312	57.5	5,214	67.5	4,442	77.5	3,869	87.5	3,427	97.5	3,075
17.6	17,040	27.6	10,860	37.6	7,974	47.6	6,299	57.6	5,205	67.6	4,435	77.6	3,864	87.6	3,423	97.6	3,072
17.7	16,940	27.7	10,820	37.7	7,953	47.7	6,286	57.7	5,196	67.7	4,429	77.7	3,859	87.7	3,419	97.7	3,069
17.8	16,840	27.8	10,780	37.8	7,932	47.8	6,272	57.8	5,187	67.8	4,422	77.8	3,854	87.8	3,415	97.8	3,066
17.9	16,750	27.9	10,750	37.9	7,911	47.9	6,259	57.9	5,178	67.9	4,416	77.9	3,849	87.9	3,411	97.9	3,063
18.0	16,660	28.0	10,710	38.0	7,890	48.0	6,246	58.0	5,169	68.0	4,409	78.0	3,844	88.0	3,407	98.0	3,059
18.1	16,560	28.1	10,670	38.1	7,869	48.1	6,233	58.1	5,160	68.1	4,403	78.1	3,839	88.1	3,403	98.1	3,056
18.2	16,470	28.2	10,630	38.2	7,849	48.2	6,220	58.2	5,152	68.2	4,396	78.2	3,834	88.2	3,399	98.2	3,053
18.3	16,380	28.3	10,590	38.3	7,828	48.3	6,207	58.3	5,143	68.3	4,390	78.3	3,829	88.3	3,395	98.3	3,050
18.4	16,290	28.4	10,560	38.4	7,808	48.4	6,195	58.4	5,134	68.4	4,383	78.4	3,824	88.4	3,392	98.4	3,047
18.5	16,210	28.5	10,520	38.5	7,788	48.5	6,182	58.5	5,125	68.5	4,377	78.5	3,819	88.5	3,388	98.5	3,044
18.6	16,120	28.6	10,480	38.6	7,767	48.6	6,169	58.6	5,116	68.6	4,371	78.6	3,814	88.6	3,384	98.6	3,041
18.7	16,030	28.7	10,450	38.7	7,747	48.7	6,156	58.7	5,108	68.7	4,364	78.7	3,810	88.7	3,380	98.7	3,038
18.8	15,950	28.8	10,410	38.8	7,727	48.8	6,144	58.8	5,099	68.8	4,358	78.8	3,805	88.8	3,376	98.8	3,035
18.9	15,860	28.9	10,370	38.9	7,707	48.9	6,131	58.9	5,090	68.9	4,352	78.9	3,800	88.9	3,373	98.9	3,032
19.0	15,780	29.0	10,340	39.0	7,688	49.0	6,119	59.0	5,082	69.0	4,345	79.0	3,795	89.0	3,369	99.0	3,028
19.1	15,700	29.1	10,300	39.1	7,668	49.1	6,106	59.1	5,073	69.1	4,339	79.1	3,790	89.1	3,365	99.1	3,025
19.2	15,620	29.2	10,270	39.2	7,648	49.2	6,094	59.2	5,065	69.2	4,333	79.2	3,786	89.2	3,361	99.2	3,022
19.3	15,530	29.3	10,230	39.3	7,629	49.3	6,082	59.3	5,056	69.3	4,326	79.3	3,781	89.3	3,357	99.3	3,019
19.4	15,450	29.4	10,200	39.4	7,610	49.4	6,069	59.4	5,047	69.4	4,320	79.4	3,776	89.4	3,354	99.4	3,016
19.5	15,380	29.5	10,160	39.5	7,590	49.5	6,057	59.5	5,039	69.5	4,314	79.5	3,771	89.5	3,350	99.5	3,013
19.6	15,300	29.6	10,130	39.6	7,571	49.6	6,045	59.6	5,031	69.6	4,308	79.6	3,767	89.6	3,346	99.6	3,010
19.7	15,220	29.7	10,090	39.7	7,552	49.7	6,033	59.7	5,022	69.7	4,302	79.7	3,762	89.7	3,342	99.7	3,007
19.8	15,140	29.8	10,060	39.8	7,533	49.8	6,020	59.8	5,014	69.8	4,295	79.8	3,757	89.8	3,339	99.8	3,004
19.9	15,070	29.9	10,030	39.9	7,514	49.9	6,008	59.9	5,005	69.9	4,289	79.9	3,752	89.9	3,335	99.9	3,001
20.0	14,990	30.0	9,994	40.0	7,496	50.0	5,996	60.0	4,997	70.0	4,283	80.0	3,748	90.0	3,331	100.0	2,998

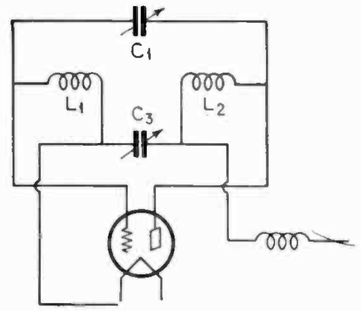


Figure 20

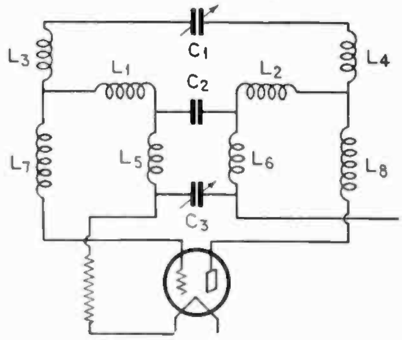


Figure 21

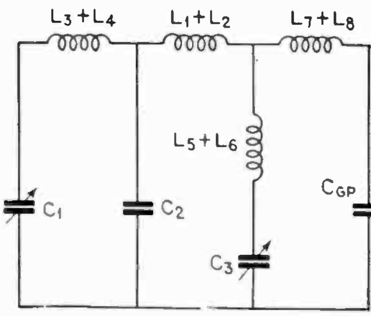


Figure 22

Short-Wave Circuit Design

NEARLY every radio experimenter is immediately struck with the simplicity of the tuning circuits in short-wave apparatus, particularly those adapted for reception on waves below 10 meters. Short-wave receiver design is not so simple, however. There are several simple circuits in use, some regenerative circuits, working into a tube or a pair of tubes in push-pull. In some cases the plate potential is interrupted (a la super-regeneration), but in all cases the tuning circuit is based on a simple LC circuit.

One circuit that is frequently used is that in Figure 20. Here we have two similar coils, L1, L2 (usually having a diameter less than one inch), with from 1 to 10 turns of wire. Two tuning condensers, C1, C3, in series, make up the variable element. Now comes the difficulty. The leads to the condensers and to the tube represent large turns of wire which may have an inductance greater than L1 + L2 unless precautions are taken to avoid excessive lengths. Actually the circuit should be drawn as per Figure 21, or simplified as Figure 22. Here the coils, L3, L4, represent the leads to the condenser C1 (actually the wires, condenser frame and shaft up to the center of capacity all contribute to this factor). Similarly the effect of the other leads is considered.

In order to be able to determine which of these factors are important, it will be necessary to determine possible values for all of these coils. The inductance of a single turn of No. 16 wire of various diameters such as are commonly found due to wiring loops is shown in Figure 24. However, connection wires do not often follow a circular route. In fact, they do not even lie in the same plane in ordinary cases. However, even though rectangular and irregular, it is not uncommon to have effects equivalent to a two-or three-inch turn of wire, which in conjunction with a 40 mmfd. condenser might have a wavelength of 6 meters. Frequently a rough estimation may be made by considering the inductance of small rectangular circuits, since the wiring leads are frequently in the same plane for a considerable portion of their length. Possible data in Figure 23 might be used to obtain a rough indication of the inductance of leads of various lengths and spacing. It is therein assumed that No. 16 wire is used for connections, although small differences in wire diameter will not affect the results much.

The inductance of the main coils, L1 and L2, depends upon a number of factors—wire size, turn spacing, diameter of coil and coil separation. Due to the relatively large spacing between turns, the inductance formulæ usually used are not accurate unless correction factors are applied. Usually the coils are wound with large wire, around a mandrel which is later removed. The diameter of the coil will be a little larger than the diameter of the mandrel plus the diameter of the wire. To obtain representative inductance values for four types of coils, all formed of No. 16 wire, the curves in Figure 25 may be used. Two of these are wound on half-inch mandrels at the rate of 10 and 5 turns per inch, and two are wound on one-inch mandrels with the same spacing. The curves indicate the inductance of coils of various turns directly.

Referring to Figure 22, it may be assumed that the capacity C2 is usually very small in comparison with either C1 or C3. Neglecting for the moment the L7-L8-CGP circuit, it will be seen that the real tuning circuit is L1, L2, L3, L4, L5, L6 with C1, C3. In the specific example afforded by this circuit, let us assume

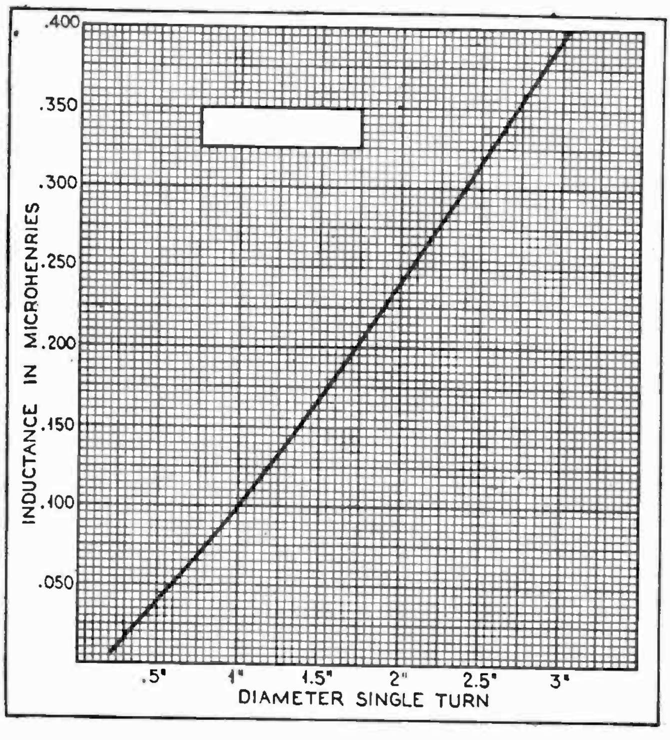
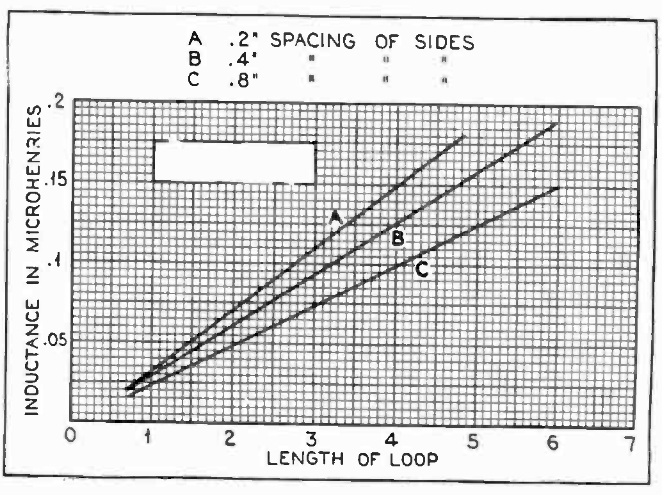
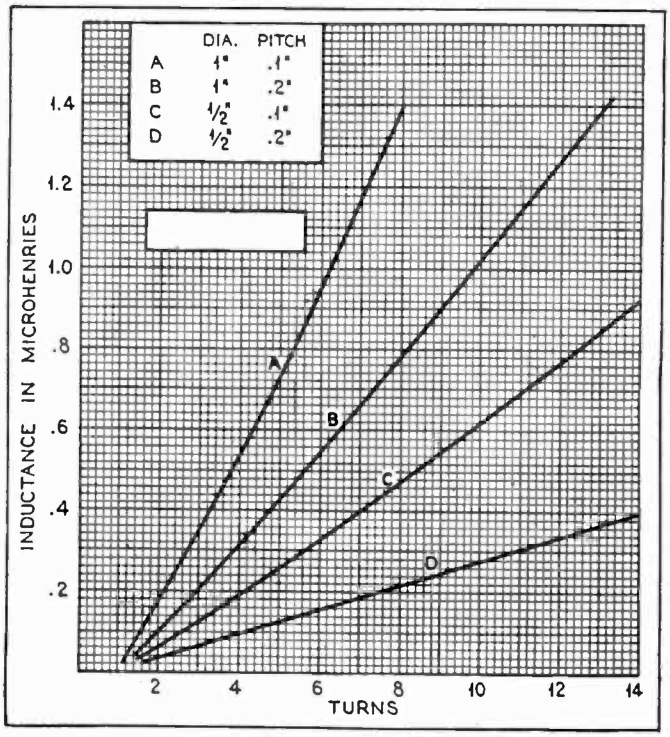


Figure 23 (Below)

Figure 24 (Left)





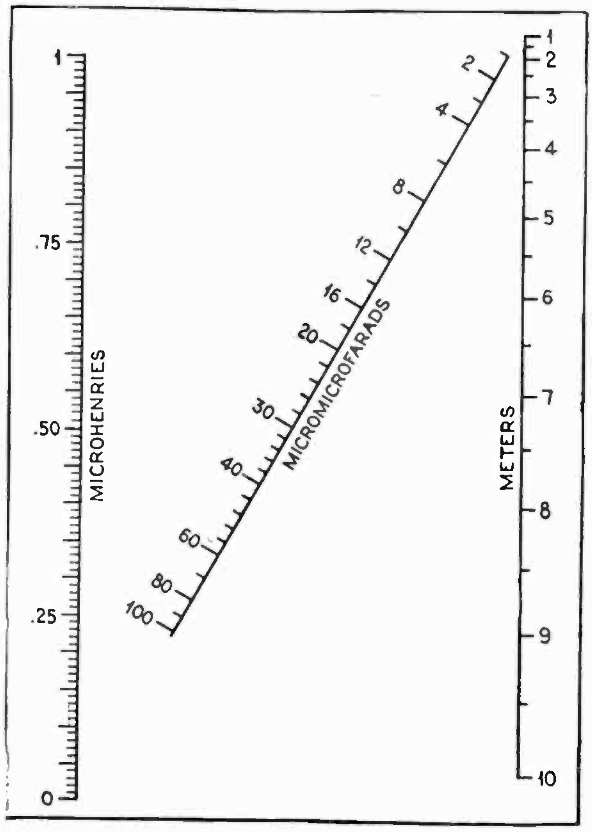


Figure 25—Left
Figure 26—Right

that a wavelength of 5 meters is desired. The main coils, L1 and L2, are mounted about 3 inches from the center of the capacity of the condenser C1 (which has a capacity of 100 mmfd.). The condenser C3 might be a small fixed capacity of 15 mmfd. mounted one inch from the terminals of the coils. The inductance of the latter, with its leads, is thus about .040 microhenry. The leads to C1 include several bends, but an estimation based on the information of Figure 23 gives an approximate value of .125 microhenry.

The average capacity of C1 is 50 mmfd., which in series with C3 of 15 mmfd., is roughly equal to 12 mmfd. Neglecting the effect of L7, L8 for the moment, the capacity CGP might increase this to 20 mmfd. A chart, Figure 26, is given, by which the required inductance for any wavelength up to 10 meters may be obtained. A straight line across the scales from 5 meters and 20 mmfd. will intersect the inductance scale at .355 microhenry, which is the maximum value permissible for all the circuit. Of this we already have .040 + .125 microhenry, so that but .19 microhenry is needed in the coils. The coils L1 and L2 are actually coupled together so that the mutual inductance will contribute a little to this value, but the computation is rather tedious. A short cut is to find out how many turns are required for .19 microhenry and for .095 microhenry. The average between the latter and one-half of the former gives a fair value for the required number of turns for either L1 or L2. By adopting the conditions represented by Curve D, Figure 25, it will be found that each coil should have 4 turns of wire wound on a ½-inch mandrel, spaced at the rate of 5 turns per inch.

If in the circuit arrangement two variable condensers had been used, leads to them were poorly arranged and longer than 3 inches, it would have been found that the stray inductance would have made up the total permissible.

A number of assumptions have been made in the above computations, the most important of which was that L7 and L3 could be neglected. As long as their combined value is considerably smaller than the rest of the circuit, this is permissible. If, however, this circuit (L7, L3, CGP) has a resonance period within the active range of the receiver, it will be impossible to regenerate at that wave, and at other points the circuit will resonate at two frequencies, one above and one below the period of the L7-L8-CGP circuit.

Finally, a few words concerning the wavelength chart, Figure 26. It is possible that in some circuits it may be desired to use larger capacities than indicated on the scale on the diagonal. If the values of this scale are multiplied by 10, the inductance scale on the left must be divided by the same factor 10.

A Single-Tube All-Wave Set

THIS tiny single-tube all-wave universal set, Figure 27, is probably the simplest complete receiver that the beginner can build. It is made possible by the employment of the new type 12A7 tube, which is a combination pentode and rectifier.

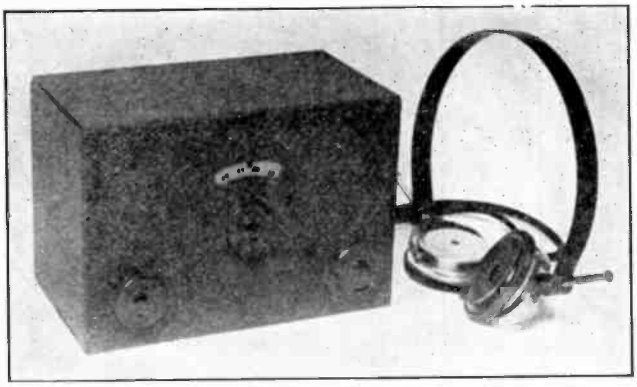
The overall dimensions are only 6 inches long, by 4 inches high, by 3½ inches deep. Considering its compact size, it is truly a portable universal set, adapted to any type of operation and it makes an ideal traveling set for the hotel room, camp, and many other applications which will suggest themselves.

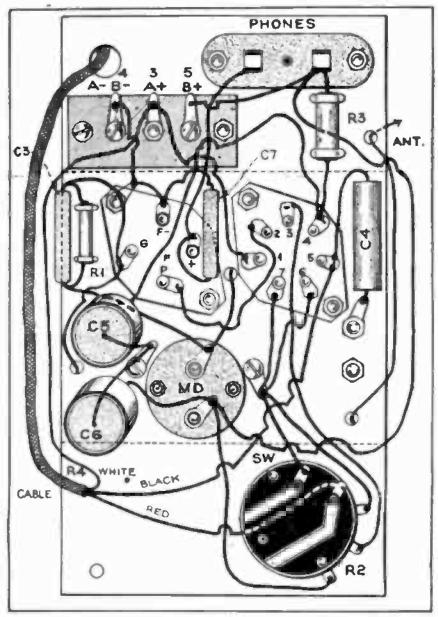
The circuit, Figure 28, consists of a standard regenerative detector employing the pentode section of the 12A7 tube. A conventional grid-leak arrangement is used and it will be noticed that the antenna is capacitively-coupled, through the condenser C1, to the detector circuit. The power-filter system employs a resistance of 25,000 ohms, R3, and two 8 mfd. electrolytic condensers, C5 and C6.

There are three plug-in coils covering a wavelength range from 40 to 500 meters. For those who desire to wind their own coils, the specifications for the three coils are given in Figure 29.

The connections are so simple and self-evident in Figures 28, 30 and 31 that detailed description is unnecessary.

For battery operation, simply replace the type 12A7 tube with a type 6F7 tube and connect a battery cable to the battery terminal strip as indicated in the schematic wiring diagram in Figure 28. The type 6F7 tube is a heater type which includes a triode and a remote cut-off pentode tube, in a common envelope. It requires 6.3 volts for the heater voltage instead of the 12 volts which was necessary for the 12A7 tube. For this purpose, four 1½-volt dry cells can be connected in series or a 6-volt storage battery can be used. For the plate supply use 45 to 90 volts of B battery blocks. There are no other changes and the operating instructions remain the same





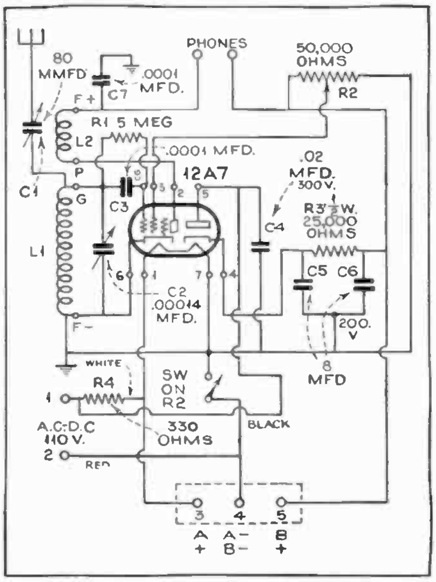


Figure 28

as when the set is used on house-lighting current. When the set is used on battery operation, insulate the two prongs of the 110-volt line connecting cord, this is to prevent a possible short-circuit of the A battery terminals.

When the receiver is operated on 110-volt, direct-current supply, *it is necessary to observe polarity!* If the set does not produce a signal after a minute or so, reverse the line plug and a signal should be heard *immediately!*

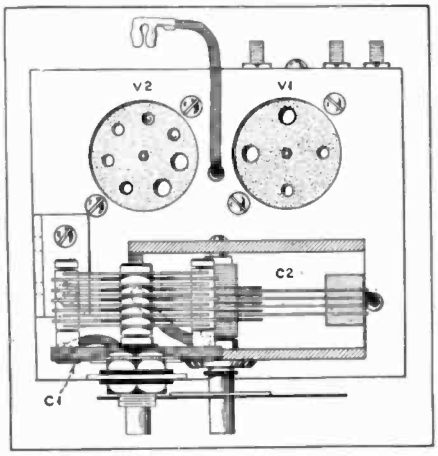


Figure 27—Top
Figure 30—Above

In operation, the regeneration control should be advanced until the tube just oscillates, then by rotating the main tuning dial, C2, a whistle should be heard for every station. The detector tube should now be brought out of oscillation and this is done by slowly retarding the regeneration control until the signal is brought in with clarity and greater volume. The antenna coupling condenser, C1, should be adjusted for best results with the antenna being used. The position of the aerial condenser is very important, it is not only dependent upon the aerial but also on the coil that is employed. *Do not use a ground connection unless it is coupled through a condenser of approximately* .01 *mfd. capacity!*

The set is operated on 110-volt, 60-cycle lighting lines in the usual manner.

COIL DATA		
Wavelength Range	Grid Coil	Tickler Coil
40-100 meters	19 turns	13 turns
100-230 "	38 "	19 "
230-500 "	110 "	22 "

Figure 29—Above
Figure 31—Top

The specifications in Figure 29 are for either tube bases or standard 1½ inch coil forms when used with a .00014 mfd. tuning condenser. The two short-wave inductances employ No. 28 enameled wire for both the grid and tickler windings. The broadcast coil uses No. 32 enameled wire for both windings. The ticklers are spaced about one-eighth of an inch from the grid winding and it is important that the grid and tickler windings are wound in the same direction on the coil form.

The complete kit of parts for this receiver, including a cadmium-plated chassis and a crackle-finished metal cabinet are made available by a New York radio company.

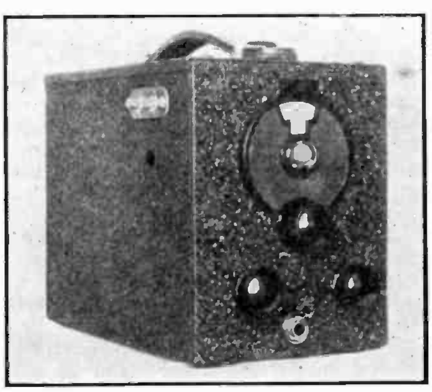
A Band-Spread Portable

THIS simple, easily assembled short-wave receiver, Figure 32, the "Band-Spread Portable," fits into a black enameled steel carrying case only 8¾ by 6¾ by 5¼ inches overall. Tapped plug-in coils give comfortable band spreading on the short-wave broadcast and amateur channels.

Two type 30 tubes are used in a reliable regenerative-detector, one-stage audio circuit, as shown in Figure 34. A 140 mmfd. midget condenser, operated by a small vernier dial, is the main tuning control, while regeneration is adjusted by means of a 1-megohm variable resistor in the detector plate lead. A large 4½-volt C battery is used for filament supply and a single 45-volt B battery for plate voltage.

The steel case is supplied in two sections, which merely bolt together. A hole

Figure 32



in the top, protected by a sliding cover, permits insertion and removal of the plug-in coils.

The Band-Spread Portable is intended for earphone operation. When used with an outside aerial, it is capable of good foreign reception of short-wave broadcasting stations. It also makes an effective monitor for the amateur station.

A complete kit of parts is supplied by a New York radio firm.

List of Parts

L1—2-winding, 5-prong band-spread coils (Figure 33)
RFC—2.2 mh. r.f. choke coil
C1—140 mmfd. midget variable
C2—.00025 mfd. mica grid condenser
C3—.0005 mfd. mica by-pass condenser

COIL DATA				
WAVE BAND METERS	SECONDARY		TICKLER, NUMBER OF TURNS	TRIMMER CAPACITY MMFD.*
	NUMBER OF TURNS	TAP FROM BOTTOM		
19	4½	1¼	4¾	80
25	4½	1¼	4¾	180
31	11½	4¾	6	180
49	11½	4¾	6	180

* VARIABLE CONDENSER INSIDE COILS. VALUES SHOWN ARE MAXIMUM. ALL SECONDARY COILS ARE WOUND WITH Nº. 24 BARE WIRE SPACED TO A WINDING LENGTH OF 1¼". TICKLERS ARE CLOSE WOUND WITH Nº. 28 OR 30 S.C.C. WIRE.

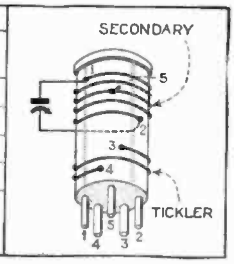


Figure 33

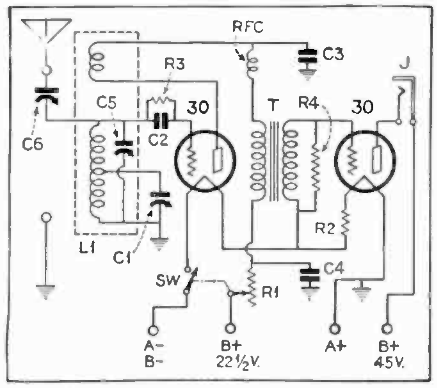


Figure 34

C4—.5 mfd. paper by-pass condenser
C5—Trimmer condensers built into coils
C6—2-plate, 5 mmfd. antenna trimmer
R1—1,000,000-ohm potentiometer
R2—8-ohm wire-wound resistor
R3—10-megohm grid leak
R4—1-megohm grid leak
J—Single open-circuit phone jack with insulating washers
T—3½-to-1 ratio uncased audio transformer
Three-inch vernier dial for condenser C1, knobs for R1 and C6, double binding-post strip, five-prong socket for plug-in coil L1, and incidental hardware and mounting screws.
1 steel cabinet as specified
1 4½-volt C battery
1 45-volt B battery

A 3-Band Short-Wave Set

THE receiver shown in Figure 35 is ideal for the fellow who wants a good easy-to-handle distance-getting short-wave set without too much expense or complicated features.

As shown in Figure 36, the circuit consists of a standard regenerative detector followed by two stages of resistance- and condenser-coupled audio-frequency amplification. The receiver has a continuous frequency range from 22 mc. to 4.5 mc. (13 to 65 meters approximately), being divided into bands as follows: band 1—13 to 24 meters; band 2—24 to 39 meters and band 3—39 to 65 meters. This arrangement effectively covers most of the frequencies used in present day short-wave activities excepting those included in the 80 meter amateur band.

A type 19 "twin" tube is used in the detector and first audio stage and a type 33 pentode is used for output.

The construction of the set is very simple and even the most inexperienced person should have little difficulty in building it. The various parts are mounted on a 1/16 inch thick aluminum panel and chassis 6 by 10½ and 4½ by 10 inches respectively. The chassis is 2 inches deep.

The coil and the inductance switch are probably the most difficult items to construct, although even these are easily made. As shown in Figure 37, the coil is of the tapped variety, the change from one band of frequencies to another being accomplished by the simple process of shorting out the unnecessary portion of the winding. In this particular coil the windings are placed on a one inch bakelite form, taps being taken off at the fourth, seven and three-fourths and fifteenth turns. *Whenever a tap is taken off, the next winding must be spaced at least ⅜ inch or more from the turns of* the preceding coil. If the windings are not spaced in this manner losses will take place in spite of every precaution. The tickler coil is wound in the reverse direction to that of the grid winding in order to reduce the detuning effect of the regeneration control and is coupled to the *grid end* of the tuning coil. Do not wind this coil between the turns of the grid coil! Four turns of No. 28 enameled wire, close wound, will give sufficient excitation on all bands without saturation at the high-frequency portion of the tuning range.

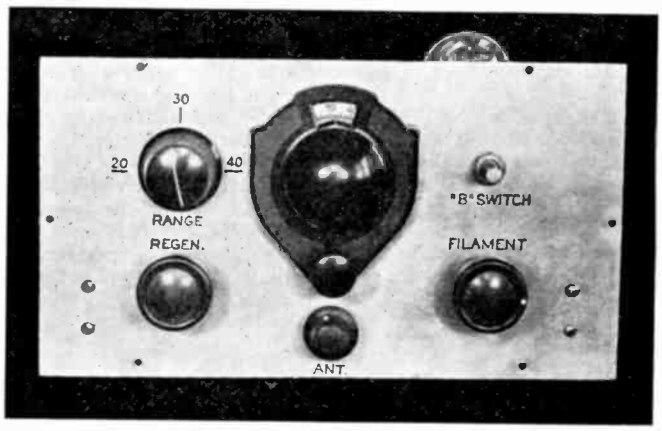
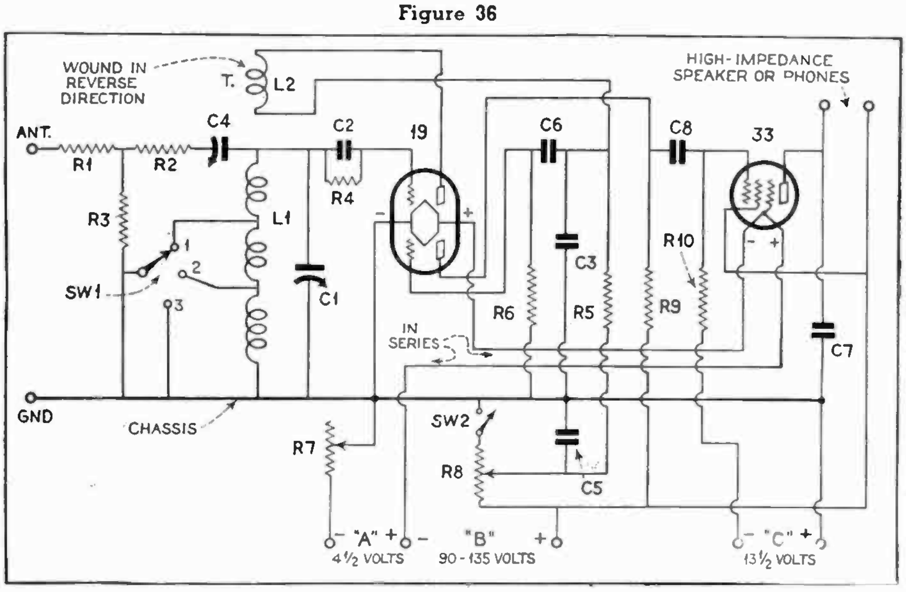


Figure 35

As shown in Figure 37, the home-made wave-change switch is made from an Eby ceramic socket and an old filament rheostat of the midget type. The rivets holding the socket terminals were drilled out and the contacts were removed from the socket. Three switch points were then fitted to the rivet holes, the tops being rounded off somewhat to allow the rheostat arm to sweep smoothly over them. The resistance element was removed from the rheostat and the arm was reversed on the shaft as shown. Finally the socket and rheostat were assembled as shown in Figure 37, be-

Figure 36



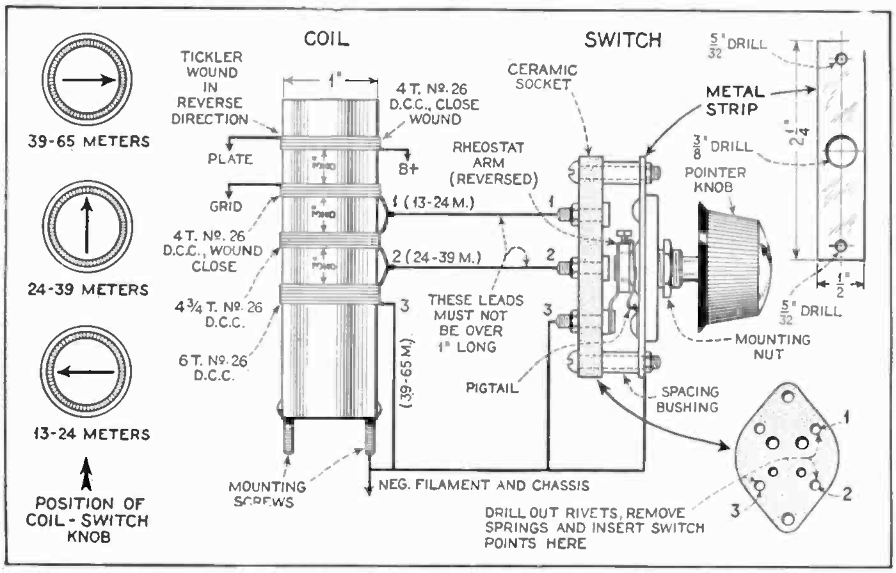


Figure 37

ing held together by means of two one inch long machine screws. To obtain a "sure-fire" connection to ground, a flexible "pig-tail" wire is soldered to the arm and to the grounded portion of the switch. The positions of the switch knob for the different ranges are also illustrated in Figure 37.

Either 90 or 135 volts can be used on the plates with good results. If a speaker is used, the higher voltage will give more volume, of course; if phones are used 90 volts will give plenty of volume and there is less danger of damage to the phones. Three ordinary dry cells are used for the A battery, and since the total drain is only .26 ampere, they should last at least two to three months before a replacement is necessary.

There is no "C" bias used on the 19 unless a "motorboating" sound is heard when adjusting the regeneration control. In case this happens, it will be necessary to cut the lead between the grid resistor of the first audio stage and the ground, and insert a 1½, 3 or 4½ volt bias on the 19 tube.

Switch S2, when closed makes a potentiometer out of the regeneration control. When the switch is open, the control becomes a series variable resistance. The set will work both ways but one method may give slightly better results than the other. When turning off the receiver, this switch should be opened so as not to place a drain on the B-batteries.

The receiver described above is not intended to be used with a doublet antenna system. The resistor "T" pad in the antenna circuit is designed especially for the elimination of "dead-spots" and body capacity effects and is effective only when used with the grounded antenna. The doublet type can be used, however, if a suitable method of coupling is utilized. An "H" pad, or better still a coupling coil will do this effectively.

List of Parts

C1—Hammarlund Midline Midget variable condenser, 80 mmfd.
C2—Sangamo fixed condenser, 100 mmfd.
C3—Sangamo fixed condenser, 2000 mmfd.
C4—Small adjustable condenser, neutralizing type
C5—Bypass condenser, 1 mfd. paper type
C6, C8—Cartridge condensers, .01 mfd. 400 V. type
C7—Sangamo fixed condenser, 250 mmfd.
L1, L2—Grid and tickler coils. (See Figure 37)
R1, R2—Fixed resistors, 300 ohms
R3—400 or 500 ohms
R4—3 megohms
R5, R9—75,000 ohms
R6, R10—1 megohm
R7—15 ohm rheostat
R8—Potentiometer, insulated shaft type, 100,000 ohms. (If potentiometer has switch attached the p.p. switch illustrated is not required)
SW1—3 point inductance switch (see Figure 37)
SW2—s.p.s.t. switch (see R8 above)
One 6-prong Eby isolintite socket and one 5-prong wafer type bakelite socket.
One piece sheet aluminum, size 6 by 10½ inches (for panel)
One piece sheet aluminum, size 7 by 14 inches (for chassis)
One piece 1-inch bakelite tubing, 2¾ inches long
Dial, tubes, knobs, batteries, necessary hardware, etc.

9-Tube Amateur Receiver

HERE is the Lafayette 9-tube all-wave super-heterodyne receiver for home construction which should have special appeal to the many thousands of amateurs and short-wave listeners who like to "roll their own"—not only because it incorporates many new refinements, or the fact that the set performed exceptionally well on all operating tests—but principally because the most difficult part of superheterodyne receiver construction has been eliminated by providing a kit with a pre-assembled tuning unit, that is wired and "tracked" at the factory.

The receiver, Figure 38, has a wave-length coverage from 9.7 to 560 meters (in four different wave bands). A stage of radio-frequency amplification is used on all bands, thereby minimizing image frequency and providing additional sensitivity and selectivity. The outstanding features of the receiver include a beat-frequency oscillator for c.w. code reception, an automatic or manual volume control, which can be selected at will, continuous mechanical band-spreading and a dual-speed airplane type tuning dial. The dynamic type speaker, power supply and the audio-output stage are built on a separate chassis unit and if desired, it can be unmounted from the main chassis and placed a short

Figure 39

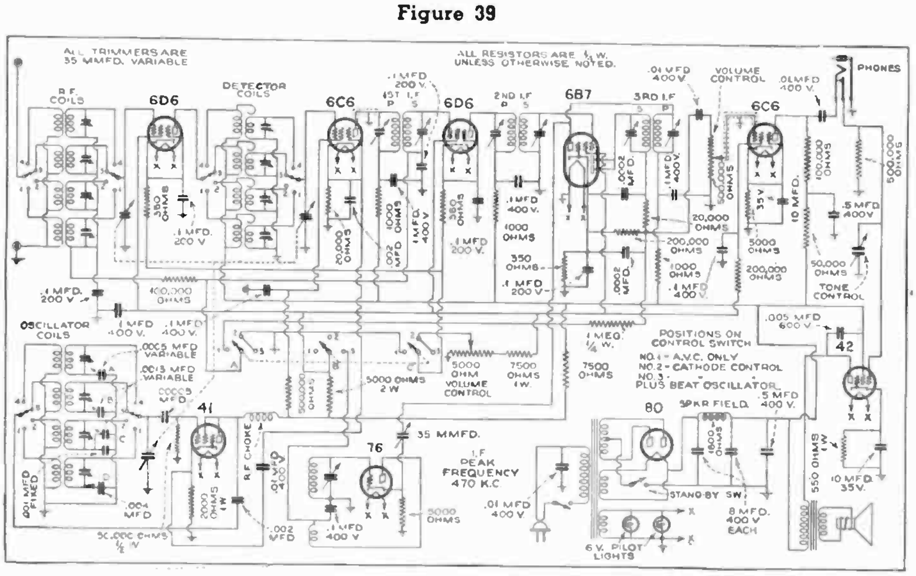
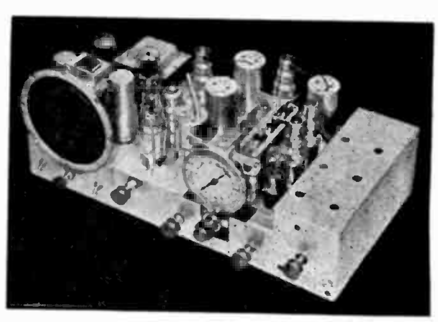


Figure 38



distance from the tuner. The crystalline finished cabinet is available with the kit and it is an unusually strong one, measuring 10 inches high by 11½ inches deep by 22½ inches long.

As shown in Figure 39, 9 tubes are employed and their functions are as follows: A type 6D6 is used for the r.f. stage, followed by a 6C6 as a first detector and the oscillator circuit employs a 41 power pentode type tube. The i.f. stage employs a 6D6 tube and is followed by a 6B7 used as a diode detector and automatic volume control tube. This is followed by a type 6C6 in the first a.f. stage and a type 42 for the power stage. A type 76 is used for the beat frequency oscillator and a type 80 for rectification.

The Browning All-Wave Set

THE Browning all-wave kit is so designed that the average set builder should have no difficulty in putting it together easily and in obtaining good results. As will be noted from the wiring diagram in Figure 41 a stage of tuned-radio-frequency amplification precedes the detector on all wave-bands, thus giving added selectivity which eliminates image frequencies and harmonics, as well as materially adding to the sensitivity of the receiver.

In order to obtain greater selectivity and at the same time finer quality, a band-pass "filter" intermediate stage is used between the 2A7 and the 58. This band-pass filter consists essentially of three separate tuned circuits. Each of the three inductances are tuned, and in turn made up of three individual "pies". The effect of the "pie" construction gives a much sharper tuning coil than may be obtained by a lumped inductance of the same value. The gain in selectivity obtained by this construction alone is about 16%. The use of "pies", together with the three tuned circuits, results in a resonance curve for the intermediate stage which has a band width of only 25 KC at 100 times input voltage, and a band width of 5.5 KC at 2 times input voltage.

The ordinary high-Q intermediate stage has a band width of 36 KC at 100 times input voltage and 3.3 KC wide at 2 times input voltage. It will be noted from the figures just given that not only does the band-pass intermediate stage have greater selectivity but also will give better quality as the "nose" of the curve is broader, thus passing the higher modulating frequencies readily.

Automatic volume control is obtained by the use of a 2A6 tube for the detector amplifier. A switch is arranged so that the a.v.c. may be turned off at will. An auxiliary volume control (on the cathode of the 58 tube), when retarded, precludes any possibility of this tube over-loading and causing cross modulation even under the severest conditions.

The receiver has a sensitivity of well under one microvolt (over its entire range which is from 23 megacycles to 550 kilocycles) so that in practice this additional volume control on the 58 RF tube can be well-retarded except under the best conditions when atmospheric static is exceptionally light.

A 2A7 is used as a mixer and oscillator. As is well known, this tube electronically couples the incoming signal with the oscillators signal without interaction between the tuned-detector input and the tuned-oscillator circuit.

A beat-frequency oscillator is included as an integral part of the set so that CW signals may be received.

Coupling from the oscillator to the intermediate-frequency stage is obtained through the suppressor grid of the 58 tube. A switch in the plate of the 56 tube oscillator turns off heterodyning frequency.

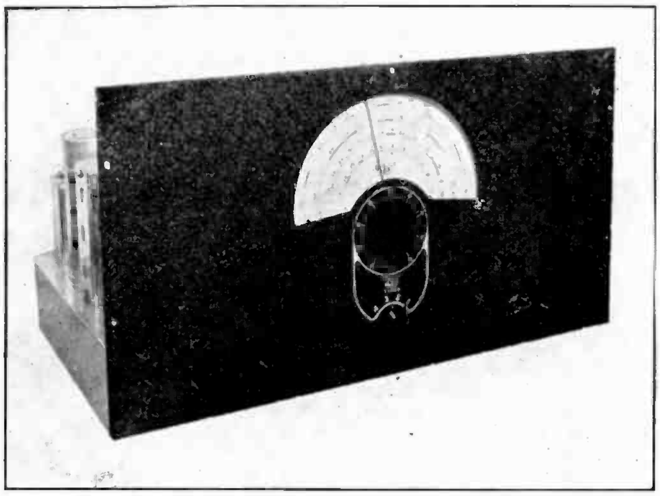


Figure 40

A semi-variable condenser is used to tune this oscillatory circuit. For maximum signal strength this circuit should be tuned about 1000 cycles, above or below the intermediate frequency. The intermediate frequency is 456 KC, which was chosen after a great deal of experimenting with the band-pass filter design.

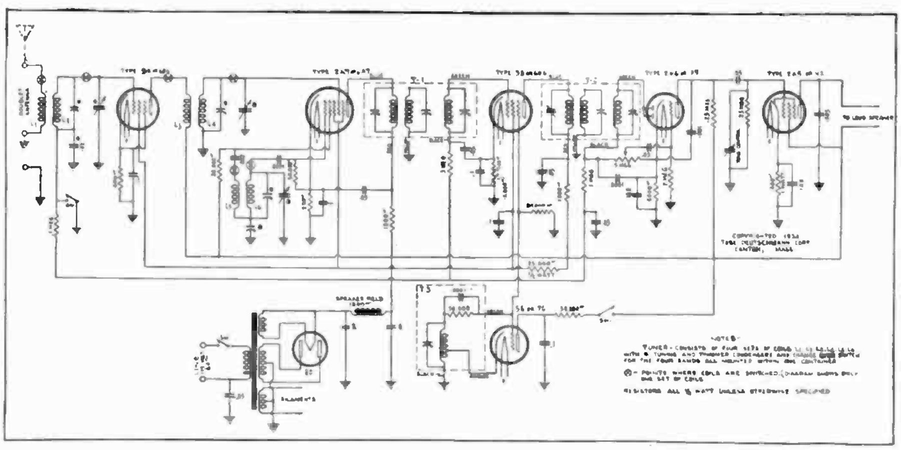
The heart of the set is really the Tobe Tuner which is essentially a "catacomb" in which the twelve tuning and oscillator coils are mounted. For each of the four bands there are three sets of coils, one for the tuned-antenna circuit, one for the tuned-radio frequency amplifier, and one for the oscillator circuit. These coil sets are all shielded from each other so that the tuning of one will in no way react on the others. In each of the three compartments there are four coils, that is, the oscillator coils for each of the four bands are mounted in one compartment, the antenna coils in the second compartment and the r.f. stage coils in the third compartment. Each compartment also contains the associated switches. These switches have silver-plated contacts, low losses and low capacities, and are so designed that all coils that are not used are short-circuited.

To reduce losses to a minimum, bare wire is used in making all connections. The high-frequency-band coils are "space-wound" with silver-plated wire which has about 5% lower resistance than copper. The various trimmers and padding or "lag" condensers are also mounted in their respective compartments. On top of the "catacomb" is mounted the 3-gang tuning condenser.

The "catacomb," including the tuning condenser, is completely wired, lined up, and tracked so that the set builder has only to make seven connections to the Tuner. The unit, as a whole, is insulated from the chassis proper by four gum-rubber washers through which the mounting bolts fit. The Tuner is then grounded to the main chassis at one point only when installed.

The intermediate transformers are also tuned and adjusted at the factory so that

Figure 41



the set builder will have only to line up the circuits for the tubes being used.

The receiver is absolutely single control, all the tuning being done by means of the 3-gang bank of condensers. Band-spread is accomplished by a micro-vernier arrangement, the shaft of which rotates a pointer on a 360-degree dial. This pointer makes 20 complete revolutions while the pointer (attached to the main shaft of the condensers) goes 180 degrees. Thus, stations may readily be logged by reference to the settings of the two pointers.

The band-spread given by this arrangement is as follows: On the 1.4 to 3.75 megacycle band, 360-degree rotation (100 divisions) is the equivalent to approximately .25 megacycle. On the 3.4 to 9.2 mc. band, 360-degree rotation is equivalent to approximately .5 mc., while on the 8.5 to 23 mc. band, 360-degree rotation is equivalent to approximately 1 mc.

The receiver, shown in Figure 40, covers a range of frequencies of from .55 to 22.6 megacycles.

Great care has been taken throughout in the selection of parts, for the completed receiver is no better than each item of its kit of components. The base and panel are drilled and finished so that the assembly of the parts is relatively simple. As will be noted the transformer has a 2.5 and a 6.3 filament winding so that either 6.3 or 2.5 volt tubes may be used according to the set builder's desire. For those who want to work from picture-wiring diagrams rather than from the schematic, a set of 5 "blueprints" can be obtained along with the kit.

After the wiring has been done, a careful check should be made to see that all the parts are properly located and connected. When this is done the receiver is ready to try out. Be sure to plug in the loudspeaker before turning on the set, for if this is *not* done a considerable higher voltage than normal is placed on one of the filter condensers.

This receiver may be conveniently used as a tuner employing various audio circuits by simply plugging in an audio amplifier in place of the 2A5 tube. Many servicemen and experimenters will find that there are individuals who have high-grade receivers lacking the short-wave feature. These may be readily converted into an all-wave receiver.

Radio News Short-Wave Converter

BROADCAST receivers in general use today vary widely in sensitivity; the best home receivers being rated at 1 microvolt or less, while the midgets may reach as low as 400 microvolts. A short-wave converter, if it is to be generally applicable, should be capable of providing maximum usable short-wave sensitivity when working into a broadcast receiver of this least sensitive type. In the average home the level of noise from atmospherics and man-made interference is such that a signal below 5 microvolts is lost.

The Radio News Short-Wave Converter, Figure 42, was designed to meet or exceed these sensitivity requirements.

