Simplicity of Radio

By
Powel Crosley, Jr.

The Blue Book of Radio

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THIRTEENTH EDITION

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SIMPLICITY OF RADIO FOREWORD

Radio is no longer the plaything of the child. The progress in improvement of radio equipment has been so marked, that radio has become a public servant of great value to all mankind. Through broadcasting, we may expect a new democracy of thought and the culmination of plans for a universal language. The magnitude of the radio audience is such that there can be spread ideas of culture and universal contact that will affect more people than have ever been reached by any agency with the possible exception of the printing press.

Although the theories of radio engineering depend upon scientific and technical laws, it is not necessary to attempt to master these to be able to receive broadcast concerts and news in your own home. It is through the efforts of radio engineers that modern apparatus has been made so simple that it is little more difficult to operate a radio set than to play a phonograph record.

Radio takes its name from the word "radiate," which means the giving off of energy in all directions, just as the spokes on a wagon wheel protrude from the hub to the rim. You are familiar with the electrical energy sent over the wires which supply current to light your home, and the electrical force used in radio is similar to that. The difference between sending electrical energy through a wire and into the air is that the path of the former is limited to its wired lines, while the latter is unlimited, radiating in all directions.

Radio waves are sent into the air and reach your receiving set just as the waves reach the edge of a pool after a stone is thrown into the water. The stone would represent the transmitting set in the radio studio and the edge of the pool would be the same as your receiving set at home.

With the radiating of this electrical energy in every direction it is possible for it to be collected by a radio receiving set and thus utilized by people many miles away at the same time and from the same source.

The radio wave is not a sound wave but the electrical force which will produce sound in the receivers. It travels at the rate of 186,000 miles a second or the speed of light. This radio wave is sent out from an apparatus known as a transmitting set.

GENERAL DISCUSSION

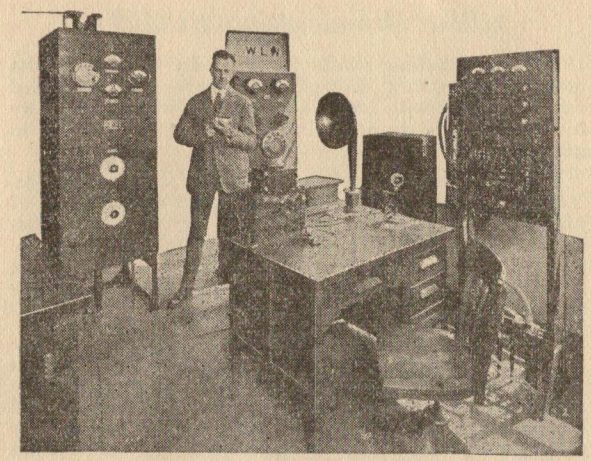
Broadcasting

Radio broadcasting in this country has reached a point far in advance of that in any other country, a condition brought about to a great extent by the broad and far-reaching policies adopted by our government. Our navy was the first agency to grasp the tremendous importance of wireless communication. And then when the great wave of interest in radio swept over the country, our generous government set up no barriers of restrictions to dwarf this new art and new industry in its infancy.

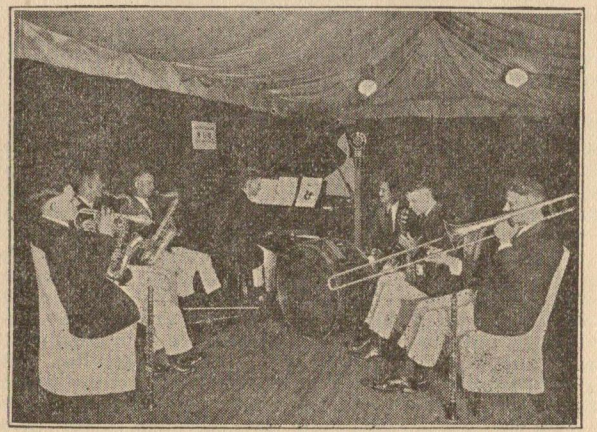
Three short years have seen a fairy like development in radio broadcasting. Beginning with the sending out into the unknown, concerts of reproduced music from phonographs and player-pianos, the studio work has evolved into something very distinctive for it is now possible to arrange and produce performances of two and three hours duration that continue without a break. The large stations have for their theatre the entire continent, with occasional reaches to the other hemisphere.

The better studios put on performances of brass bands, orchestras, instrumental and vocal solos, readings, speeches and plays. The entire business of broadcasting is still in a state of development, with a constant process of elimination and construction tending toward the permanent and definite values in what will make radio, eventually, one of the greatest factors in our general life. A microphone placed in any theatre, church or auditorium and connected by telephone line to the broadcasting apparatus enables anyone with a receiving set, tuned to the station, to hear the performance.

But the real development of broadcasting will be evolved in the studio itself. Already the drama has been transformed into the radio play, or *radario,* and this in turn will form the nucleus of the bigger and more definite radio program. And besides this, the utility of radio will constantly increase because of its quick transmission of news, its business and market reports, and its dissemination of education and culture.



Mr. Powel Crosley, Jr., in the operating room of radio station WLW of The Crosley Radio Corporation, Cincinnati



WLW Broadcasting Studio

The Broadcasting Studio

The broadcasting studio is the room in which radio broadcast programs take place. Everyone who has had any experience with sound phenomenan will immediately realize that certain acoustic rules must be observed to get best reproduction.

First, all sounds must be excluded from the outside. Various sound-proof materials are used on the walls of radio studios, such as felt, cork, or air pocket arrangements. Second, the echoes and reverberation must be suppressed to a point where the concert is not roary but at the same time, the extreme must not be reached where sounds seem thoroughly dead and bodiless.

Usually the walls of the studio are draped with sliding velvet curtains or other absorbant material with a four to ten inch air pocket between the wall and the draperies. The ceiling is also draped with hangings and the general shape of these is most important. Heavy carpetings cover the floors to complete the soft setting of the radio broadcast studio.

Artists and speakers must be carefully placed in proper relation to the microphone so that natural and pleasing reproduction is assured.

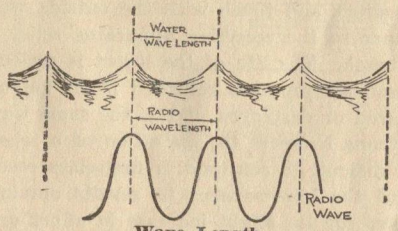
Broadcasting Transmitters

In order that music and speech may be broadcast, it is necessary to use a special type of apparatus, known as a broadcasting transmitter. Its function is to generate a steady stream of radio waves of high power which waves may be controlled in character to correspond with the particular sounds that originate in the studio. For the generation of this radio power, special large vacuum tubes are used but in construction and theory they are exactly like those used in receiving apparatus which will be described later. Transmitting vacuum tubes are rated according to their power output, viz., 5 watts, 50 watts, or 250 watts. High-powered broadcasting stations are rated at 500 watts, but use four 250 watt tubes, two for generation of the radio power and two for controlling this power, to correspond to the music or speech in the studio. In addition to these, there are used one 50 watt tube, one 5 watt tube, and two or more of smaller rating.

Wave Length and Frequency

Everyone, who has had even the slightest contact with radio, has heard used the term "wave length" and is now hearing the word "frequency" used in a somewhat similar manner.

Wave-length is merely a notation to identify the character of the particular wave in question. Returning to our analogy of a stone dropped in a pool, if we were to measure the distance between successive crests of the ripples formed, that distance would be called the wave-length, as shown in the accompanying illustration.



Wave Length

Radio waves are measured in meters (the European Continental Standard of length), one meter being equal to 39.37 inches or approximately, one yard. Therefore, when we say that a station is operating on a wave-length of 309 meters, we mean that the distance from crest to crest of the imaginary radio wave eminating from that station is 309 meters or 338 yards.

As mentioned before, radio waves travel at a speed of 186,000 miles a second, which corresponds to 300,000,000 meters a second. Now, if the waves travel three hundred million meters in one second and the distance between successive crests or peaks is 309 meters, it is apparent that there will be 970,000 of these crests or peaks occurring in one second. This latter figure is commonly called the *frequency* of the wave and is measured in "cycles per second." Since that number is always large and cumbersome in radio measurements, the unit, kilocycles per second has been originated and one kilocycle is equal to 1,000 cycles. It is apparent, therefore, that a 309 meter wave has a frequency of 970 kilocycles. In general, the frequency of any wave can be determined simply by dividing 300,000 by the wave length in meters and the result will be in kilocycles.

Always remember that the wave length or frequency used by a broadcasting station has nothing whatever to do with its distance from your receiver. These notations are merely an identification of the tuning positions necessary to receive a given station.

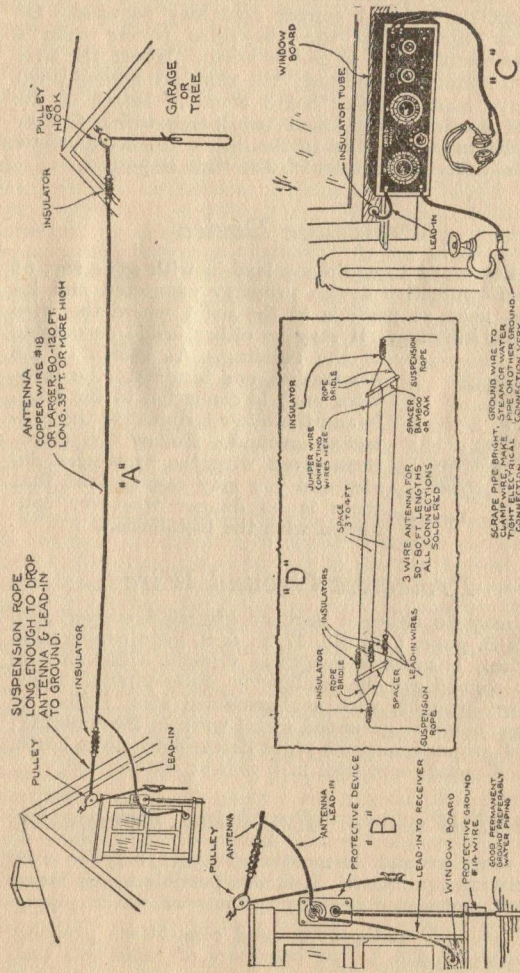
The Antenna

The antenna takes its name from that part of an insect which protrudes from its brain and is commonly called the "feelers." Just as an insect depends entirely for its contact and touch with the outside world upon its antennae so the receiving apparatus relies upon the radio antenna. The life of the insect is seriously jeopardized and his progress retarded if his antennae have been injured or destroyed and in the same way, a poor radio antenna hampers the operation of a receiving set. It is not difficult to construct a first-class receiving antenna and the improvement in results obtainable certainly pays for the slight increase in effort or expense.

In erecting an antenna, No. 18 bare copper wire is satisfactory. However, almost any sort of wire that has sufficient strength and low resistance may be used. Insulated wire will function but it merely increases the cost of the installation. There has been published in the National Electric Code, 1923 edition, Rule No. 86, Radio Equipment, a complete and detailed list of specifications for the installation of an antenna so that there will be no danger or hazard connected therewith. The illustration shows some of the many ways to rig an antenna. It is important that the ends of the wire or wires be insulated with a standard porcelain or other insulator. All splices or joints, unless made with clamps or splicing devices should be soldered.

The Lead-In

The wire leading from the antenna proper to the receiving equipment is called the "lead-in." This lead-in should be of copper or copper-clad steel, which will not

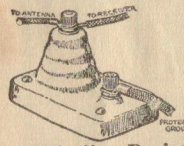


"A," single wire antenna. "B," lead-in and protective device. "C," connections to receiver. "D," for short antenna.

corrode excessively and should not be smaller than No. 14, except that No. 17 copper clad may be used. Do not allow the lead-in wire to come nearer than 4 inches to electric light or power wires. Where the wire passes through the building, the simplest arrangement is to have made a small board equal in length to the width of a window and about two inches wide. One or more holes may be drilled in this board to accommodate porcelain tubes through which the wire is passed.