If the broadcast receiver uses 5 or more modern tubes, its sensitivity is likely to be between 20 and 50 microvolts. At the latter value, the converter will result in short-wave sensitivity ranging well below 1 microvolt, which is more than can ever be used. The range of the converter is from 5800 to 16,300 kc. (51.7-18.4 meters)—wide enough to include the most important short-wave broadcast bands—19, 25, 31 and 49 meters. In addition, it includes numerous commercial phone, aviation and amateur bands, and therefore offers about every type of service obtainable on the short-waves.

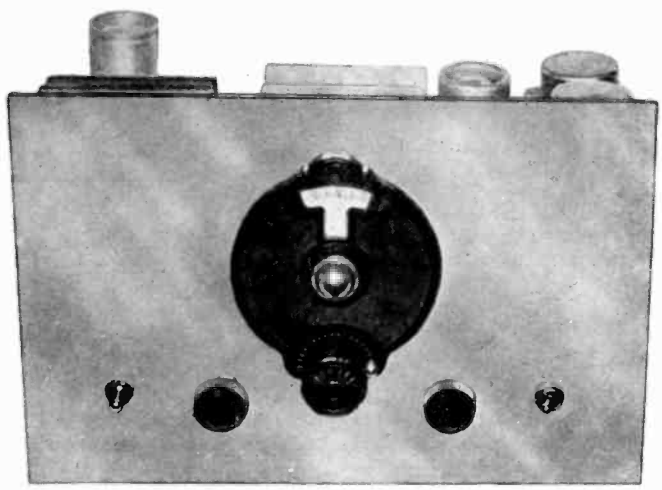


Figure 42

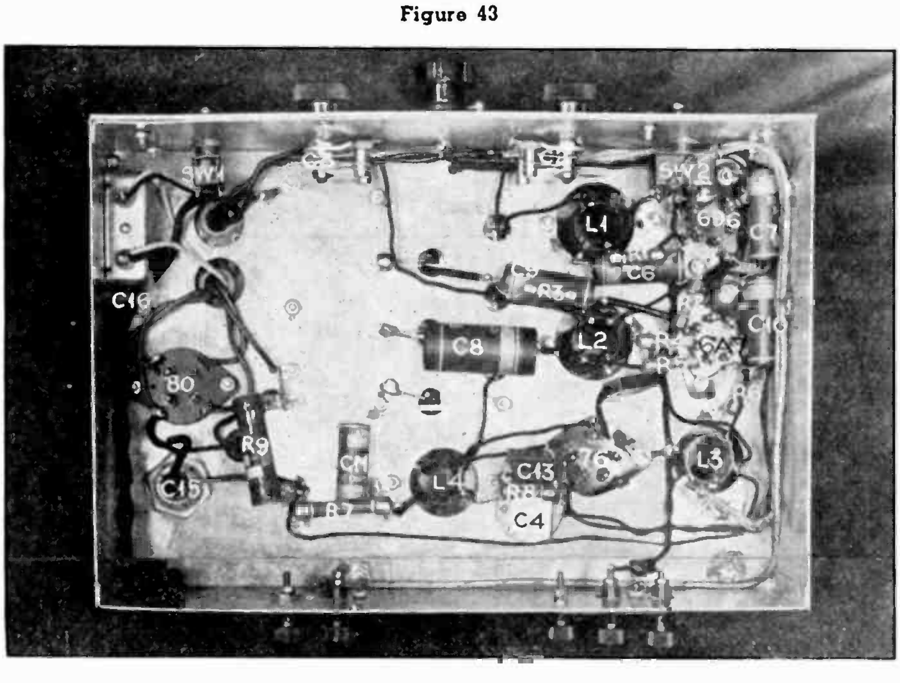
The antenna switch on the front panel of the converter provides for changing over the antenna when straight broadcast-band reception is desired, automatically disconnecting the converter input and output circuits. At the left of the panel is the line switch.

There are three controls, the large one is the tuning control. The other two are auxiliary trimmers in the r.f. and detector stages. These trimmers are used instead of those of the compression type usually included on the r.f. and detector tuning condensers and are placed on the front panel to make possible exact alignment at any desired frequency when absolute maximum efficiency is desired. Normally, they need not be used in tuning but instead can be adjusted to resonance at any point in the tuning range of the converter and left that way. All tuning throughout the entire range is then accomplished by means of the single main tuning knob.

As will be noted from the schematic circuit, Figure 45, this converter employs 4 tubes—a 6D6 in the tuned r.f. stage, 6A7 modulator, 76 oscillator and 80 rectifier.

Tuning of the r.f., detector and oscillator circuits is accomplished by means of the 3-gang condenser, C1. Alignment is obtained by means of the semi-adjustable padding condenser (C4-C13), the oscil-

Figure 43



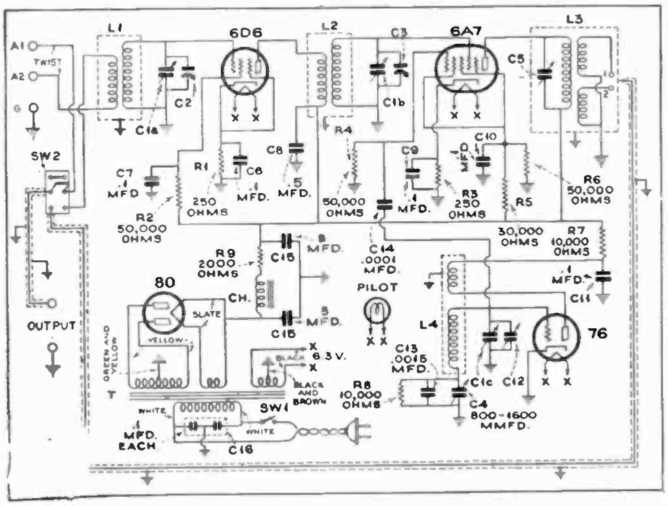


Figure 45

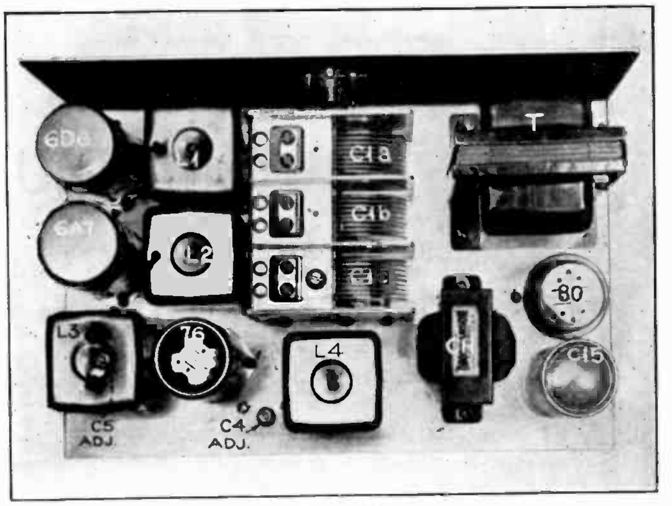


Figure 44

lator trimmer C12, which is built into the 3-gang condenser, and the r.f. and detector trimmers C2 and C3. The output transformer, providing inductive coupling to the broadcast receiver, is tuned by a compression type condenser mounted in the same can. This transformer has two output windings, one to match it to broadcast receivers having high-impedance inputs and the other for receivers with low-impedance inputs. Sufficient capacity range is provided in C5 to permit the selection of any intermediate frequency between approximately 500 and 600 kc. About 540 kc. is generally employed for this purpose.

Assembling the Converter

For those who may prefer to make their own chassis and panel, complete working drawings are provided in blueprints available from RADIO NEWS for the small sum of 50c. A full-size picture diagram, showing how to run each wire, is also included in the blueprints.

In assembling the job, all the parts that belong on top of the chassis, as shown in Figure 44, can be mounted at once. In fact, all parts except the tubular by-pass condensers, resistors, antenna switch and midget condensers can be mounted before starting the wiring.

Leads going from the output coil (this lead is temporarily connected to either one of the 2 output terminals of transformer L3) to the antenna switch and from the antenna switch to the output terminals of the converter should be shielded wire. These should be run together along the end wall of the chassis and the shielding should be securely grounded by soldering or clamping the shield to the chassis every few inches. The leads from the antenna terminals A1 and A2 should not be shielded but should be twisted together to avoid pickup from adjacent circuits. A bottom view of the converter is shown in Figure 43.

Installation

In installing the converter connect the antenna lead to antenna terminal A1. If an L-type antenna is used, put a jumper from Terminal A2 to the ground terminal. If a doublet is used omit the jumper and connect the two antenna leads to A1 and A2. The output of the converter should be connected to the antenna and ground terminals of the broadcast receiver by means of a shielded wire. It is desirable that the converter be placed close enough to the broadcast receiver so that this lead need not be more than 3 or 4 feet in length. The shield on this wire is used as the ground lead.

Plug the converter into the line, tune the broadcast receiver to about 540 kc., and the converter is ready for final adjustment.

Adjustment

If a calibrated signal generator is available, follow the usual procedure employed in lining-up r.f. tuning circuits. For those who do not possess such a generator, the suggestions below will indicate the method of alignment, using short-wave broadcast signals. But first certain other adjustments must be made.

The first step is to tune the broadcast receiver to about 540 kc., and turn the gain high. Then tune the converter to its highest frequency and adjust the midget condensers, C2 and C3, to resonance as indicated by maximum noise. If resonance cannot be obtained screw the padding condenser (C4) in or out until a definite resonance point is found with C2 and C3. The output transformer (L3) is next tuned to the same frequency as the broadcast receiver, by adjusting the screw of C5, mounted in the top of the can of this transformer, for maximum noise. Be careful that the screwdriver employed has an insulated handle and that the blade does not touch the can because this condenser screw is in the B plus circuit.

The last adjustment is to match the output impedance of the converter to that of the receiver. This is accomplished by touching the output lead of the converter to each of the 2 output terminals of the output coil. One of these output coils is of the high-impedance type and the other of the low-impedance type. One or the other will give the best response depending on whether the broadcast receiver has a low or high-impedance input.

When shifting this lead from one output coil to the other, it will be necessary to readjust the output tuning condenser C5.

Alignment

With the main dial set at 97 (plates almost all meshed) adjust the oscillator padding condenser (C4) for more or less capacity until a 49-meter broadcast station is heard. The two condensers C2 and C3 should be kept adjusted to resonance during this process. Now, again vary the padding condenser until the repeat point for this station is heard. The correct one of these 2 points is the one at which the least capacity of C5 is used. This condenser is adjustable from either above or below the chassis, the screw being slotted at both ends. *When adjusted from above the chassis, the capacity decreases as the screw is turned clockwise.* This is just the opposite of normal action and this fact must be borne in mind to avoid confusion in determining which of the repeat points is the one obtained at the low capacity setting.

Now go to the high-frequency end of the main dial and adjust the three panel controls for minimum background noise. In doing this, the small trimmer condenser on the top of the oscillator section of the gang condenser should be very nearly all out. If the point of resonance is reached on condenser C2 and C3 it is an indication that alignment is fairly close.

List of Parts

The Foundation Kit

L1, L2, L3, L4—Set of special "Radio News S.W. Converter" coils
C1—Tuning condenser, 3-gang, each section 360 mmfd.
C2, C3—Hammarlund midget condensers, 4-plate, 30 mmfd.
C4—Special compression type padding condenser variable 800-1600 mmfd.
C5—Supplied (built-in) with coil L3
C12—Trimmer included in C1
C13—Fixed mica condenser, .0015 mfd., accurate to + 5 percent
1 Cadmium-plated, drilled chassis with panel welded in position; 4 tube sockets, 3 tube shields, 2 binding-post strips. Chassis 12 inches long, 7½ inches deep, 2 inches high. Panel 13 inches long, 8 inches high.

Other Parts Required

C6, C7, C9, C10, C11—Sprague tubular by-pass condensers, .1 mfd., 600 volts peak
C8—Sprague tubular by-pass condenser, .5 mfd., 600 volts peak
C14—Solar mica condenser, pigtail type, .0001 mfd.
C15—Mallory 2-section (8-8 mfd.) electrolytic condenser with grounded can, inverted type, 450 volts
C16—Sprague 2-section by-pass condenser in shield can, .1-.1 mfd., 400 volts
Ch—Thordarson type T-4402 filter choke
R1, R3—IRC pigtail resistors, 250 ohms, ½ watt
R2, R6—IRC pigtail resistors, 50,000 ohms, ½ watt
R4—IRC pigtail resistor, 5000 ohms, ½ watt
R5—IRC pigtail resistor, 30,000 ohms, ½ watt
R7—IRC pigtail resistor, 10,000 ohms, 1 watt
R8—IRC pigtail resistor, 10,000 ohms, ½ watt
R9—Electrad wire-wound resistor, 2000 ohms, 10 watts
SW1—Toggle switch, s.p.s.t.
SW2—Toggle switch, d.p.d.t.
T—Thordarson power transformer, type T-5472 with secondary windings of 575 volts (ct.), 5 volts and 6.3 volts (c.t.)
1 National "Velvet Vernier" dial, type B, with variable ratio, 100-0-100 scale and pilot light bracket
2 grid caps
1 line cord and plug
Shielded wire (about 5 feet)
Tubes, one 6D6, one 6A7, one 76, one 80

AMATEUR RADIO

A 10-Meter Transmitter

THIS transmitter for 10-meter operation consists of a single, electron-coupled oscillator using a 59-type tube and a 210 tube as a final amplifier. The grid circuit of the oscillator is tuned to one-half of the operating frequency, or twice the wave-length, i.e., between 14,000 and 14,250 kilocycles. The plate circuit of the 59 tube is tuned to the operating frequency in the 28,000 kilocycle band. Such an arrangement gives far more stability than it is possible to obtain by operating the oscillator grid circuit on the operating frequency. The layout of parts closely follows the accompanying schematic wiring diagram, Figure 46. The oscillator is mounted at the right of the baseboard with the grid and plate coils on either side. The amplifier is at the left and also follows the congruent layout. All leads should be made as short as possible, and every component part should be securely fastened.

All tuning condensers used are 50 mmfd. The oscillator-doubler grid coil, L1, has nine turns of 3/16-inch copper tubing 2 inches in diameter. All other coils have four turns of the same material and also are 2 inches in diameter. The copper tubing provides an extremely rigid coil, and may be self-supporting. Spacing between turns is about equal to the diameter of the tubing. The coils are wound on a piece of pipe having an outside diameter of two inches. The tubing is wound close together and after it is slipped off the pipe, a screwdriver shank should be passed between the turns several times until the desired spacing is obtained. This method of winding facilitates uniform spacing which probably could not be obtained readily if an attempt was made to wind the coil with the desired spacing.

Copper tubing of this size lends itself well to plug-in mounting. The threaded end of a banana plug will conveniently fit into the hole in the tubing and may be soldered by sweating. Porcelain stand-off insulators, with banana plug jacks, are used for mounting.

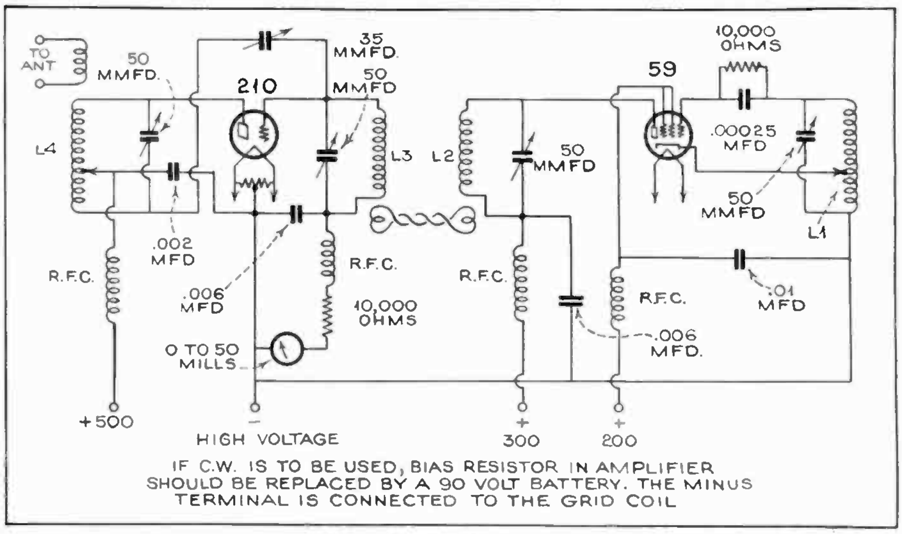


Figure 46

The electron-coupled oscillator is always preferable when there is no buffer stage. It provides frequency stability comparable to crystal-control, something that is essential, especially if the amplifier is to be modulated for voice transmission. Also mechanical vibration should be avoided. The link coupling coils used between the oscillator and amplifier also should be securely mounted. One turn, coupled closely to the oscillator plate coil and the amplifier grid coil at the cold ends of each, will be found sufficient. These also are made of copper tubing to insure stability. It was found that it was possible to obtain as high as 10 milliamperes of rectified grid current with such an arrangement, which is more than sufficient to excite a 210 tube or any tube of equivalent power. A grid-current meter in the amplifier circuit is almost essential. Plate meters are valuable too, but in order to obtain stable operation on this high frequency, it is necessary that the final tube have sufficient excitation, particularly if modulation is to be used. Those who have constructed 20-meter 'phone transmitters probably already have made this discovery.

The transmitter just described is only one of many possible combinations that may be used on this band. It will be found that the new 801-type tubes function exceptionally well on this band. It is a simple matter to substitute one of them for a 210. Also, there are a number of other tubes that might have been chosen for the doubler-oscillator. The 2A5 will give results similar to the 59. Others that might be used are the 57 and the 24-A, although the latter tube will not provide nearly the harmonic output that the 59 and the 2A5 will.

A Crystal Transmitter

THIS medium-powered transmitter for all-band operation is designed for inputs from 100 to 200 watts and is suitable for voice or telegraph. The transmitter has been laid out in the simplest manner and essentially follows the schematic wiring diagram, Figure 48. It might be described as a baseboard transmitter, but is made somewhat neater by mounting the baseboard on a rectangular box 5 inches high. The box arrangement provides a convenient mounting for all meters and hides all of the small component parts such as small condensers, resistors, etc., leaving only the tube sockets, coils and associated apparatus exposed on the surface as shown in Figure 47.

The transmitter employs a 47 type tube in a crystal oscillator circuit followed by a 210 type tube as a buffer-amplifier or doubler and uses a 211 type tube in the final amplifier. In place of the latter tube a 203-A type tube might be substituted, but it will be found that the 211 is much easier to excite than the higher "mu" tube and therefore, easier to handle.

The components are laid out almost exactly as they appear in the schematic wiring diagram. The baseboard is 48 by 14 inches. The crystal oscillator is mounted at the left, with the crystal itself placed in a convenient place so others of different frequency may be substituted with ease. The coil and condenser associated with the crystal circuit are mounted immediately in front of the tube. An ordinary plug-in type form is used for the crystal tuning circuit, providing a vertical mounting for the coil. Coupling to the buffer stage is provided through a 100-mmfd. fixed condenser which taps on the crystal oscillator tank circuit, one-quarter of the total number of turns from the plate end of the coil. This connects directly to the grid of the buffer-amplifier. The essential components of this stage are the tuning condenser, coil and neutralizing condenser. It will be noted a stator tank condenser is employed. This is used to facilitate all-band operation, as it simplifies neutralization by making it permanent for all bands once it is set. Also only two connections to the coil are necessary. This makes it possible to use "banana plug" mountings.

The coils are wound on 2-inch forms. Coupling to the final amplifier is accomplished by means of the "link" method. While this necessitates an extra tuning circuit, it provides greater efficiency in transfer of energy from the buffer-amplifier to the final amplifier by virtue of a better impedance match. The link coupling should consist of three turns wound about the buffer plate tank-and-grid coils for 160-meter operation, two turns for 80- and 40-meter operation and one turn if a 40-meter crystal is used for 20-meter operation. The link is coupled to a tuned circuit in the grid of the final amplifier. A high L-to-C (i.e., large coil and small capacity) is desirable in this circuit. The number of turns and design of the coils is identically the same as the tank circuit in the buffer stage.

Aside from the grid tuning, the remainder of the final amplifier stage is identically the same as the buffer-amplifier, except a coil and condenser designed to accommodate the higher power is provided. The plate tank coil is one made by a large radio company in New York. They are available for the three most popular amateur bands, i.e., 160, 80 and 40 meters. A coil for the 20-meter band is easily constructed. Switches are provided in the plate circuits of the buffer-amplifier and the final amplifier. This greatly facilitates tuning. If the transmitter is to be used exclusively for telephone transmission, it is possible to use automatic bias throughout. On the other hand, if c.w. is to be used, combination battery and resistor bias should be used on the final amplifier. The 211 requires in the neighborhood of 260 volts, minus grid bias, for Class C operation, i.e., twice cut-off. Therefore, at least 135 volts of battery bias, used

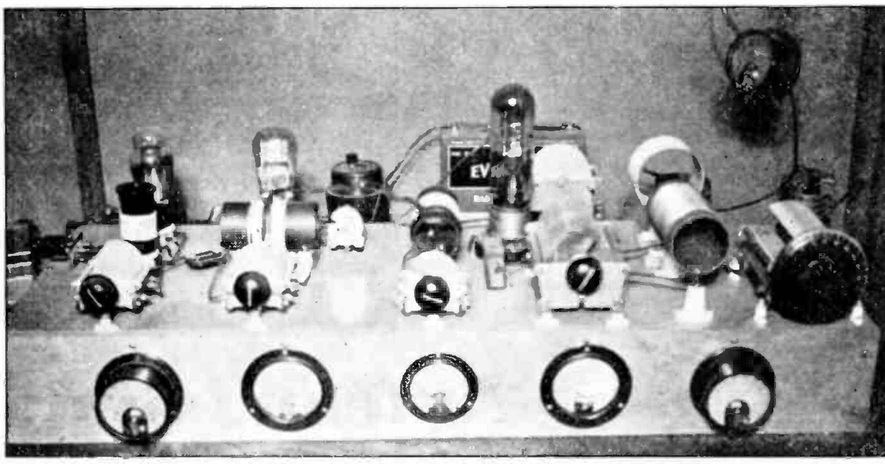


Figure 47

in conjunction with a biasing resistor, must be used in the final amplifier for this type of operation. Such a voltage will provide complete cut-off when excitation is taken off the grid of the final amplifier by keying in the buffer-amplifier filament-center-tap circuit.

Operating Data

To set the transmitter in operation, the filaments are lighted and the key circuit is closed. The plate power-supply is then turned on, but with the switches in the plate circuits of the buffer and amplifier open. The oscillator tuning condenser is adjusted until a decided dip in the plate current is noted. This will indicate resonance. As a further check for oscillation, a neon bulb may be touched to the plate side of the tank circuit. Glowing indicates oscillation. The oscillator tank condenser should then be rotated several times to make sure that resonance always takes place at the same point. After making this check, the condenser capacity should be reduced slightly to provide for greater stability.

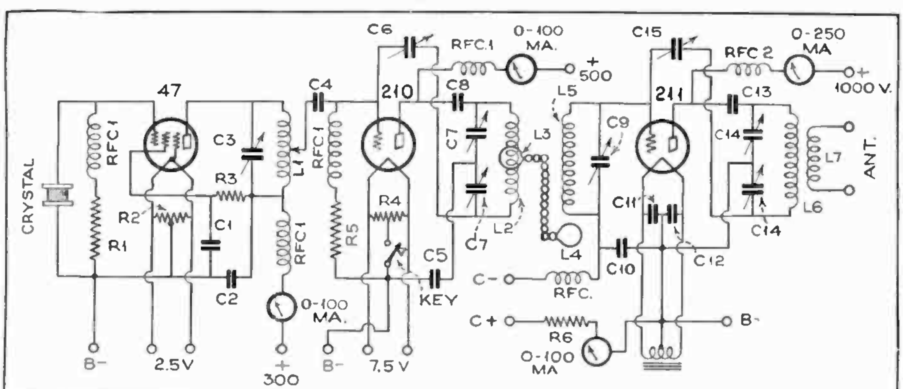
The next operation is to tune the buffer. The neon tube should be connected to the plate side of the tank coil, and the tank condenser tuned until resonance is indicated. It will glow brightly at resonance unless by chance the circuit is neutralized. Then the neutralizing condenser is tuned until the neon bulb stops glowing. The tank condenser should be rotated again to determine if there is any radio-frequency current in the tank circuit. If it does not glow, it indicates the buffer is neutralized. If it does, further adjustment should be made on the neutralizing condenser until a point is reached where there will be absolutely no indication of radio-frequency in the buffer tank circuit. This indicates proper neutralization. Then the switch in the plate circuit should be closed, and the buffer tank circuit tuned until the plate current takes a sharp dip. Minimum plate current indicates resonance.

So much for the buffer. Then the grid condenser in the final amplifier is tuned for maximum grid current. If a grid meter is not used, a neon bulb may be used to indicate when maximum radio-frequency is applied to the grid of the final amplifier. If a grid current meter is used, the grid current should be between 30 and 50 milliamperes. The final amplifier is then neutralized in the same manner as the buffer stage, and of course, with the switch in the plate circuit open and the key depressed. After neutralization, the plate voltage is applied, and the tank circuit is tuned to resonance which is indicated by a minimum plate current. It should be between twenty and thirty milliamperes with 1,000 volts applied to the plate. Finally, the antenna is coupled to the plate tank circuit of the final amplifier and the antenna circuit tuned for maximum plate and antenna current. If the plate current is too high for the tube, the coupling between the tank and antenna coil should be reduced; if it is too low, the coupling should be tightened until the desired current is obtained.

The transmitter is now ready for operation. The key should be opened, and the plate and antenna currents should fall to zero. If this does not take place, more bias should be added on the final amplifier, until full cut-off is obtained with zero excitation.

For all-band operation, it is desirable to obtain crystals for 160-, 80- and 40-meter bands. On each of these bands, of course, the specified crystal is used. For 20-meter band operation, the 40-meter crystal should be selected to double into the higher frequency channel. The buffer-amplifier is then tuned to one-half the wavelength or twice the frequency of the crystal and is excited by the harmonic of the oscillator. This in turn drives the 211 tube in the 41,000-kilocycle band.

Figure 48



List of Parts

C1, C2, C5, C8, C11, C12—.002 mfd. fixed condensers (Aerovox)
C4—.0001 mfd. fixed condenser (Aerovox)
C10, C13—.002 mfd. fixed condensers (Aerovox, 5,000 volts)
C3, C9—100 mmfd. variable (Cardwell Midway)
C7—Split stator variable condenser, 150 mmfd. per section (Cardwell)
C14—Split stator variable condenser, 100 mfd. per section (Hammarlund double spaced)
C6—50 mmfd. midget variable condenser (Hammarlund)

C15—50 mmfd. variable transmitting condenser (Cardwell)
R1—25,000 ohms 10 watts
R2—R4—100 ohms center tapped
R3—50,000 ohms 10 watts
R5—10,000 ohms 25 watts
R6—10,000 ohms, tapped, 100 watts
R.F.C. 1—Radio frequency choke coils (National receiving type)
R.F.C. 2—Radio frequency choke coil; transmitting type (National)

Data on Coils

160 METERS: L1, 70 turns No. 22 DSC wire wound close on 1½ inch receiving coil form; L2, 60 turns No. 22 DSC wound on 2 inch form; L5, 50 turns No. 22 DSC wound on 2 inch form; L6, 45 turns No. 14 wire wound on 3 inch form (Gross); L7, 15 turns No. 14 wire wound on three inch form (should be experimented with for best results); L3 and L4, three turns wound around center of buffer plate tank and coupled to filament end of grid circuit of final amplifier.

80 METERS: L1, 30 turns No. 18 DSC wire wound close on 1½ inch form; L2, 35 turns No. 18 on 2 inch form; L5, 35 turns on 2 inch form; L6, 30 turns No. 14 on 2½ inch form; L7, 10 turns No. 14, 3 inch diameter; L3, L4, see text.

40 METERS: L1, 18 turns No. 18 DSC, 1½ inch diameter; L2, L5, 8 turns No. 14 close wound 2 inches in diameter; L6, 12 turns No. 14 wire spaced slightly more than the diameter of the wire; L7, same as 80 meters; L3 and L4, one turn.

20 METERS: L1, same as 40 meters, if 40 meter crystal is used; L2 and L5, 5 turns No. 14 spaced slightly on 2 inch form; L6, 7 turns 3/16 inch copper tubing two inches in diameter and spaced about 3/16 inch between turns. (Banana plugs are mounted in holes drilled through flattened ends); L3 and L4, one turn.

All coils for L1 are tapped one-quarter the total number of turns from the plate end of the coil. It will be found that the antenna coil, L7, may vary somewhat depending on the type of antenna, length of feeders, etc.

Antenna Systems

THE ideal transmitting antenna, basically, is one which is either half wavelength or full wavelength long and about quarter wavelength above ground. On the 7000- and 14,000-kilocycle bands such an antenna is not difficult to put up. On the latter two frequencies a quarter wavelength is only thirty-three and fifteen feet, respectively. Frequently an antenna strung in a large attic will give surprisingly good results on these bands. But, on the popular bands of 3500 and 1750 kilocycles, the stringing of an antenna quarter wavelength above ground becomes more difficult. On 3500 kilocycles, the ideal height is roughly about 65 feet, and on 1750 kc. it amounts to the almost impossible figure of 132 feet.

If operation is to be done on the two higher-frequency bands, every effort should be made to have an antenna of ideal height. If the lower-frequency channels are chosen for operation, the antenna should be erected as high as possible. These figures are, of course, for the so-called Hertz-type antenna. In the case of the Marconi type, where it is necessary to use either a ground or a counterpoise, a portion of the aerial runs through a coupling device to the ground. This reduces the electrical height; it is impossible to erect a Marconi antenna more than an average height between ground and the highest point of the antenna. Therefore, the ideal Marconi antenna would be one that is strung vertically.

Many amateurs wonder what method is the best for coupling the transmitter to the antenna: voltage feed or current feed; also, if it is more desirable to use either a doublet or a single-wire feeder. The answer is: one is as good as the other. The one to use is the one that is most adaptable to a particular location. If it is more convenient to feed the middle of the antenna because the "shack" is situated at the middle of the "location," by all means use that method. If feeding at the end is more feasible, use that arrangement, and if one wants to use a single-wire feeder because of the appearance, that is the one to select. The point is that any of the accepted systems (when properly constructed) will give about the same results. However, for the "ham" who lives in an apartment, the single-wire, voltage-feeding arrangement is ideal. It permits erecting the antenna without regard to the feeder length. The feeder may be from twenty to 200 feet from the radiator.

There are, however, a few points to bear in mind. For instance, the length of the wire, for either the current-fed or the doublet, is not critical. Any length in the vicinity of half wavelength will be flexible and will give good efficiency on any part of the band it is designed to operate, or the "harmonic bands." However, in the construction of this type antenna, the feeders should be cut to a quarter wavelength or any multiple thereof. That is, 15 feet, 30, 45, 60 or 120 feet, and so on. The most desirable feeder length is quarter wavelength for the highest band on which the transmitter is to operate. If multi-band operation is contemplated, both series and parallel tuning feeders should be provided. Series tuning should be used whenever possible. The feeders may be doubled back in order to gain the correct length, if necessary, and if this arrangement is not feasible, the Collins or "pi" network should be employed. The tuning methods for different length of antennas, where multi-wire feeders are employed, are given in Figure 50.

In the case of the so-called voltage-fed Hertz (although all radiators functioning independently of ground are Hertzian radiators), the determination of the length is quite critical and should be computed as accurately as possible by formula. Even then it may be found that after the antenna has been cut carefully to the correct length, it may not resonate at the computed frequency. The reason for this is that some object is having an effect on the electrical length of the antenna. But in general, if the aerial is strung clear of surrounding objects and the guy wires on the antenna mast are broken up with insulators, there will be no trouble of this kind. The formula for computing the length of the single-wire, voltage-fed antenna is:

$$\text{Length in feet} = \frac{468{,}000}{\text{Frequency in kilocycles}}$$

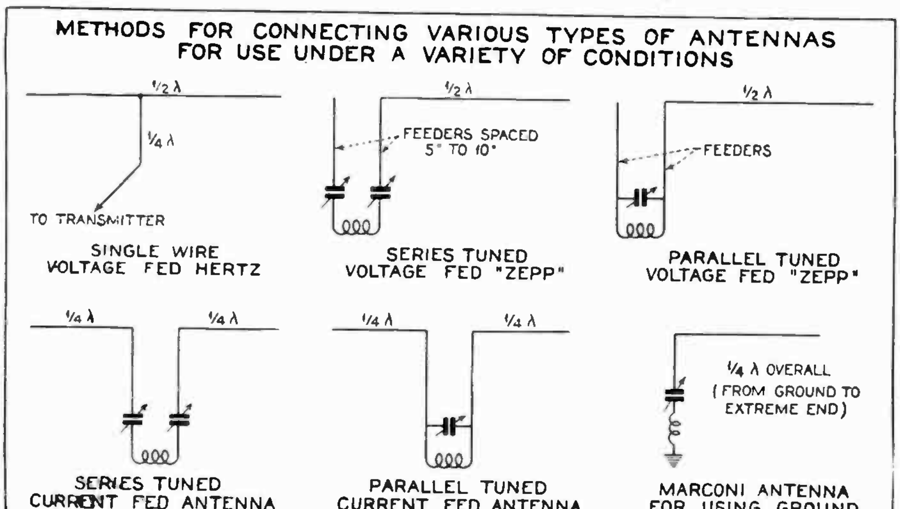
There is another point to remember in the use of this type antenna. The feeder should be run for at least a quarter wavelength, at right angles to the antenna itself.

The Marconi antenna is finding increasing popularity again. Its reappearance has been due to the increasing activity on the 1750-kilocycle band, where it is practically impossible for most amateurs to erect a half-wave antenna, although quite a few stations are known to be blessed with the space for such antennae. In general, its length is not critical. The usual practice is to make it 23.7% of its length in meters (i.e., length in meters divided by 4.2). Wavelength (in meters) may be determined by dividing the frequency (in kc.) into the velocity, 300,000. That means 125 feet will be adequate for the 150-meter band. On the other hand, it will be seen that the 80-meter Hertz will form an excellent quarter-wave (Marconi) antenna, when operated against a counterpoise or ground.

Figure 49

BAND	FEEDER LENGTHS IN FEET					
	120	90	60	45	30	15
1,750 Kc	SERIES	PAR	SERIES	(NOT RECOMMENDED)		
3,500 "	PAR.	SERIES	SERIES	PAR	(NOT RECOMMENDED)	
7,000 "	PAR	SERIES	PAR.	SERIES	SERIES	PAR
14,000 "	PAR.	PAR.	PAR	PAR	PAR.	SERIES

Figure 50



Constructing An Antenna Mast

The design and construction of a light and reasonably high antenna mast is a problem which frequently confronts the "ham."

The mast, shown in Figure 51, is 47 feet high. The base section consists of a 30-foot four-by-four, and the top section is constructed of 18-foot one-by-fours. The ground section is a crotch arrangement which in addition to providing a substantial means of mounting the mast rigidly in the ground, greatly facilitates raising it. The construction is quite simple. The base section, or crotch, is made up of a six-foot length of four-by-four, which is the same cross-section as the base of the mast. Two 10-foot two-by-fours are fastened securely on each side with a combination of nails and bolts. Twenty-penny nails are used. It might be better to use three-by-fours for this purpose. That portion which is to be buried is given two heavy coats of asphalt paint.

In building the mast itself, it is a good plan to use a sidewalk as a "straight-edge" to facilitate accurate alignment. The four-by-four is laid out straight and the two one-by-fours are placed so they overlap about two feet. Two holes are bored four inches from the top of the four-by-four and the bottom of the one-by-fours, and securely fastened with bolts. A few nails may be added for providing additional structural strength. Then a piece of one-by-four (about one foot long) is placed between the top ends of the one-by-fours; a hole is drilled through the three sections, and a bolt is used to draw the whole thing together. Nails again may be added to provide greater rigidity. Then to increase the strength of the top section, pieces of one-by-four are placed in between the tapering side sections and securely nailed from the outside. If six or more of these pieces are placed between the sides, the strength of the top section almost will equal a solid piece of wood, will have less tendency to bend, and will provide a top section of extremely light weight.

The guys then are fastened. The top ones are placed within a foot of the hoisting pulley at the extreme top and the lower ones just below the middle joint. Ordinary heavy-gauge galvanized wire may be used, but one of the best and most inexpensive materials for the purpose is the so-called steel clothesline. This is a heavily galvanized cable, consisting of 7 strands of No. 18 wire and is readily available at most hardware stores. The "egg" insulators are the best type to use. They are arranged so that if the porcelain should break, the loops of the wire passing through the insulator will overlap, thereby providing utmost safety. The anchors may be almost anything driven into the ground, but a type which has been found most satisfactory, particularly where the guy wires must necessarily be placed close to the base of the pole, consist of pieces of pipe buried in the ground horizontally, and pieces of heavy cable fastened to them.

The "dead men" used on the mast shown are two-foot pieces of pipe buried four feet deep. Rocks and earth are piled in on top of them so as to further distribute the

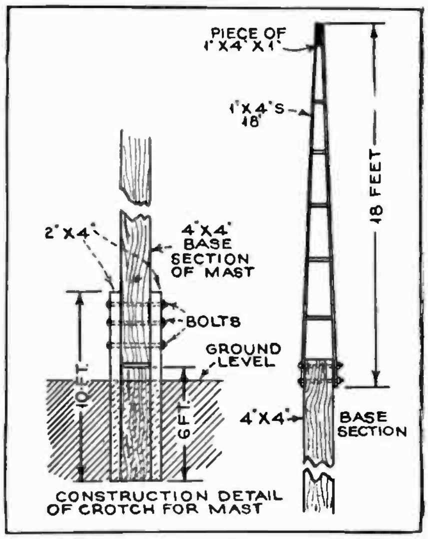


Figure 51

upward force over a greater area. Concrete thrown in on top of the pipes would provide greater rigidity. As a precaution against rust, the pipe and the wire attached to it should be given a coat of asphalt paint.

To raise the mast, the base should be placed between the sling and the lowest bolt inserted to serve as a fulcrum. With the aid of two ladders and about four pairs of hands, no difficulty should be experienced in swinging the pole into position. As for cost, the whole thing may be put together, painted and swung into position for less than $5.

A 3/4 Meter Transceiver

WHILE the portable, shock-proof transceiver described here could have been made a great deal smaller the size is convenient, allowing plenty of room for making adjustments, and the popular type National case is well adapted to the layout, as shown in Figure 52.

Let us start with the wiring diagram, Figure 55. From left to right we see an antenna switching system with adjustable coupling in both "Transmit" and "Receive" positions, the 75 cm. oscillator (Gutton-Touly), other parts of the switching system and the audio stage. We will consider each item separately.

When a single tube is used for both detector and transmitting oscillator, especially when super-regeneration is being used, some arrangement must be made for securing optimum coupling to (loading of) the oscillator circuit. In many popular 5 meter "self-supering" transceivers no adjustment is provided, in which case coupling must be set correctly for the "Receive" position. This position requires fairly loose coupling in order to permit super-regeneration. When switched to "Transmit" position the coupling is too loose for proper power transfer—perhaps ½ the output power is literally thrown away. In this transceiver two coupling loops are provided which may be adjusted for best efficiency in "Transmit" and "Receive" positions.

This type of oscillator has proven itself well adapted to the acorn tube operating at 50 to 100 cm. as well as being the

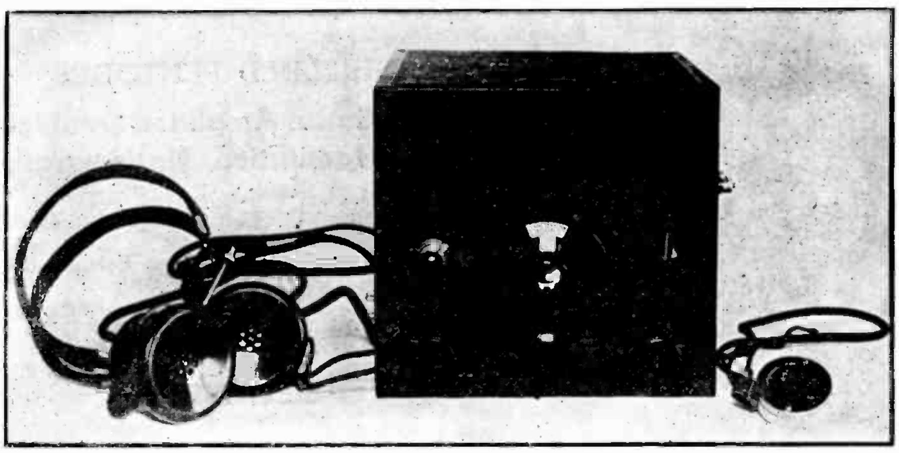


Figure 52

simplest circuit possible. No special parts are required. L3 and L4, constituting the plate and grid "coils," are the pig-tailed leads of blocking condenser C1 cut to ¾ or 13/16 of an inch. It was found that a little cathode impedance, L5, was necessary to start oscillations, 1-inch of wire being satisfactory although 1½ inches was finally used. The space between this wire and the sub-panel is fairly critical. A Cardwell Trim-Air condenser is stripped of all but two plates and these are spaced somewhat wider than originally. The stator plate is then cut in two, leaving about ⅛ inch between the halves. The cut edges are well rounded. The condenser is so placed that only ¼ inch of lead is used to the grid and plate terminals, connections being made *right at the tube, not on the circuit end of the socket terminals.* Such an arrangement permits a range of approximately 72 to 76 cm.

The transformer, T1, operates from the detector plate to the pentode grid in the "Receive" position and from the single button microphone to the audio grid in "Transmit" position. The transformer, T2, is a regular speaker output transformer

Amateur Transmitting Tubes

TRIODES

Type Number	Max. Dimen. Overall	Fila. Rating	Pl. Volts Nominal Output	DESCRIPTION
RK-10	2 1/16" x 5⅜"	7.5v 1.25a	450v 10w	Modulator, R.F. Oscillator, Amplifier, Thoriated Fil., Isolantite Base
RK-15	2 1/16" x 6"	2.5v 1.75a	400v 10w	Zero Bias Cl. B Mod. R.F. Ampli., Doubler, Oxide Fil., Isolantite Base, Grid Top Conn.
RK-16	2 1/16" x 5⅝"	2.5v 2.0a	250v 1.25w	Class A Driver, R.F. Amplifier, Heater Type, Isolantite Base
RK-18	2 1/16" x 8½"	7.5v 3.0a	1000v 40w	Cl. B Mod., R.F. Osc., Amplifier, Thor. Fil., Iso. Base, Plate Top Conn.
RK-24	1 9/16" x 4¼"	2.0v 0.12a	180v 1.5w	Modulator, R.F. Oscillator, Amplifier, Especially adapted for 56 MC Transceivers, Oxide Fil., Isolantite Base
RK-30	2 11/16" x 6⅜"	7.5v 3.25a	1250v 65w	High Freq. R.F. Osc., Amplifier, Plate and Grid Conn. Top of Bulb
RK-31	2 1/16" x 8½"	7.5v 3.0a	1250v 125w(2)	Zero Bias Class B Modulator, Isol. Base
RK-32		7.5v 3.25a	1250v 50w	High Frequency Triode
RK-34	1 9/16" x 4 11/16"	6.3v 0.8a	400v 20w	High Freq. R.F. Osc., Amplifier, Isol. Base, Twin Triodes, Plate Conn's Top of Bulb
RK-100	2" x 5¼"	6.3v 0.9a	150v 15w	Gaseous Discharge Amplifier Heater
R-203A	2 5/16" x 7⅞"	10v 3.25a	1250v 100w	Hi-Mu Triode, Class B Modulator or Amplifier, R.F. Amplifier or Oscillator. Thoriated Filament, Metal Shell Base
R-841	2 1/16" x 5⅜"	7.5v 1.25a	450v 13w	High Amplification Factor, Audio Amp., R.F. Osc., Amp., Doubler
R-842	2 1/16" x 5⅜"	7.5v 1.25a	425v 7w	Low Amplification Factor, Modulator, Amplifier
R-864	1 3/16" x 3¾"	1.1v 0.25a	90v	Low Microphonic Response, Tube for Modulator Preamplifier

PENTODES

Type Number	Max. Dimen. Overall	Fila. Rating	Pl. Volts Nominal Output	DESCRIPTION
RK-17	2 1/16" x 6"	2.5v 2.0a	400v 10w	R.F. Oscillator, Amplifier, Doubler, Heater Type, Iso. Base, Grid Top Conn.
RK-28	2 5/16" x 9½"	10v 5.0a	2000v 100w	Osc., Mod., R.F. Power Ampl. Cl. B & C., Thoriated Filament, Isolantite Base
RK-29		10v 5.0a	2000v 100w	Osc., Mod., R.F. Power Ampl. Cl. B & C., Thoriated Filament, Porc. Comp. Base

SHIELDED PENTODES

R.F. Oscillator, Amplifier, Doubler Suppressor Modulation, No Neutralization

Type Number	Max. Dimen. Overall	Fila. Rating	Pl. Volts Nominal Output	DESCRIPTION
RK-20	2 1/16" x 8¾"	7.5v 3.0a	1250v 50w	Thor. Filament, Isolantite Base, Plate Top Conn.
RK-23	2 1/16" x 6"	2.5v 2.0a	500v 15w	Heater Type, Isolantite Base, Plate Top Conn.
RK-25	2 1/16" x 6"	6.3v 0.8a	500v 15w	Heater Type, Isolantite Base, Plate Top Conn.

RECTIFIERS

Type Number	Max. Dimen. Overall	Fila. Rating	Max Pl. Voltage Nom. PK. Curr.	DESCRIPTION
RK-19	2½" x 6⅝"	7.5v 2.5a	1250v 0.6a	Full Wave, High Vacuum, Low Voltage Drop, Heater Type, Top Conn. Anodes
RK-21	2½" x 6⅝"	2.5v 4.0a	1250v 0.6a	Half Wave, High Vacuum, Low Voltage Drop, Heater Type, Plate Top Conn.
RK-22	2½" x 6⅝"	2.5v 8.0a	1250v 0.6a	Full Wave, High Vacuum, Low Voltage Drop, Heater Type, Top Conn. Anodes
R-866A	2 7/16" x 6½"	2.5v 5.0a	3500v 0.6a	Half Wave, Mercury Filled, Shielded Filament, Plate Top Conn.
R-872A	2 5/16" x 8½"	5.0v 10.0a	3500v 2.5a	Half Wave, Mercury Vapor, Shielded Filament, Plate Top Conn.

Courtesy Raytheon Production Corp.

in "Receive" position and serves as a conventional Heising choke when transmitting. Two secondaries are provided, a 2000-ohm phone or magnetic speaker winding, and a 10-ohm dynamic speaker winding. The 10-ohm output could be made to feed a low impedance phone and has been so used with very satisfactory response.

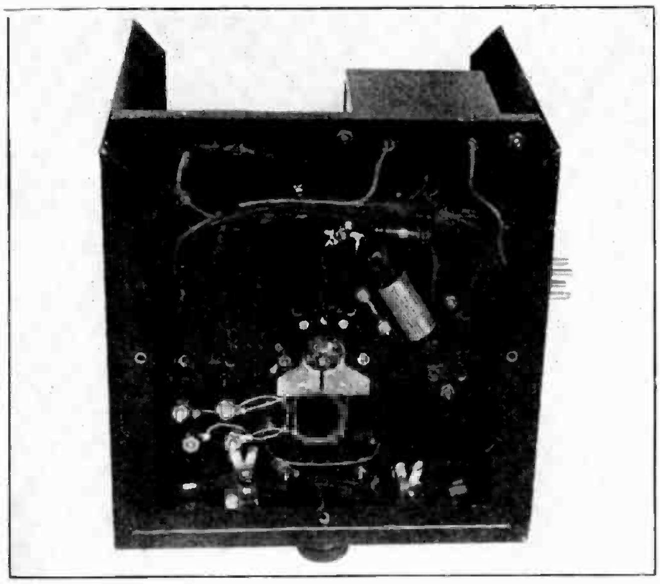


Figure 53

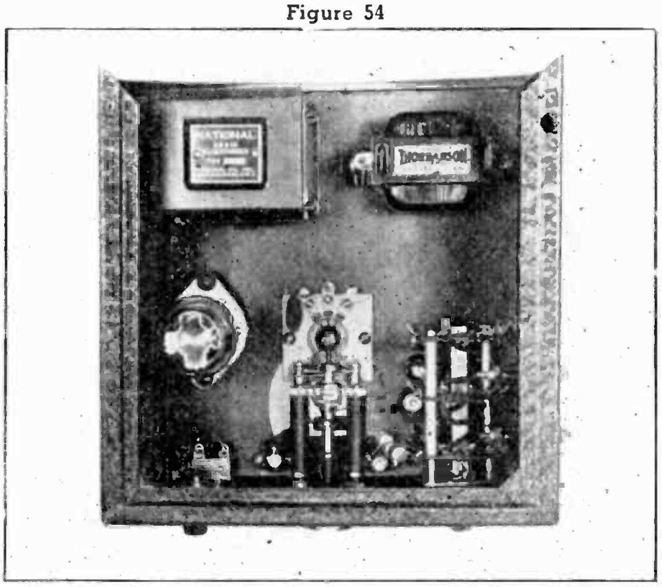
Construction Data

There is plenty of leeway allowable in constructing this transceiver. However, certain rules must be obeyed. The Cardwell condenser must be placed just above the grid and plate terminals to permit the very necessary short leads (remember—the inductances are ¾-inch wires) and to get it out of the field of the single turn circuit as much as possible. The photograph, (Figure 54) cannot tell the whole story but can be useful. Note that the acorn socket "sits" on the sub-panel and supports the loop. A large hole is cut out of the sub-panel to allow plenty of "breathing space" for those valuable 75 cm. milliwatts. The micalex socket, although a very low-loss support, is slit with a hacksaw between grid and plate just in case . . . and no sacrifice is made in mechanical strength. The socket being right on the sub-panel and the condenser being just above it, the shaft and dial positions are fixed, no alteration being permissible. The Yaxley switch must be close to the antenna lead-in bushings and must be so placed that the leads are short and direct to the coupling loops. This makes for a neat system with not too much stray field. Porcelain insulators (the same as the lead-in bushings) take the 4-loop leads through the sub-panel. The r.f. chokes should be directed away from the oscillating coil and supported on tiny insulators. The small wire used hasn't much mechanical strength but cannot be made larger for fear of increasing the distributed capacity and thereby reducing the choking action.