Protective Device

It is necessary to equip the lead-in with some sort of approved protective device properly connected and located as near as possible to the point where the wire enters the building. It may be either inside or outside of the building. As shown in the illustration, one terminal (the insulated one) is connected to the lead-in and the other terminal to the protective ground. Follow the directions given with the protective device and you may rest assured that there is no danger whatever connected with the installation.



Protective Device

Protective Ground Wire

This may be either a bare or insulated copper, No. 14 B. & S. gage, or a No. 17 B. & S. gage copper-clad steel wire. It must be run in as straight a line as possible to a good ground, preferably water-piping. There are other grounds, such as: grounded steel frames of buildings, or other grounded metal work in the building; artificial grounds, such as pipes driven into moist earth, or buried metal, or a wire in a well or cistern, etc.

Ground Wire for Receiving Equipment

The same ground as mentioned above may be used for receiving equipment. It is also possible to use steam radiators, hot-water heating systems or water piping.

Poor grounds and poor ground connections probably cause more trouble to the operators of radio sets than any other one factor. A large radio service company in New York City recently made an investigation and found

that in over nine-tenths of all the cases in which trouble was experienced that the difficulty was due to a poor ground. A careful study of grounds was made throughout the state of Ohio in connection with electrical power transmission. It was found that the average good ground was 90 feet below the surface.

To insure proper operation, the radio set must first be grounded to an object of the proper type, and second, the ground connection must be made in the proper manner. In city installation, perhaps the best object to use for a ground is a water pipe. Make your connection, however, as near as possible to the point where the water piping enters the building. If the water meter is located in the building, make the connection on the far side of the water meter. A steam or water heating system is usually connected to the water supply, and in this case may serve as a ground. However, it is better to go direct to the water system as just mentioned. The gas piping may also be used for a ground. In this case make your connection as near as possible to the point where the pipe enters the building. If several systems are available try out one after another, and use the one giving the best results. Also try using two or more systems connected in at the same time.

Where a piping system is not available a ground may be obtained by dropping a copper plate to the bottom of a well, letting the plate rest in the clay bottom. Do not attempt to use a cistern, for in ordinary cases the water is too free from salt to make a good conductor. A rod may be driven into moist soil, or a plate buried in moist earth. A ground of this type is usually very unsatisfactory, because you do not penetrate the earth far enough and sufficient contact is not made with the ground water. Very frequently such grounds become absolutely worthless in dry weather. Do not attempt to use a lightning rod ground or the telephone ground. In practically all cases, such grounds will be found to be worthless. In case you have not a good piping system on which to make your ground connection, probably the best results will be obtained from a counterpoise system. This is really a copper or wire ground, and it is constructed underneath the aerial. Stretch wires parallel to your aerial either on the ground or a few feet above the ground or buried in a trench. A wire stretched a few feet above the ground may give the best results, and if it can be erected in this position without being in the way, it is highly recommended. Connecting your

ground wire to a wire fence serves very much the same purpose, and in practically all cases is found to be greatly superior to telephone or lightning grounds, or pipes driven in the ground.

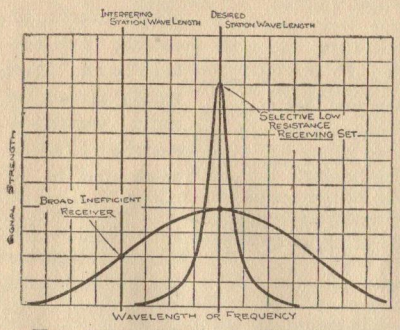
After a proper ground has been obtained be sure that a good connection is made to the wire running to the radio set. If the ground is a pipe the pipe must be scraped absolutely clean. If possible, empty the water from the pipe and solder it. If this cannot be done, use a ground clamp, and fasten it tightly to the brightened metal. If a plate is dropped in a well, solder the wire to the plate first. If a counterpoise or fence is used, the connection may be soldered very easily, or in the case of the counterpoise a continuous wire may be run into the house without break.

BEFORE ATTEMPTING ANY USE OF THE RECEIVING SET BE SURE THAT THE ABOVE INSTRUCTIONS HAVE BEEN CLOSELY FOLLOWED AND THAT ALL CONNECTIONS ARE SOLDERED, SECURELY CLAMPED, OR TIGHTLY FASTENED THROUGHOUT.

Why Tuning is Necessary

Everyone is familiar with the fact that two violin strings when tuned to the same note possess a certain ability to respond to each other. When one string is bowed into vibration, the other, even though it has not been touched, will vibrate also at its natural pitch. If, however, the second string had not been tuned to the same note as the first, there would be no vibration apparent. In order that radio may be received it is necessary that the same tuning or resonance condition hold between the transmitting station and the receiver. Since there are quite a number of broadcasting stations operating over a comparatively narrow band of frequencies, a receiving set must not only be capable of tuning in

the desired station, but it must also be selective enough to exclude the remainder of the undesired ones. In general, it might be said, that the selectivity of a receiving set is entirely dependent upon the resistance of the circuits. The lower this resistance is held, the better the selectivity of the receiver. It also happens that the efficiency of the receiving equipment is increased as its resistance is decreased, all other things remaining the same. The accompanying illustration shows how interference is eliminated when the resistance is decreased.