In conventional apparatus the single point grounding system is considered best practise. At these frequencies, however, this is not necessarily true because the length of lead necessary to reach that common ground point may act as a series choke—and does! The point where the cathode lead is attached to the base is made the pseudo-common ground point. Holes are drilled under the cathode and heater prong screws to prevent any grounds at these points. All wiring, except leads to the switches, is put beneath the sub-panel. Wires in the vicinity of the oscillating circuit are as short as possible and run right against the sub-panel as a protection against interaction. The 41 socket could have been sub-panel mounted. In mounting the micro-mite insulators it is well to put paper or lead washers under them to prevent cracking when mounting.

While this outfit was supposed to be used with a 6-volt storage battery and 135 to 180 volts of B battery, the heaters may be run from a 6.3-volt a.c. source and the plates from any suitable B supply, vibrator or a.c. type. The microphone must then be fed from a separate source which may be a 4½-volt C battery. It is important to use a plate milliammeter while tuning up and the meter might well be retained. It should show only the 955 plate current rather than the total B battery drain, and should be connected at point X in the diagram. After testing the filament circuit, the heater switch should be opened and the B supply connected. Now turn on the heaters again and watch the plate meter. In the "Transmit" position, it should rise and then dip sharply once, while in the "Receive" position, it should dip twice, indicating super-regeneration. This is very important. The test should be made with the antenna connected as the loading will have a great effect. While there is little trouble in getting the set working, many hours can be spent on any 75 cm. rig in squeezing out every bit of power available and in tuning the antenna, or tuning the set to the antenna and getting proper coupling in both positions. A Yagi or other directional antenna might as well be used at first, although until some Lecher wire wave-length measurements are made, a 14-inch antenna fed by a 2-wire line spaced about 1-inch will suffice. The line should be tapped on the antenna about 1½ inches each side of the center, forming a "Y" type impedance match.

Figure 54



Adjusting the Transceiver

In the "Receive" position two adjustments can be made to get the familiar rushing sound of super-regeneration, the length and position of the cathode impedance wire and the amount of antenna coupling. The coupling should be increased until the smooth hiss gets rough, then decreased slightly. The hiss may not be uniform throughout the frequency range but should cover a large portion of the dial. Now investigating the "Transmit" position, watch for that second dip! If it occurs, increase antenna coupling. If this won't cure it maybe some antenna adjustment will. As a last resort, decrease the transmitter grid leak to 10,000 ohms. When testing for oscillation, the plate prong will be "hotter" than the grid prong, hence touch the plate prong with the finger and watch for a rise in plate current.

The frequency should be adjusted by varying the length of L3 and L4, 1/32 of an inch at a time! In the "Receive" position, couple a pair of Lecher wires to the oscillating circuit very loosely so as to introduce as little error as possible. The antenna should be connected. Slide a rigid bar along the wires and note the points at which the rush is reduced. The distance between two such points is ½ wavelength. The tuning range should be found while the Lecher wires are connected. If it exceeds a few centimeters, it might be well to increase the condenser plate spacing, for there is no need to cover a lot of territory and make adjustments harder. A variation of frequency when shifting from "Transmit" to "Receive" position can be compensated for by sliding the coupling

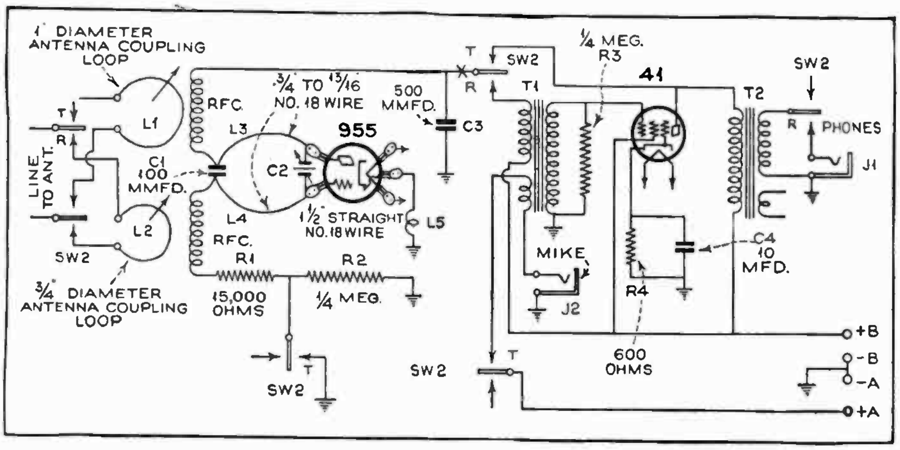


Figure 55

loop of the higher frequency circuit toward the high r.f. voltage part of the circuit (toward the tube) and so introducing a proper amount of capacity coupling. This can be done without changing the amount of total coupling although a few trials may be necessary.

A volume control may be used across the secondary of T1 in place of the 1/4-megohm fixed resistor if a pair of headphones are used. With a handset, it is unnecessary. If the microphone gives too high a level on 6 volts, the voltage may be reduced, a few hundred ohms may be used in series or the mike may be fed to a 400-ohm potentiometer connected across the transformer input. The completed transmitter may be tested by using a crystal detector (of 1920 vintage) across a pair of phones, a short wire connected to the crystal being placed near the antenna. The receiver may be tested by listening to car ignition or, better, by picking up harmonics of a nearby 5-meter transmitter — or even a 20-meter phone. Of course, a single transceiver is quite useless. Like trousers, you must have a pair to be able to use them! The construction and outdoor field testing of a pair of 75 cm. transceivers would certainly be an excellent summer program for a radio club.

As to the range to be expected—car to car in a residential section, 1/4 to 1/2 mile; rural section, 1/2 to 1 mile; house to car, perhaps 2 to 5 miles, depending on location, height and conditions along the path of transmission. In a test at Jones Beach State Park, Wantagh, L. I., voice communication was carried on up to a distance of 12 miles with 100% intelligibility up to about 10 miles.

Seventy-five cm. work is very convenient for beginners in the amateur game. Of course, a license is required as with any type transmitter. There is no interference of any kind, barring some car ignition and man-made interference, but these are much less bothersome at this wavelength than at 5 meters. It really amounts to a clear channel on the air. It is ideal for code practice or private chats. And there are no worries about being off frequency—for the present, at least.

List of Parts

C1—Aerovox mica condenser, type 1468, .0001 mfd.
C2—Cardwell "Trim Air" midget condenser, type RT-15
C3—Aerovox mica condenser, type 1468, .0005 mfd.
C4—Aerovox electrolytic condenser, type PR25, 10 mfd., 25-volt
J1, J2—Yaxley junior jacks, type 701
R1—Lynch resistor, 15,000 ohms, 1/2 watt
R2, R3—Lynch resistors, 1/4 megohm, 1/2 watt
R4—Lynch resistor, 600 ohms, 1/2 watt
SW1—Yaxley midget jack switch, type 10
SW2—Yaxley 6-pole, 2-throw gang switch, type 1335, 3-deck
T1—National combination microphone and plate-to-grid transformer, type TR-1
T2—Thordarson pentode plate to 2000- and 10-ohm output transformer, T-6806
1 National receiver case
1 National "Velvet Vernier" dial, type BM
1 Communication Eng. Co. micalex socket for 955
1 National 6-prong Isolantite or equal tight-grip socket
1 Jones 4-prong plate plug
1 Jones 4-contact cord socket
1 4-wire battery cable for outside use
6 Birnbach smallest porcelain lead-in insulators
2 Birnbach Micro-Mite porcelain stand-off insulators
1 0-10 ma. d.c. meter for setting up (optional)
10 feet No. 10 or 12 solid antenna wire, or brass rod
1/4 oz. No. 33 d.s.c. or s.e. wire for r.f. chokes
1/4 inch bakelite shaft with 6-32 screw pinned in one end to serve as extension shaft for Cardwell condenser 2 inches in length
3 inches bakelite rod to serve as mounting bushings for Cardwell condenser, ends drilled and tapped for No. 4 screw

International Call Letters

CALL letters of foreign code stations are of special interest to the radio amateur because from these it is possible to tell the nationality of the transmitter. Thus any call beginning with G indicates a station in Great Britain; F in France, D in Germany, etc. Smaller countries with fewer transmitters have more limited assignments. Morocco, for instance, is assigned all calls which employ CN as the first two letters. The list of these "International Call Letter Assignments" is given herewith.

For the benefit of short-wave fans, we call attention to the fact that, in code transmission, the call letters are always preceded by — . . . (de). The letters of the station called are usually repeated 3 times, followed by the letters of the caller, also repeated 3 times, thus: XAB, XAB, XAB de KNL, KNL, KNL, would indicate a U. S. Station calling a Mexican station.

Inasmuch as c.w. (code) transmissions carry further than 'phone or broadcast signals, and as many c.w. stations employ high power, it is possible to log many countries in this way, who either do not have broadcast transmitters or whose broadcast transmitters do not reach out.

Call Signal	*Country*
CAA-C[illegible]	Chile
CFA-CKZ	Canada
CLA-CMZ	Cuba
CNA-CNZ	Morocco
COA-COZ	Cuba
CPA-CPZ	Bolivia
CQA-CRZ	Portuguese Colonies
CSA-CUZ	Portugal
CVA-CXZ	Uruguay
CYA-CZZ	Canada
D	Germany
EAA-EHZ	Spain
EIA-EIZ	Irish Free State
ELA-ELZ	Liberia
EPA-EQZ	Persia
ESA-ESZ	Estonia
ETA-ETZ	Ethiopia
EZA-EZZ	Territory of the Saar
F	France and colonies and protectorates
G	Great Britain
HAA-HAZ	Hungary
HBA-HBZ	Switzerland
HCA-HCZ	Ecuador
HHA-HHZ	Haiti
HIA-HIZ	Dominican Republic
HJA-HKZ	Colombia
HPA-HPZ	Republic of Panama
HRA-HRZ	Honduras
HSA-HSZ	Siam
HVA-HVZ	Vatican City
HZA-HZZ	Saudi Arabia
I	Italy and colonies
J	Japan
K	United States of America
LAA-LNZ	Norway
LOA-LWZ	Argentina
LXA-LXZ	Luxemburg
LYA-LYZ	Lithuania
LZA-LZZ	Bulgaria
M	Great Britain
N	United States of America
OAA-OCZ	Peru
OEA-OEZ	Austria
OFA-OHZ, OIA-OJZ	Finland
OKA-OKZ	Czechoslovakia
ONA-OTZ	Belgium and colonies
OUA-OZZ	Denmark
PAA-PIZ	Netherlands
PJA-PJZ	Curacao
PKA-POZ	Dutch East Indies
PPA-PYZ	Brazil
PZA-PZZ	Surinam
Q	(abbreviations)
R	U. S. R. R.
SAA-SMZ	Sweden
SOA-SRZ	Poland
SSA-SSZ, STA-SUZ	Egypt
SVA-SZZ	Greece
TAA-TCZ	Turkey
TFA-TFZ	Iceland
TGA-TGZ	Guatemala
TIA-TIZ	Costa Rica
TKA-TZZ	France and Colonies and Protectorates
U	U. S. S. R.
VAA-VGZ	Canada
VHA-VMZ	Australia
VOA-VOZ	Newfoundland
VPA-VSZ	British colonies and protectorates
VTA-VWZ	British India
VXA-VYZ	Canada
W	United States of America
XAA-XFZ	Mexico
XGA-XUZ	China
XYA-XZZ	British India
YAA-YAZ	Afghanistan
YBA-YHZ	Dutch East Indies
YIA-YIZ	Iraq
YJA-YJZ	New Hebrides
YLA-YLZ	Latvia
YMA-YMZ	Free City of Danzig
YNA-YNZ	Nicaragua
YOA-YRZ	Roumania
YSA-YSZ	Republic of El Salvador
YTA-YUZ	Yugoslavia
YVA-YWZ	Venezuela
ZAA-ZAZ	Albania
ZBA-ZJZ	British colonies and protectorates
ZKA-ZMZ	New Zealand
ZPA-ZPZ	Paraguay
ZSA-ZUZ	Union of South Africa
ZVA-ZZZ	Brazil

BROADCAST RECEIVERS

A Universal Superhet

THE universal "transformerless" superheterodyne presented here uses only 4 tubes yet has enough sensitivity to operate on a short aerial. The tubes are so chosen as to be adaptable to battery operation and the power dissipation is unusually low. The tubes employed are the 6A7, the 6C6, the 38A and the 25Z5.

The circuit (Figure 58) consists of one oscillator-modulator stage, one regenerative detector stage, and a stage of audio-frequency power amplification.

The unique feature of this design is the utilization of the 6C6 as a fixed regenerative detector, part of the amplified intermediate frequency is reflected from the plate to the grid circuit through the C16, L3 channel. This renders the set very selective and sensitive. It thus is, with less parts, the equivalent in performance of a 5-tube superheterodyne receiver. The mechanical construction of the 6C6 tube necessitates its shielding.

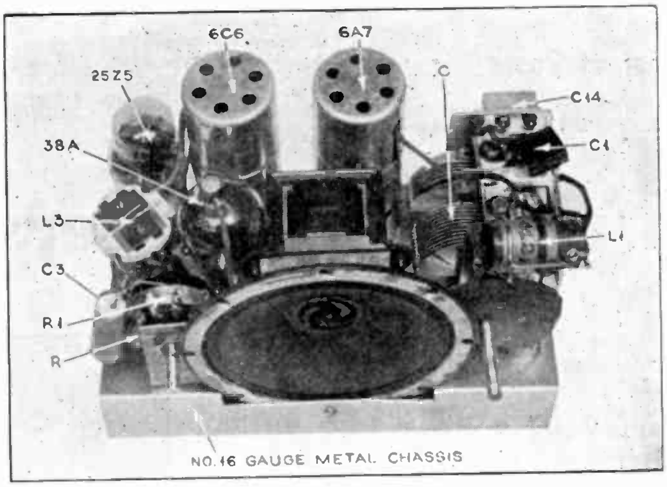


Figure 56

The oscillator coil has been calculated to 130 microhenrys. If such a coil is not available, it can be constructed as follows: Wind closely on a ¾-inch tubing, 100 turns of No. 32 enamel covered wire. Over this tuning section, starting from the ground end of the coil, wind in the same direction 50 turns of the same size wire. These two windings should be separated by impregnated paper of not less than 1/32 inch thickness. The terminal of the coupling winding nearest the ground end of the tuning coil should go to the oscillator plate of the 6A7, grid number 2, while the other end of the coupling coil goes to B plus. The high end of the tuning section goes to the oscillator grid of the 6A7 tube (grid number 1).

If the unshielded 456 transformer, L3, employed does not contain a feed-back winding, this section can be easily constructed as follows: Scramble wind 60 turns of number 40 enamel copper wire on a sleeve (tubing) that is tight fitting on the dowel of this transformer. This tubing should be placed next to the grid coil of the transformer. The feed-back winding should be in the same direction as the grid coil winding.

Connect the inside terminal of the feed-back winding to the outside terminal of the grid coil which goes to ground. The outside terminal of the feed-back winding should be connected to the moving part of the padding condenser, C16.

By moving the tubing to and fro from the grid coil an additional method of adjusting the regeneration of the detector is afforded to that of the padding condenser C16.

For operation on light lines, the heaters of the four tubes are connected in series and the line voltage is reduced by means of the dropping resistor R10. The sequence of the connection of the heaters of the various tubes as shown in the schematic diagram should be strictly followed as this arrangement was found to give a minimum amount of hum. For automobile use, an adapter makes possible the connection of the heaters in parallel

Figure 58

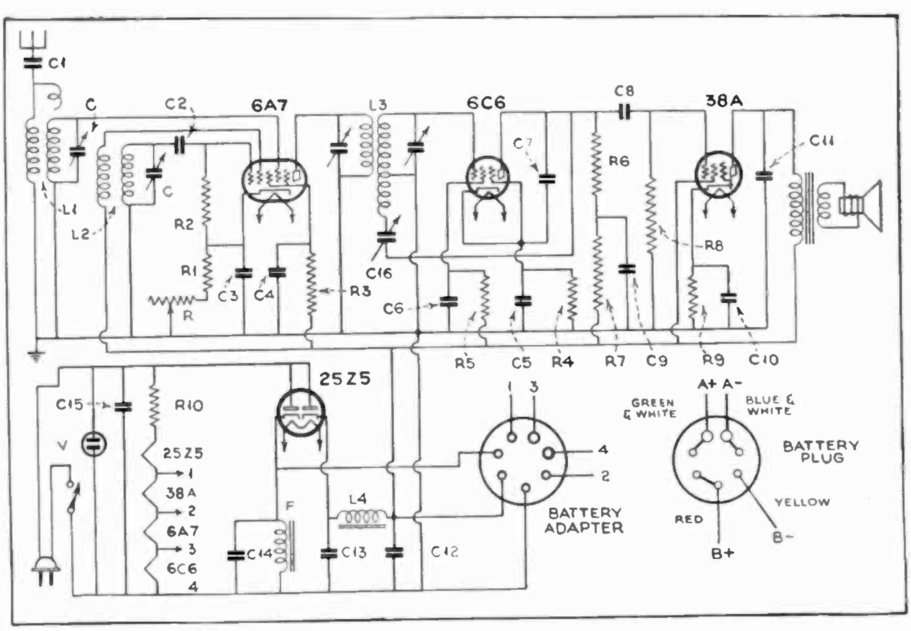
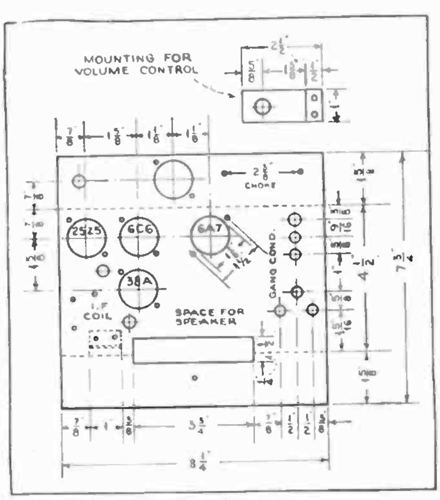


Figure 57



and the introduction of a separate B supply.

How sensitive this set is may be appreciated from the fact that with only 25 feet of indoor aerial and no ground connection, distant stations such as WLW, Cincinnati, and WTAM, Cleveland, were received with good volume at a location in New York. The selectivity of the receiver is about 30 kc. The receiver chassis is probably one of the smallest yet designed; its dimensions being 8¼ inches by 4½ inches by 1⅝ inches.

The complete specifications for the chassis are given in Figure 57 for those who desire to fabricate this at home. The layout of parts is easily followed from the photograph, Figure 56.

List of Parts

C—General Instrument midget 2-gang variable air condenser, clockwise type, oscillator section cut for 456 kc.i.f.; t.r.f. section 365 mmfd., shaft 2" long, ¼" diameter

C1—Solar mica condenser 0.001 mfd. 200-volt peak

C2—Solar mica condenser, 0.00025 mfd., 200-volt peak

C3, C4, C6, C9—Solar tubular paper condensers 0.1 mfd., 175-volt peak

C5, C10—Solar dry electrolytic tubular condensers 10 mfd., 35-volt peak

C7—Solar mica condenser 0.005 mfd., 200-volt peak

C8—Solar tubular paper condenser 0.03 mfd., 175-volt peak

C11—Solar tubular paper condenser 0.006 mfd., 175-volt peak

C13, C12—Solar dry electrolytic condensers dual 16-8 mfd., 175-volt peak

C14—Solar dry electrolytic condenser 8 mfd., 175-volt peak

C15—Solar tubular paper condenser 0.05 mfd., 175-volt peak

C16—Hammarlund padding condenser 450 mmfd. maximum

L1—Gen Ral Type RFB No. 4 antenna coil

L2—Gen Ral Type RFB No. 4 oscillator coil

L3—Gen Ral Type RFB No. 4 i.f. transformer with feed-back winding, 456 kc.

L4—Kenyon 30 henry, 40 milliampere choke, 300 ohms

R—One Stackpole 5000-ohm potentiometer with line switch

R1—Micamold resistor, 150 ohms, ½ watt

R2, R4—Micamold resistors 25,000 ohms, ½ watt

R3—Micamold resistor 30,000 ohms, ½ watt

R5—Micamold resistor 0.25 megohm, ½ watt

R6—Micamold resistor 0.5 megohm, ½ watt

R7—Micamold resistor 100,000 ohms, ½ watt

R8—Micamold resistor 2 megohms, ½ watt

R9—Micamold resistor 1500 ohms, 1 watt

R10—Gavitt line cord with resistor 250 ohms, 25 watts

V—General Electric neon glow lamp, 110-volt type

One Eby 7-prong socket for 6A7 tube

One Eby 7-prong socket for automobile adapter

Two Eby 6-prong sockets

One Eby 5-prong socket

One Jensen 5-inch dynamic reproducer with output transformer designed for the 38A tube, field resistance of speaker 3500 ohms

One Insuline electralloy chassis 8¼ inches by 4½ inches by 1⅝ inches high

One Crowe tuning unit with escutcheon

One Crowe plate for volume control

Two Kurz Kasch knobs, one for R and one for C.

One Eby 7-prong plug with 8 feet of 4-wire cable

One antenna reel 25 feet long

2-Volt DX'ers Super

WHILE this new, battery-operated receiver was designed with the requirements of the DX'ers uppermost in mind, nevertheless, it is an ideal receiver for those living out in the country where line supply is not available. It has all the features necessary to satisfy the ordinary broadcast listener. The extra features thrown in for the benefit of the DX'er will be found likewise useful to this ordinary listener.

The receiver design incorporates an unusual combination of features. The set contains:

1. Both automatic and manual gain control.
2. A signal strength and tuning meter providing a deflection of over 2 inches on strong local signals, and so sensitive that deflection of nearly ½ inch is obtained on the weakest signal.
3. A headphone-speaker switch which permits either of these units to be switched in, automatically cutting out the other; and with both headphones and speaker connected to an output transformer, preventing shock and d.c. overload.
4. A tone-control knob on the front panel which permits drastic attenuation of the high frequencies, thus materially improving the signal-to-noise ratio when trying for weak signals.
5. Full battery operation, eliminating all line noise.
6. Three dual-purpose tubes included (1A6, 1B5 and 19), thus permitting seven tubes to perform the functions of ten.
7. Absolute single-control tuning with air-plane dial.
8. Frequency range wide enough to include the high-fidelity channels at 1530 and 1550 kc.
9. Ample loudspeaker volume to fill a good-size room, even on distant stations.
10. Sensitivity and selectivity to gladden the heart of the most critical DX'er.

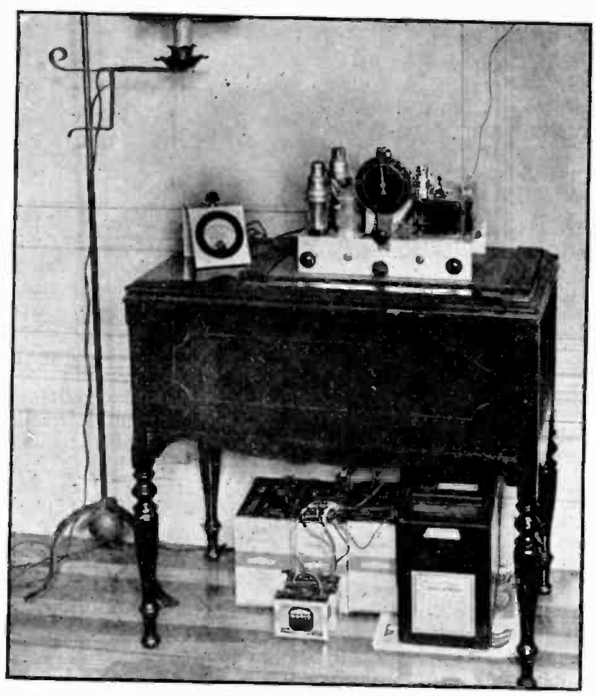


Figure 59

The circuit diagram, Figure 61, shows a type 34 r.f. stage; a type 1A6, combined oscillator-mixer; 2 type 34, 175 kc. i.f. stages; a type 1B5 duplex-diode triode, detector, a.v.c. and audio stage; a type 30 driver and a type 19 class B audio power stage. A toggle switch, SW2 provides for use of either manual or automatic gain (volume) control and another switch, SW3 allows a choice of speaker or headphones. The tuning meter is in the plate circuits of the first three tubes (which are a.v.c. controlled). For economy, the plate voltage was limited to 135 with 9 and 3 volt separate C batteries. The 3-volt C battery provides minimum bias for the first three tubes and cannot be grounded in the a.v.c. position. Hence the separate battery. The filaments may be supplied from a single 2-volt storage cell directly, from an Eveready Air Cell (through a 0.44 ohm resistor connected at "X" in Figure 61) or from a 3-volt series-parallel bank of dry cells (through a 6-ohm rheostat connected at "X"). The filament drain is 680 ma. which includes one 60 ma., 2-volt pilot lamp. The B drain with no signal will be 25 to 30 ma. The 19 will draw additional plate current momentarily on loud signal peaks.

The output transformer employed has two output windings. The 4000 ohm winding is for a magnetic or a permanent-magnet type dynamic speaker. This impedance is desirable for operating speakers of these types, because a better match is provided, particularly at the higher audio frequencies. The 2000 ohm winding is preferred for headphones, providing a better impedance match for the medium audio frequency ranges and somewhat attenuating the higher frequencies and therefore, noise. Headphones and speakers can both be left permanently connected to the receiver and one or the other selected at will by means of the toggle switch at the right of the tuning knob.

Signal-Strength Meter

A tuning meter is important in any highly selective receiver. However, the small tuning meters employed in commercial receivers fall far short of the ideal. The one employed with the 2-volt DX'ers Super overcomes the obstacles of the ordinary tuning meter and is one of inestimable value to the DX'er. In the first place, in order to spread out the scale, a standard milliammeter is employed. Then to take fullest advantage of this wide scale, an adjustable shunt, R14, is connected across the meter so that full-scale deflection, with no signal tuned in, is obtained. This permits of maximum retardation when signals are tuned in. When the meter is connected to the receiver and with no signals tuned in, or the antenna disconnected, the shunt rheostat is adjusted until the meter reads full scale. Thereafter, each station tuned in will cause the meter to retard more or less, depending on the strength of the signal. During the tests of this receiver, powerful local stations caused the neddle to swing approximately 2 inches, and so great is the meter sensitivity that the weakest signal that could be heard on headphones caused the meter to retard nearly half an inch. With such wide variations as these, the meter serves not only as a tuning meter but, more important still, as a direct indicator of signal strengths

In view of the fact that the tubes drawing their plate current through this meter have a total drain of only about 2.5 ma., it is necessary that the meter range be less than this value. For this reason a meter having a range of 0-1 ma. is employed. This meter could have been mounted in the receiver, but it is more convenient to use it externally. The meter and its shunt rheostat are, therefore, mounted on a strip of aluminum, bent to convenient shape and connected to receiver by means of a pair of twisted flexible wires. (See Figures 59 and 62.)

Connecting and Aligning

A set of "Blueprints" including a *full size* chassis drilling template (Figure 63), and a picture wiring diagram of the "2-Volt DX'ers Super" may be obtained by sending 50c. to RADIO NEWS, Blueprint Dept., 461 8th Avenue, New York City.

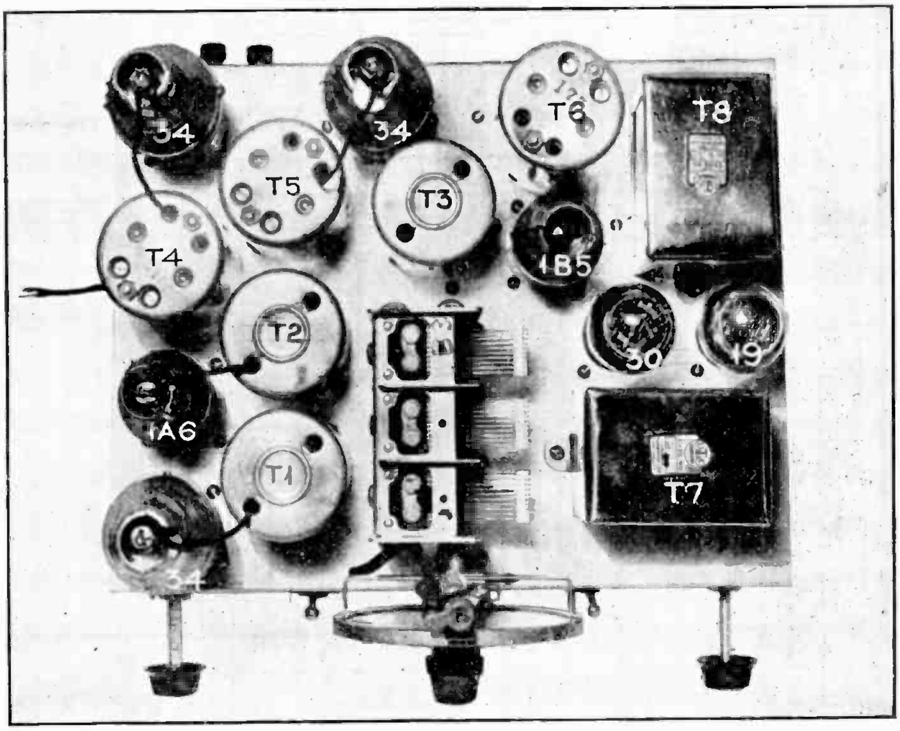


Figure 60

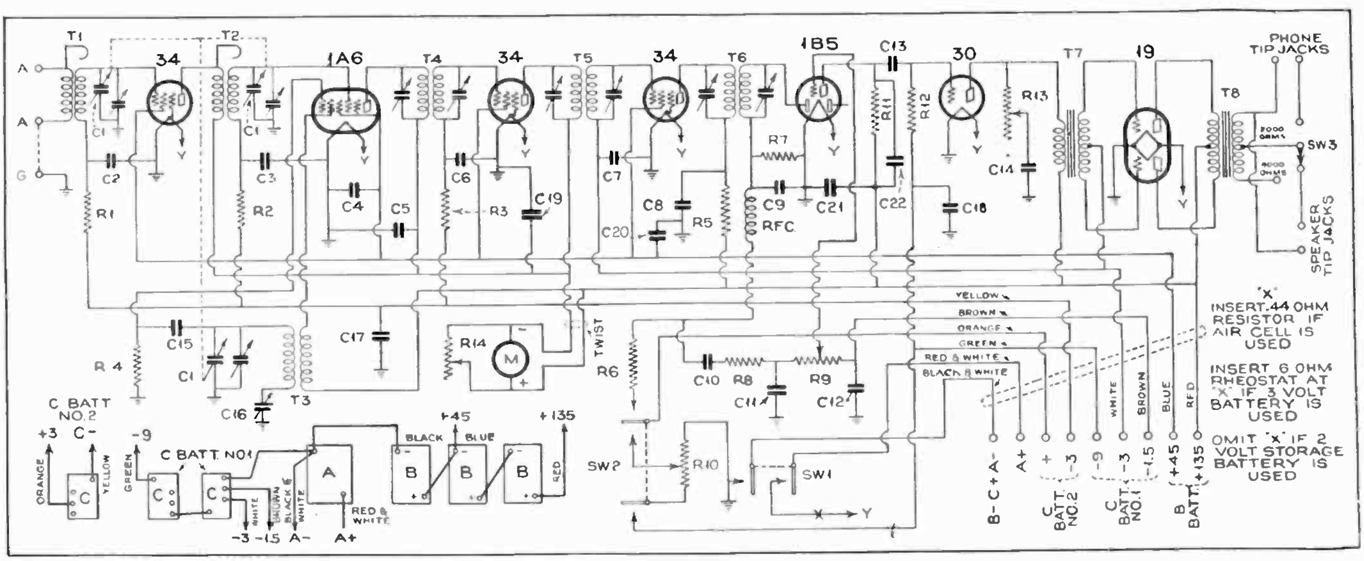
A top view of the chassis is shown in Figure 60.

When the wiring has been completed and the set ready for test, connect the A battery only; and remember the filament series resistor if an Air Cell or 3-volt pack is used. The tubes should glow at a dull red which is hard to distinguish in bright light. Next, connect the C batteries. Before connecting the B batteries, put a 10,000 ohm resistor in series with the tuning meter and temporarily connect resistors of 1000 ohms or so in the plus 45 and 135 volt leads to save the batteries in the event of a short circuit. A 25 to 100 ma. meter in the negative B lead will also help get things running—but make sure those resistors are in. With speaker or phones connected, there should be a click when adding the 135 volts. If all is well, some station will probably be heard.

The set should now be carefully aligned, starting with the i.f. stages. If possible, secure an oscillator which is accurately calibrated at 175 kc. The oscillator signal is applied to the plate terminal of the 1A6 socket. The tuning meter forms an excellent alignment meter (when the a.v.c. switch is in the "on" position), and the test signal need not be modulated. In aligning the i.f. transformers, *the following precautions must be observed.* First, use a non-metallic screw-driver, preferably made from a bakelite rod. An accidental short circuit of the shield of the i.f. transformer to the adjusting screw will burn out the meter. It is also advisable during all adjusting operations to keep the 10,000 or 15,000 ohm resistor in series with the tuning meter. Adjust each trimmer until maximum retardation of the meter is secured. Now proceed directly with the r.f. alignment.

First, tune the oscillator to 1400 kc. Then tune the receiver to the same and adjust each trimmer on the gang condenser until the meter reading is a minimum. Now, tune the oscillator and receiver to 600 kc. Don't touch the trimmers, but adjust the padding condenser until minimum meter reading is secured,

Figure 61



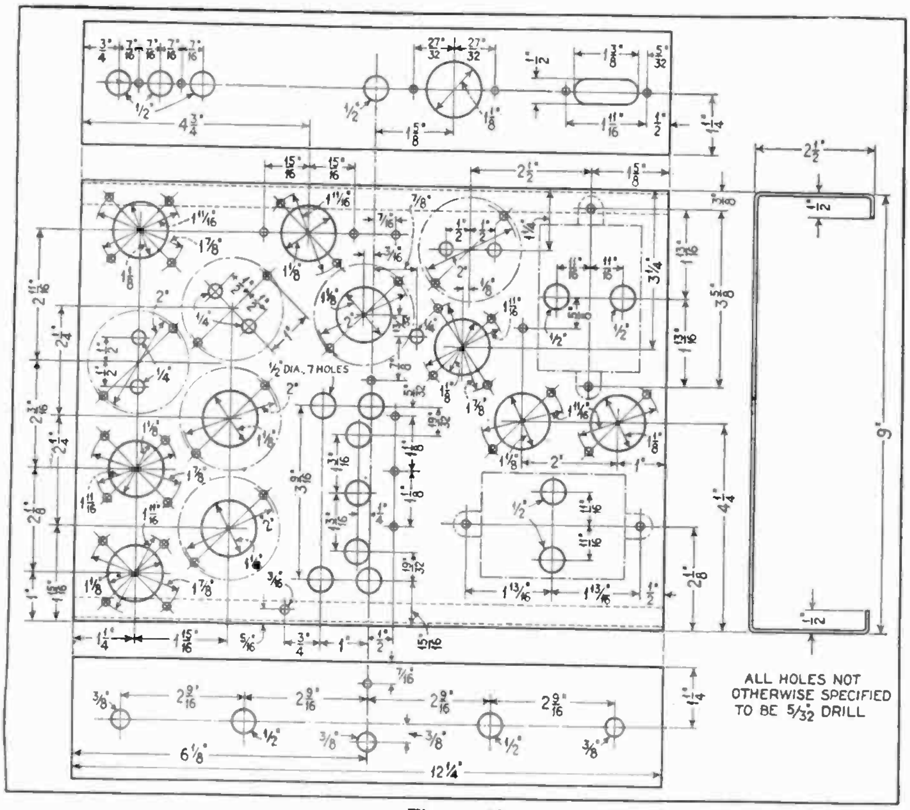


Figure 62

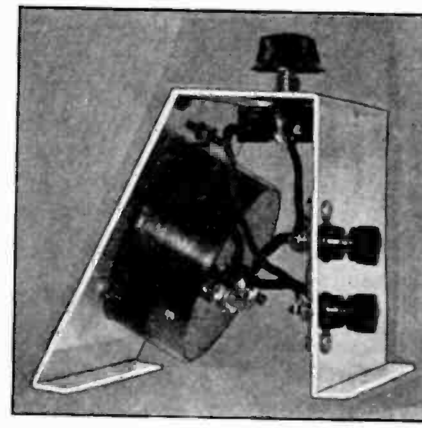


Figure 63

rocking the gang condenser back and forth while making the adjustment. Now recheck at 1400 kc. If an oscillator is not available, align the r.f. circuits first by tuning in good steady station signals at around 1400 and 600 kc. Then when the r.f. end is lined up make the adjustments in the i.f. transformer tuning to bring them into exact alignment.

The protective resistors may now be removed and meter rheostat adjusted so that the meter shows full-scale deflection with the a.v.c. switch "on" but no signal tuned in. The receiver is then ready for use.

When working properly, the receiver should have some tube hiss and more or less background noise, depending on the location, when turned full-on. The tuning should be very sharp in the "manual" position. Though not broader, the tuning will *appear* so in the a.v.c. position.

Two antenna posts are provided for doublet and other types of ungrounded antennas. When an ordinary antenna is used the middle post should be connected to the ground post (chassis).

It should be noted that filament type tubes encourage feedback, or coupling, between stages. Therefore, a receiver with such tubes will be inherently somewhat less stable than a set using unipotential (heater) type tubes. This may not be noticeable, but, for the utmost gain possible, it will pay to experiment a bit with a by-pass condenser (0.1 to 1.0 mfd.) connected from the positive filament to chassis. In this particular set, the condenser had no effect. In another, it may be useful. Additional plate and screen-grid filters consisting of a 10,000 ohm resistor and 0.1 mfd. condenser may permit a bit more gain.

Parts List

C1—Trutest variable condenser, type TRF, 3-gang, .000365 mfd. (each section) with trimmers
C2, C3, C6, C7, C10—Aerovox tubular condensers, type 284, .05 mfd., 200 volt.
C4, C5, C8, C12, C20, C21—Aerovox tubular condensers, type 284, .1 mfd., 200 volt
C14—Aerovox tubular condenser, type 284, .03 mfd., 200 volt
C17—Aerovox tubular condenser, type 284, .006 mfd., 200 volt
C18, C19—Aerovox tubular condenser, type 284 .5 mfd., 200 volt
C9—Aerovox mica condenser, type 1467, .00035 mfd.
C11—Aerovox mica condenser, type 1467, .0001 mfd.
C13—Aerovox mica condenser, type 1450, .01 mfd.
C15—Aerovox mica condenser, type 1467, .00025 mfd.
C22—Aerovox mica condenser, type 1467, .0005 mfd.
C16—Hammarlund oscillator padding condenser, type MICS-1000, .0006 to .001 mfd.
R1, R2, R3—Lynch fixed resistors—100,000 ohms, ½ watt
R4, Electrad volume control, type 272W, 100 ohms
R5—Lynch fixed resistor, 20,000 ohms, ½ watt
R6, R7—Lynch fixed resistors, 250,000 ohms ½ watt
R8, R14—Lynch fixed resistors, 50,000 ohms, ½ watt
R12—Lynch fixed resistor, 1 megohm ½ watt
R9—Electrad volume control, type 203, 500,000 ohms (with special d.p.s.t. snap-on-switch, SW1)
R10, R13—Electrad volume controls, type 205, 50,000 ohms
R.F.C.—National, type 100, r.f. choke
SW1—Electrad switch (see R9)
SW2—Toggle switch, d.p.d.t.
SW3—Toggle switch, s.p.d.t.
T1—Sickles antenna r.f. transformer, type 550
T2—Sickles interstage r.f. transformer, type 551
T3—Sickles oscillator coil, type 570
T4, T5, T6—Hammarlund 175 kc. i.f. transformers, type T-175
T7—United Transformer Company input Class B, 30 to 19, audio transformer, type NS-29
T8—United Transformer Company output Class B audio transformer, plates of 19 to 2000 and 4000 ohms, type NS-33
1—Metal chassis (see Figure 62)
1—Eby triple antenna post assembly
2—Eby 2-gang phone-tip jack strips
1—Trutest airplane type dial, 0-100 divisions
3—Small bakelite knobs, for ¼-inch shaft
1—2-volt, 60 ma. pilot lamp
1—Electrad Tru-volt resistor 1 ohm, 10 watt (used only with air cell battery) adjust
6—Triple lug mounts for supporting small parts
1—9 wire cable, moisture-proof, length 4 feet or more
4—4-prong wafer type sockets
3—6-prong wafer type sockets
2—Goat tube shields, type ST12
3—Goat tube shields, type ST14
4—Rubber grommets, for cushion mounting of variable condenser
1—Type 1A6 tube
3—Type 34 tubes
1—Type 30 tube
1—Type 1B5 tube
1—Type 19 tube

Accessories List

M—Triplett 0-1 ma. milliammeter, type 321, bakelite case (knife edge pointer optional)
1—Pair head-phones
1—Permanent-magnet dynamic, or magnetic type speaker
1—Eveready Air Cell, type SA600, or other A battery
3—45-volt B batteries, medium or heavy duty
3—4½-volt C batteries, tapped
1—Stand for meter
1—Electrad potentiometer, type 272W, 100 ohms (for variable meter shunt)
1—Eby double binding post strip (for meter stand)

A Superhet De Luxe

THE receiver described in this article was designed by B. Gordon Valentine to meet his requirements of an ideal receiving unit. The set offers a number of novelties and is presented primarily for the experienced set builder and for those who will be able to apply such features of this receiver as particularly appeal to them.

The prime requisite aimed at in the tuner—designated V-8 for brevity in future references—was reproduction of broadcast programs—musical numbers in particular—as nearly perfect as could reasonably be expected under existing conditions of channel separation. This meant that in the

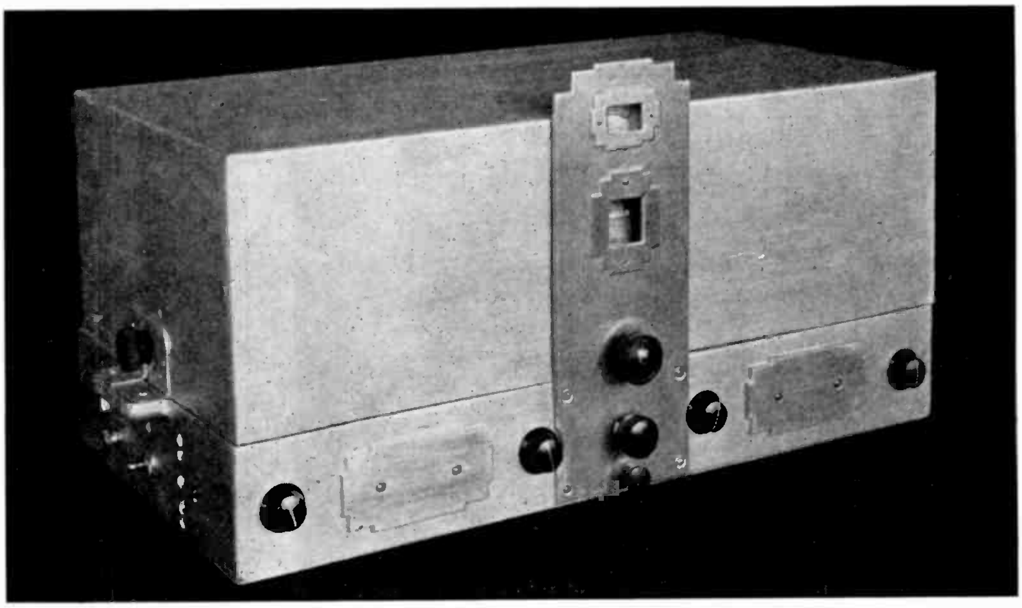


Figure 64

first place, the tuner must be selective. When one considers that to obtain realistic reproductions of musical numbers a wide frequency response is required, the foregoing statement may sound somewhat paradoxical. With 10 k.c. channels however, one must be able to eliminate completely interference from adjacent stations in order to really enjoy any program—even though some sacrifice in fidelity is involved in so doing. When conditions permit, however, it is desirable to have some convenient method for reducing selectivity and thereby improving fidelity. The new variable coupling intermediate frequency transformers introduced recently by Hammarlund provide a ready means for doing this, and their use greatly increases flexibility of operation.

The V-8 is for the broadcast band of frequencies 540-1650 k.c. only, as it was decided that the introduction of all-wave features would involve many complications.

For variety in broadcast reception, particularly in locations at a distance from powerful stations, a tuner should be sensitive—*and the sensitivity should be usable.*

To achieve these various requirements no limitation was placed on the number of controls provided.

With these definite aims in view a circuit was selected as follows: two stages of radio-frequency amplification using 58 pentodes, a 57 modulator and 56 oscillator, two stages of i.f. using 58's, followed by a 56 connected as a diode second detector and a.v.c. tube and, last, a 56 as an audio amplifier. The circuit is shown in Figure 65.

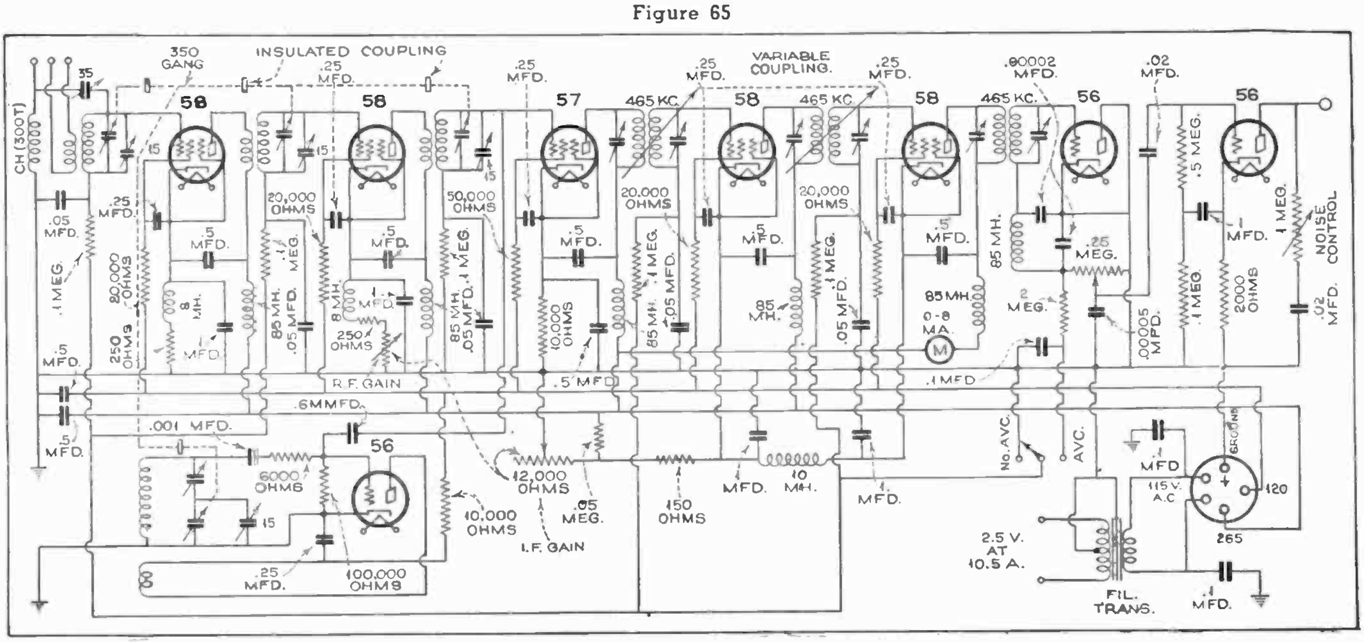
Many layouts were tried, to give the best sequence of stages in arrangement of the chassis, with due regard to simplicity and directness of wiring, etc. A conventional steel chassis and numerous copper shields were made, remade and altered until the original carefully constructed chassis took on the appearance of the proverbial Swiss cheese. It was felt, nevertheless, that experience and information so gained justified the building of another tuner and the hope was entertained that this one would be a more permanent and less ventilated model than its predecessor. Several essentials for the attainment of satisfactory results had been made evident: (1) rigidity of the chassis, (2) more than ordinary care in shielding and filtration, and (3) high grade components. (1) was best met by a casting, and this preference extends to (2) also. Item (3) involved a little higher initial outlay for parts but saved many recriminations and further outlay at a later time.

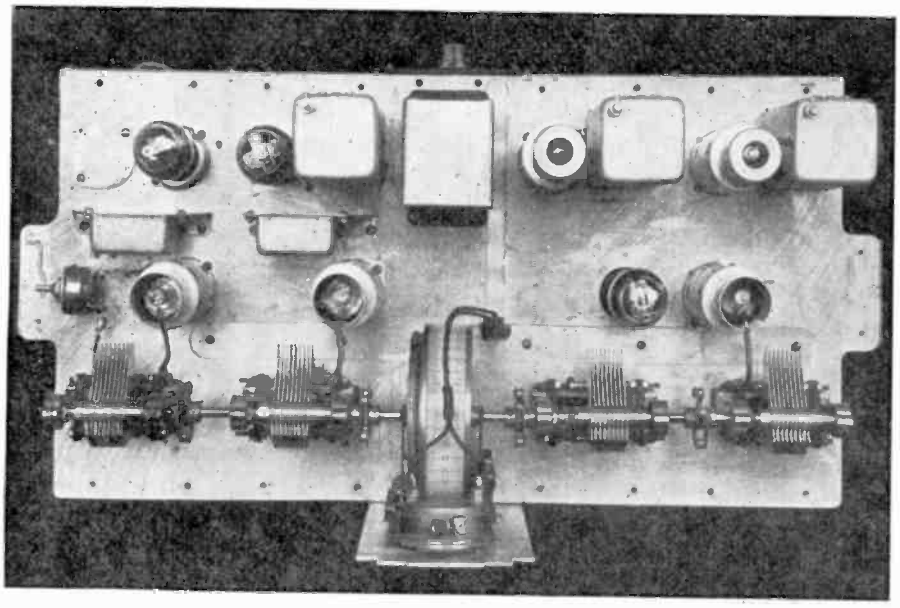
On the strength of these convictions, and giving due consideration to physical size and its relationship to circuit efficiency, an aluminum casting 20¾ inches long, 11 inches wide and 3 inches deep was made from a carefully constructed pattern. An alloy with minimum iron content was used. Figure 68 shows the cellular construction employed. The top and bottom surfaces were disc ground, and grooves milled in the upper surface for wiring. The designer is aware that this class of work may be somewhat out of the realm of the average radio fan, and considers himself fortunate in having facilities for doing it.

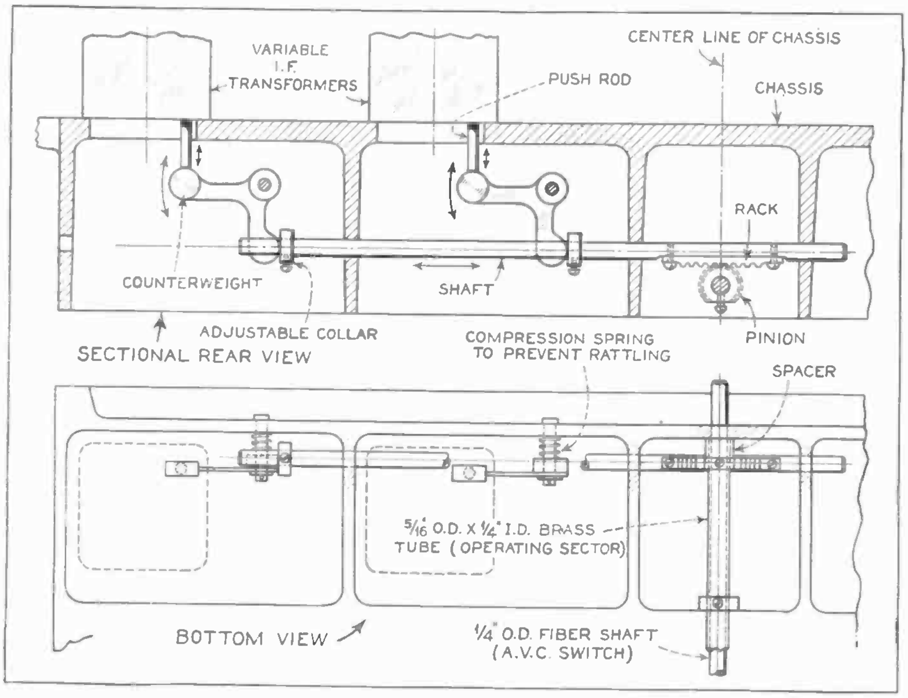
Chassis Arrangement

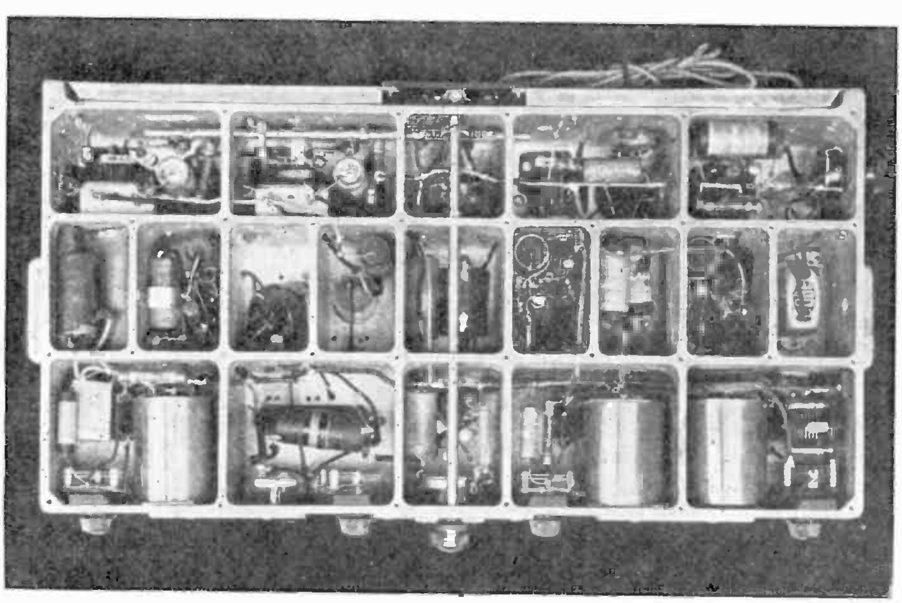
The general arrangement of the chassis is such that the r.f. signal progresses from left to right along the front of the chassis—the modulator being at the right front.

Figure 65









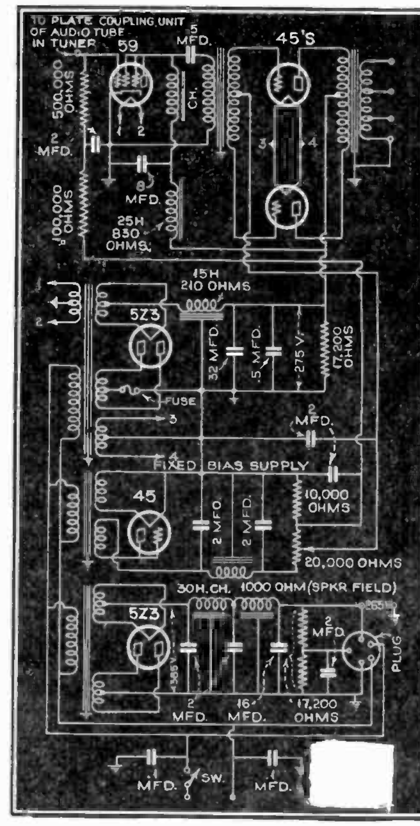


Figure 66—Top Left
Figure 67—Middle Left
Figure 68—Bottom Left
Figure 69—Above

The i.f. signal progresses from right to left along the back. As there was the possibility of the tuner being at some distance from its associated amplifier and power supply a filament transformer was included in the tuner. A 5-pin plug located at the back provides connections for plate, screen, and a.c. line supply, and ground. The enclosed space ½-inch wide at the back of the chassis contains filament, screen and a.v.c. leads for the i.f. amplifier. The output lead from tuner to amplifier is at the left rear where it is removed from other connecting wires. The 265 and 125-volt leads are run in the covered transverse and longitudinal grooves, branches being taken to the various compartments containing tube sockets and filters. A deep longitudinal groove carries the plate lead from the third r.f. transformer to the 2nd r.f. tube plate. This groove is separate from the other. Antenna and ground connections are made to pin jacks through the left-hand wall of the chassis adjacent to the 1st r.f. transformer. The audio volume control knob is located on the left-hand end, toward the back, as shown in Figure 66. This position may seem rather unusual, but was chosen primarily because the potentiometer which it operates is close to the diode where it belongs, and secondly because the tuner is set on top of a speaker cabinet, and the control is convenient to the left hand when tuning with the right hand.

From left to right along the front of the tuner as shown in Figure 64 are 1st and 2nd r.f. trimming condensers, and omitting the controls on the centre panel, the oscillator and 3rd r. f. trimmers. From top to bottom in the center panel are the tuning meter, frequency indicating dial, frequency selector, and i.f. gain control. Below this is what at first sight might appear to be a simple control, but in reality is dual, the large knob controlling the variable coupling of the coils in the first two i.f. transformers, and the hexagon shaped one being the a.v.c.—no a.v.c. switch control. The large knob is attached to a brass tube running through to the back of the chassis where a pinion is mounted on it. The teeth of the pinion engage with those of a rack attached to a push rod sliding transversely in guides in the chassis. This push rod carries collars, each of which bears on one arm of levers whose other arms are in contact with the spring-returned push rods carrying the plate coils, in two of the Hammarlund i.f. transformers. This sounds rather involved, but a glance at Figure 67 should make it clear. Rotation through about 90 degrees of the panel control gives ¾ inch movement of the plate coils, and with the adjustments provided on the transformer push rods and on the rack push rod, any fraction of this maximum movement can be obtained. To prevent rattles developing due to vibration the bell crank levers are slightly loaded at their bearings by means of a light spring mounted on the pivot pin. To offset the effect of friction so introduced, the ends of the levers in contact with the transformer push rods are weighted, thus relieving the springs in the transformers of all duty other than returning the coils to the position of minimum coupling. A control of radio-frequency gain is provided on the left-hand side of the chassis.

As regards choice of intermediate frequency to employ, experience with fixed coupled i.f. transformers tended to show that more gain and better inter-channel selectivity was obtainable using 175 kc. than 465 kc. Using variable-coupling transformers this probably still applies as regards gain, but at that we have more gain available at 465 kc. than can ever readily be used, and any degree of selectivity can be attained.

All grounding is done to a heavy tinned copper bus insulated from the chassis by varnished cambric tubing at all points where it passes through the partitions, and the chassis is connected to this bus at one point only, and that as near to the five-pin connection plug as possible. Furthermore, all tuned circuits are completed independent of the chassis, and independent of each other, by insulating the tuning condensers from the chassis and from each other. In this way eddy currents in the chassis itself are prevented.

As has already been stated, the coupling of the first and second i.f. transformers can be varied. The transformer preceding the diode is set at a fixed degree of coupling.

Though somewhat beyond the scope of this article, the primary purpose of which has been to describe the V-8 tuner, a circuit diagram is given of the amplifier and power supply (Figure 69.) The parallel feed choke in the plate of the 59 triode combined with the .5 mfd. coupling condenser were chosen to favor response to frequencies in the neighborhood of 4500 cycles. The use of fixed bias on the 59 driver and 45 tubes, using Class A prime, allows of obtaining high output and adapts the amplifier to handle the very healthy signals supplied by the tuner. To prevent feed-back both tuner and amplifier are mounted on sponge rubber cushions, and the speaker baffle is similarly insulated from the bounding walls of the cabinet.

The designer makes no extravagant claims for this tuner, but does say that from his own experience, and from that of others who have built it, results justify what may appear to be somewhat unusual methods of construction.

Trap-Circuit Tenatuner

DUE to the variety of input circuits employed in different receivers today, the design of an antenna tuner is somewhat complicated. It was because of this that a comprehensive study of this whole problem was undertaken to determine whether *any* antenna tuner could be worked out to function successfuly with all types of present-day broadcast-band receivers. This study has resulted in the development of the "Trap-Circuit Tenatuner," shown in Figures 70 and 72, which incorporates five different circuits—three of which are antenna tuning circuits and the other two wave trap circuits, any of which is selected by a flip of the switch (SW2).

A really amazing kick-up in signal voltage is obtained by tuning the antenna —as proven by *actual measurements* made in testing out this unit. For instance, in the RADIO NEWS Broadcast Band Listening Post in New York City, using a superheterodyne receiver equipped with means for actually measuring signal inputs, a group of stations were tuned in and their signal voltages measured with and without tuning the antenna. These measurements *showed an average improvement of* 820 *percent in signal voltage when the antenna was tuned.* A DX signal so weak as to be inaudible can be brought up to moderate loudspeaker volume through the use of this Tenatuner. Figure 71 shows the complete schematic circuit.

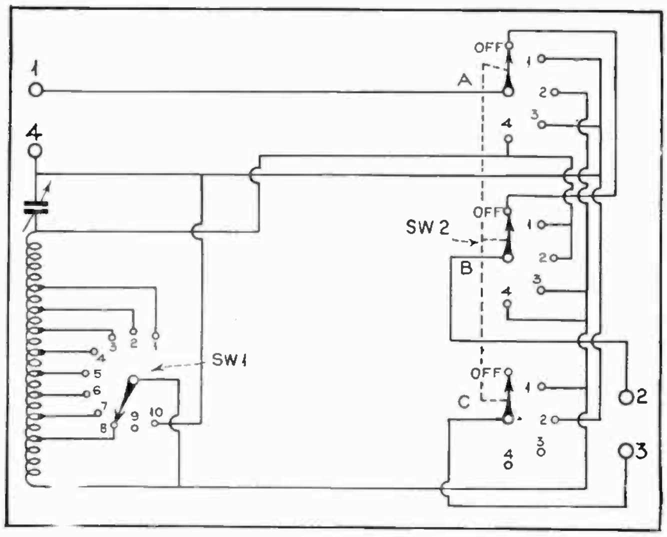


Figure 71

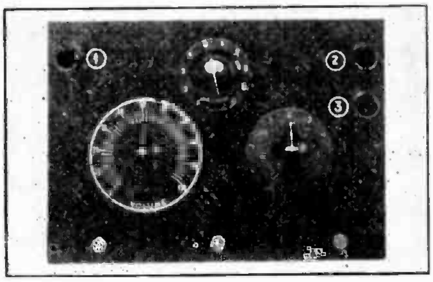


Figure 70

Figure 73 shows at (B), (C), and (D) the three antenna tuning circuits of this unit. (D) is the conventional series tuned circuit while (B) and (C) are series parallel circuits. In general, circuit (D) is most effective with receivers having low-impedance inputs while (B) and (C) are most successful with receivers having medium- and high-impedance inputs. It is not always possible to say in advance which one of these three circuits will work best with any one receiver but an instantaneous change from one circuit to the other is obtainable by means of the circuit selector switch SW2. In using this Trap-Circuit Tenatuner therefore it is only necessary to connect it ahead of your receiver. This is accomplished by connecting your antenna to terminal 1, the antenna binding post of your receiver to terminal 2 and the grounded ground binding post of your receiver to terminal 3. Then when SW2 is set in the "off" position the tuning unit is automatically short-circuited, connecting the antenna direct through to the receiver. In position 1 the tuner functions as circuit (B), in position 2 circuit (C) is in use and in position 3 the circuit becomes the series tuned one shown in (D). A little experimenting with this switch in position 1, 2, and 3 will show which of the three positions is most effective with your particular receiver.

The circuits (E) and (F), Figure 73, are wave-trap circuits. (E) is intended primarily for use in superheterodynes having an intermediate frequency around 465 kc. and is used to eliminate interference picked up at the intermediate frequency. It will also function as a wave trap over a good part of the broadcast-band. If there are powerful local stations toward

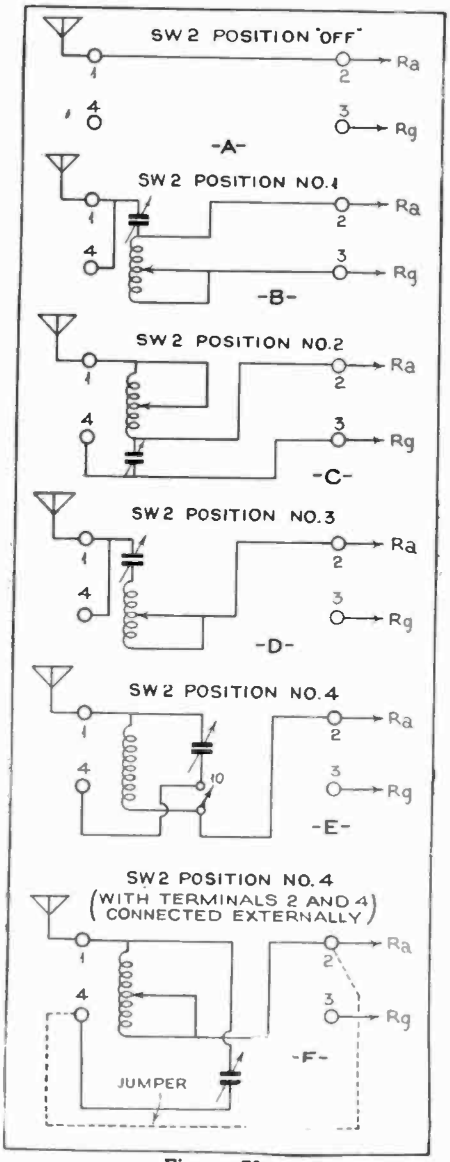


Figure 73

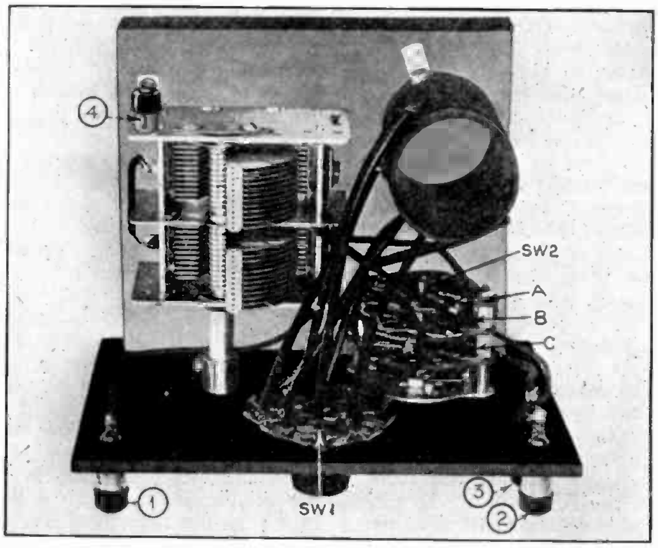


Figure 72

the high-frequency end of the broadcast-band which cannot be trapped out with circuit (E) then circuit (F) will do the trick because in this circuit the inductance can be reduced by means of tap switch SW1 whereas in circuit (E) the tap switch (SW1) must be set on tap 10 and the entire inductance is therefore in the circuit at all times. In using circuit (F) it is necessary to connect an external jumper between terminals 2 and 4 of the tuning unit. This is the only circuit of the six that requires this special external connection.

The switch SW2 employed is one of the new Yaxley type gang switches. These switches are supplied with the sections widely spaced and with a shaft several inches long. For purposes of compactness this switch was taken apart and the shaft and spacers cut down. If the constructor follows this example, he will not find it a difficult task but he must be sure that all parts are reassembled following the original alignment, etc. If one of the old type Yaxley gang switches can be obtained this operation will be unnecessary as this older type was supplied with narrow spaced sections. Or, if the constructor is not particularly interested in compactness the new Yaxley switch can be used without attempting to cut down its size. SW1 of the model unit is one of the old type Yaxley switches which happened to be on hand. Either the new or the old type can be used here.

The coil is home made. It consists of 135 turns, tapped at every 15th turn by twisting a small loop in the winding. The specifications are given in the list of parts. The switch SW1 is connected so as to short-circuit the unused portion of the coil. Thus, when this switch is set on tap 1 there are only 15 turns in the tuned circuit, 30 turns at tap 2, etc. When set on tap 9 the entire coil is in the circuit—also when set on tap 10. Tap 10 is used only when employing the wave trap circuit (E).

The actual construction of the Trap-Circuit Tenatuner is so simple that the average reader will require no elaboration here. For the inexperienced constructor complete working blueprints are available and may be obtained from RADIO NEWS, Blueprint Department, at 25c the set. These blueprints make the construction so simple that even the veriest novice will have no difficulty in assembling and wiring the parts.

The two sections of the gang condenser are used in parallel. This is accomplished by simply connecting the terminal lugs of the two stators together. The binding post which serves as terminal 4 is mounted directly in one of the holes provided in the rear of the condenser frames.

List of Parts

1 "Trutest" variable condenser, 2 gang, .000365 mfd. each section, with ¼ inch shaft coupling
1 Yaxley single-deck 10-point switch (SW1)
1 Yaxley 3-deck 6-point switch (SW2)
1 Yaxley dial scale, Type 384 (for SW2)
1 Yaxley dial scale, Type 380 (for SW1)
1 Calibrated dial or calibrated scale and knob (for variable condenser)
4 Binding posts
1 Bakelite tube 1¾ inch outside diameter, 3¼ inches long (for coil form)
1 Bakelite or wood panel, 5 inches by 7 inches by 3/16 inch
1 Baseboard, 5 inches by 6 inches by ¾ inch
1/16 pound No. 28 double silk covered wire
3 Right-angle mounting brackets, ½ inch (for mounting variable condenser)
Push back wire, spaghetti tubing, etc.

Radio News Blueprints

Complete sets of construction "blueprints" including full-scale picture wiring diagrams, chassis specifications, drilling layouts, etc., are available on the following radio apparatus described in this book:

"RADIO NEWS SHORT-WAVE CONVERTER"—described on pages 24 and 25—Price 50c.
"RADIO NEWS 2-VOLT DX'ERS SUPER"—described on pages 34, 35 and 36—Price 50c.
"RADIO NEWS TRAP-CIRCUIT TENATUNER"—described on pages 39 and 40—Price 25c.
"RADIO NEWS DX CONVERTER"—described on pages 41 and 42—Price 50c.

RADIO NEWS
AND SHORT WAVE RADIO
461 Eighth Avenue **Blueprint Dept.** **New York, N. Y.**

Broadcast-Band DX Converter

IF you are using a superheterodyne receiver this converter connected ahead of it will result in a "double super" or "triple detection" circuit—a type of circuit which is finding increasing popularity among the trans-oceanic commercial telephone receiving stations in this country and abroad. It will increase both sensitivity and selectivity of your present superheterodyne without introducing complications of any kind. If, on the other hand, you are using a tuned r.f. receiver this new converter makes a superheterodyne out of the combination, with increased selectivity and an increase of approximately one hundred times in sensitivity.

When used in connection with any type of receiver, the receiver is tuned to the low-frequency end of its range, 540 kc. or thereabouts, and thereafter all stations are tuned in on the single dial of the converter. The converter circuit consists of one r.f. stage, oscillator, and detector. Any signal tuned in is converted to the low frequency to which the regular receiver is tuned. The result is that the signal input to the receiver from the converter is vastly greater than the signal produced by the antenna. Furthermore, the addition of the three tuned signal circuits of the converter naturally provides a very decided increase in selectivity.

After the final model of the converter was completed it was tried out with approximately a dozen different receivers of both the standard and home-made varieties —receivers ranging all the way from a two-stage tuned r.f. job up to a 19-tube superheterodyne. In every case the converter worked with extreme satisfaction and without any objectionable characteristics.

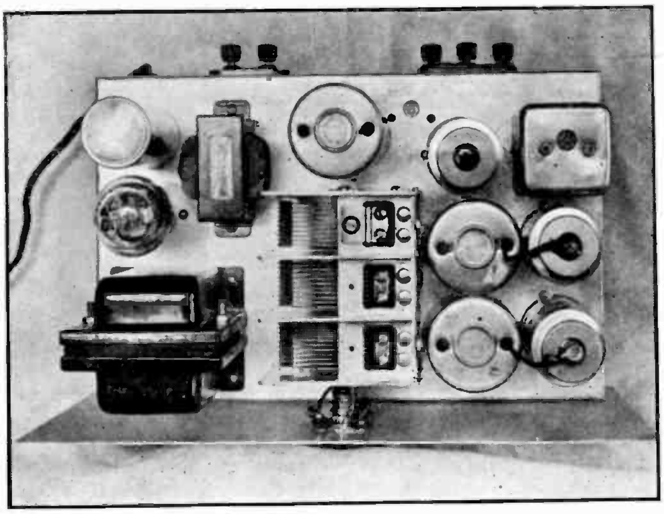


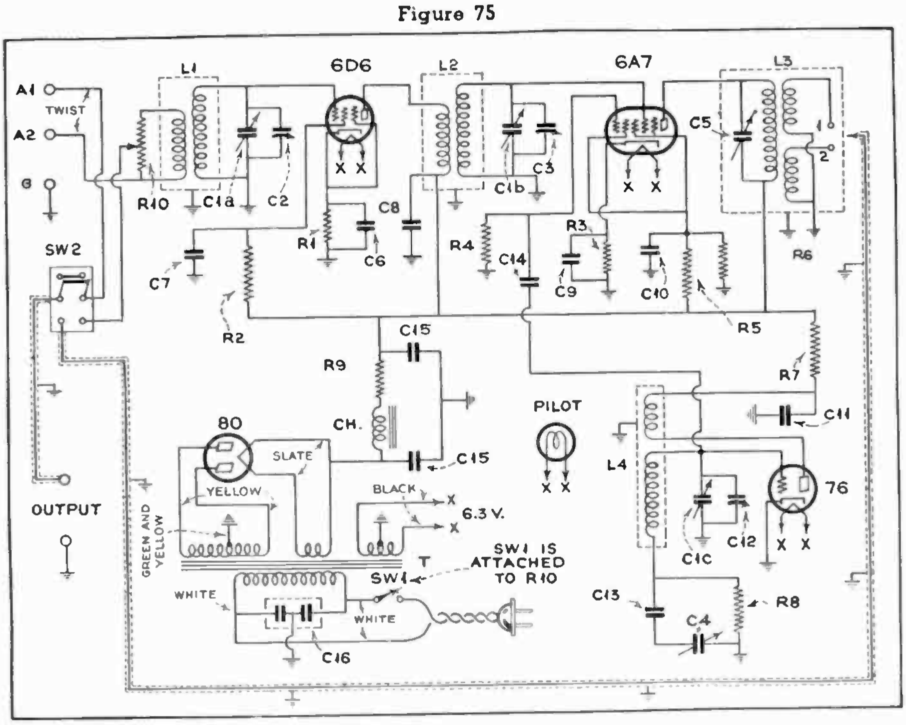
Figure 74

Simple to Build

In working out the design of this new converter, the thought was borne in mind, constantly, that its construction would be undertaken by many DX'ers of little experience in building radio equipment. To further this end, RADIO NEWS has arranged with a radio mail order company to make available a foundation kit which includes all of the essential parts—a completely drilled chassis, special coils, gang tuning condensers, trimmer condensers, etc. By following the picture wiring diagram provided in the special set of blueprints which include an enlarged photo of the under-chassis wiring, a full-size chassis layout, and a chassis drilling template for those who prefer to make the chassis themselves, even the novice can do the wiring without difficulty. The blueprints may be obtained by sending 50c to RADIO NEWS Blueprint Department, 461—8th Avenue, New York City. Bottom and top views are shown in Figure 74 and 76.

As indicated in the circuit diagram, Figure 75 the tubes employed are 6D6 r.f. amplifier, a 76 oscillator, a 6A7 oscillator coupling tube and detector, and a type 80 rectifier. The r.f. stage, detector and oscillator are tuned by a 3-gang condenser. To insure absolutely accurate alignment at all frequencies within the broadcast band, the trimmer condensers in the r.f. and detector circuits are brought out to the front panel. This is an advantage because in receiving far-distant stations these controls can be adjusted as necessary for *exact* resonance. Small midget condensers are used for this purpose. If mica trimmer condensers are found on the front and middle sections of the gang condenser they should be removed by taking out the adjustment screws and breaking off the flexible plates. The trimmer condenser on the rear section of the main condenser should be left intact, as this is employed as the oscillator trimmer.

Figure 75



Matches Set Impedance

The output transformer is a special one designed for this converter. Its primary or plate coil is tuned. Two untuned secondaries are provided, one low-impedance and one high-impedance. When connecting the converter to a receiver, each of these secondaries should be tried and permanent connections made to the one which produces the loudest signal. In making this test it will be necessary to retune the primary of this transformer, as the shift is made from one secondary to the other.

The switch SW2 is the antenna switch. When thrown to one side it connects the antenna to the converter input and connects the converter output to the receiver. Thrown to the other side, it connects the antenna direct to the receiver for normal operation.

Connecting to Set

The converter is connected to the receiver by means of either a twisted pair or a single-conductor shielded lead with the shield serving as the second lead (ground). The use of a twisted pair is recommended because of its lower capacity. However, if the receiver or converter show

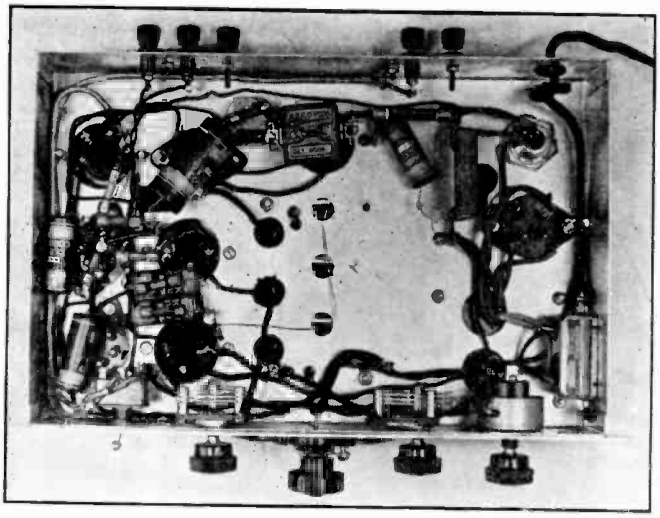


Figure 76

any signs of instability it will be necessary to substitute a shielded lead for the twisted pair.

When the converter is completed it should be connected to the receiver and the receiver tuned to its lowest frequency. If an ordinary antenna is employed, connect it to one of the antenna posts and connect the other to the ground post. The "ground" may be connected to the ground post on the converter or on the receiver. If any type of 2-wire antenna lead-in is used, connect the leads to the 2 antenna posts of the converter.

Tune the output transformer of the converter to the point which produces maximum noise in the loudspeaker output. The alignment of the oscillator and r.f. circuits can then be tackled, following the usual routine in aligning superheterodyne input circuits. If an oscillator is available so much the better, but if not the job can be done readily using broadcast station carriers.

When the alignment has been completed it will be found that the tuning range of the converter covers from approximately 1600 k.c. to 540 k.c.

The last step is to try the other secondary of the output transformers, retuning the primary of this transformer. Then make the final connections to the coil which produces best results.

In closing it should be pointed out that the full benefit of the converter will not be noticeable with a receiver having automatic volume control unless the test is made on a very weak signal. Where such a receiver is used the extra gain provided by the converter is offset by the action of the a.v.c. on anything but very weak signals. If the receiver is equipped with a tuning meter the tremendous increase in signal voltage provided by the converter will be quite apparent on the meter. During tests of the converter in New York many out-of-town stations kicked the tuning meter up full scale, whereas without the converter even the local stations would not register full scale on the meter.

One final suggestion is that receivers be operated at relatively low gain in cases where there is a manual sensitivity control and assuming that the receiver itself is capable of fairly high gain. This, in effect, will mean that the i.f. amplifier is working at low gain and will result in the best possible signal to noise ratio.

List of Parts

The Foundation Kit

L1, L2, L3, L4—Set of special "Radio News DX Converter" coils
C1—Tuning condenser, 3-gang, each section—405 mmfd.
C2, C3—Hammarlund midget condensers, 4-plate, 50 mmfd.
C4—Special compression type padding condenser variable 800-1600 mmfd.
C5—Supplied (built-in) with coil L3
C12—Trimmer included in C1
C13—Fixed mica condenser, .00065 mfd.
1 Cadmium-plated, drilled chassis with panel welded in position; 4 tube sockets, 3 tube shields, 2 binding-post strips. Chassis 12 inches long, 7½ inches deep, 2 inches high. Panel 13 inches long, 8 inches high.

Other Parts Required

C6, C7, C9, C10, C11—Sprague tubular by-pass condensers, 1 mfd., 600 volts peak
C8—Sprague tubular by-pass condenser, .5 mfd., 600 volts peak
C14—Solar Mica condenser, pigtail type, .0001 mfd.
C15—Mallory 2-section (8-8 mfd.) electrolytic condenser with grounded can, inverted type, 450 volts
C16—Sprague 2-section by-pass condenser in shield can, .1-.1 mfd., 400 volts
Ch—Thordarson type T-4402 filter choke
R1, R3—IRC pigtail resistors, 250 ohms, ½ watt
R2, R6—IRC pigtail resistors, 50,000 ohms, ½ watt
R4—IRC pigtail resistor, 5000 ohms, ½ watt
R5—IRC pigtail resistor, 30,000 ohms, ½ watt
R7—IRC pigtail resistor, 10,000 ohms, 1 watt
R8—IRC pigtail resistor, 10,000 ohms, ½ watt
R9—Electrad wire-wound resistor, 2000 ohms, 10 watts
R10—Electrad 15000 ohm potentiometer, type 201, with switch
SW1—See R10
SW2—Toggleswitch, d.p.d.t.
T—Thordarson power transformer, type T-5472 with secondary windings of 575 volts (c.t.), 5 volts and 6.3 volts (c.t.)
1 National "Velvet Vernier" dial, type B, with variable ratio, 100-0-100 scale and pilot light bracket
2 grid caps
1 line cord and plug
Shielded wire (about 5 feet)
Tubes, one 6D6, one 6A7, one 76, one 80

Free Information Service

If you require any further information regarding parts, wiring or operating data on the radio apparatus described in this book, mail us a postcard with your questions. The information will be furnished promptly — absolutely free of charge.

RADIO NEWS

AND SHORT WAVE RADIO

461 Eighth Avenue **New York, N. Y.**

SERVICING AND SOUND EQUIPMENT

Using The Cathode-Ray Oscillograph

THE cathode-ray tube is an electron gun which projects a stream of electrons along the length of the tube. At the end of the tube, a screen is provided. This is coated with salts which glow when bombarded by the electron stream. Properly focused by controls provided in the energizing circuits, the electron stream is seen on the screen as a small green spot.

The electron stream on its way to the screen passes between two sets of plates, one of which is mounted in a horizontal plane, and the other in a vertical plane. Considering any one pair of plates, it is apparent that polarizing one plate negatively and the other positively will cause the electron stream to be attracted or bent towards the positive plate. This bending motion will be proportional to the voltage applied.

Thus it is seen that the beam acts as the pointer on a voltmeter, although it actually has two properties that make it superior for many measurements to this simple analogy, namely: the electron stream has no inertia and so is able to follow the most instantaneous voltage variation applied to the plates; and it cannot break off or be damaged by too-high potentials.

It is customary to call the pair of plates which lie in the horizontal plane, the "vertical" deflecting plates, since they are effective in deflecting in the vertical direction. Likewise the other set of plates are called the "horizontal" plates. This terminology will be used throughout the discussion.

Figure 77 shows a self-contained a.c. operated oscillograph with the tube mounted in the top section and the power supply and 60-cycle sweep supply in the lower section.

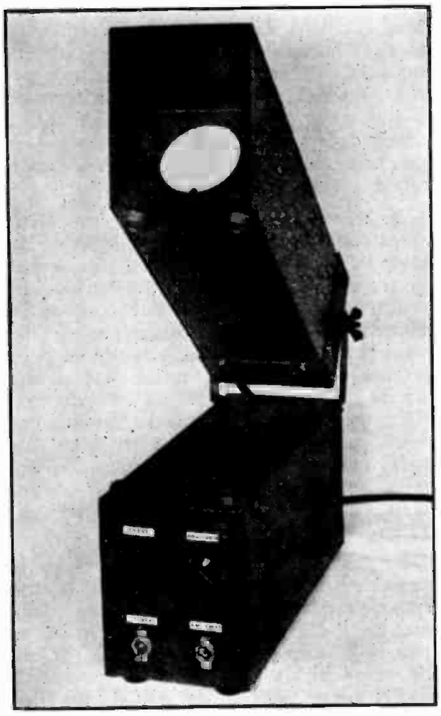


Figure 77

In most commercial tubes, such as the type 906, one vertical and one horizontal plate are connected together and grounded within the instrument case. In order that the polarity of the deflections shall correspond to that ordinarily used in electrical terminology, the tube is held in its mount as shown in Patterns 1 and 2, Figure 78, with the "free" plates at the right and upper side when viewed from the front of the tube.

In this way positive voltages applied to the free horizontal plate will deflect the beam to the right and positive voltages applied to the free vertical plate will deflect the beam upwards. It is important to keep this fact in mind when dealing with measurements in which polarity is an important consideration.

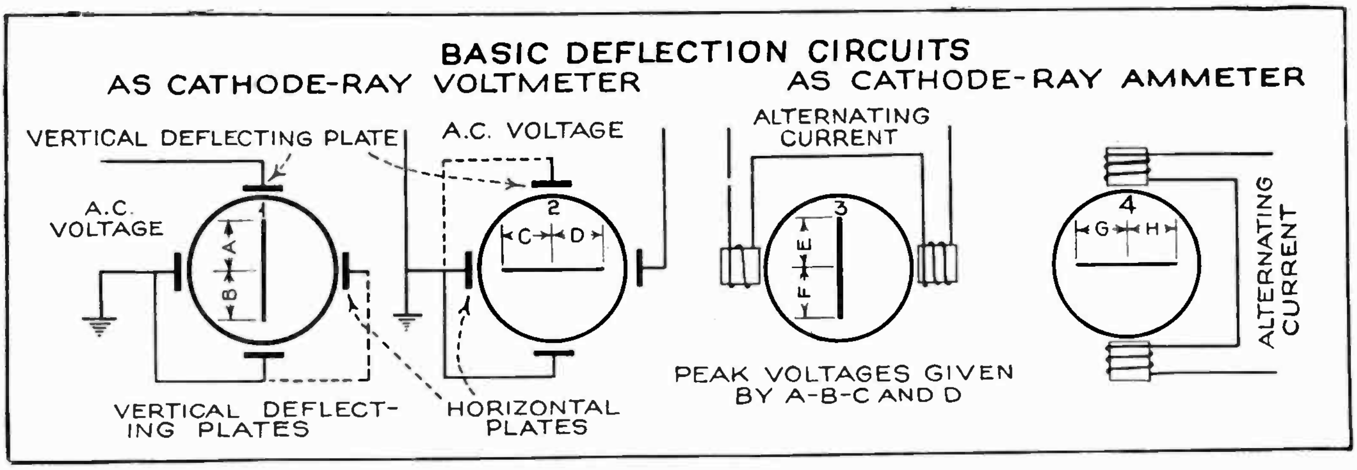
If an a.c. potential is applied to the "vertical" plates as shown in Pattern 1, the spot is deflected up and down, giving a straight line trace as indicated in the figure. Likewise a horizontal straight line trace will result if the voltage is applied to the horizontal plates as shown in Pattern 2. By scaling the distances "a" and "b," or "c" and "d," the peak voltages of the wave causing the deflection will be obtained. In the event that a quantitative measure of the peak voltage is needed, a scale may be provided on the face of the tube and calibrated by the application of known voltages from batteries or by a sinusoidal a.c. wave making calibrations of the scale at various distances from the center of the "zero" spot of the tube.

It should be noted in Patterns 1 and 2 that the deflecting plates have been drawn outside the tube for illustration purposes, but are actually enclosed within the bulb to secure the highest possible deflection sensitivity.

In some circuits there is not enough voltage available to deflect the spot across the screen, although such circuits may carry currents of considerable magnitude. Magnetic deflection of the beam may be used in these cases. This is illustrated in Patterns 3 and 4, Figure 78. By the application of an external coil, the tube has been caused to act as an ammeter, the electron beam being deflected by the magnetic field set up by current in the coils.

This deflection can be calibrated against a scale in the same manner as a voltage, by applying measured values of direct current through the coils and noting the re-

Figure 78



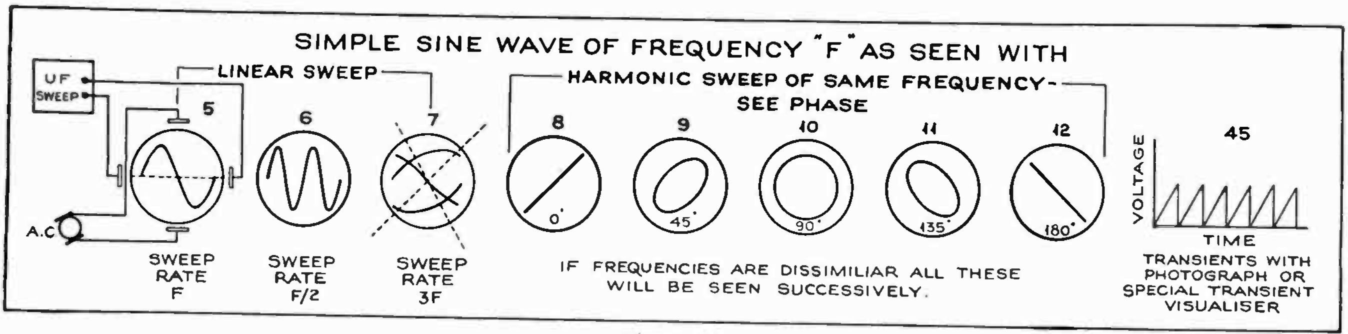


Figure 79

sulting deflection. The amount of deflection indicates the peak current value. Reference to Patterns 3 and 4 shows that the deflection of the beam is at right angles to the common axis of the coils.

In some measurements it is of value to read current along one axis of the screen and voltage along the other. This can be done by applying a set of coils to cause deflection in the desired direction and using one set of plates to cause a deflection at right angles. The unused deflecting plates should be shorted and grounded.

Basic Patterns

The most useful applications of cathode-ray equipment come from its ability to show not only the peak value of a wave but also its value at all points of the cycle. In addition, other data such as phase and frequency relationship can be observed by applying the tube to the circuit under test in the correct manner.

Thus if separate generators or sources of a. c. voltage are attached to each set of plates and they are of the same frequency and in phase, a straight line trace, tilted at some angle will result as in Pattern 8 (Figure 79). If the voltages are of the same value, the tilt of the line will be 45 degrees. Should the generators be out of phase, then figures will be produced such as shown in Patterns 9 to 12. Below each is marked the difference in phase between the generators producing the pattern.

A slight difference in frequency between the generators will cause the figures produced on the screen to wax and wane through the complete range of figures illustrated in Patterns 8 to 12, and the difference in frequency causes the instantaneous phase relationship to shift. Thus the appearance of the pattern will be that of a hoop rolling over and over, and the rate of the rolling will be that of the difference between the frequencies of the two generators.

This is the simplest application of the principles of Lissajou's Figures. Such figures are extensixely used for comparison of an unknown frequency with a known one for frequency calibration. These patterns take the form of "figure eights" or more complex forms. They are illustrated in most elementary physics texts.

Suppose that instead of an ordinary source of a. c. voltage, a special voltage generator such as the Clough-Brengle Model UFS-A Linear Sweep is connected to the "horizontal" plates of the cathode-ray tube. This unit is an oscillating circuit in which the charge and discharge of a condenser is governed by a gas filled triode tube. Its output voltage wave is graphed in Pattern 45, and is sometimes called a sawtooth wave.

If this wave is applied to the horizontal deflecting plates of the cathode-ray tube as in Pattern 5, a trace represented by the dotted line of this illustration, will result. This is not the same trace as in Pattern 2, due to the difference in the wave producing it. What actually happens is that the spot starts at the left of the screen and moves across to the extreme right and then snaps back to the starting point in such a short time that the material of the screen does not glow on the return. This operation repeats continuously as shown in the graph of voltage, Pattern 45.

Suppose an a. c. sine-wave generator is connected to the "vertical" plates of the cathode-ray tube as in Pattern 5. (This may be the ordinary 60 cycle a. c. power line if it is free from harmonics.) If the linear sweep is now adjusted so that it pulses every 60th of a second, the sinusoidal variation of the potential from the a. c. generator will be plotted across the screen of the tube as indicated by the solid line curve in Pattern 5. In order for such a pattern to be stationary and readily observable the rate of the sweep circuit must be in absolute synchronism with the frequency of the voltage being observed. This is accomplished in practice by using a little current from the generator or other source being investigated, to control the timing of the voltage pulses from the linear sweep. When the oscillating circuit of the linear sweep is adjusted to approximate synchronism with the observed wave, the control circuit holds the pulsing of the linear sweep in constant ratio to the observed wave, resulting in a steady pattern on the screen, despite drifting of the observed potential's frequency.

If instead of setting the linear sweep to a 60 cycle rate, it is set to a 30 cycle rate, then two cycles of the 60 cycle current applied to the "vertical" plates would occur while the spot is driven horizontally across the screen by the linear sweep potential. Thus the steady pattern will be that of two cycles of the observed voltage rather than a single one. Such a figure is shown in Pattern 6. It is the same wave sine shape as in Pattern 5, but the pattern is compressed horizontally to accommodate the two waves. In the same way, the sweep frequency may be set to other submultiples of the observed frequency to show more cycles of the same voltage phenomena.

A frequent error in the adjustment of a linear sweep is to set the sweep frequency at a rate greater than the frequency of the observed voltage. In this case the spot traverses horizontally before the observed cycle has completed, with the result that a multiple trace is seen. Pattern 7 illustrates the trace caused by sweeping at 180 cycles while attempting to observe a 60 cycle voltage.

Therefore it must be borne in mind that the number of cycles which will be viewed on the screen depends upon the ratio of the observed frequency to the sweep rate. This ratio must be an even multiple, and greater than one. Multiple traces occur while securing adjustment, but they are not useable.

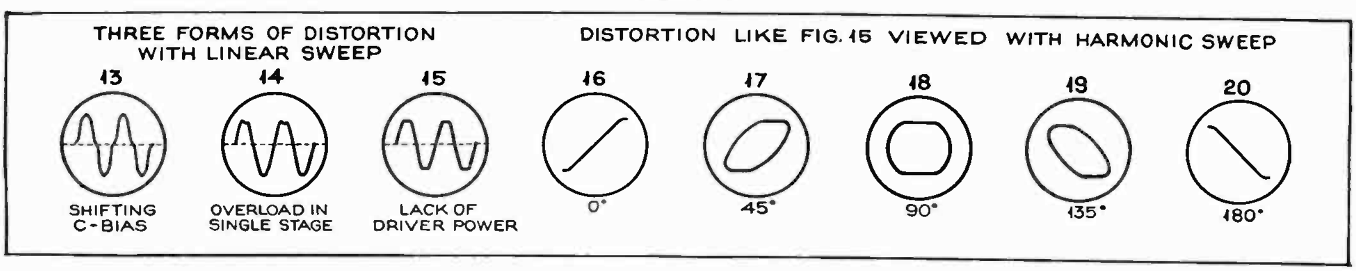
In some measurements, a sinusoidal voltage is applied to the horizontal plates as was done in the construction of Patterns 8 to 12 and as will be done in some of the subsequent patterns. When this is done the sweep voltage is referred to as a harmonic or sinusoidal sweep.

It should be noted that in many measurements the use of the harmonic or linear sweep yield the same information if the pattern can be properly interpreted. In many cases, however, the linear sweep yields patterns which are more easily interpreted, though in other types of measurements there is little choice in the selection of the proper type of sweep voltage.

An important application of this equipment is in observation of the performance of public address amplifiers and speech amplifiers for use with radiophone transmitters.

In examining performances of the amplifier, it will be convenient to use for input potential to the amplifier, a variable frequency audio oscillator, although, much

Figure 80



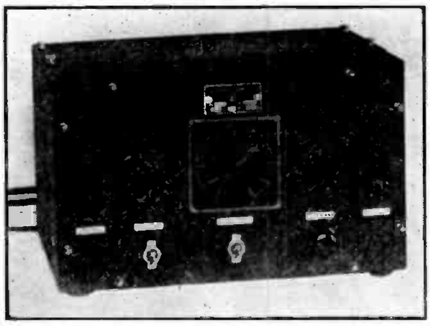


Figure 81

may be learned by the use of 60-cycle line voltage to drive the amplifier. A simple potentiometer will serve to reduce the voltage of the source to the proper level for the amplifier. The cathode-ray tube is connected to the high end of the potentiometer thereby securing sufficient voltage for good horizontal deflection when the linear sweep is not used.