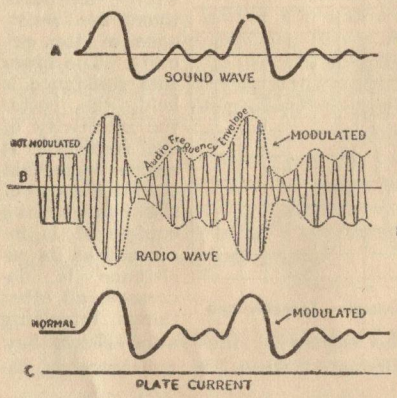


How Tuning Eliminates Interference

How a Receiving Set Works

The energy accumulated by the receiving antenna is of very small order and the apparatus used in receiving equipment must, therefore, be highly sensitive and efficient. In order that the high frequency currents in the antenna may be made usable, the antenna circuit must be tuned to the frequency or wave length of the desired station. When this is done, the current in the antenna circuit will be at a maximum. Antenna tuning circuits usually consist of a variable condenser and some form of coil or inductance. When the circuit is tuned and a comparatively large current is flowing in the coil, there will be a voltage across the terminals of this coil. However, this voltage it will be remembered, is of a high frequency type and its pulsations are at such a rapid rate that no head phones or loud speaker would be able to follow them, and if they could, the human ear would not be able to hear such rapid vibrations. Radio waves,

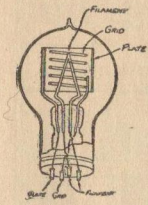
however, are not made up entirely of a high frequency current having a uniform amplitude or intensity. As mentioned in the chapter on broadcasting transmitters, the steady stream of radio waves is controlled or modulated in intensity corresponding to the sounds originating in the studio. If the form of the sound wave is as shown at "A" in the accompanying illustration, the radio frequency wave will be modulated as shown at "B." In other words, the radio frequency wave consists of high frequency impulses, the envelope of which corresponds to the sound wave picked up at the studio. The voltage across the treminals of the tuning inductance is the same as this radio frequency wave. If some form of rectifying device such as a crystal detector or a vacuum tube is used, the current in the head phones will be as shown at "C" because, rectification eliminates the lower or negative half of the radio frequency current. This plate or head phone current has the same form as the original sound wave and will be an audible and a faithful reproduction of the original sound.



The Vacuum Tube

The vacuum tube consists of a filament through which a current is passed from a battery, a grid element, so-

called because of its zig-zag shape, and a plate surrounding the other two elements. In order that a vacuum tube may be operated, it is necessary to have an "A" battery which lights the filament. The size and rating of the "A" battery depends upon the tube used and will be described later. When the filament is lighted an emission of minute particles takes place from it and these particles, commonly known as electrons travel in all directions. The plate element of the vacuum tube has connected to it the positive (+) side of a "B" battery, the size of which also depends upon the tube and conditions of operation. It is a peculiarity of a tube containing a positively charged plate and a lighted filament, that a current will flow from the plate to the filament and this current is furnished by the "B" battery. When a grid is inserted between the plate and the filament and a negative (—) battery connected to the grid, the magnitude of current flow from plate to filament is decreased. When the grid is made positive, the plate current will be increased. It requires practically no current flowing from the grid to accomplish this valve action. In other words, the operation of the three-electrode vacuum tube may be compared with the setting off of a gun by means of a trigger. To pull the trigger of a gun requires very little effort on the part of the gunner but the energy set loose by the detonation of the powder is powerful. The function of the grid, therefore, is to act as a trigger to control the current flowing from the plate to the filament. Head phones or loud speakers are always placed in the plate and "B" battery circuit of the vacuum tube and the grid is connected to the input circuit. A vacuum tube may also be thought of as a sort of relay device which takes the weak input energy or voltage and converts it into more powerful current apparent in the plate circuit.



The Vacuum Tube as a Detector

As has been explained in detail, the radio frequency current must be converted into a pulsating direct current before an audible sound will be apparent in the head phones. This means, that the negative (—) or lower half of the radio current must be eliminated or reduced. If the grid voltage of the tube is established so that operation will be on the bend or knee of the curve shown, the plate current will be correspondingly rectified