When the harmonic sweep is used, having the same frequency as the signal, the undistorted condition for the amplifier will be one of those shown in Patterns 8 to 12 incl. If the input and the output of the amplifier are exactly in phase, the straight line of Pattern 8 will result. Varying degrees of phase relationship will produce the succeeding patterns.

It will be recalled that in a perfect amplifier, the phase of the signal voltage reverses or alters by 180 degrees with each stage of amplification. In the average amplifier this condition is altered by the presence of coupling transformers or condenser reactances, so that this condition does not actually exist. Were this not the case, Patterns 8 or 12 would indicate the undistorted condition dependent upon the number of stages embodied in the amplifier. Phase relationships in an amplifier for public address or speech amplification in a transmitter, are not the most important consideration.

The important thing is to be able to recognize the Patterns 8 to 12 inclusive, as being one and the same thing as far as wave distortion is concerned, but having different phase displacements as a secondary consideration.

Analyzing Distortion and Hum

Connecting the output of the amplifier to the vertical deflecting plates and employing a linear sweep circuit as shown in Figure 81, adjust the sweep frequency to one-half the frequency of the signal passing through the amplifier, then turn the potentiometer up until the pattern takes on one of the forms shown in Patterns 13 to 15 (Figure 80). These are the distorted forms of the pure sine waves shown in Pattern 6 (Figure 79).

Three common cases of distortion are illustrated by these patterns. Pattern 13 shows flattened crossings at the zero of the wave and is commonly formed with an amplifier of the Class B or AB type in which the bias shifts to a value too high when driven to full output. With this abnormally high bias, the zero of the wave is passed by the signal voltage below the plate-current cut-off, or so low that the slope of the plate-current voltage is less than normal. This results in the plate current not rising in proportion to the change in grid voltage over a small interval.

Pattern 14 shows an amplifier in which a single-ended tube is incorrectly biased, or is too small to carry the signal voltage at full output. Note that the wave is sinusoidal on the lower side and cut off on the upper side. With such a pattern it sometimes is helpful to remove the upper plate of the oscilloscope from the output stage and connect back to the preceding plate circuit in order to locate the offending stage.

Pattern 15 shows a flattening on both positive and negative peaks. This may be caused by one of several circuit defects, but is most likely in a push-pull stage. This pattern, in comparison with Pattern 14, illustrates an important rule to bear in mind: In general, distortion exhibited on one side of the wave indicates circuit difficulties in connection with a single-ended amplifier stage, while distortion which is symmetrical on both sides indicates circuit difficulties in a push-pull stage.

Thus Pattern 15 might be caused by a push-pull stage improperly biased so that grid current was drawn by one tube on each half cycle, or it might be due to a Class B stage operated from a power supply of such poor regulation that adequate voltage is not supplied for the peaks of the cycle. It could also be due to incorrect driver transformer ratio. The important point is that the difficulty is indicated and the results of each circuit change can be observed on the screen of the cathode-ray tube.

It is a little more difficult to recognize the various forms of distortion when the linear sweep is dispensed with and the harmonic sweep is used. With a little careful analysis, however, all forms of distortion can be detected. By way of illustration, the distortion Pattern 15 has been redrawn in Patterns 16 to 20 to show how this distortion appears for various phase relationships between the input and output voltages of the amplifier.

By comparing these patterns with previous ones, the effect of distortion on the pattern as observed with the harmonic sweep will be made clear. In some similar manner, the types of distortion in Patterns 13 and 14 will reshape the true straight line, ellipse or circle which should show on the screen if there is no distortion in the amplifier.

Hum can be observed with the linear sweep circuit. It is convenient to connect the control circuit of the sweep to the power line in order to maintain a constant pattern. The input to the amplifier is now reduced to zero. Due to the many circuit elements in an amplifier which contribute to the hum, particularly in high-gain types, the hum output is seldom a simple sine wave, but is usually more complex. Pattern 21 (Figure 82) illustrates such a hum with the sweep rate set at 60 cycles. Note that at this sweep rate the trace crosses the zero axis four times, indicating that the principal component of hum is 120 cycles. This is evidence that the hum is probably set up in a poorly filtered full-wave rectifier circuit or is caused by induction from a power choke to an input transformer. 60-cycle hum would be traceable to a poorly filtered half-wave rectifying circuit or to induction from a power transformer to the input circuits.

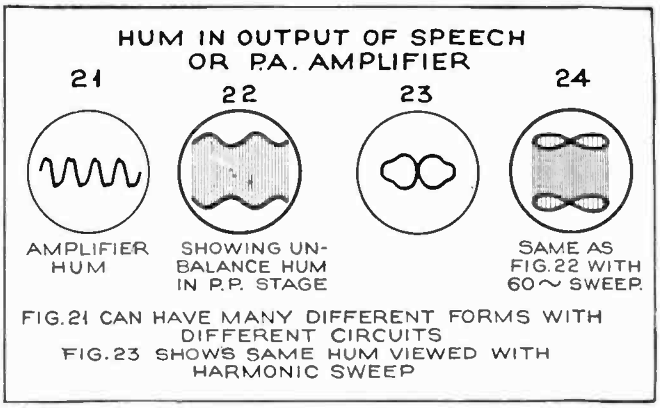


Figure 82

The same type of hum pictured in Pattern 21 with the linear sweep would appear as Pattern 23 if the harmonic 60-cycle sweep were used. Here the "figure 8" characteristic indicates that the basic hum frequency is 120 cycles. A distorted closed single loop would indicate a strong 60-cycle component of hum.

Measurements across the filter condensers of a power pack can frequently give desirable information when made in this same way. For this, a condenser of proper voltage rating and about ½ mfd. is connected in series with the vertical deflecting plates to eliminate the d.c. component across the condenser.

The peak magnitude of the voltage across the condenser can then be noted, and assurance obtained that the peak voltage does not bring the operation above the safe rating of the filter condenser.

A peculiar and often puzzling characteristic of push-pull stages can be pictured with cathode-ray equipment. Often, a push-pull amplifier which shows very little hum without signal will produce considerable hum when excited. If this excitation is music or speech, the existence of hum is too variable to be identified as such, but may in many instances be sufficiently high to cause "hash" in the reproduction.

This signal or modulation type hum can be investigated with a harmonic or a linear sweep circuit, but in either case an oscillator of some frequency other than 60 cycles must be used for the driver signal. It should preferably be in the neighborhood of 1000 cycles.

The control circuit of the linear sweep must be connected to the power line and the sweep rate adjusted to either 60 or 30 times per second. If unbalance or signal hum is present, a trace such as Pattern 22 will result.

The solidity of the pattern is due to the "filling-in" effect of the high signal frequency employed, while the depth of the "hum envelope" indicates the degree of unbalance hum which is present. Hum of this character is invariably found in amplifier designs where it is necessary to carefully select push-pull tubes by pairs in order to reduce the hum under the no-signal condition. Pattern 24 will result if signal hum is present.

A. C. Operated Pre-Amplifier

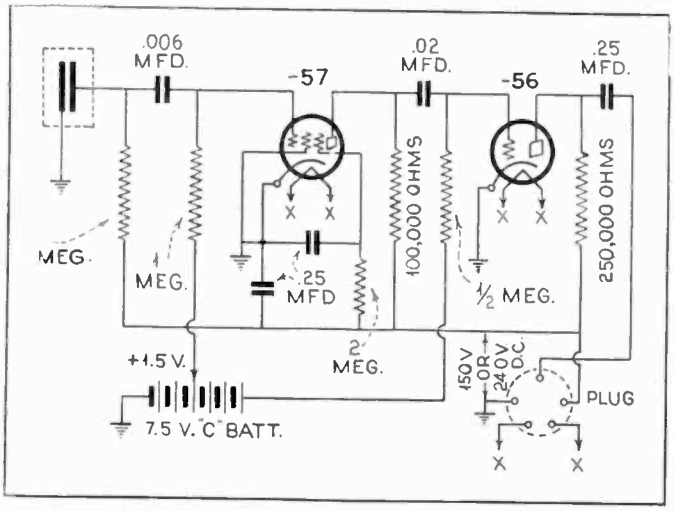


Figure 83

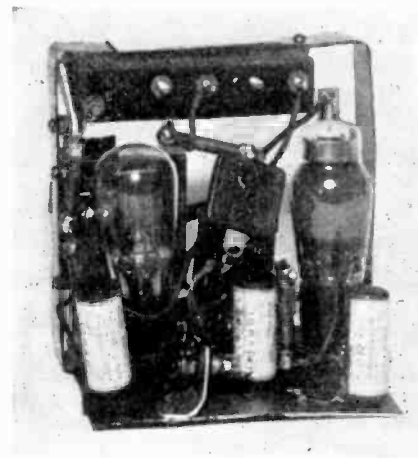


Figure 85

THIS article describes a condenser microphone amplifier designed for a.c. operation, and the power supply unit for use with it.

In Figure 83 is shown the amplifier circuit diagram, it is of conventional design for a.c. operation, with the exception of the grid battery. A fresh battery of reputable manufacture should last the better part of a year. Care must be taken to avoid leakage and resultant noise. The best way to accomplish this is through the use of high quality standard parts, complete shielding and careful construction.

The microphone power supply, Figure 84, should be a separate unit. It is unusual only in the respect that it uses an ample filter. The power transformer should supply in the vicinity of 220 volts at approximately 20 ma. Voltages within 25% plus or minus of this figure do not seem to effect operation to any degree. The greatest limiting factor is the inability of some condenser microphones to withstand a potential of more than 250 volts d.c. Two 30 henry chokes, followed by a good audio transformer primary as the final choke, together with a total of 32 mfds. (450 volts) of electrolytic condenser, comprise the filter. A 5-watt resistor, of about 15,000 ohms, connected as shown, will often improve stability.

As shown in the photographs (Figures 85 and 86), the amplifier has been made quite compact and is assembled on a metal base and framework which is slipped into a small metal case on the cover of which is mounted the condenser head. The power supply unit is assembled in an ordinary switch box, such as is commonly employed for housing the switches and fuses in electric light installations. These two metal cases provide the complete shielding which is highly important in condenser microphone equipment.

The two units are connected together by means of an unshielded battery cable about 35 feet long. Anyone following this design may, of course, use longer or shorter cable as circumstances may require. It is well to bear in mind that the leads carrying the filament current should be not smaller than No. 18 wire and where the cable length exceeds 25 feet, should be preferably No. 16, or better still No. 14 wire. To facilitate quick connections, it is desirable to equip this cord with a 5-prong plug and to mount a corresponding 5-prong socket on the case of the power supply unit. Some may prefer, however, to equip the cord with plugs at both ends and mount a corresponding socket on each unit.

The electrical output of this pre-amplifier unit is sufficiently high to eliminate the need for an output tube to line transformer on cable runs up to 200 feet providing ordinary shielded antenna wire or its equivalent is used. This equipment is designed to operate nicely, with a single stage power amplifier consisting of two type -47 tubes in push-pull.

Referring to the photographs (Figures 85 and 86), a good idea of the assembly details will be obtained. The two tube pre-amplifier is shown removed from its case. The upright frame provides convenient means for mounting the 7½ volt C battery. In another view the complete equipment is shown with the covers removed. In this view parts for the power supply are, from left to right, at the top, a double filter choke and the audio transformer employed as the third choke. At the right are the 'phone jack (for the output cable) and the power cable socket. Along the bottom of the box, at the extreme left, is the voltage divider, to the right of which appears the power transformer, the type -80 rectifier tube and the four section, 32 mfd. electrolytic filter condenser. Although an output transformer (tube to line type) is not necessary under ordinary conditions, the designer has included one in the pre-amplifier shown in the photographs, for use where the output cable is excessively long. This transformer is mounted directly behind the type -56 tube and may be seen in the photograph (Figure 85) of the pre-amplifier assembly.

Figure 84

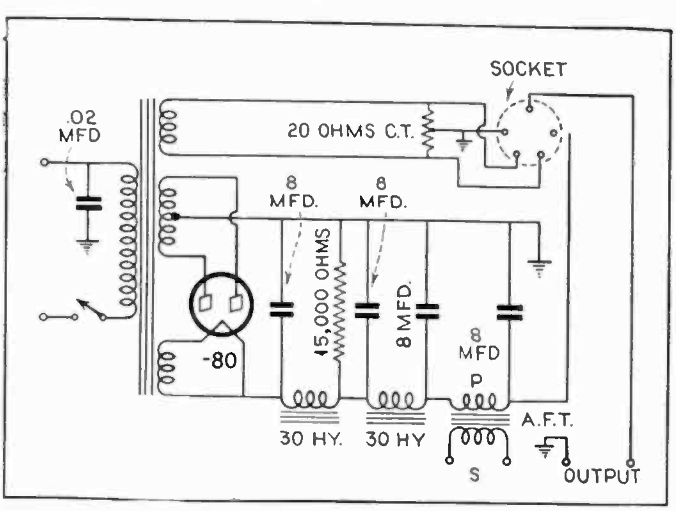
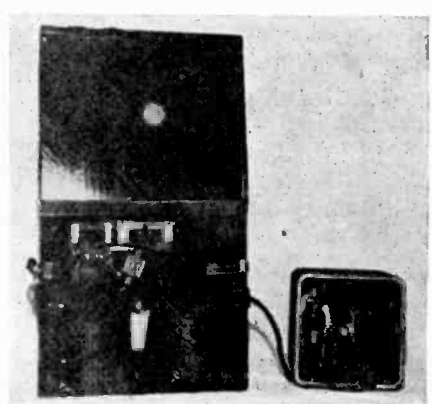


Figure 86



All-Purpose P. A. System

THIS six-tube public-address system is a direct invitation to servicemen and dealers to make extra dollars by adapting it either, as a profitable side-line for rental or for permanent installation in numerous sound-distributing applications. The circuit diagram is shown in Figure 88.

Featuring high-quality and high-gain (approximately 120 db. at 1000 cycles) this new 8-watt amplifier is equipped with mixing and fading facilities, a tone control that can be used to reduce acoustical feedback and to compensate for poor room acoustics and universal input and output provisions, not usually provided in a small amplifier of this type. The input circuit of the amplifier is arranged for either carbon, crystal or velocity type microphones and there are provisions for radio and phonograph connections. The use of a carbon microphone simply requires a matching transformer and a small battery connected in the conventional manner to supply the exciting voltage for the microphone. The transformers, filter units and the tubes are fully shielded. The level of hum is extremely low. The overall dimensions are 6½ inches by 8¾ inches by 15 inches and the weight is 12½ pounds.

The amplifier is designed to deliver 8 watts of undistorted power output to the speaker voice coils, sufficient power to operate two large auditorium type dynamic speakers, or 7 small size dynamics or 20 magnetic type reproducers.

In a brief summary of the design and operation of the unit we first point out that it works directly from 105-125 volts, 50-60 cycles, a.c. line. There are four stages in all, employing five tubes. The first stage incorporates a type 57 which is resistance-coupled to a type 53 connected as a triode. This tube is in turn resistance-coupled to a 56 tube which is transformer-coupled to a pair of 2A5's in push-pull. The new 83V tube is used for rectification. The power consumption is about 75 watts.

The controls and connections on the front of the chassis (Figure 87) reading from left to right, are, first, the dual tip jack for phono-radio connections, the microphone socket, microphone volume control, phonograph-radio control, combined "on-off" switch and tone control, a socket for the additional speaker and a jewel-type "ruby" pilot which indicates when the a.c. power is on. The 5-prong speaker socket is mounted on the rear of the chassis.

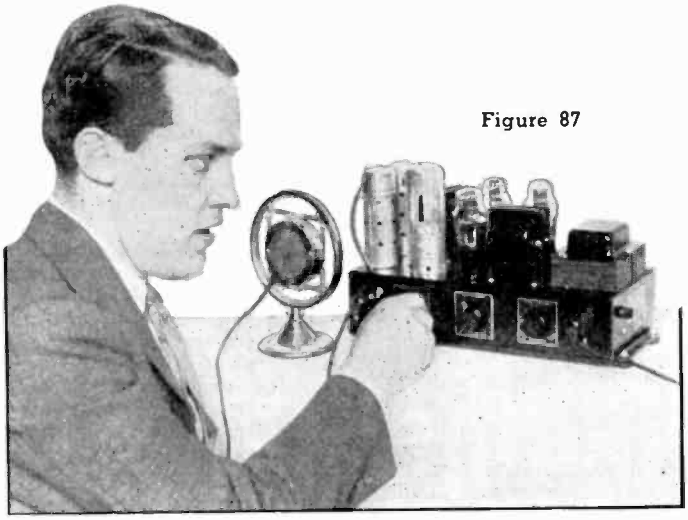
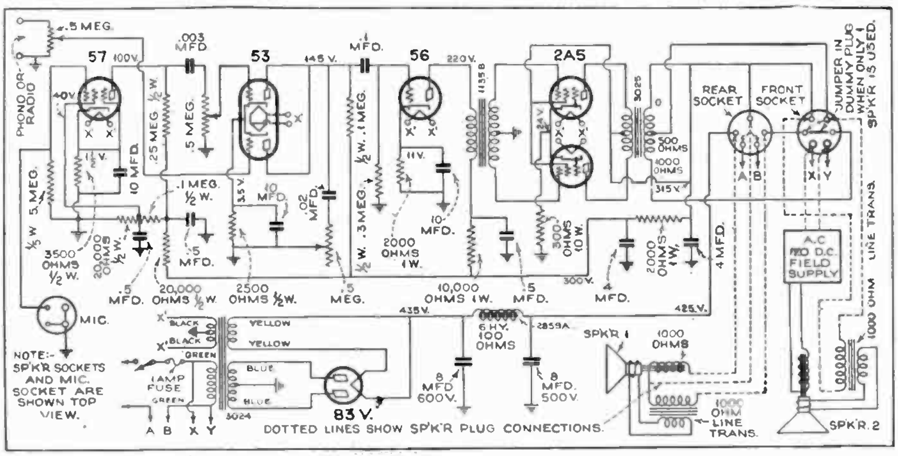


Figure 87

Figure 88



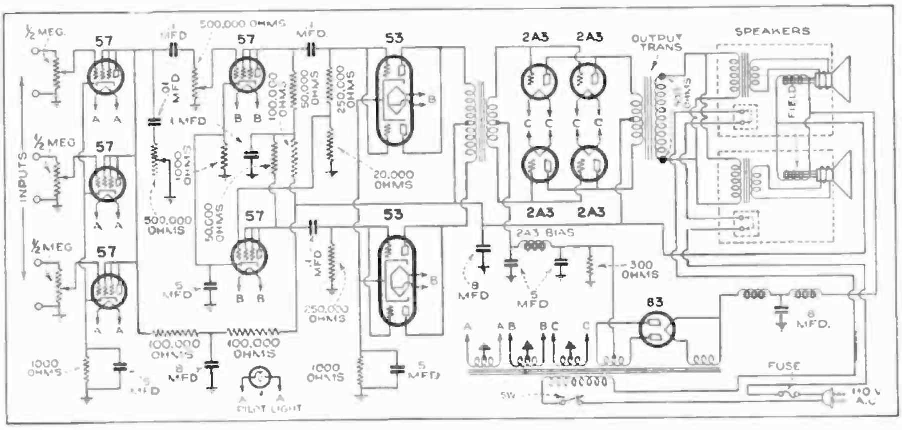
A 12-Tube Portable Amplifier

A POWER amplifier that has proven popular among broadcast engineers and servicemen for free-lance work is shown in Figure 90. In designing this 20-watt portable amplifier it was decided that since all "portables" are heavy at best, there was no sense in skimping on important parts and a portable that is the equal of a fixed outfit was the goal set.

The outfit consists of two identical carrying cases, one containing the amplifier proper and its associated control equipment and the other two 12-inch dynamic speakers. The speakers draw their field current from the amplifier and are connected to it through 500-ohm lines and suitable matching transformers. The connecting cables are 50 feet long.

The amplifier itself uses push-pull parallel 2A3's, with full output of 20 watts

Figure 89



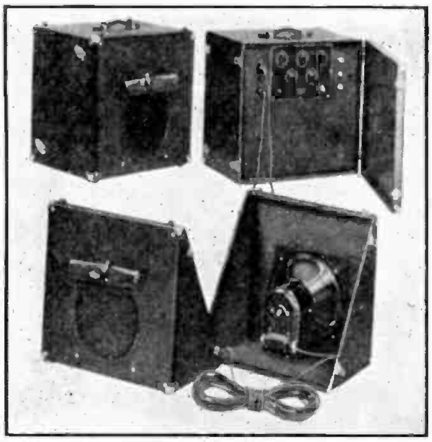


Figure 90

into a 500-ohm line. The tube line-up starts with a 57, connected as a triode, which works into another triode-connected 57, arranged as a phase inverter, to give push-pull action without transformers. This feeds into two 53's in push-pull parallel,

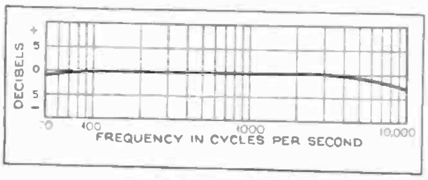


Figure 91

which in turn drive four 2A3's in push-pull parallel (see Figure 89). With a harmonic content of only 4%, at maximum rated output, and a frequency response as indicated by the curve of Figure 91, this amplifier easily falls in the "wide range" class.

Obtaining field current for the speakers without affecting the power supply regulation was solved in the manner shown in Figure 89. As the amplifier is of the Class "A" type, the operating plate current remains constant, and the plate supply regulation is therefore not dependent on the use of low-resistance elements. The amplifier tubes receive their plate current from a separate filter system, not directly dependent on the speaker fields, as in ordinary circuits. Another innovation in the power system is provision for stabilized bias voltage for the 2A3's. This contributes noticeably to the general stability of the amplifier and to the low harmonic content.

Preceding the amplifier proper is the Electronic Mixer, which permits the use of any input device, regardless of its impedance, as long as it delivers a minimum of .05 volt. This mixer has a slight gain, rather than a loss, the overall gain of the mixer and amplifier combination being 96 db. With this gain, crystal type microphones and phonograph pick-ups can be used directly. The mixer will handle three independent input signals, there being three individual channel controls and one master control. It has no frequency discrimination worth considering, the response being flat from 20 to 10,000 cycles, within 2 db.

The carrying cases are 19½ by 18½ by 13½ inches overall, the whole outfit weighing 112 lbs. The speaker cases are split diagonally, each half serving as an effective baffle. When not in use, the speaker openings in front are protected by waterproof covers.

Sound-Head Servicing

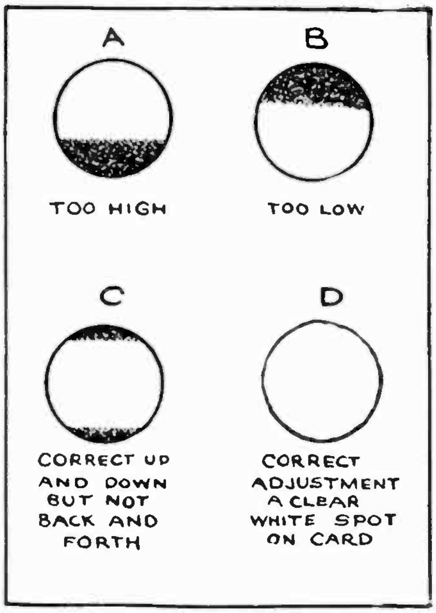


Figure 92

THE burden of servicing talking motion-picture projecting equipment often devolves upon the radio serviceman—particularly in rural and surburban areas.

Servicing of sound projector equipment can be divided into two classes—that of the amplifier and associated apparatus, and service of the sound-head. The former does not differ materially from service work on public-address systems and so will not be considered at this time.

The major problem in servicing the sound-head is the delicate matter of adjustment. There are four different kinds of adjustment, each one of which is essential to clear, undistorted reproduction and these apply equally to the variable-width and variable-density recordings. These adjustments affect the position of the exciter lamp in respect to the optical system, the focus of the optical system, the centering of the aperture in reference to the sound-track, and the rotational adjustment. The exciter lamp is so mounted as to admit the necessary movements for correct alignment. This is checked by removing the photo-electric cell and placing a piece of white cardboard in its place—about as far away from the sound-gate or aperture plate (the plate with the slit in it against which the film is in contact during projection) as the elements of the photocell. The exact distance is not important. An image will be seen in accordance with Figure 92, which is self-explanatory. The indicated adjustments should be made on the lamp until the spot of light appears as in Figure 92-D.

The optical adjustment is effected by threading through a few feet of frequency film—from 5000 to 10,000 cycles (the higher the frequency, the better and more difficult the adjustment). This film can be seen in Figure 93. Run through sufficient film to make sure it is in proper alignment. The image on the card will now correspond to one of the illustrations in Figure 94—probably C or D. The lens tube should be worked back and forth as the film is moved slowly—turning the machine by hand—until the spot of light fades in and out, showing no horizontal lines. (By referring to a "black spot" in Figure 94-A, we are, of course, not to be taken literally. There will not appear a "black" spot on the white cardboard—merely no light at all.)

If the spot of light becomes weaker as the film passes, but will not disappear completely (still no horizontal lines), it is due to the slit of light not being centered in the sound track—overlapping on one side or the other. In projection, if the light slit touches the sprocket holes, a 200-cycle "ripple" will be heard. If, on the other hand, it touches the frames (the individual pictures), the result will be a low-frequency "flutter." In some sound-heads the slit can be adjusted by moving the aperture plate horizontally, thus centering the slit in the sound-track. In other systems, the rollers, guiding the film, are shifted laterally, to center the sound-track over the aperture. The aperture slit should, of course, be at right angles to the length of the film (parallel with the lines on the frequency film). It is also desirable to check the rotational adjustment while focusing the optical system. The slit within the lens tube (which cannot be seen) must parallel the slit in the aperture plate. If the lens barrel is rotated slightly, so that the slit within the lens tube does not parallel that in the sound aperture, the pattern of the lines on the cardboard (the optical system being slightly out of focus, so that these lines exist) will be distorted

Figure 93

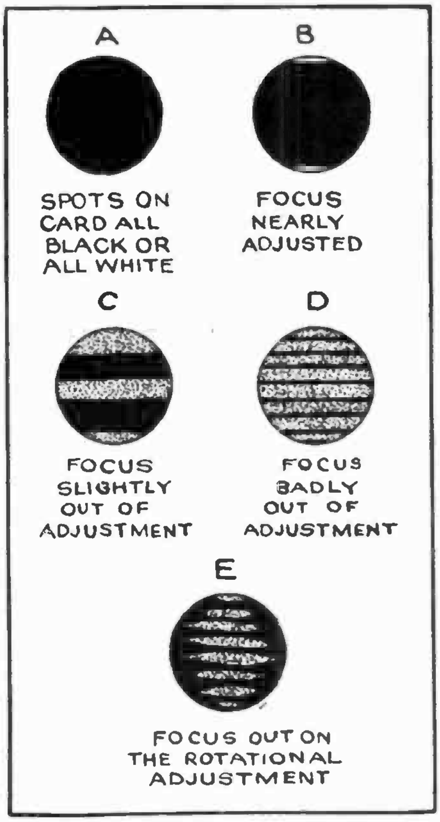


Figure 94

as shown in Figure 94-E. The lens tube should be turned until the lines are of constant width and horizontal, and the focal adjustment then corrected as outlined above.

If the sound-head is badly out of adjustment, it may be necessary to check and recheck these settings several times. Dirt, oil and wax will collect in the aperture slit and on the front lens of the lens tube, making cleaning and inspection desirable every week or more often in cases of unsatisfactory reproduction. As soon as exciter lamps turn black on the inside, they should be replaced, as this is a warning that their usefulness will shortly be terminated, if left in the sockets, with an *embarrassing return to silent pictures!* Care should be observed to burn them at the rated voltage only. Excessive current will shorten their usefulness all out of proportion to the overload.

The "volume" output of both soundheads should be equalized. This is usually effected by varying the polarizing voltages on the respective photocells. Adjustment should be made with two reels of the same picture in both projectors, as recordings differ in output levels. Change over the sound from one projector to the other, making the necessary adjustments until the volume from both projectors is the same.

Photoelectric cells should be replaced once a year. After about three months of service the effective response has usually dropped to around 25 percent of the original sensitivity. If used cells are stored in the dark, they can be employed in emergencies, as, when so kept, they have a tendency to recuperate.

Service calls on sound projectors are usually a matter of unsatisfactory operation, complete failure, or routine. Minor faults can usually be traced to weak P.E. tubes, poor optical alignment, dirty lens and aperture, or battery trouble in the case of a system depending on this source of power. A pipe-cleaner, dipped in Carbona or commercial carbon tetrachloride, will do a satisfactory cleaning job between the exciter lamp and the photocell. Dirt in the gap of the dynamic speakers may cause low volume and distortion. In instances of total failure, the first check is to note whether the exciter lamp is burning and if the light is reaching the film. Again dirt or a burned-out lamp may be at fault. Upon eliminating the optical system as the source of trouble, the amplifier is the next suspect. If the monitor speaker operates, but the stage speakers are dead, the voice coils and field supplies are obviously in line for examination. If a phono pick-up is used for incidental music, it should be employed in an effort to establish the probable limits of the difficulty. Change P.E. cells—and test batteries if used. Different sound systems have different change-over devices, which should be checked carefully.

Most emergency service work can be avoided by periodical, routine and thorough examination about once every thirty-two shows. The entire system, from exciter lamp to speakers, should be checked and tested. Tube prongs and all switching devices, faders, etc., should be cleaned. The photocell socket, as well as the prongs, must be scrupulously clean. Batteries, especially on the photocell, should be replaced when a 45-volt unit drops to 35 volts.

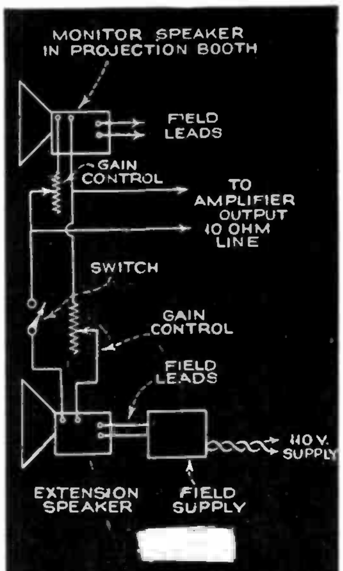


Fig. 95

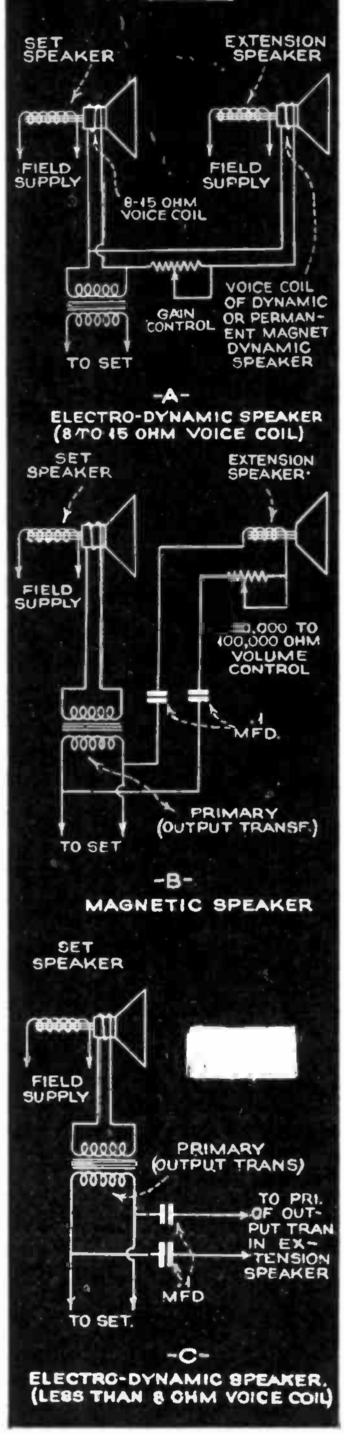


Fig. 96

Profits In Extension Speakers

SERVICEMEN and dealers can obtain additional income by installing extension speakers and the following article will show them some potential applications.

An extension speaker takes up but little of the precious space available in the luggage compartments of an automobile and may be arranged to plug in a jack which the serviceman can install on the instrument board of the car and wire in to the terminals of the standard auto-radio speaker, thus providing service in tents or cabins when the vacation budget does not permit the outlay for a complete additional set. When there is no local supply of electricity, as is so often the case in vacation-land, this feature provides the simplest and most economical method of enjoying radio. Likewise, an easy installation job for the serviceman and a profitable speaker sale.

NEIGHBORHOOD MOVIE THEATERS are excellent prospects for extension speakers. One or more dynamic speakers installed over the ticket office have proved of value in attracting patrons during slack periods. During a performance, the sound recording may be conducted from the theater speaker circuit to the extension speakers, invariably arousing the interest of passersby.

SERVICING SOUND-MOVIE EQUIPMENT is profitable business and is often less difficult than many of the receiver-servicing problems which servicemen handle without trouble. Theater owners, however, may hesitate to entrust their source of income to any but a sound specialist unless confidence is first established by doing an easy job right. The installation of extension speakers presents no serious technical difficulties and therefore provides servicemen not only with a means of making a good profit but also of smoothing the way for further remunerative work. Figure 95 shows how this type of installation may readily be accomplished. There is usually a monitor speaker in the projection booth, which, in smaller theaters, is generally close to the front of the theater and the ticket office. The output of the sound amplifier is fed to the house and monitor speakers, a gain control consisting of a rheostat in series with the voice coil of the monitor speaker serving to maintain a low sound level in the projection booth. Leads from the voice-coil terminals of the extension speaker are simply connected in parallel with the leads from the output of the amplifier to the monitor speaker panel, as shown in Figure 95. This point of connection is shown because it is usually the most accessible and does not require removing screws or disturbing the apparatus in any way if a preliminary demonstration is insisted upon, which is usually the case. The extension speaker should have its own field supply and an 8 to 15 ohm voice coil.

Since the voice coil leads do not carry high voltage, it is unnecessary to have the wiring done by a licensed electrician. The power for the field supply may be obtained by plugging in to an outlet in the ticket office. If this power line is not exposed to rain etc., and not permanently anchored by staples or otherwise, no violation will result in most localities, although it will be well to get a ruling on the requirements from the local inspector.

If it is desired to operate the extension speaker at a higher sound level than those in the theater, a T pad may be inserted in the theater speaker line and the extension speaker cut in ahead of the T pad. A variable series resistance in the voice-coil circuit of the extension speaker, controllable from the ticket office, enables adjustment of the sound level. The foregoing are somewhat out of the ordinary applications of the extension speaker.

EXTENSION SPEAKERS IN THE HOME is an item often overlooked by servicemen, since we sometimes forget that the layman considers adapting a radio to operate two speakers to be a difficult and expensive task and therefore hesitates to make inquiry regarding same when they *really need and can afford them!* In hot weather, in suburban communities, one can enjoy an interesting program in comfort when an extension speaker is put out on the porch, but not in a stuffy room where the set is usually located. In winter, the same speaker may be pressed into service to avoid missing a good program during a dinner hour. (For the sick room, though the midget receiver is more desirable from the standpoint of convenience, discriminating listeners will appreciate the greater fidelity obtainable with a good extension speaker on a good set.)

For home installations, we may choose either permanent magnet dynamics, electrodynamics, or magnetic speakers. The simplest and most economical method of adding another dynamic speaker to that in the set is shown in Figure 96. This method of paralleling the voice coils provides a low impedance line which not only carries very low voltage but also does not noticeably affect the fidelity of reproduction, which is not the case with the usual form of connection if the extension speaker is located at a point remote from the receiver. This method is used only when the set speaker voice-coil and that of the extension speaker are from 8-15 ohms. Methods of controlling volume at the extension speaker are indicated in the diagram, Figure 96. Ordinary potentiometers or rheostats of the values given will be satisfactory. The permanent magnet dynamic type of speaker has the great advantage that there is no field supply current which one may forget to turn off, unless extra switches, relays and wiring are provided. The electro-dynamic type provides the best power sensitivity and the magnetic type the lowest cost.

WHEN ESTIMATING FOR TRADE-INS, it is well to bring up the suggestion to the customer of employing the speaker in his old set as an extension speaker, thus relieving one of the burden of resale of obsolete merchandise and at the same time benefiting the customer. The life of a good dynamic speaker is usually far greater than other component parts under electrical stress and when trade-ins are unavoidable, they may be salvaged and re-sold to the benefit of all concerned.

Service Sales Tips

IT may be said with very little fear of contradiction that the opportunities for money-making in the radio industry today are just about double what they were four or five years ago. This may sound very much like an overstatement to the more cynical members of the profession. It is nevertheless a fact that will bear the closest examination.

Many radio men have suffered unduly from the depression merely because they do not look for business—*in the right places!* They are too bound to the old channels of trade, repairing, selling new sets, with occasional business in tube replacements. This is admittedly pretty dull stuff these days, and if a fellow can make a living at it he must hump and hump fast.

Much has been written about the possibilities of the P. A. field and some nice business has been had from this source by the more alert and business-like members of the clan. They have, however, held their sales efforts to too limited an application of the P. A. field. Some of them canvass the local Masonic lodge, the Elks and let it go at that. What about the music teachers? They can do a great deal with a P. A. system provided with a recording head. Imagine, if you will, a music teacher set up in your town with a small but good recording outfit. The business advantages that they enjoy over their competitors *is simply tremendous!*

Little Willie is taking violin lessons. The teacher records his playing, advises him to take the record (which may cost a dime) home and play it on his phonograph. He listens to his own mistakes. His mother and father, naturally get all puffed up over little Willie's phonographic début. The same holds true of any instrument, but it is in voice-culture that this system has greatest advantages and proves its real worth. Foreign language schools can, and do, use the same kind of equipment for precisely the same purpose.

A radio serviceman in a city of 500,000 made six such installations within three months at a very tidy profit. After he had placed the equipment in two music studios, business began coming to those places at such a rapid pace that competitors of these studios simply had to fall in line and have the same sort of equipment. It is not difficult to get three hundred dollars for such equipment.

In one small town, the local moving-picture house used to send a truck with a 5-piece band running about town, advertising its new bills. The local radio doctor got on the job and sold the management the idea of a radio-equipped truck, playing phonograph records. He used a standard P. A. outfit with a turn-table slung from springs so that road bumps would not affect reproduction. This fellow netted $200 on the job. Now $200 in these days, divided by four, leaves a weekly income for a period of one month of $50. Not bad for such times from one sideline.

Some moving picture theatres have installed head 'phones on a group of seats so that hard-of-hearing people may listen to the talkies. Since such jobs may now be handled by servicemen, they offer a profitable field in small communities. Then, take the case of the large church. The first ten rows of pews are usually rented. Many people who are hard of hearing do not go to church because they cannot hear the sermon or take part in the service. Any minister knows this, and if the church is wealthy he is convinced that such equipment is needed. In one case, the minister was partial to the idea, but he did not have the funds to spend. The radioman was a live wire. He knew that the people who subscribed to the pews were "the" people of the town and he immediately set out to get their help. He did not have to go far. The first man he told about it agreed to bear the cost of the whole thing himself! And we still solicit two-dollar repair jobs!!!

This business is not available to fellows who sit in their places of business and recall the "good old days" when sets were sold with seventy-dollars margin and tubes brought a dollar profit for each sale. *Get out and get busy—get working along the lines pointed out here and in* Radio News *each month—and you also can cash in!*

ENGINEERING DESIGN

Ultra-Sensitive V. T. Voltmeter

ENGINEERS will be greatly interested in this new instrument because of the following features:

1. Ultra-Sensitivity—at Radio and Audio Frequencies.
2. Single Adjustment
3. Accuracy
4. Self-Calibrating
5. No Graphs or Charts Needed
6. A. C. Operated

What may well be the most important development to date in the line of radio service and laboratory instruments is the latest invention of John H. Potts—a vacuum-tube voltmeter capable of r.f. or a.f. measurements *in terms of microvolts*.

The instrument shown in Figures 97 and 98 is adaptable to an extraordinary range of tests. Voltage or current measurements may be made either d.c., or of a.c. from below 20 cycles to an undeterminable range above 25 mega-cycles. The sensitivity is great enough to enable tests of insulation leakage, such as occurs in condensers, etc. In conjunction with an oscillator, measurements of inductance, capacity, impedance and power factor may be made at any frequency within its unusual range. In conjunction with a small search coil or condenser, it is possible to make a stage by stage test of receivers at radio frequencies—invaluable for sets with intermittent troubles when the use of voltmeters of the ordinary type is impractical. An attenuator (included in this meter unit, and to be described later) makes possible the calibration of the ordinary service oscillator, giving quantitative measurements of receiver sensitivity in micro-volts.

Essentially, the instrument consists of a diode rectifier followed by a direct-copuled amplifier. The extraordinary frequency range is due to the simplicity of the input circuit and also to the fact that all amplification follows, rather than precedes, the rectifier.

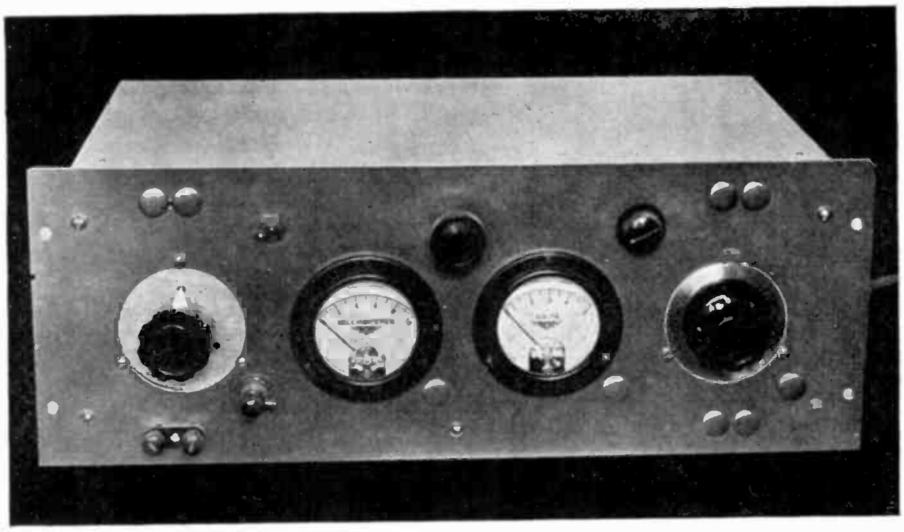
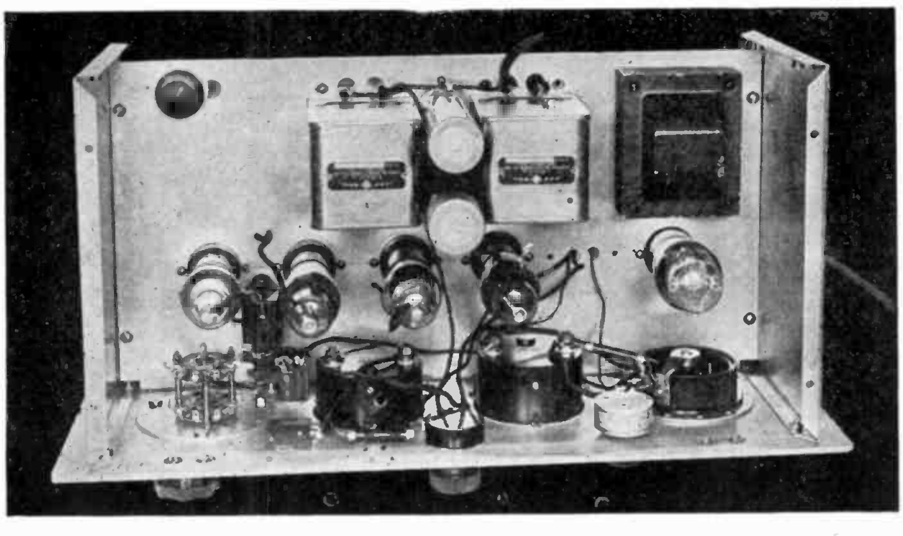


Figure 97

Though the apparatus uses a d.c. meter of 1 ma. sensitivity, full scale deflection is obtained for from 30 to 70 millivolts input, alternating current, depending on the characteristics of the tubes, the applied voltages, and other factors. The instrument requires no graphs or charts; means are included in the instrument to calibrate it instantly at any point in its range, by simply throwing a switch and turning a knob.

A schematic diagram of the complete instrument is shown in Figure 100.

Figure 98



For sensitivity measurements, a very simple but highly effective attenuator has been designed. Ladder type resistance attenuators have been so generally employed in better grade test oscillators that there is a wide-spread impression that no other types merit consideration. The construction of a ladder attenuator to meet laboratory standards of tolerance in frequency independence over the wide band of frequencies required by present-day sensitivity tests is an extremely difficult task.

The attenuator is of the capacitive type, and is substantially independent of frequency. Figure 99A shows the construction, which is much simpler than the usual ladder type. The schematic circuit of the attenuation system is shown in Figure 99B. The input voltage, E1, is in series with C1 and C2. The output voltage, E2, is proportional to the ratio of C1 to C1 plus C2. Therefore, if C1 is very small compared with C2, the voltage E2 will be very small.

The range of attenuation with this design is limited by the ratio of maximum to minimum capacitance between the electrodes a and b of C1. With the usual design of variable condenser, this ratio is less than 30 to 1, which would be inadequate and also the use of this type would require insulating the rotor from the panel. By modifying the condenser design, it is possible to easily increase this ratio to over 500 to 1.

List of Parts

C1—Special reconstructed Cardwell 150 mmfd. variable condenser (see Figure 99)

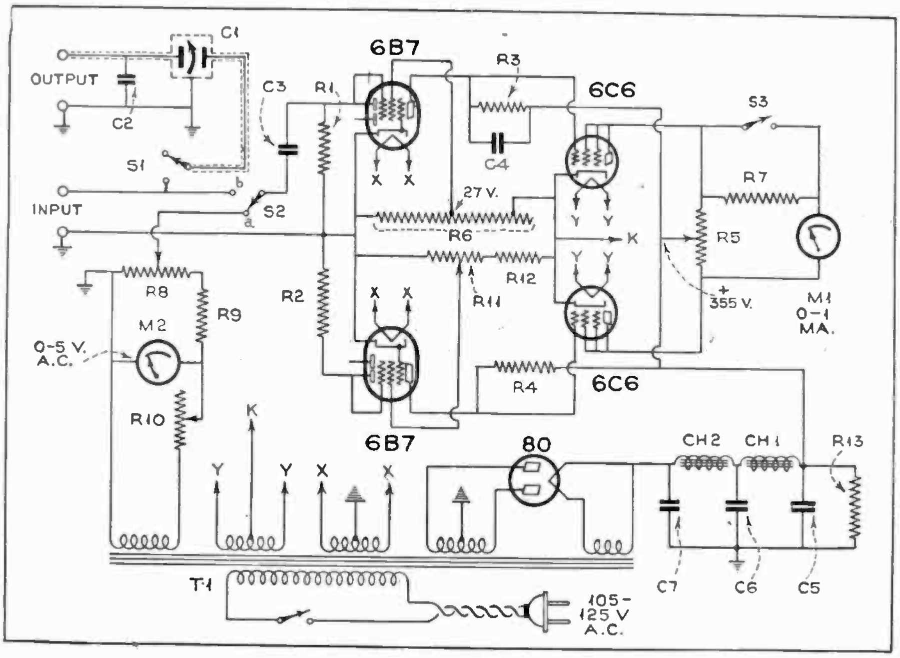


Figure 100

C2—Aerovox pigtail type mica-condenser, .00015 mfd.
C3—Aerovox bakelite case by-pass condenser, .5 mfd., 200 v.
C4—Aerovox pigtail type mica condenser, .001 mfd.
C5, C6—Aerovox dual electrolytic condenser 8-8 mfd., type GG5, 500 v.
C7—Aerovox electrolytic condenser, 8 mfd., type GM, 500 v.
R1, R2—Lynch fixed resistors, 1 megohm, 1-watt
R3, R4—Ward Leonard wire-wound resistors, 250,000 ohms, 1 watt
R5—Electrad potentiometer, type 278, 5000 ohms
R6—Ward Leonard voltage divider, 10,000 ohms, 50 watts
R7—Lynch fixed resistor 10,000 ohms, 1 watt
R8—General Radio potentiometer, 400 ohms, type 214-A
R9—Lynch fixed resistor, 19,600 ohms (low 22,000 ohm resistor will serve), 1 watt
R10—Electrad wire-wound volume control, 100 ohms, type 272 W
R11—Electrad volume control, 50,000 ohms, type 205
R12—Lynch fixed resistor, 150,000 ohms, 1 watt
R13—Aerovox wire-wound resistor, 15,000 ohms, 20 watt
S1, S3, S4—Toggle switches, single-pole-single-throw
S2—Yaxley d.p.s.t. jack switch

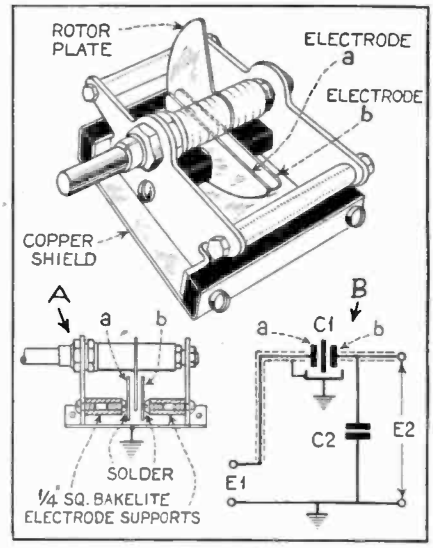


Figure 99

M1—Weston model 301, 0-1 ma. milliammeter, bakelite case
M2—Weston model 476, 0-5 volts, a.c. voltmeter, bakelite case
T1—Kenyon power transformer, special type, with extra 5-volt winding
Ch1, Ch2—Kenyon, 30 henry choke, type BC 350
1 General Radio, type 661-B, unit panel with accessories
1 General Radio, type 661-L, end- and base-plate assembly
1 General Radio plain dial, type 710-A
1 General Radio knob, type 637-J
1 General Radio dial plate, type 318-A
2 Binding post strips, 2-gang
2 7-prong wafer sockets
2 6-prong wafer sockets
1 4-prong wafer socket
2 6B7 tubes
2 6C6 tubes
1 80 tube

Calculating Voltage Divider Constants

VOLTAGE divider systems which supply the screens of a.v.c. controlled circuits, will cause the screen voltage to drop when the negative grid bias is increased, because the screen current increases along with the plate current.