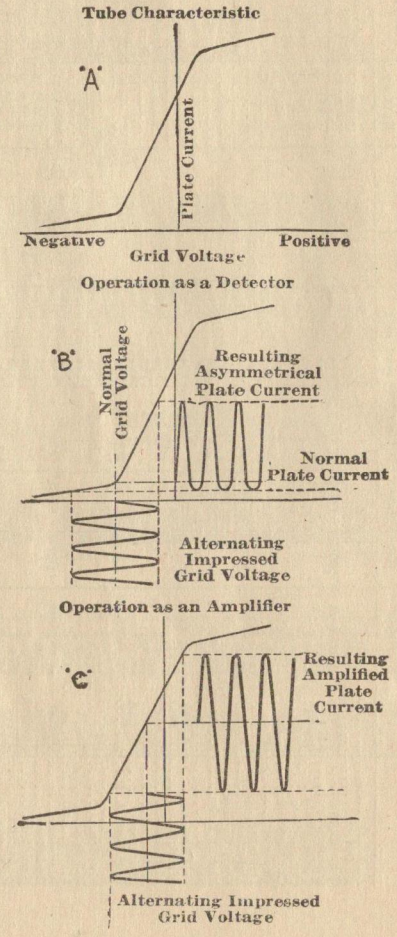
VACUUM TUBE DATA

Make	Type	FILAMENT			PLATE			Amplification Factor	Mutual Conductance
		Voltage	Current	Battery	Voltage	Milliamperes Current	Impedance		
Alpha		3.0	0.25	Two Dry Cells	45-60				
Audiotron		6.0	0.80	Six Volt Storage	15-40				
Cunningham	C300	5.0	1.00	Six Volt Storage	15-24	25-1.00	9000		
Cunningham	C301	5.0	1.00	Six Volt Storage	45-100	1.00-5.00	14000-24000	6.5	465
Cunningham	C301A	5.0	0.25	Storage or Dry	40-120	1.00-7.5	12000-16500	8.0	485
Cunningham	C299	3.0	0.06	Three Dry Cell	40-80	0.25-4.00	16000-18500	6.25	340
Cunningham	C12	1.1	0.25	One Dry Cell	20-90	0.25-4.00	17000-19000	6.5	340
DeForest	DV1	3.0	0.06	Three Dry Cell	20-80	0.25-4.00	20000	8.0	350
DeForest	DV2	5.0	0.25	Storage or Dry	40-150		9000	6.5	650-800
DeForest	DV6A	4.0	0.25	Storage or Dry	20-100		20000	5.5	450
Electrad Diode				Dry Cells	None	None		None	None
French Tube		4.0-6.0	0.6	Six Volt Storage	20-200				
Margo				Dry Cells	None	None		None	None
Melotron	DC12A	1.25	0.25	One Dry Cell	20-80				
Melotron	DC12D	1.25	0.25	One Dry Cell	15-25				
Melotron	SB200	6.00		Six Volt Storage	15-25				
Melotron	SB201	6.00		Six Volt Storage	40-100				
Melotron	SB201A	5.00		Six Volt Storage	40-120				
Moorhead A. P.		4.0-5.0	0.6-0.7	Six Volt Storage	20-100	1.00-5.00	15000		
Mullard		4.0-6.0		Six Volt Storage					
Murdon		1.0-3.0	0.75	Four Volt Storage	16-60				
Myers	RAC3	4.0	0.8	Six Volt Storage	20-300		30000	25.0	
Myers		2.5	0.25	Two Dry Cells	20-150				
Radiotron	UV200	5.0	1.00	Six Volt Storage	15-24	0.25-1.00	9000		
Radiotron	UV201	5.0	1.00	Six Volt Storage	45-100	1.00-5.00	14000-24000	6.5	465
Radiotron	UV201A	5.0	0.25	Storage or Dry	40-120	1.00-7.50	12000-16500	8.	485
Radiotron	UV199	3.0	0.06	Three Dry Cell	40-80	0.25-4.00	16000-18500	6.25	340
Radiotron	WD12	1.1	0.25	One Dry Cell	20-90	0.25-4.00	17000-19000	6.5	340
Radiotron	WD11	1.1	0.25	One Dry Cell	20-90	0.25-4.00	17000-19000	6.5	340
Welsch	WT501	4.0-6.0	0.5-0.8	Six Volt Storage	16-25				
Western Electric	215A	1.1	0.25	One Dry Cell	40-60	0.60-1.50	25000	6.5	260
Western Electric	203B	2.5	1.10	Storage	20-45	0.50-2.00	10000-20000	6.5	650
Western Electric	VT1	2.5	1.10	Storage	20-45	0.50-2.00	10000-20000	6.5	650
Western Electric	J	2.5	1.10	Storage	20-45	0.50-2.00	10000-20000	6.5	650
Western Electric	216A	6.0	1.00	Six Volt Storage	120	7-9	5000-6000	6.0	1000

VACUUM TUBE DATA (Continued)

Make	Type	DETECTOR				AMPLIFIER			Base	List Price
		Rating	Grid Condenser	Grid Leak	Regenerative	Audio	Radio	"C" Battery		
Alpha		Fair	.00025		Yes	Fair	Poor		Standard	3.50
Audiotron		Fair	.00025		Yes	Fair	Fair		Special	3.50
Cunningham	C300	Excellent	.00025-.0005	0.25-2.50	Yes	Fair	Poor		Standard	5.00
Cunningham	C301	Fair	.0005	2-5	Yes	Very Good	Good	1.5-4.5	Standard	6.50
Cunningham	C301A	Good	.00025	2-6	Yes	Excellent	Fair	1.0-6.0	Standard	6.50
Cunningham	C299	Good	.00025	2-6	Yes	Fair	Good	1.0-4.5	Special	6.50
Cunningham	C12	Very Good	.00025	2-3	Yes	Good	Good	1.5-4.5	Standard	6.50
DeForest	DV1	Fair	.00025	2-3	Yes	Fair	Fair		Standard	
DeForest	DV2	Fair	.00025		Yes	Very Good	Fair		Standard	6.50
DeForest	DV6A	Fair	.00025		Yes	Good	Good		Standard	6.50
Electrad Diode		Fair	None	None	No	None	None		Special	2.00
French Tube		Good	00025		Yes	Good	Good		Special	
Margo		Fair	None	None	No	None	None		Special	
Melotron	DC12A	Fair	.00025	2.00	Yes	Poor	Poor		Standard	6.50
Melotron	DC12D	Fair	.00025	2.00	Yes	Poor	Poor		Standard	6.50
Melotron	SB200	Good	.00025	2.00	Yes	Poor	Poor		Standard	5.00
Melotron	SB201	Good	.00025	2.00	Yes	Good	Good		Standard	6.50
Melotron	SB201A	Fair	.00025	2.00	Yes	Good	Fair		Standard	6.50
Moorhead A. P.		Very Good	.00025	2.0-4.0	Yes	Good	Good		Standard	6.50
Mullard		Good	.00025		Yes	Good	Very Good		Special	
Murdon		Fair	.00025		Yes	Fair	Poor		Standard	3.00
Myers	RAC3	Good	.00025	1-5	Yes	Good	Good		Special	5.00
Myers		Good	.00025	1-5	Yes	Good	Good		Special	5.00
Radiotron	UV200	Excellent	.00025-.0005	0.25-2.5	Yes	Fair	Poor		Standard	5.00
Radiotron	UV201	Fair	.0005	2-5	Yes	Very Good	Good	1.5-4.5	Standard	5.00
Radiotron	UV201A	Good	.00025	2-6	Yes	Excellent	Fair	1.0-6.0	Standard	5.00
Radiotron	UV199	Good	.00025	2-6	Yes	Fair	Good	1.0-4.5	Special	5.00
Radiotron	WD12	Excellent	.00025	2-3	Yes	Good	Good	1.5-4.5	Standard	5.00
Radiotron	WD11	Excellent	.00025	2-3	Yes	Good	Good	1.5-4.5	Special	5.00
Welsch	WT501	Fair	.00025-.0005	1-5	Yes	Poor	Poor		Special	2.00
Western Electric	215A	Good	.00025	2-5	Yes	Fair	Fair	1.0	Special	5.00
Western Electric	203B	Excellent	.00025-.0005	0.5-3.0	Yes	Good	Fair	1.5	Standard	7.00
Western Electric	VT1	Excellent	.00025-.0005	0.5-3.0	Yes	Good	Fair	1.5	Standard	7.00
Western Electric	J	Excellent	.00025-.0005	0.5-3.0	Yes	Good	Fair	1.5	Standard	7.00
Western Electric	216A	Fair	.00025	1-5	Yes	Excellent	Good	9.	Standard	12.50

as shown, at "B." It will be seen that the increases in plate current are greater than the decreases and it follows, therefore, that the original grid voltage with its symmetrical increasing and decreasing values has been rectified.