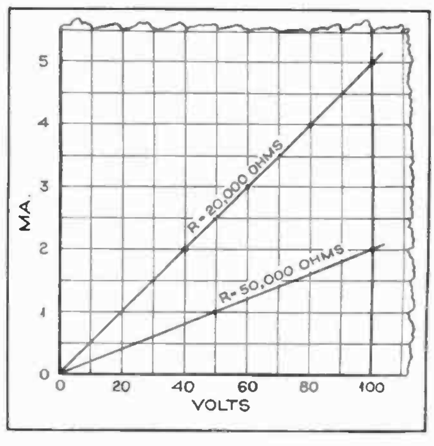
If the voltage divider from which the screen voltage is taken, consists of too high values, the increase in screen current will lead to a decrease in screen voltage which counteracts the action of the a.v.c. The bleeder circuit should therefore consist of sufficiently low values to prevent this voltage drop. On the other hand, for the sake of economy in resistors and power transformer it would be desirable to keep it as high as possible. The following graphical method gives the correct value of the resistors to be used in a very simple and quick way.

If we plot the current through a resistor as a function of the voltage across it, we get a straight line as per Figure 101. As an example, in Figure 101 are plotted the lines for 20,000 ohms (5 milliamperes at 100 volts, 4 milliamperes at 80 volts, 3 milliamperes at 60 volts, etc.), and 50,000 ohms (2 milliamperes at 100 volts, 1 milliampere at 50 volts).

Now assume that we place a resistance of 8000 ohms and one of 12,000 ohms in series across 200 volts as in Figure 102 (a). The voltages across the two resistors must add up to 200 volts, and the currents through them must be alike. Starting from zero voltage, we plot the straight line for the 8000-ohm resistor, which would pass 12½ milliamperes at, for instance, 100 volts, 25 milliamperes at 200 volts, etc. (Figure 103). For R_2 we consider the 200-volt point as zero point, counting our voltage values toward the left; at 200 volts this resistor would pass $\frac{200}{12,000} = 16\ 2/3$ milliamperes. It must now be kept in mind that the horizontal distances between the left vertical line and the line for R_1 represent the voltages across R_1, and, in a similar manner, the horizontal distances between the right vertical line (through the 200-volt point) and R_2 the voltages across R_2. If, for instance, 5 milliamperes were flowing in both resistors, point P_1 tells us that the voltage across R_1 would be 40 volts, point P_2 tells us that the voltage across R_2 would be 60 volts. The two voltages do not add up to 200 volts, the horizontal distance P_1 and P_2 indicating by what amount they fail to do so. Only for the intersection point P do the two voltages add up to 200 volts; the current is 10 milliamperes, the voltage across R_1 equals 80 volts, across R_2, 120 volts.

Now let us put a load in shunt with R_1, as in Figure 102 (b). Let us assume that the load is drawing, for instance, 5 milliamperes. We would like to know now how much the voltage across R_1 decreases due to a 5-milliampere load current. Obviously, the voltages across R_1 and R_2 must still add up to 200 volts, but the currents are no longer alike, the current through R_2 being 5 milliamperes more than through R_1. In our diagram, this means we have to find a vertical line to the left of P (because to the left of P the currents through R_2 are larger than

Figure 101



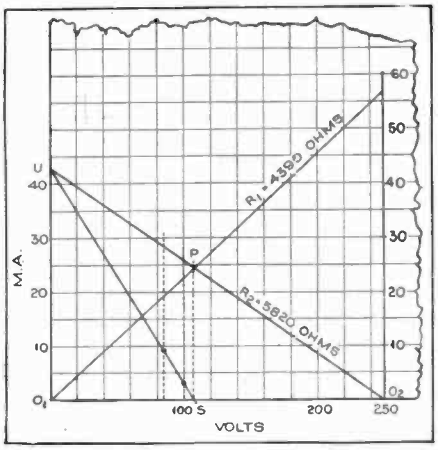


Figure 104

through R_1), in such a manner that the vertical distance VW equals 5 milliamperes. It is seen that WR is the current through resistor R_1 with a voltage 0_1R across it and VR the current through resistor R_2 with the voltage 0_2R across it. The two voltages add up to $0_10_2 = 200$ volts, and the difference VW in the two currents is the load current. We could find the position of this vertical line VR with the help of a compass, fitting a length equivalent to 5 milliamperes between these two lines, but an easier method is at once obvious. We draw a vertical line through P, giving us point S, and connect S with U, then TR = VW. The proof is as follows:

$$\frac{VW}{U0_1} = \frac{PW}{P0_1} = \frac{SR}{S0_1} = \frac{TR}{U0_1}.$$ The first and last expressions show that VW = TR. Therefore, if we make the line TR equal 5 milliamperes, or simply draw a horizontal line through 5 milliamperes, intersecting the line US in the point T, the abscissa $0_1R = 56$ volts of point T will give us the voltage across R_1 and across the load; $0_2R = 144$ volts the voltage across R_2, WR = 7 milliamperes the current in R_1 and VR = 12 milliamperes, the current in R_2; every question is, therefore, answered.

We had chosen 5 milliamperes as an example, but it is obvious that the construction holds true for any value of load current, so that the line US can justly be called "load characteristic" of the voltage divider R_1R_2. As a further example, the diagram shows that for a load current of 10 milliamperes, for instance, the voltage across R_1 or the "load voltage" would be 32 volts, the current through $R_1 = 4$ milliamperes, the voltage across $R_2 = 168$ volts and the current through $R_2 = 14$ milliamperes.

If the line US is extended downward, it crosses the vertical through 0_2 in the point Z. It is then $0_2Z = 0_2Q$, because

$$\frac{0_2Z}{PS} = \frac{UZ}{US} = \frac{0_10_2}{0_1S} = \frac{Q0_2}{PS}$$

The "load characteristic" of a voltage divider R_1R_2 is therefore very simple to find: make 0_1U equal the current that resistor R_2 would pass if connected alone across the supply voltage; in a similar manner, 0_2Z, the current that R_1 would pass under the same condition; then UZ represents the "load characteristic," giving all corresponding load voltages and currents. If besides the load characteristic the individual currents through R_1 and R_2 are of interest, the two lines for R_1 and R_2 must be drawn, and in that case it is recommended to find the point S rather by projection of intersection point P than by drawing 0_2Z downward. With the first-mentioned construction, better use can be made of the available amount of cross-section paper, thus increasing the accuracy.

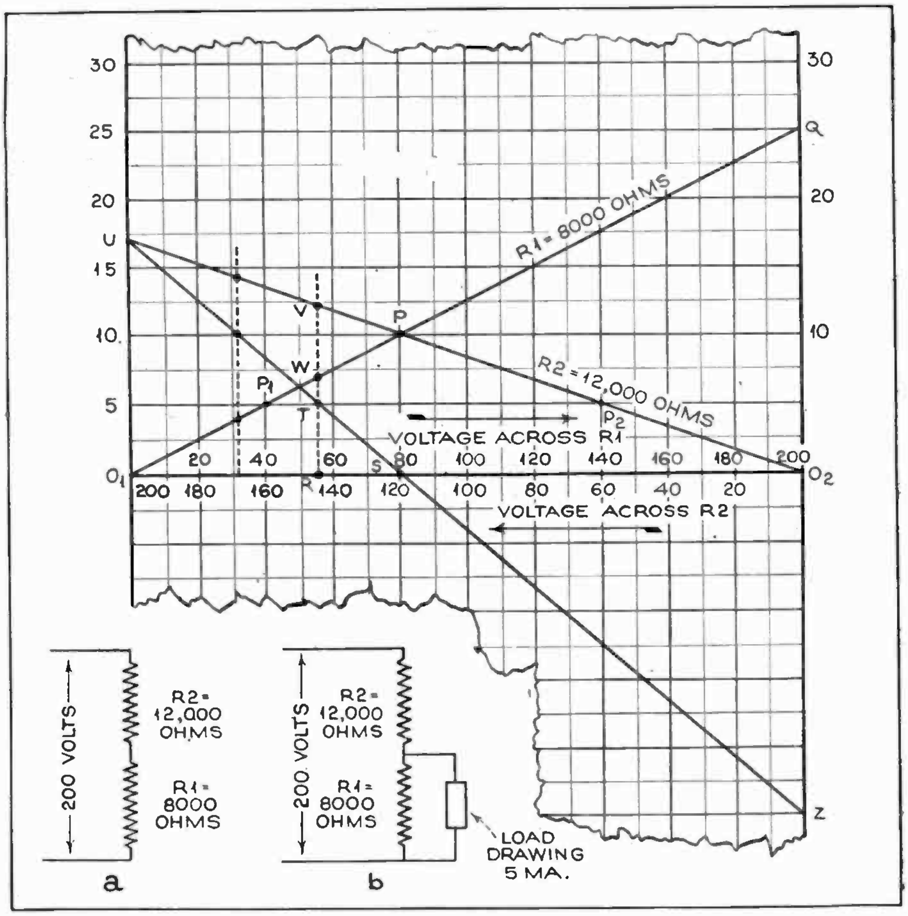


Figure 102—Below

Figure 103—Above

The advantage of this solution of the voltage-divider problem is its extreme flexibility, combined with the fact that it shows the influence of all factors at once. We had started out to find the load characteristic of a given pair of resistors, but we can now reverse the problem. From the construction it is apparent that to every load characteristic belongs a certain pair of resistors.

Let it be required, for instance, to find a voltage divider across 250 volts to supply the screen voltage to three a.v.c. controlled 58 type tubes and that it has been established that the combined screen currents fluctuate between 3 and 9 milliamperes. With 3 milliamperes the screen (or load) voltage should not exceed 100 volts, and with 9 milliamperes it has been found permissible that the voltage drops to 85 volts. The two points, namely, 100 volts, 3 milliamperes and 85 volts, 9 milliamperes establish our desired load characteristic. (See Figure 104.) This gives us points U and S; we connect now point U with the 250-volt point on the voltage scale, this line representing the resistance R_2; this resistance must be such as to pass 43 milliamperes ($=0_1U$) at 250 volts = 250/.043 = 5820 ohms. To find resistance R_1 we could extend US downward, but since we like to know the individual currents, we establish Point P by going perpendicularly up from S until it intersects the line $U0_2$. Now draw the line 0_1P, which intersects the vertical through 0_2 at 57 milliamperes; R_1 is therefore 250/.057 = 4390 ohms. By drawing verticals through the original points of the load characteristic, we see that with a 3-milliampere load the currents through R_2 and R_1 will be 25.8 and 22.8 milliamperes respectively, with the desired voltage of 100 volts across R_1; at 9 milliamperes load current and 85 volts, the currents through R_2 and R_1 will be 28.4 and 19.4 milliamperes respectively. 28.4 milliamperes will also be the maximum current drawn by the divider.

The construction can, of course, also be used if the maximum current that can be spared for the voltage divider is given and it is desired to find the voltage regulation. This simply means that the line for R_2 and one point on the load characteristic is given. This establishes point S and therefore P and R_1.

Engineers

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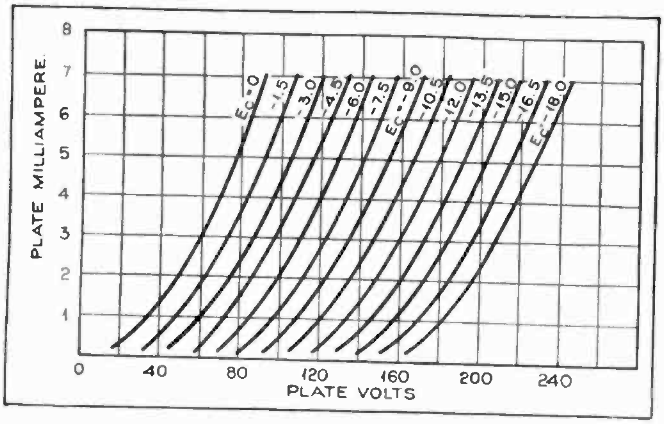
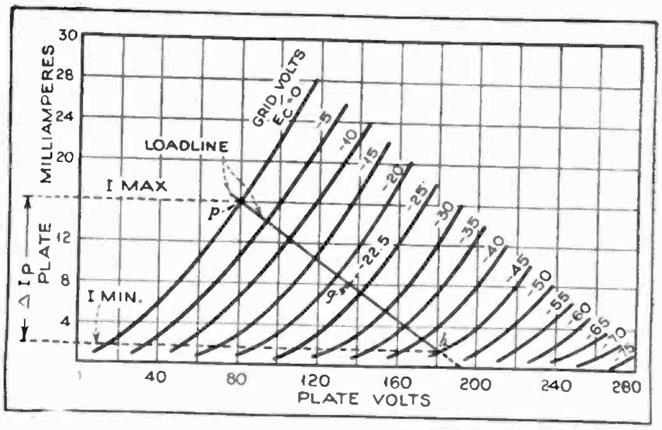
RADIO NEWS





V. T. Power-Output Formulas

WHAT is the maximum power output of a given triode in Class A amplification? Engineers and experimenters have been asked this question at one time or another. There is a definite answer for each case. By following the method outlined below, you can calculate the undistorted power output for any set of operating conditions.

In order to use this information to the best advantage, we must first briefly examine the equivalent plate circuit of a triode as shown in Figure 107.

Any circuit for the transfer of power may be divided into two parts, namely, (1) the source and (2) the load. This division is indicated in the diagram by the dotted lines. For the purpose of this analysis, we will assume that R_L is a pure resistance.

The total a.c. power expended in this circuit is given by the formula:

$$P_T = (\Delta I_P)^2 (R_P + R_L)$$

When ΔI_P = r.m.s. alternating current. The "power output" of the circuit (i.e., the useful power delivered to the load), is

$$P_L = (\Delta I_P)^2 R_L$$

It can be shown mathematically that, for an given generator voltage, the maximum power is delivered to the load when $R_L = R_P$. If the reader doubts this fact he can prove it for himself graphically.

If the plate circuit of a triode were a device that obeyed Ohm's law for any applied voltage, our problem would be solved. The maximum useful power output would be delivered to the load when $R_L = R_P$, and, under this condition the load would receive 50% of the total power developed in the circuit.

Everyone knows, however, that the plate voltage-plate current curve for a triode is not a straight line. Figure 105 is a typical "family" of such curves for a familiar triode. More voltage is required, per unit of current, near the base of the characteristic, hence it shows a curvature. The slope of the curve is also determined by the amount of grid bias, so that we have a slightly different characteristic for every grid voltage.

For distortionless amplification only the straight portion of any one of the E_P-I_P curves can be used. This decides two important facts about the power output of the tube:

1. Much less than 50% of the power expended in the plate circuit can be delivered to the load.
2. The actual amount of power available from a given triode depends upon the allowable distortion.

In general, the optimum condition is obtained when R_L has a value somewhere between R_P and $2R_P$. Both power output and distortion decreases with an increase of R_L above a value equal to R_P.

Figure 106 is a set of characteristics for a 31 type tube. The following outline shows how the power output and the amount of distortion can be calculated for a given load and given operating point. We will illustrate with a typical case, assuming the following conditions:

Load resistance	=	R_L	=	7000 ohms
Plate current	=	I_P	=	8 milliamperes
Plate voltage	=	E_P	=	135 volts (approx.)
Grid bias	=	E_C	=	—22.5 volts

With such a set of data given the maximum power output can be determined as follows:

1. Using Figure 106, find the point corresponding to 135 volts and 8 miliamperes on the curve for $E_C =$ —22.5. Call this point "*q*." This is the position of the operating point when there is no signal on the grid.
2. To obtain the path of this operating point we must draw through "*q*" a line—the "load line"—with a slope corresponding to 7000 ohms. This line generally can be found by dividing the B-supply voltage by the load resistance. However, we do not yet know the voltage of the B supply. With no signal coming in, the plate current was 8ma., so the drop in the load resistance equals $7000 \times .008 = 56$ volts and the B supply should be $135 + 56 = 191$ volts.

   The load line is now drawn by connecting 191 volts on the voltage axis with the operating point "*q*" and producing the line until it meets the curve $E_C = 0$.
3. Label this line *p-b*. It represents the path of the operating point of the tube as the incoming signal swings the grid between $E_C = 0$ and $E_C = -45$ volts.

The maximum possible power output will now be given by the formula

$$P_{MAX} = (\Delta I_P)^2 R_L$$

when ΔI_P = rms change in plate current.

The maximum current flows when $E_C = 0$. From the diagram we see that this is I_{MAX} = 16 milliamperes. Similarly, I_{MIN} 1.5 milliamperes, when $E_C = -45$ volts.

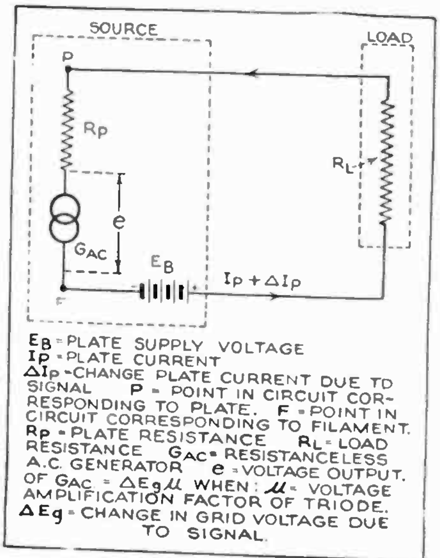


Fig. 105—Top Left - Fig. 106—Top Right
Figure 107—Above

Assuming that we are dealing with a sinusoidal current, both I_{MAX} and I_{MIN} are peak values, and must be reduced to rms values by dividing by $\sqrt{2}$. Hence, we have, finally:

$$P_{MAX} = \left[\frac{\Delta I_P}{2\sqrt{2}}\right]^2 R_L$$

Substituting the numerical value for the conditions given above, we have:

$$P_{MAX} = \tfrac{1}{8} \times .0145 \times .0145 \times 7000$$
$$= .184 \text{ watts} = 184 \text{ milliwatts}$$

By changing the value of R_L, it is possible to obtain higher values for P_{MAX}. It should be noted, however, that this will bring the operating path down on the curve portions of the characteristics when the grid is most negative. This results in distortion of the output signal.

The percentage of second harmonic distortion may be calculated by means of the following formula:

$$\%\ \text{2nd harmonic distortion} = \frac{\dfrac{I_{MAX} + I_{MIN}}{2} - I_P}{I_{MAX} - I_{MIN}} \times 100$$

For the numerical case given above:

$$\%\ \text{2nd harmonic distortion} = \frac{\dfrac{16 + 1.5}{2} - 8}{14.5} \times 100$$
$$= 5.2\% \text{ approximately}$$

When selecting the value of output resistor, it is considered good practice not to exceed 5% second harmonic distortion.

RADIO EXPERIMENTING

EXPERIMENTATION has been the force that has motivated most of the fundamental radio inventions that have been made since Marconi's earliest days. That is how he started out and that is what he is doing now—always experimenting! The old adage should read "Once an experimenter always an experimenter"; and you may ask "Who is *not* an experimenter who is *truly* a radioman?" You may be interested in radio simply as an experimental set-builder, at home. That does not prevent you from getting just as much of a thrill out of doing some original experimental work as the professional research engineer, working for one of the large companies in a huge developmental laboratory. No one has a "corner" on brains and if you like radio experimentation—"research" is another name for it—you have just as much chance of making a fundamental discovery as anyone else. It is true that the professional researcher has better "tools" at hand and possibly more experience, but Brains are the greatest "tools" after all.

Radio experimentation may be your Hobby or it may be your Work, and still you always want to know what are the newest developments in radio, in which experimentation is expanding the world's knowledge. Your interests may be in Physical Research or it may be along the lines of Applied Electronics. It may be from an Engineering standpoint, in developing new receivers. You may be interested in a special field like Television or the Short Waves, or again you may be simply interested in Tinkering with Circuit Designs, Transmitters and Receivers for your own use or for Home Laboratory Experiments in amusing your friends. No matter what your interest, we believe you will find it awakened and refreshed in the material in this chapter.

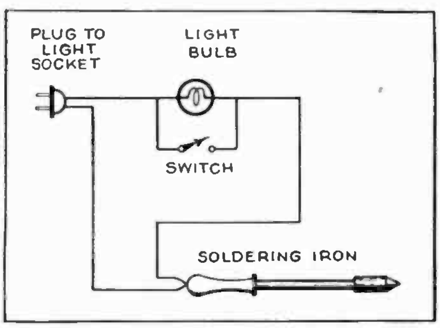
The Care of Soldering Irons

If a soldering iron is left connected to the supply line for hours at a time the tip generally blackens very quickly, becomes pitted and in a very short while it is necessary to obtain a new tip for the iron.

The accompanying circuit (Figure 108) shows an arrangement to overcome this condition. The procedure is to connect the plug to the light line, close the switch S, and the iron is connected directly across the line so that it reaches a satisfactory operating temperature quickly. When this temperature is reached the switch is then reopened, which puts the electric light in series with the iron, thereby reducing the voltage so as to maintain correct temperature without overheating, even though the power be left on for hours.

The wattage of the electric light bulb depends upon the soldering iron. The switch may be almost any type, although it is a good idea to use some kind of an enclosed switch made for use on 110-volt lighting circuits.

Figure 108



A Simple R. F. Indicator

In the efficient servicing of superheterodynes it is desirable to possess means of determining the effectiveness of the oscillator over the entire frequency range. Here is a simple r.f. indicator that would work on even the worst type of oscillator, namely the autodyne. The result is a simple arrangement using inexpensive parts, most of which will be available in the average service shop. The circuit is shown in Figure 109. No plate voltage is used, a small filament transformer being the only supply necessary. An 0-5 range, TM-108 tuning meter made by Readrite is employed as an indicator, although a more expensive milliammeter may be substituted. Where a calibrated scale is not desired, these tuning meters leave nothing to be desired as sensitive milliammeters. It will be noticed that the circuit is really a diode detector hook-up with a visual indicator. The clip, connected to the blocking condenser, C, is connected to the insulated plate of the oscillator condenser (usually the stator). This applies an r.f. voltage to the —56 which, in turn, is rectified in the grid-cathode circuit. This rectified current flows through the tuning meter and the resultant deflection indicates the strength of the applied r.f. wave. Thus a complete check on the strength of oscillations of the superheterodyne oscillator can be obtained in one operation. This indicator will not affect the circuit very much, and will prove a valuable asset in servicing supers, especially those having autodyne oscillators in which it is usually necessary to try several tubes before one is found which will work over the entire scale. The indicator can be connected and the tuning condenser run over the scale. If the oscillator quits working at any point, the tuning meter needle will fall back to zero.

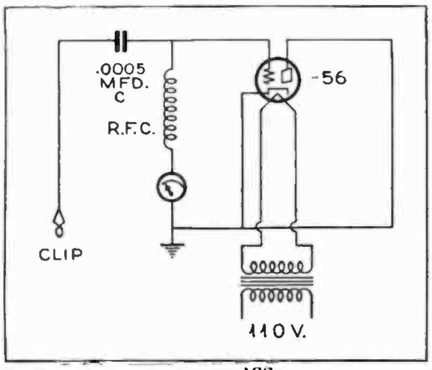


Figure 109

A Live-Wire Tip

Many unhandy and impractical things are applied to the handles of pliers and wire cutters for insulation, or to better the grip when working in cold weather with heavy gloves. Tape is sticky, always coming off, and does not last. Tubing is not heavy enough or too heavy. Force on a pair of inexpensive tricycle handles as shown in Figure 110. Squeeze a bit of cement into the handles first if it is available. Such handles are of a soft but tough, durable rubber, and can be forced neatly over the handles of any ordinary pliers on which such an addition is necessary. The small knobs at the ends make an excellent grip.

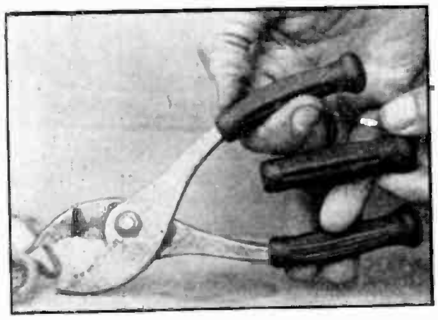


Figure 110

Chart of Tap and Clearance Drills

In radio construction work experimenters are often confronted with the problem

Figure 111

SCREW NUMBER	THREADS PER INCH	DRILL NUMBER FOR TAP	DRILL NUMBER CLEARANCE
3	40	49	39
3	48	45	38
3	56	44	38
4	32	43	31
4	36	42	31
4	40	41	31
5	30,32	40	29
5	36	38	29
5	40	37	29
6	30,32	35	26
6	36	33	26
6	40	32	26
7	30	31	21
7	32	30	21
8	24,30	30	17
8	32	29	17
9	24	29	13
9	28	28	13
9	30	27	13
9	32	25	13
10	24	25	8
10	30	22	8
10	32	21	8

of selecting the correct size drill for tapping, or for drilling a clearance hole to take a certain size machine screw, and Figure 111 gives this information at a glance. It is suggested that the chart be mounted on a piece of heavy cardboard and tacked over the workbench for quick reference. The first and second columns identify the machine screw, the third column gives the drill size where the hole is to be tapped. If the hole is to be drilled so that the machine screw passes through the hole, then the size drill is selected under the column headed "Clearance."

Transformer Providing Eleven Different Voltages

Figure 112 shows a method for utilizing a filament transformer to provide eleven different voltages which will take care of practically all the tubes on the market to-

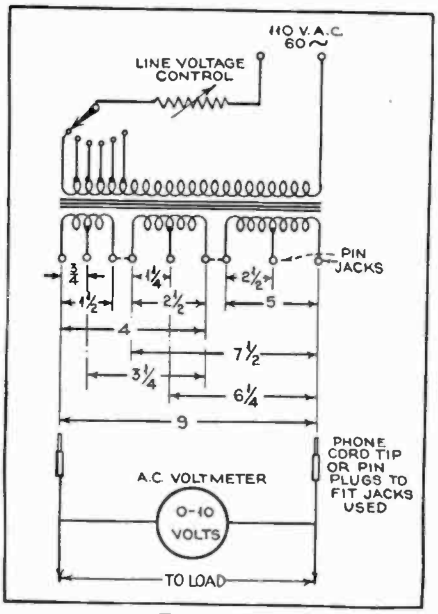


Figure 112

day. Employing a transformer having but three secondary output windings of 1½, 2½ and 5 volts, it is possible to provide, by an interconnecting arrangement of these three voltages, eight additional voltages ranging from ¾ volt up to 9 volts.

Originally the idea was applied to a tube tester. However, in its present arrangement of pin-jack connections it is employed to supply various voltages for the operation of test lamps, door-bells, oscillators and numerous other electrical devices and testing equipment.

Home-Made Radio Cement

A good grade of radio cement can be easily made at a small cost from acetone and celluloid. Experimenters and servicemen will find a cement of this kind extremely handy for cementing speaker cones, insulating coils, repairing tube bases, etc.

A small amount of acetone and a few strips of celluloid may be procured from any drug store. Next obtain a small bottle with a brush attached to the cap. A discarded bottle formerly used for fingernail polish answers the purpose very nicely. The celluloid strips are dropped into the acetone, where they slowly dissolve to form the cement. If the cement becomes too thick, simply add more acetone; if too thin, add more celluloid.

To Prevent Motorboating

A simple circuit to overcome motorboating generally due to interactive coupling between stages is given in Figure 113.

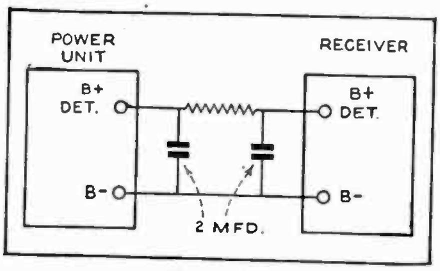


Figure 113

This circuit consists of a network of condensers and a resistance connected between the power unit and the detector B+ terminal of the set, as shown in the diagram.

It is preferable to locate the resistance at a point close to the receiver rather than at the power unit. The value of the resistance is dependent to a certain extent upon the characteristics of the receiver and power unit. With some amplifiers a value of 10,000 ohms is satisfactory, while with others a resistance of 50,000 to 100,000 ohms is required. A resistance of 50,000 ohms seems to be satisfactory in most cases. In using these higher values it may be found desirable to increase the voltage somewhat, to compensate for the drop across the resistor.

Band Spreading

Ham operators will be interested in this simple auxiliary dial (Figure 114) for spreading the amateur bands.

The pointer is made from a strip of soft brass or aluminum. A 6-32 machine screw and nut fastens the pointer to the outside edge of the tuning knob as shown in the drawing. The dial is cut from a piece of cardboard, numbered and then glued to the receiver panel just above the regular dial opening. It is approximately three inches long and is divided into twenty equal divisions.

To set this auxiliary dial the main dial is first tuned to the highest frequency end

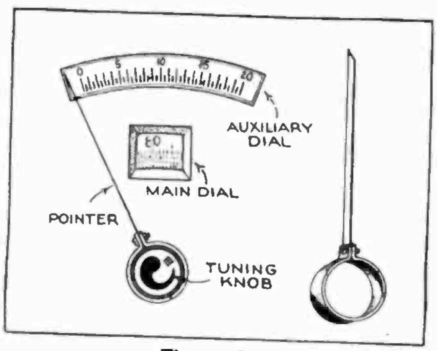


Figure 114

of the desired band and then the bandspread pointer is placed at zero setting and fastened. It must be realized, of course, that the pointer must be reset when it is desired to operate the receiver on a different ham band.

Line Noise Filter

It has been proven in many cases that hum is caused by an ineffectively grounded lighting circuit. As an example, where the lighting line is grounded at a point far removed from the radio set installation a steady hum is frequently encountered and is directly traceable to the power lines.

The simplest type of line filter will in some cases cure this trouble and a unit of this kind can be quickly and easily made

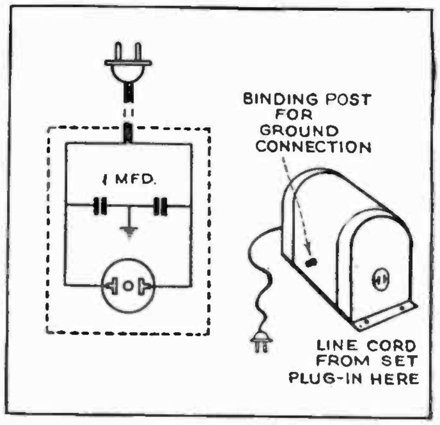


Figure 115

from parts generally found in any service man's shop. An old discarded relay box lends itself very nicely to the idea as it contains the necessary imput line socket and the line connecting cord. Simply remove the relay and install and connect the two—1.0 mfd. condensers, rated at 150 volts a.c. to the plug and socket as shown in Figure 115. Be sure to use a good ground, preferably a wire tightly clamped to a water pipe which has been previously scraped clean. Connect this wire to the ground post on the filter box.

Inexpensive Output Indicator

Lining up a receiver for maximum output is usually accomplished by the serviceman with the aid of a modulated oscillator and an output meter.

If an output meter is not available connect a Mazda flash-light bulb in series

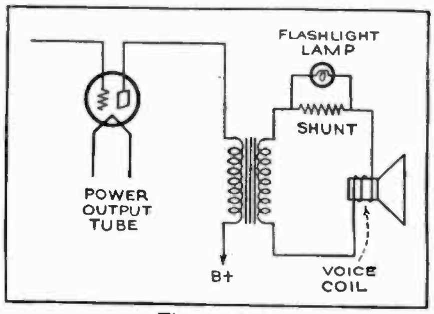


Figure 116

with the speaker voice coil, shunted with low resistance and experimenters will find that it makes an excellent indicator of the output power. The circuit is shown in Figure 116.

Increasing Voltmeter Range

Probably the most widely used single test instrument of the past ten years is the old Weston Model 489, thousand-ohm-per-volt d.c. voltmeter, reading 0-50 and 0-250 volts.

Few owners of these meters seem to realize how easy it is to increase the voltage range to 1000 volts. The idea simply

Guage No. B&S	Cross Sectional Area: Dia. in Mils	Cir. Mils	Sq. Inches	Turns per Linear Inch: DCC.	SCC.	DSC.	SSC.	Enam.	Enam. and SCC.	Enam. and SSC.	Turns per Square Inch: DCC.	SCC.	DSC.	SSC.	Enam.	Enam. and SCC.	Enam. and SSC.	Ft. per Pound: DCC	SCC.	Bare	Res per 1000 Ft. Copper
0000	460.0	211600	.1662																	1.561	.0499
000	409.6	167800	.1318																	1.968	.0629
00	364.8	133100	.1045																	2.482	.0793
0	324.9	105500	.08289																	3.130	.1000
1	289.3	83690	.06573																	3.947	.1260
2	257.6	66370	.05213																	4.977	.1592
3	229.4	52640	.04134																	6.276	.2004
4	204.3	51740	.03278																	7.914	.2336
5	181.9	33100	.02600																	9.980	.3192
6	162.0	26250	.02062	5.44	5.60															12.58	.4028
7	144.3	20820	.01635	6.08	6.23															15.87	.5080
8	128.5	16510	.01297	6.80	6.94													19.6	19.9	20.01	.6405
9	114.4	13090	.01028	7.64	7.68													24.6	25.1	25.23	.8077
10	101.9	10380	.008155	8.51	8.55													30.9	31.6	31.82	1.018
11	90.74	8234	.006467	9.58	9.60													38.9	39.8	40.12	1.284
12	80.81	6530	.005129	10.62	10.80	11.8	12.1	12.1	11.4	11.8	121	136	139	146	146	130	139	48.9	50.2	50.59	1.619
13	71.96	5178	.004067	11.88	12.06	13.2	13.5	13.5	12.8	13.2	153	171	173	183	183	162	173	61.5	63.2	63.80	2.042
14	64.09	4107	.003225	13.10	13.45	14.7	15.1	15.2	14.2	14.7	187	213	216	229	239	201	216	77.3	79.6	80.44	2.575
15	57.07	3257	.002558	14.68	14.90	16.4	16.9	17.0	15.8	16.5	229	264	268	287	290	250	271	97.3	100	101.4	3.247
16	50.82	2583	.002028	16.40	17.20	18.2	18.9	18.7	17.6	18.4	260	327	333	358	350	309	338	119	126	127.9	4.094
17	45.26	2049	.001609	18.10	18.80	20.3	21.2	21.4	19.5	20.5	340	404	412	448	458	381	421	150	155	161.3	5.163
18	40.30	1624	.001276	20.00	21.00	22.6	23.6	24.0	21.7	22.9	412	498	510	559	575	469	524	188	196	203.4	6.510
19	35.89	1288	.001012	21.83	23.60	25.4	26.8	27.2	26.2	25.8	508	629	644	715	739	587	665	237	247	256.5	8.210
20	31.96	1022	.0008023	23.91	26.40	27.8	29.5	30.1	26.5	28.4	596	752	773	867	904	701	805	298	311	323.4	10.35
21	28.46	810.1	.0006363	26.20	29.70	30.0	32.8	33.6	29.6	31.5	752	949	949	1078	1129	878	991	370	389	407.8	13.05
22	25.35	642.4	.0005046	28.58	32.00	34.1	36.6	37.7	32.7	35.0	699	1161	1161	1337	1419	1071	1227	461	491	514.8	16.46
23	22.57	509.5	.0004002	31.12	34.30	37.6	40.7	42.3	36.1	39.0	1070	1416	1416	1656	1785	1306	1518	584	624	648.4	20.76
24	20.10	404.0	.0003173	33.60	37.70	41.5	45.3	47.2	39.7	43.1	1266	1722	1722	2048	2225	1575	1858	745	778	817.7	26.17
25	17.90	320.4	.0002517	36.20	41.50	45.7	50.3	52.9	43.7	47.9	1491	2085	2085	2525	2800	1907	2289	903	958	1031	33.00
26	15.94	254.1	.0001996	39.90	45.30	50.2	55.7	59.0	47.8	52.8	1745	2515	2515	3108	3484	2281	2788	1118	1188	1300	41.62
27	14.20	201.5	.0001583	42.60	49.40	55.0	61.7	65.8	52.1	58.1	2029	3019	3019	3811	4328	2713	3381	1422	1533	1639	52.48
28	12.64	159.8	.0001255	45.50	54.60	60.1	68.3	73.9	57.0	64.4	2347	3611	3611	4666	5456	3250	4141	1759	1903	2067	66.17
29	11.26	126.7	.00009953	48.00	58.80	65.5	75.4	82.2	61.9	70.6	2696	4294	4294	5688	6761	3830	4988	2207	2461	2607	83.44
30	10.03	100.5	.00007894	51.10	64.40	71.3	83.1	92.3	67.4	77.9	3076	5081	5081	6911	8527	4547	6075	2534	2893	3287	105.20
31	8.928	79.70	.00006260	56.80	69.00	77.3	91.6	103.0	72.8	85.3	3489	5981	5981	8389	10568	6305	7267	2768	3483	4145	132.70
32	7.950	63.21	.00004964	60.20	75.00	83.7	101.0	116.0	79.1	93.9	3931	7003	7003	10101	13363	6250	8818	3137	4414	5227	167.30
33	7.080	50.13	.00003937	64.30	81.00	90.3	110.0	130.0	85.6	103.0	4398	8143	8143	12130	16952	7326	10672	4697	5688	6591	211.00
34	6.305	39.75	.00003122	68.60	87.60	97.0	120.0	145.0	91.7	112.0	4883	9407	9407	14499	20967	8403	12610	6168	6400	8319	266.00
35	5.615	31.52	.00002476	73.00	94.20	104.0	131.0	164.0	98.8	123.0	5391	10817	10817	17247	26745	9766	15186	6737	8393	10480	335.00
36	5.000	25.00	.00001964	78.50	101.00	111.0	143.0	182.0	105.0	133.0	5917	12346	12346	20408	33051	11080	17777	7877	9846	13210	423.00
37	4.453	19.83	.00001557	84.00	108.00	118.0	155.0	206.0	113.0	146.0	6452	13996	13996	24015	40766	12758	21295	9309	11636	16660	533.40
38	3.965	15.72	.00001235	89.10	115.00	126.0	168.0	235.0	120.0	157.0	6978	15763	15763	28106	54990	14291	24685	10660	13848	21010	672.60
39	3.331	12.47	.000009793	95.00	122.50	133.0	191.0	261.0	128.0	172.0	7524	17630	17630	32690	68120	16308	29412	11907	18286	26500	848.10
40	3.134	9.888	.000007766	102.50	130.00	140.0	194.0	290.0	134.0	184.0	8045	19569	19589	37779	81246	[illegible]	43727	14222	24381	33410	1069.00
41	2.800	7.841	.000006160	112.00	153.00													17920	30610	42130	1323.00
42	2.494	6.220	.000004885	124.00	168.00													22600	38700	53100	1667.00
43	2.221	4.933	.000003873	140.00	192.00													28410	48600	66970	2105.00
44	1.978	3.910	.000003073	153.00	210.00													35950	61400	84460	2655.00

Courtesy Radio Magazine

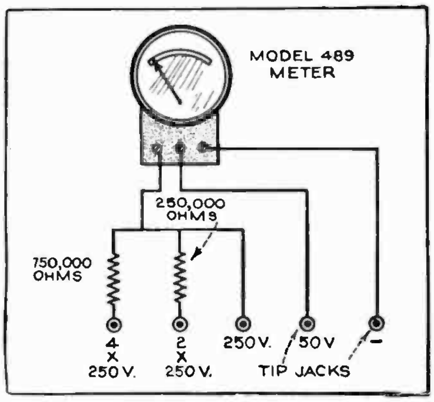
COPPER WIRE TABLE

is to mount the meter on a small bakelite or other insulating panel, as shown in Figure 118, and to add additional multiplier resistors to the 250-volt post (Figure 117).

To double the 0-250-volt scale, use a 250,000-ohm, 1-watt, wire-wound resistor; to quadruple this scale, use a 750,000-ohm, 1-watt resistor. Precision resistors with an accuracy of 1% are required.

The fact that the top scale readings are multiplied by such easy numbers as 2 and 4 makes the mental arithmetic quick and simple. Every owner of a Model 489 will find the extra resistors very much worth while.

Fig. 117—Below Fig. 118—Bottom



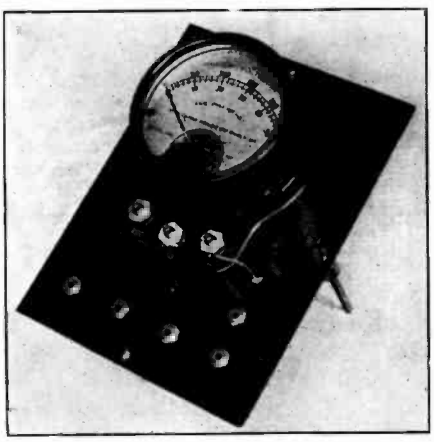


Photo-Cell Amplifier

This highly effective, inexpensive photo-electric cell amplifier, employs a unique circuit. The resistors R3, R4, R5 and the plate resistance of the tube form a bridge arrangement as shown in Figure 119. When the ratio of the arms of the bridge are equal there will be no current flow through R which in this case is the relay. However, if the resistance of the tube shown as Rp, should change, the bridge becomes unbalanced and current flows through Rp thence to R and R4 and back to the power supply. This change can take place when the grid bias on the 47 tube is varied, the effective resistance between the filament and the plate will change accordingly, and it will cause current to flow through R (relay).

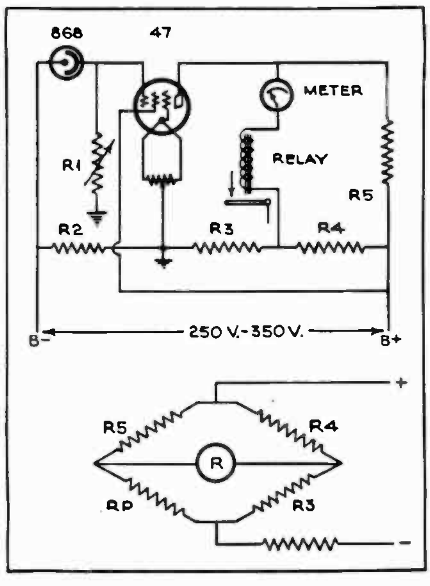
In operation there will be a voltage developed across R2, this voltage will be impressed on the circuit consisting of the photo-cell and R1. The voltage will divide across these two elements according to their resistance. For instance, if the resistance of R1 is 5 megohms and that of the cell is 5 megohms then the voltage will divide equally between the elements. However, the drop across R1 acts to bias the grid of the 47 tube in a negative direction, and when the resistance of the photo-cell changes as it will when light shines upon it, there will be a greater voltage developed across R1 which raises the bias of the tube and consequently increases the plate resistance which in turn will cause current to flow through the relay.

Employing a good photo-cell, you can obtain a variation of the current through the relay, as high as 10 mas. at 10 volts.

The resistor R1 should be variable in order to balance the bridge circuit. This resistance should be kept as high as possible. The relay was made from a telephone bell magnet and its resistance is approximately 1400 ohms. The resistance of the meter is about the same as the relay. Where a sensitive relay is used the meter is necessary, so that the current can be adjusted to zero point.

The value of parts, for use with the type 47 tube, are: R1, variable resistance, 10 megohm; R2, 2,000 ohms, 10 watts; R3, 40,000 ohms, 5 watts; R4, 10,000 ohms, 5 watts; and R5, 5,000 ohms, 10 watts.

Figure 119



WATTS	Section of Core (inches)	Area of Core (Square inches)	Primary Turns	Primary Wire Size	Turns per Volt	SECONDARY WINDINGS (Turns for Voltages Given) 2.5 volts	5.0 volts	6.3 volts	7.5 volts	10 volts	HIGH-VOLTAGE WINDING 250 volts	300 volts	350 volts	400 volts	450 volts	500 volts	600 volts	700 volts	800 volts	900 volts	1000 volts	1250 volts	1500 volts
10	½ x ½	.25	3500	31	32	80	160	205	240	320													
10	½ x ⅝	.31	2800	31	24.2	61	122	147	182	242													
12	½ x ¾	.37	2300	30	20.0	50	100	126	150	200													
12	⅝ x ⅝	.38	2280	30	19.6	48	96	124	147	196													
15	⅝ x ¾	.46	1875	29	16.1	42	84	105	124	161													
22	⅝ x 1	.62	1400	28	12.2	31	61	77	92	122													
20	¾ x ¾	.55	1570	28	13.6	34	68	86	102	136													
25	¾ x 1	.75	1150	27	10.0	25	50	63	75	100	2620	3150	3700	4200	4750	5250							
30	¾ x 1¼	.93	930	26	8.1	21	42	52	62	81	2100	1500	3140	3400	3800	4200							
50	¾ x 1½	1.12	770	24	6.7	17	34	43	50	67	1860	2100	2500	2840	3150	3500	4200	5000					
50	1 x 1	1.0	860	24	7.5	19	38	48	57	75	1950	2400	2700	3150	3600	3900	4700	5500					
60	1 x 1¼	1.25	690	23	6.0	15	30	38	45	60	1600	1900	2200	2500	2800	3150	3800	4400					
65	1 x 1½	1.50	575	23	5.0	13	25	32	38	50	1300	1575	1850	2100	2400	2650	3150	3700					
75	1 x 1¾	1.75	490	22	4.2	11	21	27	31	42	1100	1320	1550	1750	2000	2200	2650	3150	3800	4000	4400		
110	1 x 2	2.0	430	21	3.7	9	18	23	28	37	980	1170	1370	1550	1750	1960	2300	2750	3100	3500	3900		
105	1¼ x 1¼	1.56	550	21	4.8	12	24	31	36	48	1260	1510	1770	2050	2240	2510	3050	3500	4100	4500	5020		
100	1¼ x 1½	1.87	460	21	3.8	9	19	25	29	38	1000	1200	1400	1600	1800	2000	2400	2720	3200	3560	4000		
120	1¼ x 1¾	2.18	400	20	3.5	9	18	21	26	35	920	1100	1315	1470	1650	1840	2200	2560	2940	3300	3700	4620	5500
140	1¼ x 2	2.5	350	19	3.2	8	16	20	24	32	840	1020	1180	1340	1510	1680	2050	2350	2680	3000	3380	4200	5050
125	1½ x 1½	2.25	380	20	3.3	8	16	21	25	33	870	1040	1210	1400	1560	1730	2100	2420	2800	3120	3500	4400	5250
150	1½ x 1¾	2.64	330	18	2.9	7	14	19	22	29	760	910	1130	1220	1360	1530	1840	2100	2450	2750	3050	3800	4650
200	1½ x 2	3.0	290	17	2.42	6	12	15	18	24	630	765	890	1020	1150	1265	1522	1780	2050	2380	2350	3200	3840
300	2 x 2	4.0	215	15	1.87	5	9	12	14	19	490	590	690	780	880	980	1180	1360	1570	1760	1950	2350	2940
400	2 x 2½	5.0	175	14	1.52	4	8	10	12	15	395	470	550	640	710	790	950	1110	1265	1420	1590	1980	2400
500	2 x 3	6.0	115	13	1.26	3	6	8	9	12	330	395	455	530	595	660	790	920	1060	1200	1330	1650	2000

Courtesy Radio Magazine

TRANSFORMER DESIGN TABLE

Interstation Noise Suppressor System

Radio receivers equipped with interstation noise suppression generally employ a separate tube and the grid bias action of this tube is controlled by the automatic volume control circuit of the receiver in such a way as to block the audio amplifier when the signal strength fades to a predetermined minimum.

This system, of course, is successful but the circuit is complex and not easily installed in a receiver. Also, it requires an extra tube with the necessary additional operating voltages.

The system shown in Figure 120 is simple and easy to install. It can be used in all Wunderlich and —55 type tube circuits in which the triode section is diode biased and where the manual volume control is installed in the audio amplifier. As can be seen in the diagram, a variable resistor is connected in the cathode lead of the detector circuit and it is by-passed by the 1 mfd. condenser. The plate current of the detector tube causes a voltage drop through this resistor which results in a negative bias being placed on the diode plates or the dual grids as the case may be.

The receiver is tuned to a point between stations, where the noise is loudest and the rheostat is turned until the bias on the diode plates is greater than the voltage generated by the noise. This stops rectification and therefore detection and the set will be silent.

As soon as the receiver is tuned to a station which provides a signal input to the diode which is greater than the diode bias, then rectification takes place. This results in an increased bias on the grid of the triode and a decrease in the current flowing through the cathode resistor.

If the receiver is tuned to a station that fades in and out of the noise level, reception will be choppy, due to the set going silent as the signal enters the noise level. This is common to all interstation noise suppression systems.

The distortion introduced by operating the tube in this fashion is very small at normal inputs. It increases near the cut-off point but is no worse than in other systems in which the grid of the audio tube may be driven negative enough to operate the tube as a bias detector instead of as a distortionless amplifier.

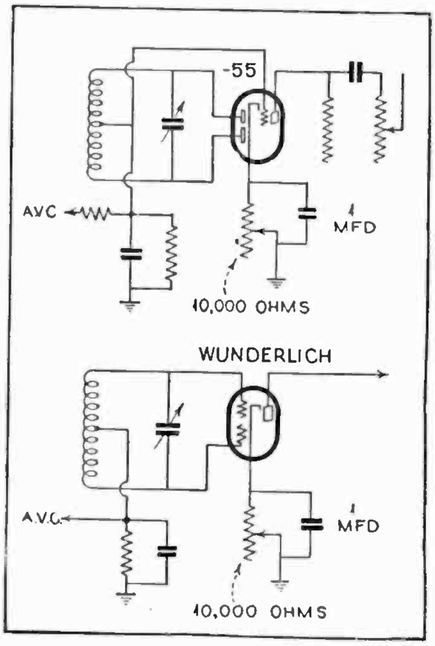


Figure 120

Extension Speaker Hook-Up

Here is an easy way to connect an extra magnetic type speaker (or headphones) to a receiver already equipped with an electro-dynamic speaker.

The magnetic speaker is connected in series between two condensers of 1 mfd. capacity each, across the primary of the output transformer as shown in Figure 121. Make sure the condensers are of sufficient voltage rating to insure against breakdown. The switches may be added as shown for operating one or both speakers as desired.

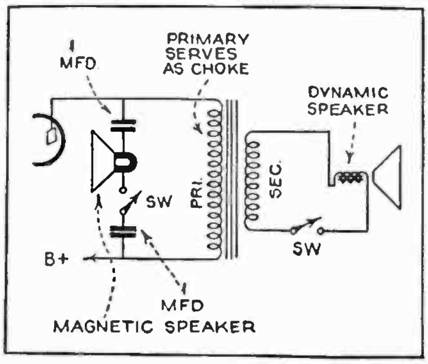


Figure 121

RADIO NEWS

Keeps You Up-to-Date With Radio

STATION LISTS

Broadcast Stations In The U. S.

(ALPHABETICALLY BY CALL LETTERS)

Call	Location	Kc.	Kw.
KABC	San Antonio, Texas	1420	.1
KABR	Aberdeen, S. D.	1420	.1
KADA	Ada, Okla.	1200	.1
KALB	Alexandria, La.	1420	.1
KALE	Portland, Ore.	1300	.5
KARK	Little Rock, Ark.	890	.25
KASA	Elk City, Okla.	1210	.1
KAST	Astoria, Ore.	1370	.1
KBPS	Portland, Ore.	1420	.1
KBTM	Jonesboro, Ark.	1200	.1
KCMC	Texarkana, Ark.	1420	.1
KCRC	Enid, Okla.	1360	.25
KCRJ	Jerome, Ariz.	1310	.1
KDB	Santa Barbara, Calif.	1500	.1
KDFN	Casper, Wyo.	1440	.5
KDKA	Pittsburgh, Pa.	980	50.
KDLR	Devils Lake, N. Dak.	1210	.1
KDYL	Salt Lake City, Utah	1290	1.
KECA	Los Angeles, Calif.	1430	1.
KEHE	Los Angeles, Calif.	780	.5
KELD	El Dorado, Ark.	1370	.1
KELW	Burbank, Calif.	780	.5
KERN	Bakersfield, Calif.	1370	.1
KEX	Portland, Ore.	1180	.5
KFAB	Lincoln, Nebr.	770	10.
KFAC	Los Angeles, Calif.	1300	1.
KFBB	Great Falls, Montana	1280	1.
KFBI	Abilene, Kansas	1050	5.
KFBK	Sacramento, Calif.	1490	5.
KFDM	Beaumont, Texas	560	.5
KFDY	Brookings, South Dak.	780	1.
KFEL	Denver Colo.	920	.5
KFEQ	St. Joseph, Mo.	680	2.5
KFGQ	Boone, Iowa	1370	.1
KFH	Wichita, Kansas	1300	1.
KFI	Los Angeles Calif.	640	50.
KFIO	Spokane, Wash.	1120	.1
KFIZ	Fond du Lac, Wis.	1420	.1
KFJB	Marshalltown, Iowa	1200	.1
KFJI	Klamath Falls, Ore.	1210	.1
KFJM	Grand Forks, N. Dak.	1370	.1
KFJR	Portland, Ore	1300	.5
KFJZ	Forth Worth, Texas	1370	.1
KFKA	Greeley, Colo.	880	.5
KFKU	Lawrence, Kansas	1220	1.
KFNF	Shenandoah, Iowa	890	.5
KFOR	Lincoln, Nebr.	1210	.1
KFOX	Long Beach, Calif.	1250	1.
KFPL	Dublin, Texas	1310	.1
KFPW	Ft. Smith, Ark.	1210	.1
KFPY	Spokane, Wash.	890	1.
KFQD	Anchorage, Alaska	780	.25
KFRC	San Francisco, Calif.	610	1.
KFRO	Longview, Texas	1370	.1
KFRU	Columbia, Mo.	630	.5
KFSD	San Diego, Calif.	600	1.
KFSG	Los Angeles, Calif.	1120	1.
KFUH	Del Monte, Calif.	1210	.1
KFUO	St. Louis Mo.	550	.5
KFVD	Los Angeles, Calif.	1000	.25
KFVS	Cape Girardeau, Mo.	1210	.1
KFWB	Hollywood, Calif.	950	1.
KFXD	Nampa, Idaho	1200	.1
KFXJ	Grand Junction, Colo.	1200	.1
KFXM	San Bernardino, Calif.	1210	.1
KFXR	Oklahoma City, Okla.	1310	.1
KFYO	Lubbock, Texas	1310	.1
KFYR	Bismarck, N. Dakota	550	1.
KGA	Spokane, Wash.	1470	5.
KGAR	Tucson, Ariz.	1370	.1
KGB	San Diego, Calif.	1330	1.
KGBU	Ketchikan, Alaska	900	.5
KGBX	Springfield, Mo.	1230	.5
KGBZ	York, Nebr.	930	1.
KGCA	Decorah, Iowa	1270	.1
KGCU	Mandan, N. Dakota	1240	.25
KGCX	Wolf Point, Montana	1310	.1
KGDE	Fergus Falls Minn.	1200	.1
KGDM	Stockton, Calif.	1100	1.
KGDY	Huron, S. Dak.	1340	.25
KGEK	Sterling, Colo.	1200	.1
KGER	Long Beach, Calif.	1360	1.
KGEZ	Kalispell, Mont.	1310	.1
KGFF	Shawnee, Okla.	1420	.1
KGFG	Oklahoma City, Okla.	1370	.1
KGFI	Corpus Christi, Texas	1500	.1
KGFJ	Los Angeles, Calif.	1200	.1
KGFK	Moorhead, Minn.	1500	.1
KGFL	Roswell, N. Mex.	1370	.1
KGFW	Kearney, Nebr.	1310	.1
KGFX	Pierre, S. Dak.	630	.2
KGGC	San Francisco, Calif.	1420	.1
KGGF	Coffeyville, Kansas	1010	1.
KGGM	Albuquerque, N. Mex.	1230	.25
KGHF	Pueblo, Colo.	1320	.5
KGHI	Little Rock, Ark.	1200	.1
KGHL	Billings Mont.	780	1.
KGIR	Butte, Mont.	1340	1.
KGIW	Alamosa, Colo.	1420	.1
KGKB	Tyler, Texas	1500	.1
KGKL	San Angelo, Texas	1370	.1
KGKO	Wichita Falls, Texas	1240	1.
KGKY	Scottsbluff, Nebraska	1500	.1
KGMB	Honolulu, Hawaii	750	2.5
KGMC	Amarillo, Texas	1410	1.
KGNF	North Platte, Nebr.	1430	1.
KGNO	Dodge City, Kansas	1340	.25
KGO	San Francisco, Calif.	790	7.5
KGU	Honolulu, Hawaii	750	2.5
KGVO	Missoula, Mont.	1260	1.
KGW	Portland, Ore.	620	1.
KGY	Olympia, Wash.	1210	.1
KHJ	Los Angeles, Calif.	900	1.
KHQ	Spokane, Wash.	590	1.
KHSL	Chico, Calif.	950	.25
KICA	Clovis, N. Mex.	1370	.1
KID	Idaho Falls, Idaho	1320	.25
KIDO	Boise, Idaho	1350	1.
KIDW	Lamar, Colo.	1420	.1
KIEM	Eureka, Calif.	1210	.1
KIEV	Glendale Calif.	850	.25
KINY	Juneau, Alaska	1310	.1
KIT	Yakima, Wash.	1310	.1
KIUJ	Sante Fe, New Mexico	1310	.1
KIUL	Garden City, Kans.	1210	.1
KIUN	Pecos, Texas	1420	.1
KIUP	Durango, Colo.	1370	.1
KJBS	San Francisco, Calif.	1070	.5
KJR	Seattle, Wash.	970	5.
KLCN	Blytheville, Ark.	1290	.1
KLO	Ogden, Utah	1400	.5
KLPM	Minot, N. Dakota	1240	.25
KLRA	Little Rock, Ark.	1390	1.
KLS	Oakland, Calif.	1440	.25
KLUF	Galveston, Texas	1370	.1
KLX	Oakland, Calif.	880	1.
KLZ	Denver, Colo.	560	1.
KMA	Shenandoah, Iowa	930	1.
KMAC	San Antonio, Texas	1370	.1
KMBC	Kansas City, Mo.	950	1.
KMED	Medford, Ore.	1310	.1
KMJ	Fresno, Calif.	580	1.
KMLB	Monroe, La.	1200	.1
KMMJ	Clay Center, Nebr.	740	1.
KMO	Tacoma, Wash.	1330	.25
KMOX	St. Louis, Mo.	1090	50.
KMPC	Beverly Hills, Calif.	710	.5
KMTR	Hollywood Calif.	570	1.
KNOW	Austin, Texas	1500	.1
KNX	Hollywood, Calif.	1050	50.
KOA	Denver, Colo.	830	50.
KOAC	Corvallis, Ore.	550	1.
KOB	Albuquerque, N. Mex.	1180	10.
KOH	Reno, Nev.	1380	.5
KOIL	Council Bluffs, Iowa	1260	1.
KOIN	Portland, Ore.	940	1.
KOL	Seattle, Wash.	1270	1.
KOMA	Oklahoma City, Okla.	1480	5.
KOMO	Seattle, Wash.	920	1.
KONO	San Antonio, Texas	1370	.1
KOOS	Marshfield, Ore.	1200	.25
KORE	Eugene, Ore.	1420	.1
KOTN	Pine Bluff, Ark.	1500	.1
KOY	Phoenix, Ariz.	1390	.5
KPAC	Port Arthur, Texas	1260	.5
KPCB	Seattle, Wash.	710	.1
KPJM	Prescott, Ariz.	1500	.1
KPLC	Lake Charles, La.	1500	.1
KPO	San Francisco, Calif.	680	50.
KPOF	Denver, Colo.	880	.5
KPPC	Pasadena, Calif.	1210	.05
KPQ	Wenatchee, Wash.	1500	.1
KPRC	Houston, Texas	920	1.
KQV	Pittsburgh, Pa.	1380	.5
KQW	San Jose, Calif.	1010	1.
KRE	Berkeley, Calif.	1370	.1
KREG	Santa Ana, Calif.	1500	.1
KRGV	Weslaco, Texas	1260	.5
KRKD	Los Angeles, Calif.	1120	1.
KRKO	Everett, Wash.	1370	.05
KRLC	Lewiston, Idaho	1420	.1
KRLD	Dallas, Texas	1040	10.
KRMD	Shreveport, La.	1310	.1
KRNT	Des Moines, Iowa	1320	.5
KROC	Rochester, Minn.	1310	.1
KROW	Oakland, Calif.	930	1.
KRSC	Seattle Wash.	1120	.1
KSAC	Manhattan, Kan.	580	.5
KSCJ	Sioux City, Iowa	1330	1.
KSD	St. Louis, Mo.	550	1.
KSEI	Pocatello, Idaho	900	.25
KSFO	San Francisco, Calif.	560	1.
KSL	Salt Lake City, Utah	1130	50.
KSLM	Salem, Ore.	1370	.1
KSO	Des Moines, Iowa	1430	.25
KSOO	Sioux Falls, S. Dakota	1110	2.5
KSTP	St. Paul, Minn.	1460	10.
KSUN	Lowell, Ariz.	1200	.1
KTAR	Phoenix, Ariz.	620	1.
KTAT	Forth Worth, Texas	1240	1.
KTBS	Shreveport, La.	1450	1.
KTFI	West Twin Falls, Idaho	1240	1.
KTHS	Hot Springs, Ark.	1060	10.
KTRB	Modesto, Calif.	740	.25
KTRH	Houston, Texas	1290	1.
KTSA	San Antonio, Texas	550	1.
KTSM	El Paso, Texas	1310	.1
KTUL	Tulsa, Okla.	1400	.5
KTW	Seattle, Wash.	1220	1.
KUJ	Walla Walla, Wash.	1370	.1
KUMA	Yuma, Ariz.	1420	.1
KUOA	Fayetteville, Ark.	1260	1.
KUSD	Vermillion, S. D.	890	.5
KVI	Tacoma, Wash.	570	1.
KVL	Seattle, Wash.	1370	.1
KVOA	Tucson, Ariz.	1260	.5
KVOD	Denver, Colo.	920	.5
KVOL	Lafayette, La.	1310	.1
KVOO	Tulsa, Okla.	1140	25.
KVOR	Colorado Springs, Colo.	1270	1.
KVOS	Bellingham, Wash.	1200	.1
KVSO	Ardmore, Okla.	1210	.1
KWBG	Hutchinson, Kans.	1420	.1
KWEA	Shreveport, La.	1210	.1
KWG	Stockton, Calif.	1200	.1
KWJJ	Portland, Ore.	1040	.5
KWK	St. Louis, Mo.	1350	1.
KWKC	Kansas City, Mo.	1370	.1
KWKH	Shreveport, La.	850	10.
KWLC	Decorah, Iowa	1270	.1
KWSC	Pullman, Wash.	1220	1.
KWTN	Watertown, S. Dak.	1210	.1
KWTO	Springfield, Mo.	560	5.
KWYO	Sheridan, Wyo.	1370	.1
KXA	Seattle, Wash.	760	.25
KXL	Portland, Ore.	1420	.1
KXO	El Centro, Calif.	1500	.1
KXRO	Aberdeen, Wash.	1310	.1
KXYZ	Houston, Texas	1440	1.
KYA	San Francisco, Calif.	1230	1.
KYW	Philadelphia, Pa.	1020	10.
NAA	Arlington, Va.	690	1.
WAAB	Boston, Mass.	1410	.5
WAAF	Chicago, Ill.	920	.5
WAAT	Jersey City N. J.	940	.5
WAAW	Omaha, Nebr.	660	.5
WABC	New York, N. Y.	860	50.
WABI	Bangor, Maine	1200	.1
WABY	Albany, N. Y.	1370	.1
WACO	Waco, Texas	1420	.1
WADC	Akron, Ohio	1320	1.
WAGF	Dothan, Ala.	1370	.1
WAGM	Presque Isle, Maine	1420	.1
WAIM	Anderson, S. C.	1200	.1
WAIU	Columbus, Ohio	640	.5
WALA	Mobile, Ala.	1380	.5
WALR	Zanesville, Ohio	1210	.1
WAML	Laurel, Miss.	1310	.1
WAPI	Birmingham, Ala.	1140	5.
WARD	Brooklyn, N. Y.	1400	.5
WASH	Grand Rapids, Mich.	1270	.5
WATR	Waterbury, Conn.	1190	.1
WAVE	Louisville, Ky.	940	1.
WAWZ	Zarephath, N. J.	1350	.5
WAZL	Hazleton, Penna.	1420	.1
WBAA	West Lafayette, Ind.	890	1.
WBAL	Baltimore, Md.	1060	10.
WBAP	Forth Worth, Texas	800	50.
WBAX	Wilkes-Barre, Penna.	1210	.1
WBBC	Brooklyn, N. Y.	1400	.5
WBBL	Richmond, Va.	1210	.1
WBBM	Chicago, Ill.	770	50.
WBBR	Brooklyn, N. Y.	1300	1.

Call	Location	Kc.	Kw.
WBBZ	Ponca City, Okla.	1200	.1
WBCM	Bay City, Mich.	1410	.5
WBEN	Buffalo, N. Y.	900	1.
WBEO	Marquette, Mich.	1310	.1
WBIG	Greensboro, N. C.	1440	.5
WBNO	New Orleans, La.	1200	.1
WBNS	Columbus, Ohio	1430	.5
KBNX	New York, N. Y.	1350	.25
WBOQ	(See WABC)		
WBOW	Terre Haute, Ind.	1310	.1
WBRB	Red Bank, N. J.	1210	.1
WBRC	Birmingham, Ala.	930	1.
WBRE	Wilkes-Barre, Pa.	1310	.1
WBSO	Babson Park, Mass.	920	.5
WBT	Charlotte, N. C.	1080	50.
WBTM	Danville, Va.	1370	.1
WBZ	Boston, Mass.	990	50.
WBZA	Springfield, Mass.	990	1.
WCAC	Storrs, Conn.	600	.5
WCAD	Canton, N. Y.	1220	.5
WCAE	Pittsburgh, Pa.	1220	1.
WCAL	Northfield, Minn.	1250	1.
WCAM	Camden, N. J.	1280	.5
WCAO	Baltimore, Md.	600	.5
WCAP	Asbury Park, N. J.	1280	.5
WCAT	Rapid City, S. Dak.	1200	.1
WCAU	Philadelphia, Pa.	1170	50.
WCAX	Burlington, Vt.	1200	.1
WCAZ	Carthage, Ill.	1070	.1
WCBA	Allentown, Penna.	1440	.5
WCBD	Waukegan, Ill.	1080	5.
WCBM	Baltimore, Md.	1370	.1
WCBS	Springfield, Ill.	1420	.1
WCCO	Minneapolis, Minn.	810	50.
WCFL	Chicago, Ill.	970	1.5
WCHS	Charleston, W. Va.	580	.5
WCKY	Covington, Ky.	1490	5.
WCLO	Janesville, Wis.	1200	.1
WCLS	Joliet, Ill.	1310	.1
WCMI	Ashland, Ky.	1310	.1
WCNW	Brooklyn, N. Y.	1500	.1
WCOA	Pensacola, Fla.	1340	.5
WCOC	Meridian, Miss.	880	.5
WCOL	Columbus, Ohio	1210	.1
WCRW	Chicago, Ill.	1210	.1
WCSC	Charleston, S. C.	1360	.5
WCSH	Portland, Maine	940	1.
WDAE	Tampa, Fla.	1220	1.
WDAF	Kansas City, Mo.	610	1.
WDAH	El Paso, Texas	1310	.1
WDAS	Philadelphia, Penna.	1370	.1
WDAY	Fargo, N. Dakota	940	1.
WDBJ	Roanoke, Va.	930	1.
WDBO	Orlando, Fla.	580	1.
WDEL	Wilmington, Del.	1120	.25
WDEV	Waterbury, Vt.	550	.5
WDGY	Minneapolis, Minn.	1180	1.
WDNC	Durham, N. C.	1500	.1
WDOD	Chattanooga, Tenn.	1280	1.
WDRC	Hartford, Conn.	1330	1.
WDSU	New Orleans, La.	1250	1.
WDZ	Tuscola, Ill.	1020	.25
WEAF	New York, N. Y.	660	50.
WEAN	Providence, R. I.	780	.5
WEBC	Superior, Wis.	1290	1.
WEBQ	Harrisburg, Ill.	1210	.1
WEBR	Buffalo, N. Y.	1310	.1
WEDC	Chicago, Ill.	1210	.1
WEED	Rocky Mount, N. C.	1420	.1
WEEI	Boston, Mass.	590	1.
WEEU	Reading, Penna.	830	1.
WEHC	Charlottesville, Va.	1420	.1
WEHS	Cicero, Ill.	1420	.1
WELL	Battle Creek, Mich.	1420	.1
WENR	Chicago, Ill.	870	50.
WESG	Elmira, N. Y.	850	1.
WEVD	New York, N. Y.	1300	1.
WEW	St. Louis, Mo.	760	1.
WEXL	Royal Oak, Mich.	1310	.05
WFAA	Dallas, Texas	800	50.
WFAB	New York, N. Y.	1300	1.
WFAM	South Bend, Ind.	1200	.1
WFAS	White Plains, N. Y.	1210	.1
WFBC	Greenville, S. C.	1300	1.
WFBE	Cincinnati, Ohio	1200	.1
WFBG	Altoona, Pa.	1310	.1
WFBL	Syracuse, N. Y.	1360	1.
WFBM	Indianapolis, Ind.	1230	1.
WFBR	Baltimore, Md.	1270	.5
WFDF	Flint, Mich.	1310	.1
WFEA	Manchester, N. H.	1340	.5
WFIL	Philadelphia, Pa.	560	1.
WFLA	Clearwater, Fla.	620	1.
WFMD	Frederick, Md.	900	.5
WGAL	Lancaster, Pa.	1500	.1
WGAR	Cleveland, Ohio	1450	.5
WGBB	Freeport, N. Y.	1210	.1
WGBF	Evansville, Ind.	630	.5
WGBI	Scranton, Pa.	880	.5
WGCM	Mississippi City, Miss.	1120	.25
WGES	Chicago, Ill.	1360	.5
WGH	Newport News, Va.	1310	.1
WGL	Ft. Wayne, Ind.	1370	.1
WGN	Chicago, Ill.	720	50.
WGNY	Chester, N. Y.	1210	.1
WGPC	Albany, Ga.	1420	.1
WGR	Buffalo, N. Y.	550	1.
WGST	Atlanta, Ga	890	.5
WGY	Schenectady, N. Y.	790	50.
WHA	Madison, Wis.	940	2.5
WHAM	Rochester, N. Y.	1150	50.
WHAS	Louisville, Ky.	820	50.
WHAT	Philadelphia, Pa	1310	.1
WHAZ	Troy, New York	1300	.5
WHB	Kansas City Mo.	860	1.
WHBC	Canton, Ohio	1200	.1
WHBF	Rock Island, Ill.	1210	.1
WHBI	Newark, N. J.	1250	1.
WHBL	Sheboygan, Wis.	1410	.5
WHBQ	Memphis, Tenn.	1370	.1
WHBU	Anderson, Ind.	1210	.1
WHBY	Green Bay, Wis.	1200	.1
WHDF	Calumet, Mich.	1370	.1
WHDH	Boston, Mass.	830	1.
WHDL	Olean, N. Y.	1420	.1
WHEB	Portsmouth, N. H.	740	.25
WHEC	Rochester, N. Y.	1430	.5
WHEF	Kosciusko, Miss.	1500	.1
WHFC	Cicero, Ill.	1420	.1

Call	Location	Kc.	Kw.
WHIO	Dayton, Ohio	1260	1.
WHIS	Bluefield, W. Va.	1410	.25
WHJB	Greensburgh Pa.	620	.25
WHK	Cleveland, Ohio	1390	1.
WHN	New York, N. Y.	1010	1.
WHO	Des Moines, Iowa	1000	50.
WHOM	Jersey City, N. J.	1450	.25
WHP	Harrisburg, Pa.	1430	1.
WIBA	Madison, Wis.	1280	1.
WIBG	Glenside, Pa.	970	.1
WIBM	Jackson, Mich.	1370	.1
WIBU	Poynette, Wis.	1210	.1
WIBW	Topeka, Kansas	580	1.
WIBX	Utica, N. Y.	1200	.1
WICC	Bridgeport, Conn.	600	.5
WIL	St Louis, Mo.	1200	.1
WILL	Urbana, Ill.	890	1.
WILM	Wilmington, Del.	1420	.1
WIND	Gary, Ind.	560	1.
WINS	New York, N. Y.	1180	1.
WIOD	Miami, Fla.	1300	1.
WIP	Philadelphia, Pa.	610	.5
WIRE	Indianapolis, Ind.	1400	.5
WIS	Columbia, S. C.	1010	.5
WISC	Milwaukee, Wis.	1310	.1
WISN	Milwaukee, Wis.	1120	.25
WJAC	Johnstown, Pa.	1310	.1
WJAG	Norfolk, Nebr.	1060	1.
WJAR	Providence, R. I.	890	.5
WJAS	Pittsburgh, Pa.	1290	1.
WJAX	Jacksonville, Fla.	900	1.
WJAY	Cleveland, Ohio	610	.5
WJBC	Bloomington, Ill.	1200	.1
WJBK	Detroit, Mich.	1500	.1
WJBL	Decatur, Ill.	1200	.1
WJBO	Baton Rouge, La.	1420	.1
WJBW	New Orleans, La.	1200	.1
WJBY	Gadsden, Ala.	1210	.1
WJDX	Jackson, Miss.	1270	1.
WJEJ	Hagerstown Md.	1210	.1
WJIM	Lansing, Mich.	1210	.1
WJJD	Chicago, Ill.	1130	20.
WJMS	Ironwood, Mich.	1420	.1
WJR	Detroit, Mich.	750	50.
WJSV	Washington, D. C.	1460	10.
WJTL	Atlanta, Ga.	1370	.1
WJW	Akron, Ohio	1210	.1
WJZ	New York, N. Y.	760	50.
WKAQ	San Juan, Puerto Rico	1240	1.
WKAR	East Lansing, Mich.	1040	1.
WKBB	East Dubuque, Ill.	1500	.1
WKBH	La Crosse, Wis.	1380	1.
WKBI	Cicero, Ill.	1420	.1
WKBN	Youngstown, Ohio	570	.5
WKBO	Harrisburg, Pa.	1200	.1
WKBV	Richmond, Ind.	1500	.1
WKBW	Buffalo, N. Y.	1480	5.
WKBZ	Muskegon, Mich.	1500	.1
WKEU	Griffin, Ga.	1500	.1
WKJC	Lancaster, Pa.	1200	.1
WKOK	Sunbury, Pa.	1210	.1
WKRC	Cincinnati, Ohio	550	.1
WKY	Oklahoma City, Okla.	900	1.
WKZO	Kalamazoo, Mich.	590	1.
WLAC	Nashville, Tenn.	1470	5.
WLAP	Lexington, Ky.	1420	.1
WLB	Minneapolis, Minn.	1250	1.
WLBC	Muncie, Ind.	1310	.05
WLBF	Kansas City, Kans.	1420	.1
WLBL	Stevens Point, Wis.	900	2.5
WLBZ	Bangor, Maine	620	.5
WLEU	Erie, Pa.	1420	.1
WLLH	Lowell, Mass.	1370	.1
WLNH	Laconia, N. H.	1310	.1
WLS	Chicago, Ill.	870	50.
WLTH	Brooklyn N. Y.	1400	.5
WLVA	Lynchburg, Va.	1200	.1
WLW	Cincinnati, Ohio	700	50.
WLWL	New York, N. Y.	1100	5.
WMAL	Washington, D. C.	630	.25
WMAQ	Chicago, Ill.	670	50.
WMAS	Springfield, Mass.	1420	.1
WMAZ	Macon, Ga.	1180	1.
WMBC	Detroit, Mich.	1420	.1
WMBD	Peoria, Ill.	1440	.5
WMBG	Richmond, Va.	1210	.1
WMBH	Joplin, Mo.	1420	.1
WMBI	Chicago, Ill.	1080	5.
WMBO	Auburn, N. Y.	1310	.1
WMBQ	Brooklyn, N. Y.	1500	.1
WMBR	Jacksonville, Fla.	1370	.1
WMC	Memphis, Tenn	780	1.
WMCA	New York, N. Y.	570	.5
WMEX	Boston, Mass.	1500	.1
WMFD	Wilmington, N. C.	1370	.1
WMFF	Plattsburgh, N. Y.	1310	.1
WMFG	Hibbing, Minn.	1210	.1
WMFH	Boston, Mass.	1230	1.
WMFI	New Haven, Conn.	900	.5
WMFJ	Daytona Beach, Fla.	1420	.1
WMFN	Clarksdale, Miss.	1210	.1
WMFO	Decatur, Ala.	1370	.1
WMFR	High Point, N. C.	1200	.1
WMMN	Fairmont, W. Va.	890	.5
WMPC	Lapeer, Mich.	1200	.1
WMT	Cedar Rapids, Iowa	600	1.
WNAC	Boston, Mass.	1230	1.
WNAD	Norman, Okla.	1010	1.
WNAX	Yankton, S. Dak.	570	1.
WNBC	New Britain, Conn.	1380	.25
WNBF	Binghamton, N. Y.	1500	.1
WNBH	New Bedford, Mass.	1310	.1
WNBR	Memphis, Tenn	1430	.5
WNBX	Springfield, Vt.	1260	1.
WNBZ	Saranac Lake, N. Y.	1290	.1
WNEL	San Juan, Puerto Rico	1290	.5
WNEW	Newark, N. J.	1250	1.
WNOX	Knoxville, Tenn.	560	1.
WNRA	Muscle Shoals, Ala.	1420	.1
WNRI	Newport, R. I.	1200	.1
WNYC	New York, N. Y.	810	1.
WOAI	San Antonio, Tex.	1190	50.
WOC	Davenport, Iowa	1370	.1
WOCL	Jamestown, N. Y.	1210	.05
WOI	Ames, Iowa	640	5.
WOKO	Albany, N. Y.	1430	.5
WOL	Washington, D. C.	1310	.1

Call	Location	Kc.	Kw.
WOMT	Manitowoc, Wis.	1210	.1
WOOD	Grand Rapids, Mich.	1270	.5
WOPI	Bristol, Tenn.	1500	.1
WOR	Newark, N. J.	710	50.
WORC	Worcester, Mass.	1280	.5
WORK	York, Pa	1320	1.
WOS	Jefferson City, Mo.	630	.5
WOSU	Columbus, Ohio	570	.75
WOV	New York, N. Y.	1130	1.
WOW	Omaha, Nebr.	590	1.
WOWO	Ft. Wayne, Ind.	1160	10.
WPAD	Paducah, Ky.	1420	.1
WPAR	Parkersburg, W. Va.	1420	.1
WPAX	Thomasville, Ga.	1210	.25
WPAY	Portsmouth, Ohio	1370	.1
WPEN	Philadelphia, Pa.	920	.25
WPFB	Hattiesburg, Miss.	1370	.1
WPG	Atlantic City, N. J.	1100	5.
WPHR	Petersburg, Va.	880	.5
WPRO	Providence, R. I.	630	.25
WPRP	Ponce, P. R.	1420	.1
WPTF	Raleigh, N. C.	680	1.
WQAM	Miami, Fla.	560	1.
WQAN	Scranton, Pa.	880	.25
WQBC	Vicksburg, Miss.	1360	1.
WQDM	St. Albans, Vt.	1370	.1
WRAK	Williamsport, Pa.	1370	.1
WRAW	Reading, Pa.	1310	.1
WRAX	Philadelphia, Pa.	920	.25
WRBL	Columbus, Ga.	1200	.1
WRBX	Roanoke, Va.	1410	.25
WRC	Washington, D. C.	950	.5
WRDO	Augusta, Maine	1370	.1
WRDW	Augusta, Ga.	1500	.1
WREC	Memphis, Tenn.	600	1.
WREN	Lawrence, Kansas	1220	1.
WRGA	Rome, Ga.	1500	.1
WRJN	Racine, Wis.	1370	.1
WROK	Rockford, Ill.	1410	.5
WROL	Knoxville, Tenn.	1310	.1
WRR	Dallas, Texas	1280	.5
WRUF	Gainesville, Fla.	830	5.
WRVA	Richmond, Va.	1110	5.
WSAI	Cincinnati, Ohio	1330	1.
WSAJ	Grove City, Pa.	1310	.1
WSAN	Allentown, Pa.	1440	.5
WSAR	Fall River, Mass.	1450	.25
WSAZ	Huntington, W. Va.	1190	1.
WSB	Atlanta, Ga.	740	50.
WSBC	Chicago, Ill.	1210	.1
WSBT	South Bend, Ind.	1360	.5
WSFA	Montgomery, Ala.	1410	.5
WSGN	Birmingham, Ala.	1310	.1
WSIX	Springfield, Tenn.	1210	.1
WSJS	Winston-Salem, N. C.	1310	.1
WSM	Nashville, Tenn.	650	50.
WSMB	New Orleans, La.	1320	1.
WSMK	Dayton, Ohio	1380	.2
WSOC	Charlotte, N. C.	1210	.1
WSPA	Spartanburg, S. C.	920	1.
WSPD	Toledo, Ohio	1340	1.
WSUI	Iowa City, Iowa	880	.5
WSUN	St. Petersburg, Fla.	620	1.
WSVA	Harrisonburg, Va.	550	.5
WSVS	Buffalo, N. Y.	1370	.05
WSYB	Rutland, Vt.	1500	.1
WSYR	Syracuse, N. Y.	570	.25
WTAD	Quincy, Ill.	900	.5
WTAG	Worcester, Mass.	580	.5
WTAL	Tallahassee, Fla.	1310	.1
WTAM	Cleveland, Ohio	1070	50.
WTAQ	Eau Claire, Wis.	1330	1.
WTAR	Norfolk, Va.	780	.5
WTAW	College Station, Texas	1120	.5
WTAX	Springfield, Ill.	1210	.1
WTBO	Cumberland, Md.	800	.25
WTCN	Minneapolis, Minn.	1250	1.
WTEL	Philadelphia, Pa.	1310	.1
WTFI	Athens, Ga.	1450	.5
WTIC	Hartford, Conn.	1040	50.
WTJS	Jackson, Tenn.	1310	.1
WTMJ	Milwaukee, Wis.	620	1.
WTMV	East St. Louis, Ill.	1500	.1
WTNJ	Trenton, N. J.	1280	.5
WTOC	Savannah, Ga.	1260	1.
WTRC	Elkhart, Ind.	1310	.05
WVFW	Brooklyn, N. Y.	1400	.5
WWAE	Hammond, Ind.	1200	.1
WWC	Spartanburg, S. C.	1420	1.
WWJ	Detroit, Mich.	920	1.
WWL	New Orleans, La.	850	10.
WWNC	Asheville, N. C.	570	1.
WWRL	Woodside, N. Y.	1500	.1
WWSW	Pittsburgh, Pa.	1500	.1
WWVA	Wheeling, W. Va.	1160	5.
WXYZ	Detroit, Mich.	1240	1.

PLEASE NOTE

These station lists have been thoroughly checked for accuracy. However, since short-wave stations change their call letters or frequencies quite often and there are frequent changes in broadcast stations, the editors suggest that you follow RADIO NEWS for changes.

United States Time Signals

THE standard time for the United States is derived from star observations made at the U. S. Naval Observatory, Washington, D. C. After the necessary corrections have been applied, signals from a transmitting device are sent by wire to the radio stations at Arlington, Virginia, (NAA), and Annapolis, Md. (NSS), where they are automatically broadcast by radio. The signals begin 5 minutes before the hour and consist of dashes. Beginning exactly on the hour a much longer dash is sent.

These time signals, if received directly and automatically are seldom in error by as much as 0.10 second. The average error is generally less than 0.02 second. The signals from NPG are broadcast from a clock, located at Mare Island, which is first synchronized with the signals from Arlington. NBA and NPM relay the signals received from Arlington. NPO transmits signals from a clock at the Manila Central Observatory. These signals are independent of Arlington and the errors may be somewhat greater than for the other stations.

All of the naval time signals are sufficiently close for ordinary commercial use. The times given below are those of the final signal of the series. All time is Eastern Standard. Subtract one hour for Central Standard, two hours for Mountain Standard, three hours for Pacific Standard and add five hours for Greenwich Mean Time.

Time	Kc.	Call	Location
1 a.m.	113	NAA	Arlington, Va.
1:30 a.m	8090	NPM	Honolulu, T.H.
2 a.m	113	NAA	Arlington, Va.
3 a.m.	17.8	NSS	Annapolis, Md.
	46	NBA	Darien, Canal Zone
	113	NAA	Arlington, Va.
	9050	NAA	Arlington, Va.
4 a.m.	113	NAA	Arlington, Va.
5 a.m.	113	NAA	Arlington, Va.
6 a.m.	113	NAA	Arlington, Va.
7 a.m.	113	NAA	Arlington, Va.
8 a.m.	113	NAA	Arlington, Va.
9 a.m.	42.8	NPG	San Francisco, Calif.
	108	NPG	San Francisco, Calif.
	12885	NPG	San Francisco, Calif.
10 a.m.	113	NAA	Arlington, Va.
12 Noon	17.8	NSS	Annapolis, Md.
	46	NBA	Darien, Canal Zone
	113	NAA	Arlington, Va.
	690	NAA	Arlington, Va.
	8410	NAA	Arlington, Va.
	12615	NAA	Arlington, Va.
	16820	NAA	Arlington, Va.
1 p.m.	113	NAA	Arlington, Va.
2 p.m.	113	NAA	Arlington, Va.
3 p.m.	113	NAA	Arlington, Va.
4 p.m.	17.8	NSS	Annapolis, Md.
	113	NAA	Arlington, Va.
	9050	NAA	Arlington, Va.
4:30 p.m.	16180	NPM	Honolulu, Hawaii
5 p.m.	113	NAA	Arlington, Va.
6 p.m.	113	NAA	Arlington, Va.
7 p.m.	17.8	NSS	Annapolis, Md.
	42.8	NPG	San Francisco, Calif.
Call	*Location*	*Kc.*	*Kw.*
	108	NPG	San Francisco, Calif.
	113	NAA	Arlington, Va.
	9050	NAA	Arlington, Va.
	12885	NPG	San Francisco, Calif.
8 p.m.	113	NAA	Arlington, Va.
9 p.m.	22.9	NPO	Cavite, P. I.
	9050	NPO	Cavite, P. I.
9:30 p.m.	8090	NPM	Honolulu, Hawaii
10 p.m.	17.8	NSS	Annapolis, Md.
	46	NBA	Darien, Canal Zone
	113	NAA	Arlington, Va.
	690	NAA	Arlington, Va.
	9050	NAA	Arlington, Va.
12 p.m.	17.8	NSS	Annapolis, Md.
	42.8	NPM	Honolulu, T.H.
Time	*Kc.*	*Call*	*Location*
	108	NPG	San Francisco, Calif.
	113	NAA	Arlington, Va.
	4525	NAA	Arlington, Va.
	8590	NPG	San Francisco, Calif.
12:30 p.m.	56	NPO	Cavite, P. I.
	8872	NPO	Cavite, P. I.
	17744	NPO	Cavite, P. I.

Accurate time signals are also transmitted through experimental station W9XAM, located at Elgin, Ill., by the Elgin National Watch Company. This station operates on 4797.5 kc., with a crystal controlled 500-watt transmitter, on the following schedule (Central Standard Time):

7:55— 8:00 a.m.	daily except Sunday
8:55— 9:00 a.m.	daily except Sunday
9:55—10:00 a.m.	daily except Sunday
11:55—12:00 a.m.	daily except Sunday
1:55— 2:00 p.m.	daily except Sat., Sun.
9:55—10.00 p.m.	daily except Sunday

These transmissions are especially convenient to owners of short-wave receivers.

World Short-Wave Stations

(All Time is Eastern Standard Time)

Meters	Call	Kc	Location	Kw	Service, etc.
10.06	IAF	29,817	Fiumicino, Italy	5.0	Exp.
13.45	GBU	22,291	Rugby, England	....	Phone
13.91	XGBA	21,550	Shanghai, China	18.5	Broadcast
13.92	VK3LR	21,540	Lyndhurst, Australia	...	Broadcast
13.92	W8XK	21,540	Pittsburgh, Pa.	40.0	Broadcast; relays KDKA
13.93	GSJ	21,530	Daventry, England	15.0	Broadcast
13.96	GSH	21,470	Daventry, England	15.0	Broadcast
14.00	W2XDJ	21,420	Deal, N. J.	...	Exp.
14.00	WKK	21,420	Lawrenceville, N. J.	20.0	Phone to LSN
14.00	WLO	21,420	Lawrenceville, N. J.	...	Transatlantic phone
14.19	KBI	21,140	Manila, P. I.	10.0	Phone
14.24	WKA	21,420	Lawrenceville, N. J.	...	Phone to England
14.24	KWN	21,060	Dixon, Calif.	20.0	Phone
14.27	LSN	21,020	Buenos Aires, Argentine	...	Phone to WLO, 8 a.m.; 4 p.m.
14.27	OKI	21,020	Podebrady, Czechoslovakia	...	Phone
14.37	EHY	20,860	Madrid, Spain	7.5	Phone to Buenos Aires
14.40	KSS	20,820	Bolinas, Calif.	40.0	Phone
14.43	KMM	20,780	Bolinas, Calif.	40.0	Phone
14.48	LSY	20,700	Buenos Aires, Arg.	10.0	Phone
14.49	LSX	20,680	Buenos Aires, Arg.	...	Phone to USA
14.49	LSN	20,680	Buenos, Aires, Arg.	...	Phone to Europe after 10:30 p.m.
14.57	PMB	20,580	Bandoeng, Java	60.0	Phone to PCK
14.71	GBA	20,380	Rubgy, England	15.0	Phone to ships and LSN
14.88	DWG	20,140	Nauen, Germany	...	Phone to LSG
14.96	OPL	20,040	Leopoldville, Belgian Congo	...	Phone to ORG, morn.
14.97	DHO	20,028	Nauen, Germany	7.2	Phone
15.01	KAX	19,980	Manila, P. I.	20.0	Phone to Dixon
15.03	DIH	19,950	Nauen, Germany	...	Phone
15.07	LSG	19,900	Buenos Aires, Arg.	7.0	Phone to France
15.10	WMI	19,850	Deal, N. J.	...	Phone
15.12	FTD	19,830	Ste. Assise, France	...	Phone
15.13	WKN	19,820	Lawrenceville, N. J.	20.0	Phone to England, 8 a.m.—4 p.m.
15.21	EAQ	19,720	Madrid, Spain	10.0	Phone to Latin Am.
15.23	CEC	19,680	Santiago, Chile	4.0	Phone to LSR, HJY
15.49	PMA	19,345	Bandoeng, Java	40.0	Phone, sometimes broadcast
15.57	PPU	19,260	Rio de Janeiro, Brazil	13.5	Phone to France
15.58	DFA	19,240	Nauen, Germany	...	Phone to XDA
15.60	WKF	19,220	Lawrenceville, N. J.	20.0	Phone to England
15.61	ORG	19,200	Ruysselede, Belgium	8.0	Phone
15.74	JVC	19,050	Nazaki, Japan	...	Phone, sometimes broadcast
15.76	WKW-W2XBI	19,020	Rocky Pt., N. Y.	...	Tests, mornings
15.87	WDS	18,892	Rocky Pt., N. Y.	...	Phone
15.87	ZSS	18,890	Klipheuvel, S. Africa	5.0	Phone to GAA
15.92	PLE	18,830	Bandoeng, Java	60.0	Phone to Dixon, Calif.
16.05	OCI	18,680	Lima, Peru	...	Phone
16.10	GBJ	18,620	Bodmin, Eng.	...	Phone to Montreal
16.10	GAU	18,620	Rugby, England	15.0	Phone to WMI, 6 a.m.—2 p.m.
16.12	PDM	18,600	Kootwijk, Holland	...	Phone
16.27	HJY	18,440	Bogota, Colombia	...	Phone CEC, LSR
16.18	PCM	18,535	Kootwijk, Holland	...	Phone
16.29	PCK	18,400	Kootwijk, Holland	...	Phone
16.34	ZLW	18,350	Wellington, New Zealand	...	Phone to VK2ME
16.34	FZS3	18,345	Saigon, Indo China	15.0	Phone
16.35	WLA	18,340	Lawrenceville, N. J.	20.0	Phone 8 a.m.—4 p.m.
16.38	YVQ	18,295	Maracay, Venezuela	...	Phone
16.43	FRO-FRE	18,240	Ste. Assise, France	30.0	Phone
16.45	KUS	18,220	Manila, P. I.	10.0	Phone
16.47	GAW	18,200	Rugby, England	150	Phone
16.53	PMC	18,135	Bandoeng, Java	40.0	Phone, sometimes broadcast
16.55	LSY3	18,115	Buenos Aires, Arg.	10.0	Phone, sometimes broadcast
16.56	GBK	18,100	Bodmin, England	...	Phone to CGA, 6 a.m.—2 p.m.
16.62	KQR	18,040	Bolinas, Calif.	40.0	Phone
16.64	KQJ	18,020	Bolinas, Calif.	40.0	Phone, transpacific
16.66	PLE	18,000	Bandoeng, Java	...	Phone
16.67	KQG	18,000	Bolinas, Calif.	40.0	Phone
16.69	KQZ	17,980	Bolinas, Calif.	40.0	Phone
16.78	OEV	17,870	Vienna, Austria	...	Phone
16.80	PLF	17,850	Bandoeng, Java	...	Phone
16.84	XGOX	17,800	Nanking, China	...	Broadcast
16.84	PCV	17,800	Kootwijk, Holland	40.0	Phone to Java, 6 a.m.—9 a.m.
16.85	XGBB	17,790	Shanghai, China	...	Phone
16.85	GSG	17,790	Daventry, England	15.0	Broadcast
16.86	W3XAL	17,780	Bound Brook, N. J.	15.0	Broadcast
16.86	W9XAA	17,780	Chicago, Illinois	0.5	Exp.
16.86	W8XK	17,780	Pittsburgh, Pa.	40.	Broadcast; relays KDKA
16.87	PHI	17,775	Huizen, Holland	20.0	Broadcast, summer months
16.88	DJE	17,760	Koenigswusterhausen, Ger.	8.0	Broadcast
16.89	IAC	17,750	Coltano, Italy	14.0	Phone; early mornings
16.90	HSP	17,740	Bangkok, Siam	20.0	Phone
16.93	HJ4ABA	17,713	Medellin, Colombia	...	Broadcast
17.00	GFWV	17,640	S.S. Majestic	...	Phone
	GLSQ		S.S. Olympic	...	Phone
	GDLJ		S.S. Homeric	...	Phone
	GTSD		S.S. Monarch of Bermuda	...	Phone
	GKFY		S.S. Minnetonka	...	Phone