The Vacuum Tube as an Amplifier

When it is desired to amplify with a vacuum tube either at radio or audio frequencies, the same reasoning applies as in the case of the detector, except that the grid voltage is established in the centre of the straight line portion of the tube characteristic as shown at "C." It will be seen that the symmetry of the alternating grid voltage is not disturbed but the resulting plate current is more powerful.

Audio Frequency Amplifiers

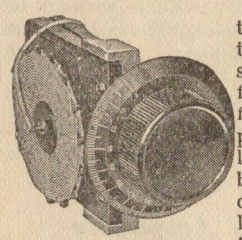
Due to the feebleness of the radio wave, the sound apparent after it has been rectified by the detector, is usually correspondingly weak. While such volume is satisfactory to operate head phones, it is not sufficient to energize a loud speaker so that a number of persons may listen simultaneously. In order that the head phone or audio frequency current may be increased to the desired intensity, it is necessary to use an audio frequency amplifier.

The vacuum tube amplifier, in connection with a suitable transformer is the device most universally used. An audio frequency amplifier is not strictly a piece of radio apparatus, since it has been used for a number of years in long-distance line telephony. However, refinements in such amplifiers have been made due to the requirements in radio broadcasting. A good single tube audio frequency amplifier increases the intensity of the sound about 15 times and two tubes, 200 to 300 times.

Radio Frequency Amplification

While audio frequency amplifiers increase the volume after the detector has rectified the high frequency current, it is often necessary to furnish the detector itself with a stronger current. It is the function of a radio frequency amplifier to increase the intensity of the high frequency currents as accumulated by the antenna before they are impressed upon the detector for rectification. In this way, the incoming wave from a distant station may be made as strong as that from a local sta-

tion, compensating for the weakening of the wave due to distance.



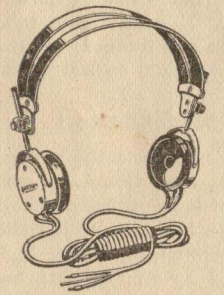
Crosley Radio Frequency Tuned Amplifier

One would immediately assume that radio frequency amplification can be accomplished in the same way as is done with audio frequency amplification. Transformers for radio frequency amplification are available but their limitation lies in the fact that broadcasting stations operate at different frequencies or wave lengths and the design of such transformers must be a compromise which means reduced efficiency to cover the necessary band of wave lengths. If, however, a tuning unit is used, composed of a condenser and inductance, as in the case of antenna tuning, maximum efficiency may be obtained over the entire range of the receiving sets. This tuned radio frequency amplification was first put on a commercial basis in Crosley apparatus.

RADIO EQUIPMENT

In order to understand fully the general types of receivers, it is necessary to understand the parts which go to make up your set.

Head Phone-Receivers



Head Phones

The head phone receivers are used as the electrical mouth of the receiving set. It is the purpose of this piece of apparatus to receive electrical impulses and convert this energy into sound. It is similar in action to the little sound box on your phonograph. The receiving range of many efficient receiving sets has been greatly reduced by inferior type telephone receivers. This part of the equipment cannot be too highly appreciated. DO NOT BUY TELEPHONES UNLESS YOU KNOW THEY ARE RELIABLE. Buy only from reputable dealers who supply recognized or well-established equipment.

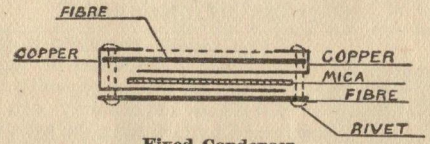
The receiving set may collect a radio message and detect it in and deliver it to the telephone receiver in an efficient manner but this signal may not be converted into sound energy due to the poor quality of the head phone receivers.

Loud Speaker

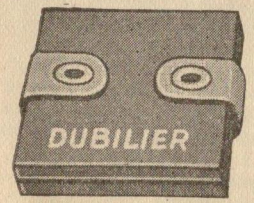
A loud speaker is a device to convert the audio frequency electrical current into audible sound waves. It may be compared to the reproducer, tone arm and horn of the phonograph except that these change the physical impressions on the record into sound waves.

The general construction of all loud speakers is the same. There is a unit which operates upon a magnetic principle practically the same as head phones but capable of greater output connected to a diaphram. Some form of horn, resonating chamber, or projecting device is attached to this unit. Within limits, the volume obtained from a loud speaker depends upon the strength of the signals, the sensitivity of the unit, and the size of the horn. It is possible to use a reflecting principle on the horn and accomplish the results given with a large horn but at the same time hold the size of the loud speaker down.

Fixed Condensers



Fixed Condenser



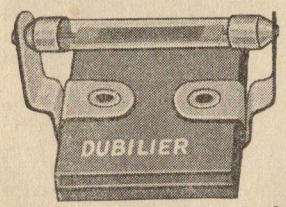
Fixed Condenser

There are places in radio circuits where a condenser which is fixed in capacity is required. These are made of pieces of metallic foil, separated by some insulating material, such as mica or waxed paper. A condenser will not allow direct current to pass but, depending upon its capacity, it will allow alternating currents to pass with greater or less ease. The most popular uses for fixed condensers are as grid condensers wnere a capacity

of .00025 microfarads is best and as phone condensers, where anything from .0005 to .003 microfarads might be used.