Meters	Call	Kc	Location	Kw	Service, etc.
17.00	GMBJ	17,640	S.S. Empress of Britain	...	Phone
17.11	DFB	17,520	Nauen, Germany	7.2	Phone
17.11	VWY	17,510	Kirkee, India	...	Phone
17.23	J1AA	17,400	Kemikawa-Cho, Japan	...	Phone to Australia
17.33	W3XL	17,310	Bound Brook, N. J.	20.0	Exp.
17.33	W6XAJ	17,300	Oakland, Calif.	...	Exp.
17.33	W8XL	17,300	Dayton, Ohio	...	Exp.
17.33	W2XCU	17,300	Ampere, N. J.	...	Exp.
17.33	VE9BY	17,300	London, Ont., Canada	...	Exp.; irr.
17.37	DAF	17,260	Norddeich, Germany	5.0	Phone; 9:15 a.m., irr.
17.50	HAS5	17,122	Szekesfehervar, Hungary	...	Broadcast
17.51	WOO	17,110	Ocean Gate, N. J.	20.0	Phone
17.55	GBC	17,089	Rugby, England	5.0	Phone
18.06	DAN	16,665	Norddeich, Germany	...	Tests with ships
18.36	VLK-VK2ME	16,330	Sydney Australia	3.5	Phone
18.39	PCL	16,300	Kootwijk, Holland	...	Phone to Bandoeng
18.43	WLK	16,270	Lawrenceville, N. J.	20.0	Phone to England
18.47	KTO	16,240	Manila, P. I.	40.0	Phone
18.49	FZR3	16,214	Saigon, French Indo China	15.0	Phone
18.54	PSA	16,162	Rio de Janeiro, Brazil	...	Broadcast
18.55	GBX	16,150	Rugby, England	...	Phone to VK2ME, 4-11 p.m.
18.70	KKP	16,030	Kahuku, Hawaii	40.0	Phone to KWO, 2-7 p.m.
18.77	KQH	15,985	Kahuku, Hawaii	40.0	Phone
18.80	PLO	15,950	Bandoeng, Java	...	Phone; afternoons
18.88	FTK	15,880	Ste. Assise, France	30.0	Phone to Saigon
18.91	CEC	15,855	Santiago, Chile	0.8	Phone
19.03	JYT	15,760	Kemikawa-Cho, Japan	5.0	Relay broadcast and tests
19.14	LSF	15,670	Buenos Aires, Arg.	...	Phone
19.15	JVE	15,660	Nazaki, Japan	...	Phone; occasional broadcast
19.20	JES	15,620	Osaki, Japan	...	Phone; sometimes broadcast
19.20	JVF	15,620	Nazaki, Japan	...	Phone; sometimes bc.
19.35	KEM	15,490	Bolinas, Calif.	40.0	Phone
19.37	KKL	15,475	Bolinas, Calif.	40.0	Phone
19.39	KKR	15,460	Bolinas, Calif.	40.0	Phone
19.40	....	15,454	Pontoise, France	...	Phone; 7-11 a.m.
19.42	PRADO	15,440	Riobamba, Ecuador	...	Phone
19.43	KWE	15,430	Bolinas, Calif.	40.0	Phone
19.45	KWO	15,410	Dixon, Calif.	20.0	Phone to Hawaii, 2-7 p.m.
19.51	HAS3	15,370	Budapest, Hungary	20.0	Broadcast
19.54	KWU	15,355	Dixon, Calif.	20.0	Phone to Hawaii, 2-7 p.m.
19.55	CT1AA	15,340	Lisbon, Portugal	...	Broadcast
19.55	DJR	15,340	Zeesen, Germany	50.0	Testing
19.56	W2XAD	15,330	Schenectady, N. Y.	20.0	Br.; relays WGY
19.60	CP7	15,300	La Paz, Bolivia	1.0	Phone
19.60	OXY	15,300	Skamlebaek, Denmark	...	Exp.
19.62	DJQ	15,280	Zeesen, Germany	50.0	Broadcast
19.64	W2XE	15,270	Wayne, N. J.	15.0	Broadcast
19.65	GSI	15,260	Daventry, England	...	Broadcast
19.67	W1XAL	15,250	Boston, Mass.	5.0	Broadcast
19.67	FYA	15,243	Pontoise, France	12.0	Broadcast
19.70	PCJ	15,220	Eindhoven, Holland	12.0	Exp.
19.72	W8XK	15,210	Pittsburgh, Pa.	40.0	Bc.; relays KDKA
19.72	DJB	15,200	Zeesen, Germany	5.0	Broadcast
19.73	VE9BA	15,190	Montreal, Que.	...	Broadcast
19.80	GSF	15,140	Daventry, England	15.0	Broadcast
19.82	VE9DN	15,130	Montreal, Que.	...	Broadcast
19.83	HVJ	15,123	Rome, Italy	10.0	Bc.; 5-5:15 a.m. daily
19.85	DJL	15,110	Zeesen, Germany	...	Broadcast
19.86	RAU	15,104	Tashkent, U.S.S.R.	20.0	Phone
19.90	TI4NRH	15,075	Heredia, Costa Rica	...	Broadcast
19.91	WNC	15,055	Hialeah, Florida	0.4	Phone
19.93	RKI	15,040	Moscow, U.S.S.R.	20.0	Phone; morn., irr.
20.04	KAY	14,980	Manila, P. I.	40.0	Phone to Dixon, 8 a.m.
20.06	HJA3	14,940	Barranquilla, Colombia	...	Phone to Colombia, Panama, Costa Rica; 6:30 a.m.—6:30 p.m.
20.08	HJB	14,830	Bogota, Colombia	...	Phone
20.27	WKU-W2XBJ	14,830	Rocky Pt., N. Y.	40.0	Tests; daytime
20.50	XDA	14,630	Mexico, D. F.	...	Phone
20.54	JVH	14,600	Nazaki, Japan	...	Phone
20.55	WMN	14,590	Lawrenceville, N. J.	20.0	Phone to England; daylight
20.63	HBJ	14,535	Geneva, Switzerland	20.0	Phone
20.64	LSN	14,530	Buenos Aires, Arg.	...	Phone
20.68	TIN	14,500	Cartago, Costa Rica	...	Phone to WNC
20.68	TGF	14,500	Guatemala City	...	Phone to WNC
20.69	LSN	14,490	Buenos Aires, Arg.	...	Phone irr.
20.70	HPF	14,485	Panama City	25.0	Phone to WNC
20.71	YNA	14,480	Managua, Nicaragua	...	Phone to WNC
20.76	GBW	14,440	Rugby, England	15.0	Phone
20.79	VPD	14,420	Suva, Fiji Is.	...	Phone
21.52	YOI	13,940	Bucharest, Roumania	...	Broadcast
21.53	WIK	13,925	Rocky Point, N. Y.	...	Phone
21.57	WQP	13,900	Rocky Point, N. Y.	...	Phone to RNE
21.62	WIY	13,870	Rocky Point, N. Y.	...	Tests, irr.
21.71	SUZ	13,811	Abu Zabal, Egypt	10.0	Phone
21.76	KKW	13,780	Bolinas, Calif.	...	Phone
21.79	CGA	13,740	Drummondville, Que.	...	Phone
21.90	KKZ	13,690	Bolinas, Calif.	40.0	Phone
21.90	HAT	13,685	Szekesfehervar, Hungary	5.0	Broadcast
22.02	JYK	13,610	Kemikawa-Cho, Japan	...	Broadcast and tests
22.06	GBC	13,591	Rugby, England	...	Phone to CGA & ships
22.24	WAJ	13,480	Rocky Point, N. Y.	...	Exp.
22.29	GBQ	13,450	Rugby, England	15.0	Phone
22.34	TIEP	13,420	San Jose, Costa Rica	...	Broadcast
22.39	WMA	13,390	Lawrenceville, N. J.	20.0	Phone
22.47	CGA	13,340	Drummondville, Que.	...	Phone
22.47	YVQ	13,340	Maracay, Venezuela	...	Phone
22.56	CGA3	13,285	Montreal, Que.	15.0	Phone to ships
22.64	KBJ	13,240	Manila, P. I.	40.	Phone
22.66	GFWV	13,230	S.S. Majestic	...	Phone
	GLSQ		S.S. Olympic	...	Phone
	GDLJ		S.S. Homeric	...	Phone
	GTSD		S.S. Monarch of Bermuda	...	Phone
	GKFY		S.S. Minnetonka	...	Phone
	GMBJ		S.S. Empress of Britain	...	Phone
22.71	ORP	13,200	Ruysselede, Belgium	...	Phone
22.92	VPIA	13,080	Suva, Fiji Islands	...	Broadcast
23.00	DDAC	13,040	S.S. Europa	...	Phone
	DDAS		S.S. Bremen	...	Phone
	DDBR		S.S. Berlin	...	Phone
	DDCB		S.S. Columbus	...	Phone
	DDCG		S.S. Resolute	...	Phone
	DDCP		S.S. Cap Polonio	...	Phone
	DDDT		S.S. Deutschland	...	Phone
	DDDX		S.S. Hamburg	...	Phone
	DDEA		S.S. Cap Arcona	...	Phone
	DDED		S.S. New York	...	Phone
	DDFF		S.S. Reliance	...	Phone
	DDFT		S.S. Oceana	...	Phone
	DDNY		S.S. Albert Ballin	...	Phone
23.10	DFC	12,980	Germany	...	Phone
23.19	OEX	12,931	Vienna, Austria	...	Phone
23.35	WOO	12,840	Ocean Gate, N. J.	20.0	Phone to ships
23.37	CNR	12,830	Rabat, Morocco	12.0	Broadcast; Sundays
23.43	IAC	12,795	Coltana, Italy	52.0	Phone to Tripoli
23.46	GBC	12,780	Rugby, England	5.0	Phone
23.51	DAF	12,745	Norddeich, Germany	5.0	Phone to ships
24.19	CT1GO	12,396	Parede, Portugal	...	Broadcast
24.29	KNRA	12,345	Schooner Seth Parker	...	Phone
24.39	ZLT	12,295	Wellington, New Zealand	1.0	Phone to Australia
24.39	PLM	12,295	Bandoeng, Java	...	Phone to VLK
24.40	ZLW	12,290	Wellington, New Zealand	...	Phone
24.40	GBU	12,290	Rugby, England	...	Phone to WMI
24.46	FTN	12,260	Ste. Assise, France	30.0	Phone
24.48	G. S	12,250	Rugby, England	...	Phone
24.48	PLM	12,250	Bandoeng, Java	...	Phone to Holland
24.60	YBJ	12,190	Medan, Sumatra	2.5	Phone
24.69	G.;S	12,150	Rugby, England	15.0	Phone to USA
24.69	FQO, FQE	12,150	Ste. Assise, France	...	Phone
24.74	SUV	12,120	Cairo, Egypt	...	Phone
24.78	CJA4	12,100	Drummondville, Que.	15.0	Tests with VIY-VK3ME
24.87	PDV	12,060	Kootwijk, Holland	60.0	Phone
24.90	NSS	12,045	Annapolis, Maryland	...	Time signals, 10 p.m.
24.90	NAA	12,045	Arlington, Virginia	...	Time signals, noon
24.93	HBO	12,030	Geneva, Switzerland	20.0	Phone
24.93	CT1CT	12,028	Lisbon, Portugal	0.5	Broadcast
24.95	VIY-VK3ME	12,020	Melbourne, Australia	...	Tests with CJA4 Drummondville
24.99	RW59	12,000	Moscow, U.S.S.R.	20.0	Broadcast, Sun.; Wed.
	RNE		Moscow, U.S.S.R.	20.0	Phone
25.01	FZS2	11,991	Saigon, French Indo China	15.0	Phone to FTK
25.10	KKQ	11,950	Bolinas, Calif.	40.0	Phone
25.12	FTA	11,950	Ste. Assise, France	30.0	Phone to Rabat
25.20	XGOX	11,900	Nanking, China	...	Broadcast
25.22	FYA	11,891	Pontoise, France	...	Broadcast
25.24	W9XF	11,880	Chicago, Illinois	...	Bc.; relays WENR
25.26	W8XK	11,870	Pittsburgh, Pa.	40.0	Bc.; relays KDKA
25.26	VUC	11,870	Calcutta, India	3.0	Broadcast
25.28	VE9CA	11,860	Calgary, Alta.	...	Broadcast
25.28	GSE	11,860	Daventry, England	20.0	Broadcast
25.31	DJP	11,855	Zeesen, Germany	50.0	Exp.
25.33	KZRM	11,840	Manila, P. I.	6.0	Broadcast
25.34	VE9HX	11,835	Halifax, N. S.	...	Bc.; relays CHNS
25.35	W9XAA	11,830	Chicago, Illinois	0.5	Bc.; relays WCFL
25.35	W2XE	11,830	Wayne, N. J.	5.0	Bc.; relays WABC
25.39	I2RO	11,810	Rome, Italy	9.0	Broadcast
25.39	VE9GW	11,810	Bowmanville, Ont.	0.5	Broadcast
25.41	OER3	11,801	Vienna, Austria	0.25	Broadcast
25.42	DJO	11,795	Zeesen, Germany	50.0	Exp.
25.43	W1XAL	11,790	Boston, Mass.	5.0	Broadcast
25.43	TITR	11,790	San Jose, Costa Rica	...	Broadcast
25.45	VE9DN	11,780	Drummondville, Que.	...	Broadcast
25.45	VE9DR	11,780	Drummondville, Que.	...	Exp.
25.48	DJD	11,770	Zeesen, Germany	5.0	Broadcast
25.50	XDA	11,760	Mexico, D. F.	...	Exp.
25.52	GSD	11,750	Daventry, England	...	Broadcast
25.56	PHI	11,730	Huizen, Holland	20.0	Bc.; winter months
25.57	FYA	11,725	Pontoise, France	15.0	Broadcast
25.59	CJRX	11,720	Middlechurch, Man.	2.0	Broadcast
25.61	HJ4ABA	11,713	Medellin, Colombia	0.05	Broadcast
25.64	YV2RC	'11,695	Caracas, Venezuela	...	Broadcast
25.64	YVQ	'11,695	Maracay, Venezuela	...	Phone
25.67	KIO	11,680	Kahuku, Hawaii	40.0	Phone to Bolinas
25.70	PPQ	11,670	Rio de Janeiro, Brazil	5.0	Exp.; irr., evenings
26.10	GBK	11,490	Bodmin, England	...	Phone
26.14	IBDK	'11,470	S.S. Electra, Marconi's Yacht	...	Exp.
26.44	DAN	11,340	Norddeich, Germany	...	Time signals; 7 a.m., 7 p.m.
26.80	XAM	11,187	Merida, Yucatan	...	Tests with XDA
26.82	CT3AQ	11,180	Funchal, Madeira	0.05	Broadcast
27.26	PLP	11,000	Bandoeng, Java	3.0	Phone; occa. bc.
27.29	ZLT	10,990	Wellington, N. Z.	...	Phone to Austra. morn
27.63	DFL	10,850	Nauen, Germany	...	Phone
27.66	KWV	10,840	Dixon, Calif.	20.0	Phone to Hawaii
27.84	GBP	10,770	Rugby, England	15.0	Phone
27.92	JVM	10,740	Nazaki, Japan	...	Phone, occasional bc.; relays JOAK
28.09	WNP	10,675	Lawrenceville, N. J.	0.5	Phone to Bermuda; day
28.10	CEC	10,670	Santiago, Chile	4.0	Phone
28.12	JVN	10,660	Nazaki, Japan	...	Bc.; relays JOAK
28.20	PLR	10,630	Bandoeng, Java	...	Phone to Holland and France
28.23	WEF	10,620	Rocky Point, N. Y.	40.0	Phone to Europe
28.23	EDN-EDX	10,613	Madrid, Spain	5.0	Phone
28.25	WEA	10,610	Rocky Point, N. Y.	40.0	Exp.
28.32	FYB	10,578	Paris, France	...	Time signals at 5:26 a.m. and 6:26 p.m.
28.42	WOK	10,550	Lawrenceville, N. J.	20.0	Phone
28.44	VLK	10,525	Sydney, Australia	...	Phone
28.75	YBG	10,430	Medan, Sumatra	3.0	Phone, occasional bc.
28.77	XGW	10,420	Shanghai, China	20.0	Phone
28.79	PDK	10,415	Kootwijk, Holland	60.0	Phone
28.80	KES	10,410	Bolinas, Calif.	40.0	Phone
28.80	LSY	10,410	Buenos Aires, Arg.	...	Phone
28.83	KEZ	10,400	Dixon, Calif.	40.0	Phone; irr. early morn.
28.86	KER	10,390	Bolinas, Calif.	40.0	Phone
28.86	GBX	10,390	Rugby, England	...	Phone

Meters	Call	Kc	Location	Kw	Service, etc.
28.88	WCG	10,380	Rocky Point, N. Y.	4.0	Phone; exp.
28.97	LSX	10,350	Buenos Aires, Arg.	12.0	Phone
29.01	ZFD	10,335	Hamilton, Bermuda	1.5	Phone
29.03	ORK	10,330	Ruysselede, Belgium	11.0	Broadcast
29.11	LSL	10,300	Buenos Aires, Arg.	5.0	Phone to Europe
29.14	HPC	10,290	Panama City	...	Phone
29.14	DIQ	10,290	Nauen, Germany	...	Phone to Sidney
29.22	PMN	10,260	Bandoeng, Java	...	Phone; occasional bc.
29.34	PSH	10,220	Rio de Janerio, Brazil	12.0	Phone
29.39	CMHB	10,200	Sanctus Spiritus, Cuba	...	Broadcast
29.50	DDAC	10,160	S.S. Europa	...	Phone
	DDAS		S.S. Bremen	...	Phone
	DDBR		S.S. Berlin	...	Phone
	DDCB		S.S. Columbus	...	Phone
	DDCG		S.S. Resolute	...	Phone
	DDCP		S.S. Cap Polonio	...	Phone
	DDDT		S.S. Deutschland	...	Phone
	DDDX		S.S. Hamburg	...	Phone
	DDEA		S.S. Cap Arcona	...	Phone
	DDED		S.S. New York	...	Phone
	DDFF		S.S. Reliance	...	Phone
	DDFT		S.S. Oceana	...	Phone
	DDNY		S.S. Albert Ballin	...	Phone
29.57	OPM	10,140	Leopoldville, Belgian Congo	15.0	Phone to ORK
29.77	EHY	10,070	Madrid, Spain	10.0	Exp.
29.84	ZFB	10,055	St. George, Bermuda	1.5	Phone to WNB
29.84	SUV	10,055	Abu Zabal, Egypt	10.0	Phone to GAA
29.89	OER	10,033	Vienna, Austria	...	Phone
29.98	....	10,000	Belgrade, Yugoslavia	2.5	Broadcast
30.01	KAZ	9,990	Manila, P. I.	40.0	Phone to PLV, morn.
30.09	LSL	9,964	Buenos Aires, Arg.	...	Phone
30.10	IRS	9,960	Rome, Italy	15.0	Phone
30.13	GCU	9,950	Rugby, England	15.0	Phone
30.19	HKB	9,930	Bogota, Colombia	...	Phone
30.19	YBF	9,930	Medan, Sumatra	1.0	Phone
30.19	HJY	9,930	Bogota, Colombia	...	Phone to OCI
30.26	CGA5	9,905	Drummondville, Que.	...	Tests with Rugby
30.32	LSN2	9,890	Buenos Aires, Arg.	5.0	Phone to Europe and USA
30.38	WON	9,870	Rocky Point, N. Y.	40.0	Phone to England
30.41	EAQ	9,860	Madrid, Spain	20.0	Broadcast
30.47	JYS	9,840	Kemikawa-Cho, Japan	10.0	Broadcast and tests
30.47	FTI	9,840	Ste Assise, France	15.0	Phone
30.50	LSI	9,830	Buenos Aires, Arg.	10.0	Phone
30.53	IRM	9,820	Rome, Italy	25.0	Phone; relays I2RO occasionally
30.63	GCW	9,790	Rugby, England	15.0	Phone
31.07	I2RO	9,650	Rome, Italy	...	Broadcast
30.72	VLJ	9,760	Sydney, Australia	3.5	Phone
30.75	WOF	9,750	Lawrenceville, N. J.	20.0	Phone
30.88	GCA	9,710	Rugby, England	10.0	Phone; evenings
30.91	WMI	9,700	Deal, N. J.	...	Phone
30.91	LQA	9,700	Buenos Aires, Arg.	...	Phone
30.97	TI4NRH	9,680	Heredia, Costa Rica	...	Broadcast
31.10	HSP2	9,640	Bangkok, Siam	...	Broadcast
31.17	DGU	9,620	Nauen, Germany	...	Phone to Egypt
31.18	VQ7LO	9,616	Nairobi Kenya, Brit. E. Africa	...	Broadcast
31.23	LQA	9,600	Buenos Aires, Arg.	...	Phone
31.23	LGN	9,600	Bergen, Norway	...	Phone
31.23	CT1AA	9,600	Lisbon, Portugal	2.0	Broadcast
31.23	XETE	9,600	Mexico City, D. F.	...	Broadcast
31.26	WKJ	9,590	Rocky Point, N. Y.	...	Phone
31.26	W3XAU	9,590	Philadelphia, Pa.	1.0	Bc.; relays WCAU
31.26	VK2ME	9,590	Sydney, Australia	20.0	Broadcast; Sundays
31.26	HP5J	9,590	Panama City	...	Broadcast
31.26	TIRA	9,590	Cartago, Costa Rica	...	Broadcast
31.28	HBL	9,585	Geneva, Switzerland	18.0	Broadcast
31.30	XGBD	9,580	Shanghai, China	18.5	Broadcast
31.30	VE9DR	9,580	Montreal, Que.	...	Exp.
31.30	GSC	9,580	Daventry, England	20.0	Broadcast
31.30	VK3LR	9,580	Lyndhurst, Vic., Australia	20.0	Broadcast
31.32	LKJ1	9,572	Jeloy, Norway	...	Exp.
31.33	W1XK	9,570	Springfield, Mass.	10.0	Bc.; relays WBZ-WBZA
31.33	KZRM	9,570	Manila, P. I.	6.0	Broadcast
31.33	SRI	9,570	Poznan, Poland	1.0	Broadcast
31.33	SUV	9,570	Cairo, Egypt	...	Broadcast
31.34	VUB	9,565	Bombay, India	...	Broadcast
31.36	DJA	9,560	Zeesen, Germany	5.0	Broadcast
31.38	VE9DN	9,555	Drummondville, Que.	...	Broadcast
31.43	DJN	9,540	Zeesen, Germany	50.0	Broadcast
31.46	W2XAF	9,530	Schenectady, N. Y.	40.0	Bc. re. WGY, 5-11 p.m.
31.49	OXY	9,520	Skamleback, Denmark	0.5	Broadcast
31.53	GSB	9,510	Daventry, England	20.0	Broadcast
31.53	VK3ME	9,510	Melbourne, Australia	2.0	Bc. Wed., Sat., 5-7 a.m.
31.53	YV3RC	9,510	Caracas, Venezuela	...	Broadcast
31.56	PRF5	9,501	Rio de Janeiro, Brazil	...	Broadcast
31.56	XGOX	9,500	Nanking, China	...	Broadcast
31.56	HSP2	9,500	Bangkok, Siam	2.5	Broadcast
31.59	WEF	9,490	Rocky Point, N. Y.	40.0	Phone
31.59	KEI	9,490	Bolinas, Calif.	20.0	Phone
31.61	PLW	9,485	Bandoeng, Java	...	Phone
31.63	KET	9,480	Bolinas, Calif.	40.0	Phone
31.73	WES-W2XBJ	9,450	Rocky Point, N. Y.	40.0	Exp.
31.80	COH	9,428	Havana, Cuba	...	Broadcast
31.84	PLV	9,415	Bandoeng, Java	80.0	Phone; sometimes bc.
31.90	XDC	9,400	Mexico City, D. F.	...	Exp.
31.96	CE32	9,380	Los Andes, Chile	0.05	Phone
31.98	XDA	9,375	Mexico City	...	Phone
31.98	EH9OC	9,375	Berne, Switzerland	...	Phone
32.00	CT3AQ	9,370	Funchal, Madeira	...	Broadcast
32.13	CJA2	9,332	Drummondville, Que.	15.0	Phone to England
32.24	CNR	9,300	Rabat, Morocco	...	Broadcast; Sundays
32.31	GCB	9,280	Rugby, England	15.0	Phone
32.41	GBK	9,250	Bodmin, England	...	Phone to Drummondville
32.66	YVR	9,180	Maracay, Venezuela	...	Phone to Europe
32.70	WNA	9,170	Lawrenceville, N. J.	20.0	Phone to England
32.86	HAT4	9,125	Budapest, Hungary	20.0	Broadcast
32.88	CP6	9,120	La Paz, Bolivia	...	Broadcast
32.93	LST	9,104	Olivos, Arg.	...	Phone
33.13	TFK	9,050	Reykjavik, Iceland	...	Broadcast
33.24	GCS	9,020	Rugby, England	15.0	Phone
33.28	KEJ	9,010	Bolinas, Calif.	40.0	Phone; relays NBC programs for KGBM

Meters	Call	Kc	Location	Kw	Service, etc.
33.40	VWY	8,975	Kirkee, India	...	Phone to England; mornings
33.48	TGX	8,955	Guatemala City, Guatemala	...	Broadcast
33.50	WEL-W2XBJ	8,950	Rocky Point, N. Y.	...	Exp.
33.59	WEC	8,925	Rocky Point, N. Y.	...	Exp.
33.69	ZLT	8,900	Wellington, New Zealand	1.0	Phone to Sydney
33.80	NPO	8,870	Manila, P. I.	...	Time sig. 10 p.m.
33.92	KNRA	8,840	Schooner Seth Parker	...	Phone
33.95	GDLJ	8,830	S.S. Homeric	...	Phone
	GFWV		S.S. Majestic	...	Phone
	GKFY		S.S. Minnetonka	...	Phone
	GLSQ		S.S. Olympic	...	Phone
	GMBJ		S.S. Empress of Britain	...	Phone
	VTSX		S.S. Monarch of Bermuda	...	Phone
34.11	TIR	8,790	Cartago, Costa Rica	...	Phone to Guatemala, Colombia, Florida
34.17	PNI	8,775	Makassar, Celebes	3.0	Phone, oc. bc.
34.19	RSZ	8,770	Irkutsk, U.S.S.R.	...	Phone
34.50	W2XAC	8,690	Schenectady, N. Y.	...	Exp.
34.54	GBC	8,680	Rugby, England	5.0	Phone to ships after.
34.66	VE9BY	8,650	London, Ont.	...	Exp.
34.66	W2XCU	8,650	Rocky Point, N. Y.	...	Exp.
34.74	W2XDO	8,630	Ocean Gate, N. J.	...	Exp.
34.74	WOO	8,630	Deal, N. J.	...	Phone
34.98	RW15	8,570	Khabarovsk, Siberia	...	Broadcast
35.00	IBEJ	8,566	S.S. Conte Rosso	...	Phone
	ICEJ		S.S. Rex	...	Phone
	IDLI		S.S. Conte di Savola	...	Phone
35.03	WOO	8,560	Ocean Gate, N. J.	20.0	Phone to ships
36.00	DAF	8,470	Norddeich, Germany	...	Phone to ships
35.48	PRAG	8,450	Porto Alegre, Brazil	...	Phone; occasional bc.
35.69	HC2AT	8,400	Guayaquil, Ecuador	...	Broadcast
35.78	IAC	8,380	Coltano, Italy	14.0	Phone
36.00	DDAC	8,328	S.S. Europa	...	Phone
	DDAS		S.S. Bremen	...	Phone
	DDBR		S.S. Berlin	...	Phone
	DDCB		S.S. Columbus	...	Phone
	DDCG		S.S. Resolute	...	Phone
	DDCP		S.S. Cap Polonio	...	Phone
	DDDT		S.S. Deutschland	...	Phone
	DDDX		S.S. Hamburg	...	Phone
	DDEA		S.S. Cap Arcona	...	Phone
	DDED		S.S. New York	...	Phone
	DDFF		S.S. Reliance	...	Phone
	DDFT		S.S. Oceana	...	Phone
	DDNY		S.S. Albert Ballin	...	Phone
36.63	PSK	8,185	Rio de Janeiro, Brazil	10.0	Phone; broadcast
36.70	RW50	8,170	Moscow, U.S.S.R.	20.0	Broadcast
36.92	KTP	8,120	Manila, P. I.	40.0	Phone to Dixon, Calif.
36.90	PLW	8,125	Bandoeng, Java	60.0	Phone
36.90	KAZ	8,120	Manila, P. I.	20.0	Phone to Dixon, Calif.
36.98	HCJB	8,108	Quito, Ecuador	0.15	Broadcast
37.01	EATH	8,100	Vienna, Austria	...	Phone
37.01	HKF	8,100	Bogota, Colombia	...	Phone
37.32	CNR	8,035	Rabat, Morocco	10.0	Broadcast; Sundays
37.57	HSJ	7,980	Bangkok, Siam	20.0	Phone
37.57	VLJ	7,980	Sydney, Australia	...	Phone to Java
37.67	VLZ	7,960	Sydney, Australia	3.5	Phone
38.00	VPD	7,890	Suva, Fiji Islands	...	Phone
38.05	JYR	7,880	Kemikawa-Cho, Japan	5.0	Broadcast
38.06	SUX	7,867	Cairo, Egypt	10.0	Phone
38.10	RXC	7,870	Panama City	...	Phone
38.29	PGA	7,830	Kootwijk, Holland	60.0	Phone
38.34	OA4C	7,820	Lima, Peru	20.0	Broadcast
38.49	HBP	7,790	Geneva, Switzerland	20.0	Broadcast
38.50	YNLF	7,788	Managua, Nicaragua	...	Broadcast
38.59	FTE	7,770	Ste. Assise, France	...	Phone
38.79	PDL	7,730	Kootwijk, Holland	20.0	Phone
38.86	KEE	7,715	Bolinas, Calif.	40.0	Phone; relays NBC programs for KGMB
38.94	HC2JSB	7,700	Guayaquil, Ecuador	...	Broadcast
39.28	OEJ	7,632	Vienna, Austria	...	Phone
39.31	RIM	7,626	Tashkent, U.S.S.R.	20.0	Phone to RKI 6-8:15 a.m.
39.40	KWX	7,610	Dixon, Calif.	20.0	Phone to Hawaii, nights
39.63	KWY	7,565	Dixon, Calif.	20.0	Phone
39.86	HJA3	7,522	Barranquilla, Colombia	...	Phone; 6:30 a.m.-6:30 p.m.
39.87	KKH	7,520	Kahuku, Hawaii	40.0	Phone
39.92	JVP	7,510	Nazaki, Japan	20.0	Phone
39.98	RKI	7,500	Moscow, U.S.S.R.	20.0	Phone to RIM, 6-8:15 a.m.
40.14	JVQ	7,470	Nazaki, Japan	10.0	Phone
40.14	HJA3	7,470	Barranquilla, Colombia	...	Phone; 6:30 a.m.-6:30 p.m.
40.14	HJP	7,470	Bogota, Colombia	...	Phone
40.28	HBQ	7,443	Geneva, Switzerland	...	Broadcast
40.43	WEG	7,415	Rocky Point, N. Y.	40.0	Phone
40.48	HJ3ABD	7,406	Bogota, Colombia	0.2	Broadcast
40.52	XEPR	7,400	Mexico City	...	Broadcast
40.52	WEM-W2XBJ	7,400	Rocky Point, N. Y.	40.0	Phone; exp.
40.52	WEN	7,400	Rocky Point, N. Y.	40.0	Phone
40.57	ZLT	7,390	Wellington, New Zealand	0.15	Phone to Sydney; morn.
40.68	KEQ	7,370	Kahuku, Hawaii	40.0	Phone
40.96	ZTJ	7,320	Johannesburg, S. Africa	...	Broadcast
41.18	HJ1ABD	7,281	Cartagena, Colombia	...	Broadcast
41.42	TI2EP	7,238	San Jose, Costa Rica	...	Amateur
41.47	DOA	7,230	Doeberitz, Germany	...	Phone
41.60	EA8AB	7,207	Tenerife, Canary Islands	0.5	Broadcast
41.78	CR6AA	7,177	Lobito, Angola, Port. W. Afr.	...	Broadcast
41.82	YNCRD	7,170	Granada, Nicaragua	...	Broadcast
41.98	YV2AM	7,142	Maracaibo, Venezuela	...	Broadcast
41.99	OA4R	7,140	Lima, Peru	...	Broadcast
42.00	HJ4ABB	7,138	Manizales, Colombia	1.0	Broadcast
42.12	HB9B	7,118	Basle, Switzerland	...	Broadcast
42.23	M2A	7,100	Penhishu, Manchuria	0.015	Exp.; broadcast
42.29	HKE	7,090	Bogota, Colombia	0.138	Broadcast
42.35	LU5CZ	7,080	Buenos Aires, Arg.	...	Amateur; sometimes bc.
42.35	PI1J	7,079	Dordrecht, Holland	...	Amateur; sometimes bc.
42.71	EAR125	7,020	Madrid, Spain	...	Broadcast
42.89	LKJ1	6,990	Jeloy, Norway	1.0	Broadcast
42.98	EAR110	6,976	Madrid, Spain	...	Broadcast

Meters	Call	Kc	Location	Kw	Service, etc.
43.45	HI3C	6,900	La Romana, D. R.	...	Broadcast
43.42	GDS	6,905	Rugby, England	15.0	Phone
43.52	KEB	6,890	Bolinas, Calif.	40.0	Phone
43.71	KEL	6,860	Bolinas, Calif.	40.0	Phone
43.77	VPE	6,850	Labasa, Vanua Levu, Fiji Is.	0.012	Exp.
	VQL		Savu Savu, Vanua Levu, Fiji Is.	0.042	Exp.
	VPF		Suva, Viti Levu, Fiji Is.	0.042	Exp.
	VRO		Taveuni, Taveuni, Fiji Is.	0.042	Exp.
43.80	KEN	6,845	Bolinas, Calif.	40.0	Phone
43.83	CFA	6,840	Drummondville, Que.	...	Phone
43.83	HAT2	6,840	Szekesfehervar, Hungary	20.0	Broadcast
44.00	HIH	6,814	San Pedro de Macoris, D. R.	0.015	Broadcast
44.38	WOA	6,755	Lawrenceville, N. J.	20.0	Phone
44.42	JVT	6,750	Nazaki, Japan	...	Phone; bc.; re. JOAK
44.48	WEJ-W2XBJ	6,740	Rocky Point, N. Y.	...	Exp.
44.63	WQO	6,720	Rocky Point, N. Y.	...	Phone
44.64	KBK	6,716	Manila, P. I.	40.0	Phone
44.68	TIEP	6,710	San Jose, Costa Rica	...	Broadcast
44.68	KEF	6,710	Bolinas, Calif.	40.0	Phone
44.71	WER	6,705	Rocky Point, N. Y.	...	Phone
44.91	HBQ	6,675	Geneva, Switzerland	20.0	Exp.
44.94	YVQ	6,672	Maracay, Venezuela	...	Phone
44.97	HC2RL	6,668	Guayaquil, Ecuador	0.2	Broadcast
44.99	YNCRG	6,664	Granada, Nicaragua	...	Broadcast
45.03	KNRA	6,660	Schooner Seth Parker	...	Phone; relays programs to W2XBJ
45.09	TITE	6,650	San Jose, Costa Rica	...	Broadcast
45.09	IAC	6,650	Coltana, Italy	...	Phone
45.32	PRADO	6,616	Riobamba, Ecuador	...	Broadcast, Thursday
45.35	REN-RW72	6,611	Moscow, U.S.S.R.	10.0	Broadcast
45.98	YV6RV	6,520	Valencia, Venezuela	...	Broadcast
46.02	WOO	6,515	Deal, N. J.	...	Phone
46.10	TPK	6,504	San Jose, Costa Rica	...	Broadcast
46.20	HJ5ABD	6,490	Cali, Colombia	0.25	Broadcast
46.25	HI4D	6,482	Santo Domingo, D. R.	...	Broadcast
46.48	HJ1ABB	6,450	Barranquilla, Colombia	0.3	Broadcast
46.67	VE9AS	6,425	Fredericton, N. B.	...	Broadcast
46.67	VE9BY	6,425	London, Ont.	...	Broadcast
46.67	W3XL	6,425	Bound Brook, N. J.	18.0	Exp.
46.70	RCAD	6,420	Minsk, U.S.S.R.	0.15	Phone
46.73	HJA3	6,416	Barranquilla, Colombia	...	Phone
46.85	YNIGG	6,400	Managua, Nicaragua	...	Broadcast
46.99	YN1OP	6,380	Managua, Nicaragua	...	Broadcast
47.04	YV4RC	6,375	Caracas, Venezuela	0.1	Broadcast
47.36	JZG	6,330	Nazaki, Japan	10.0	Phone
47.48	HIZ	6,315	Santo Domingo, D. R.	0.02	Broadcast
47.78	HJ3ABF	6,275	Bogota, Colombia	0.1	Broadcast
47.80	HI1A	6,272	San Domingo, D. R.	0.05	Broadcast
47.82	HKC	6,270	Bogota, Colombia	...	Phone
47.97	OCI	6,250	Lima, Peru	...	Phone
48.13	OAX4B	6,230	Lima, Peru	...	Broadcast
48.13	HJ4ABC	6,230	Pereira, Colombia	...	Broadcast
48.38	CT1GO	6,198	Parede, Portugal	...	Broadcast
48.45	HI1A	6,188	Santiago de los Caballeros, D.R.	0.05	Broadcast
48.67	CJRO	6,160	Winnipeg, Manitoba	...	Broadcast
48.67	KNRA	6,160	Schooner, Seth Parker	...	Phone
48.75	CO9GC	6,150	Santiago, Cuba	...	Broadcast
48.75	HJ2ABA	6,150	Tunja, Colombia	0.05	Broadcast
48.75	YV3RC	6,150	Caracas, Venezuela	...	Broadcast
48.75	VE9CL	6,150	Winnipeg, Manitoba	...	Broadcast
48.75	CSL	6,150	Lisbon, Portugal	...	Broadcast
48.83	KZRM	6,140	Manila, P. I.	6.0	Broadcast
48.83	W8XK	6,140	Pittsburgh, Pa.	40.0	Bc.; relays KDKA
48.90	ZGE	6,132	Kuala Lumpur, F. M. S.	0.18	Broadcast
48.91	LKJ1	6,130	Jeloy, Norway	...	Broadcast
48.91	XETE	6,130	Mexico, D. F.	...	Broadcast
48.91	VE9BA	6,130	Montreal, Que.	...	Broadcast
48.98	ZTJ	6,122	Johannesburg, S. Africa	5.0	Broadcast
48.99	HJ1ABE	6,120	Cartagena, Colombia	0.05	Broadcast
48.99	VE9HK	6,120	Halifax, N. S.	...	Broadcast
48.99	W2XE	6,120	Wayne, N. J.	5.0	Bc.; relays WABC
48.99	PKYDA2	6,120	Bandoeng, Java	...	Broadcast
49.05	YV2RC	6,112	Caracas, Venezuela	0.2	Broadcast
49.07	VE9HX	6,110	Halifax, N. S.	0.2	Bc.; relays CHNS
49.07	VUC	6,110	Calcutta, India	2.0	Broadcast
49.07	VE9CG	6,110	Calgary, Alberta	...	Broadcast
49.10	GSL	6,106	Daventry, England	...	Broadcast
49.15	HJ1ABD	6,100	Cartagena, Colombia	0.025	Broadcast
49.15	HJ4ABL	6,100	Manizales, Colombia	0.2	Broadcast
49.15	W3XAL	6,100	Bound Brook, N. J.	...	Bc.; relays WJZ
49.15	W9XF	6,100	Chicago, Ill.	5.0	Bc.; relays WENR
49.15	VE9CF	6,100	Halifax, N. S.	...	Broadcast
49.23	VE9BJ	6,090	St. John, N. B.	0.1	Broadcast
49.23	VE9GW	6,090	Bowmanville, Ontario	0.5	Broadcast
49.26	I2RO	6,085	Rome, Italy	...	Broadcast
49.31	TIRA	6,080	Cartago, Costa, Rica	...	Broadcast
49.31	VE9EH	6,080	Charlottetown, P. E. I.	...	Broadcast
49.31	W9XAA	6,080	Chicago, Ill.	0.5	Bc.; relays WCFL
49.31	CP5	6,080	La Paz, Bolivia	...	Broadcast
49.37	DJM	6,073	Berlin, Germany	...	Exp.
49.37	CQN	6,073	Macao, Asia	0.5	Broadcast
49.37	ZHJ	6,072	Penang, Straits Settlements	...	Broadcast
49.37	OER2	6,072	Vienna, Austria	0.25	Broadcast
49.39	VE9CS	6,070	Vancouver, B. C.	0.01	Broadcast
49.39	HJ1ABF	6,070	Barranquilla, Colombia	...	Broadcast
49.48	W3XAU	6,060	Philadelphia, Pa.	1.0	Bc.; relays WCAU
49.48	OXY	6,060	Skamleback, Denmark	.05	Broadcast
49.48	VQ7LO	6,060	Nairobi, Kenya, Africa	1.25	Broadcast
49.48	W8XAL	6,060	Cincinnati, Ohio	10.0	Bc.; relays WLW
49.48	CMCI	6,060	Havana, Cuba	0.02	Broadcast
49.48	ZL2ZX	6,060	Wellington, New Zealand	...	Broadcast
49.56	VE9CF	6,050	Halifax, N. S.	...	Broadcast
49.56	HJ3ABI	6,050	Bogota, Colombia	0.05	Broadcast
49.56	GSA	6,050	Daventry, England	...	Broadcast
49.62	HJ1ABG	6,042	Barranquilla, Colombia	0.1	Broadcast
49.64	W1XAL	6,040	Boston, Mass.	5.0	Broadcast
49.64	PRA8	6,040	Pernambuco, Brazil	...	Broadcast
49.64	W4XB	6,040	Miami Beach, Fla.	2.5	Broadcast
49.64	....	6,040	Bandoeng, Java	3.0	Broadcast
49.72	VE9CA	6,030	Calgary, Alta.	...	Bc.; relays CFCN
49.73	HP5B	6,030	Panama City	...	Broadcast
49.78	XEW	6,023	Mexico City, D. F.	...	Broadcast
49.80	DJC	6,020	Zeesen, Germany	8.0	Broadcast
49.82	HJ3ABH	6,018	Bogota, Colombia	...	Broadcast
49.82	ZHI	6,018	Singapore, F. M. S.	0.09	Broadcast
49.85	HRP1	6,015	San Pedro Sula, Honduras	...	Broadcast
49.85	VE9CX	6,015	Wolfville, N. S.	...	Broadcast
49.89	COC	6,010	Havana, Cuba	0.25	Broadcast
49.89	XEBT	6,010	Mexico, D. F.	...	Broadcast
49.93	VE9DR	6,005	Drummondville, Que.	0.05	Bc.; relays CFCF
49.93	VE9DN	6,005	Montreal, Que.	4.0	Broadcast
49.93	VE9CU	6,005	Calgary, Alta.	...	Broadcast
49.97	YOI	6,000	Bucharest, Roumania	0.3	Broadcast
49.97	XGOX	6,000	Nanking, China	...	Broadcast
49.97	FIQA	6,000	Tananarive, Madagascar	0.4	Broadcast
49.97	....	6,000	St. Denis, Reunion	0.09	Broadcast
49.97	EAJ25	6,000	Barcelona, Spain	...	Broadcast
49.97	ZL3ZC	6,000	Christchurch, New Zealand	0.25	Broadcast
49.97	RW59	6,000	Moscow, U.S.S.R.	20.0	Broadcast
49.97	YV4BSG	6,000	Caracas, Venezuela	...	Broadcast
50.00	PRA8	5,996	Pernambuco, Brazil	0.5	Broadcast
50.11	TGX	5,984	Guatemala City, Guatemala	...	Broadcast
50.10	YV4RC	5,984	Caracas, Venezuela	0.1	Broadcast
50.14	CT1AA	5,980	Lisbon, Portugal	...	Broadcast
50.14	XECW	5,980	Xantocam, Mexico	0.01	Broadcast
50.14	HIX	5,980	San Domingo, D. R.	...	Broadcast
50.14	HJ3ABH	5,980	Bogota, Colombia	0.25	Broadcast
50.22	YNLF	5,970	Managua, Nicaragua	0.1	Broadcast
50.23	HVJ	5,969	Vatican City	10.0	Broadcast
50.47	HJ1ABJ	5,940	Santa Marta, Colombia	0.25	Broadcast
50.56	HJ4ABE	5,930	Medellin, Colombia	0.1	Broadcast; evenings
50.90	JIC	5,890	Taihoku, Formosa	...	Phone
51.08	HJ2ABC	5,870	Cucuta, Colombia	...	Broadcast
51.16	XDA	5,860	Mexico, D. F.	...	Phone
51.23	WNB	5,852	Lawrenceville, N. J.	...	Phone
51.25	YV5RMO	5,850	Maracaibo, Venezuela	0.3	Broadcast
51.29	KRO	5,845	Kahuku, Hawaii	40.0	Phone
51.64	CSN	5,805	Rossland, B. C.	...	Phone
51.69	VK3LR	5,800	Lyndhurst, Vic, Australia	...	Exp.
51.69	TI4NRH	5,800	Heredia, Costa Rica	...	Broadcast
51.87	OAX4D	5,780	Lima, Peru	20.0	Broadcast
51.90	TIXGP3	5,777	San Jose, Costa Rica	...	Broadcast
51.97	XAM	5,769	Merida, Yucatan	...	Phone
52.47	CFU	5,714	Rossland, B. C.	...	Phone
52.47	HCJB	5,714	Quito, Ecuador	...	Broadcast
52.67	FIQA	5,692	Tananarive, Madagascar	0.5	Broadcast
52.97	XQAJ	5,660	Shanghai, China	...	Broadcast
55.52	HJA7	5,400	Cucuta, Colombia	0.4	Phone
55.52	HAT	5,400	Budapest, Hungary	20.0	Broadcast
57.00	WQN	5,260	Rocky Point, N. Y.	40.0	Exp.
58.17	PMY	5,154	Bandoeng, Java	2.0	Phone; occasional bc.
52.27	OK1MPT	5,145	Prague, Czechoslovakia	0.5	Broadcast
58.67	KIKB	5,110	Bolinas, Calif.	40.0	Phone
58.71	KEC	5,105	Bolinas, Calif.	40.0	Phone
58.79	KIKA	5,100	Bolinas, Calif.	1.0	Phone
59.05	WCN	5,077	Lawrenceville, N. J.	20.0	Phone to England
59.67	ZFA	5,025	Bermuda, Bermuda	1.5	Phone
59.96	WWV	5,000	Beltsville, Md.	...	Standard frequency trans.; Tue., Fri., 2:30-3:30
60.26	GBC	4,975	Rugby, England	5.0	Phone to ships
60.33	G6RX	4,970	Rugby, England	...	Exp.
60.94	LCL	4,920	Jeloy, Norway	...	Exp.
61.63	HJA3	4,865	Barranquilla, Colombia	...	Phone
62.20	GDW	4,820	Rugby, England	...	Phone to US
62.53	VE9BY	4,795	London, Ont.	...	Broadcast
62.60	CZA	4,785	Drummondville, Que.	10.0	Phone to ships
62.86	ZL2XX	4,770	Wellington, New Zealand	...	Phone
63.10	WOO	4,752	Ocean Gate, N. J.	20.0	Phone
63.10	WOY	4,752	Lawrenceville, N. J.	20.0	Phone to England
64.48	HC2EP	4,650	Guayaquil, Ecuador	...	Broadcast
66.45	ZFS	4,512	Nassau, Bahama Is.	...	Phone
67.07	YID	4,470	Bagdad, Iraq	...	Broadcast
67.68	DOA	4,430	Doeberitz, Germany	...	Phone
68.61	....	4,370	Semarang, Java	0.2	Broadcast
69.24	....	4,330	Batavia, Java	0.15	Broadcast
69.44	GDB	4,320	Rugby, England	15.0	Exp.
69.46	YNLF	4,316	Managua, Nicaragua	...	Broadcast
69.81	WTDX	4,295	St. John, Virgin Islands	0.25	Exp.
69.81	WTDV	4,295	St. Thomas, Virgin Islands	0.25	Exp.
69.81	WTDW	4,295	St. Croix, Virgin Islands	0.25	Exp.
70.00	IBEJ	4,283	S.S. Conte Rosso	...	Phone
	ICEJ		S.S. Rex	...	Phone
	IDLI		S.S. Conte di Savoia	...	Phone
70.17	RW15	4,273	Khabarovsk, U.S.S.R.	20.0	Broadcast
70.55	HJA3	4,250	Barranquilla, Colombia	...	Phone
71.78	GFWV	4,177	S.S. Majestic	...	Phone
	GLSQ		S.S. Olympic	...	Phone
	GDLJ		S.S. Homeric	...	Phone
	GTSD		S.S. Monarch of Bermuda	...	Phone
	GKFY		S.S. Minnetonka	...	Phone
	GMBJ		S.S. Empress of Britain	...	Phone
	DDAC		S.S. Europa	...	Phone
	DDAS		S.S. Bremen	...	Phone
	DDBR		S.S. Berlin	...	Phone
	DDCB		S.S. Columbus	...	Phone
	DDCG		S.S. Resolute	...	Phone
	DDCP		S.S. Cap Polonio	...	Phone
	DDDT		S.S. Deutschland	...	Phone
	DDDX		S.S. Hamburg	...	Phone
	DDDE		S.S. Cap Arcona	...	Phone
	DDED		S.S. New York	...	Phone
	DDFF		S.S. Reliance	...	Phone
	DDFT		S.S. Oceana	...	Phone
	DDNY		S.S. Albert Ballin	...	Phone
72.95	HCJB	4,110	Quito, Ecuador	0.15	Broadcast
73.13	LCL	4,100	Jeloy, Norway	...	Exp.
73.13	WND	4,100	Hialeah, Florida	0.4	Phone
74.92	CT2AJ	4,002	San Miguel, Azores	...	Broadcast
79.53	HB9B	3,770	Basle, Switzerland	...	Broadcast
79.95	CT1CT	3,750	Lisbon, Portugal	0.5	Broadcast
79.95	I2RO	3,750	Rome, Italy	12.0	Broadcast
82.82	DOA	3,620	Doeberitz, Germany	...	Phone
84.63		3,543	Lourenzo Marques, Mozambique, Port. E. Africa	...	Broadcast
85.06	HB9AQ	3,525	Switzerland	...	Broadcast
88.81	HJA3	3,376	Barranquilla, Colombia	...	Phone