Grid Leaks

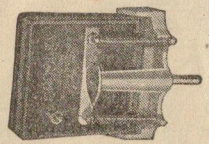
When a grid condenser is used on a detector tube, the operation will often be unstable and erratic, due to what is commonly known as "blocking" of the tube. This is apparent from symptoms such as sudden stoppage of the signal and if the finger is touched to the grid terminal of the detector tube socket operation will be resumed. To avoid this inconvenience, a grid leak may be mounted between the terminals of the grid condenser or from the grid to the positive filament connection of the vacuum tube socket. Grid leaks are made in cartridge form for easy mounting between clips and in other forms for panel mounting. They are built in resistance of from .2 to 10 megohms, 1 megohm being equal to a resistance of a million ohms.



Grid Condenser with Leak Mounted

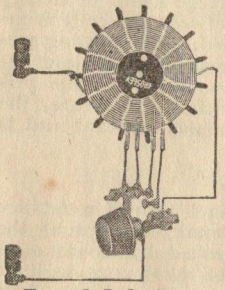
Variable Condenser

For tuning purposes it is necessary that a condenser having a continuously variable capacity be used. Variation in capacity can be obtained by changing the area of metal exposed or by changing the separation and material between plates. The interlocking plate air condenser consists of a number of spaced stationary plates and a number of similarly spaced rotating plates. As the plates are rotated so as to interlock without touching, the effective area of exposure is changed and with it the capacity of the condenser.


Crosley Model "D" Variable Condenser

The Crosley variable condenser consists of two moulded plates coated with a metallic foil. One is rigidly mounted to a die-cast frame with a piece of high-quality mica placed next to the foil. The other, is hinged where it touches the frame and may be moved to and from the stationary plate by means of a cam attached to a shaft. Connection is made to the foil by means of machine screws which also serve as binding posts. There is no danger of the plates touching so as to short-circuit the condenser because of the mica sheet between them. The capacity of this condenser is .0008 microfarads which corresponds to the ordinary 23 plate air condenser. This capacity is sufficient to give a wave-length range of from 200 to 600 meters when the condenser is connected across a suitable coil. When the frame is grounded there is positively no body capacity apparent and the hands may be taken away from the panel without detuning the set.

Inductances

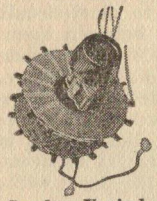

Tapped Inductance

Plain inductances may be either coils of wire wound in one layer on an insulated tube, honeycomb coils or flat lattice coils. Where a wide range of wave length is required, the inductance is tapped by bringing out a connection from an intermediate point or points to a switch. In this way, tuning can be accomplished by a combination of a condenser for the fine changes in wave length and a tapped inductance and switch for abrupt changes.

Coupled Inductances

It is often desired to transfer energy from one circuit to another without any metallic connection and for this purpose, a coupled inductance is used. The lines of magnetic force distribute themselves around a coil of wire carrying a current somewhat similar to the lines of force from a horse-shoe magnet, pictures of which are quite familiar. In radio, the lines of force follow this principle and when two coils are placed in close relation to each other, the lines of force of one are impressed on the winding of the other. This, in turn, induces current in the second coil. Now, if this second coil, here referred to as the secondary, is moved away from the first coil, the primary, this induced current will become smaller and smaller as the distance between the coils is increased, the reason for this being that the electro-

magnetic field of the primary reaches only a small distance from the coils exactly as in the case of the horseshoe magnet.



Crosley Varind

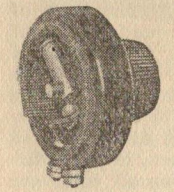
It is possible to accomplish this same effect by rotating one of the coils. When the two coils are so placed as to have their windings parallel, the induced current is at maximum. When one of the coils, usually the secondary, is rotated until its winding is at right angles to the other (primary) the induced current is at minimum.

Where two windings are placed in close relation, windings form a condenser and energy is transferred from one to the other. In many instances, this is objectionable as large losses in energy are introduced. As the distance between the coils is increased this loss is rapidly decreased. The rotating secondary type of vario-coupler cannot have the loss decreased as the secondary is not removed from the primary but rotated at various positions; therefore, the electro-static, or condenser loss remains constant and is not decreased.

Rheostats

The rheostat consists of a certain length of resistance wire and so constructed that a definite amount of the wire may be used. This is controlled by means of a switch lever. The purpose of this rheostat is to limit the amount of current to the vacuum tube to light it at proper operating point. In other words, a rheostat is like a valve in a water pipe which regulates the flow of water.

Multistat

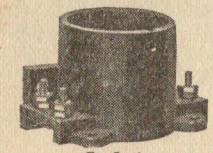


Multistat

With the introduction of the many new and various types of vacuum tubes, it became necessary to use either a different rheostat for each of these tubes or to provide some special device that would take care of any of them. The new Crosley Multistat was designed for this express purpose and makes possible the filament control of any tube now on the market. It contains a resistance element so graded that accuracy of control is possible, and at the same time sufficient resistance is available.

This rheostat should be adjusted so as to prevent the tube from burning too brilliantly, otherwise the life of the tube will be materially lowered.

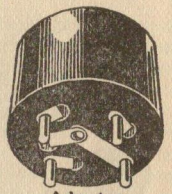
Sockets



Socket

Vacuum tubes are provided with connections in a special base and it is therefore necessary to use some form of receptacle or socket to hold them.

Some tubes do not have a standard base and to make their use possible in ordinary sets, an adapter must be used

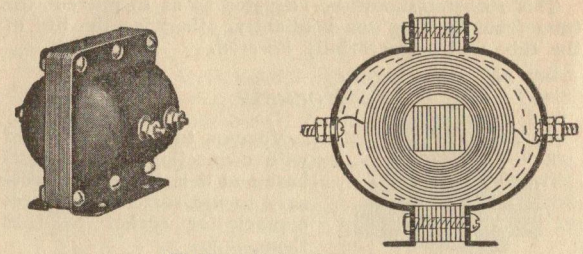


Adapter

Audio Frequency Transformers

For amplification at audio frequencies it is usually necessary to use an audio frequency transformer. These consist of many thousands of turns of fine insulated wire, layer wound, on an iron core and these layers separated by thin waxed or glassine paper. There are two separate coils, a primary which is connected in the plate circuit of the first vacuum tube and a secondary, which is connected in the grid circuit of the following tube.

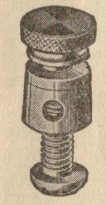
It is the function of this transformer to transfer energy from one tube to another as efficiently as possible and with the introduction of a minimum of distortion. There must be no particular notes to which the transformer is more or less responsive and no additional notes or harmonics should be introduced. The primary winding must be sufficiently large to carry the plate current of the vacuum tube to which it is connected and the terminals and insulation must be capable of withstanding the "B" battery voltage Since there is a magnetic action necessary with such a transformer, it is desirable to enclose the windings so that the magnetic field from them will not stray to other parts of the circuit. This is shown in the cross-section illustration of the sheltran.



Sheltran Audio Transformer

Binding Posts

The binding post is used for connecting the wires from the aerial, ground and the batteries.



Binding Post

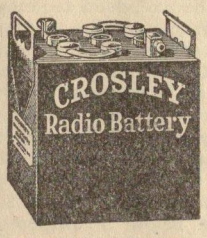
Binding posts are provided on receiving sets proper and their auxiliary apparatus for the purpose of making good electrical connections. There is a difference between a good mechanical and a good electrical connection in that the former may be made by firmly clamping an insulated wire in the binding post which could not be pulled out; that is, if a good mechanical connection has been made. Upon inspection it may be learned that the insulating covering of the wire had not been removed, therefore, no electrical contact existed between the wire and the binding post.

It is well known that electricity will not flow through an insulator, and it may be stated that a large part of the failures of radio equipment to operate successfully are due to the poor electrical contact between the various wires and other parts of the radio receiver. Where the external wires are to be secured in such places as the antenna, ground, phones and batteries, binding posts have been provided. DO NOT SLIGHT THIS PART OF YOUR INSTALLATION. Remove all traces of insulation from a wire at the connecting point with the binding post. Scrape the wire with the edge of a knife until bright, clean copper is exposed, insert the wire and clamp the cap portion down as tightly as possible. After this operation, shake the wires to insure that they are firmly secured.

Batteries

Every receiving set using a vacuum tube or tubes must have at least two batteries. One is used to light the filaments of the tubes and is called the "A" battery. The other is used in the plate circuit of the vacuum tubes and is called the "B" battery. With the introduction of some more modern and economical vacuum tubes, it has become necessary in some cases, to use a third or "C" battery. It is placed in the grid circuit of amplifier tubes.

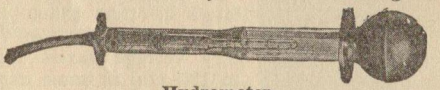
"A" Batteries



6-volt "A" Battery

An examination of the rating of vacuum tubes given in another part of this book, will show that the filament voltage and current required for different tubes is quite varied. Any vacuum tube that requires more than .25 amperes for the filament supply must be operated by means of a storage "A" battery. Storage batteries are rated for capacity in ampere hours, the actual value ranging from 80 to 120 ampere hours for radio use. It is necessary that storage batteries be recharged from time to time depending on the hours of operation of the set.

The storage or "A" battery, employed to light the filament, requires the same care as that employed in an automobile and the battery should never be permitted to stand discharged, otherwise, the battery may be ruined. That is, the battery should not be permitted to stand without recharging when its voltage falls below 5 volts with the filament turned on. If this voltage cannot be readily measured, a special instrument is obtained, called a "hydrometer," which is easily used to indicate the condition of the battery. After removing the three



Hydrometer

little black caps on the top of the battery, the end of the instrument is inserted in the battery and the solution sucked up into the glass portion of the hydro-

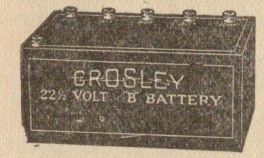
meter. When the battery is in good condition, the weighted glass float will sink to a point on the scale reading between 1300 and 1250. If the battery is in bad condition or discharged, the float will indicate a reading of approximately 1100, at which time the battery should be immediately recharged.

It is necessary that the plates of the battery be covered by solution at all times. If the solution falls to a point where the plates are exposed, water should be added in sufficient quantities to increase the level so as to cover the plates. In adding water, it is most important that distilled water be used at all times.

When the battery is moved, remember that the solution is easily spilled. Care should be exercised to keep the battery perfectly level when transporting. Never permit the battery to be turned on end. A rubber mat or some other protective material should be placed beneath it when in use as the acid will harm whatever it falls upon.

Some vacuum tubes require very little filament current and voltage. They have been so designed to be used with dry-cell "A" batteries. Ordinary No. 6 dry cells give fair service when used for currents below .25 amperes, and very efficient service below .1 amperes. Their voltage is 1.5 volts per cell and may be arranged in series to give higher voltages or in multiple to give heavier currents. The centre or carbon binding post is the positive (+) terminal and the outside or zinc binding post is the negative (—) post. The reason for the development of dry-cell "A" battery vacuum tubes is obvious because of the materially lower first cost. It is not advisable to try to use dry cells at more than .25 amperes per cell, because such operation will be more expensive in the long run than if a storage battery had been used.

"B" Batteries



"B" Battery

The current required from a "B" battery is not nearly as large as that taken from an "A" battery but the "B" battery voltage varies from 22½ to 120 and in some cases, even more. The most common form of "B" battery is made up in a 22½ volt unit, composed of 15 very small dry cells. It is possible to use a number of these batteries, connected in series to give 45 volts, 67½ volts, 90 volts, 112½ volts, etc. A good "B" battery will have a useful life of six months or more provided it has not been abused.

There are also on the market storage "B" batteries, usually assembled in 24 volt units. They require the same care, attention, and charging as storage "A" batteries but will operate for about four months on one charge.

"C" Batteries

Some tubes when used as amplifiers require a "C" battery of from 1.5 to 6 volts in the grid circuit. The negative terminal (—) of this battery is connected in the return lead from the amplifying transformer on the secondary side and its positive terminal (+) to the negative side of the "A" battery. "C" batteries are small units built up of the same size dry cell as used in "B" batteries but only four such cells are required to give the necessary 6 volts.

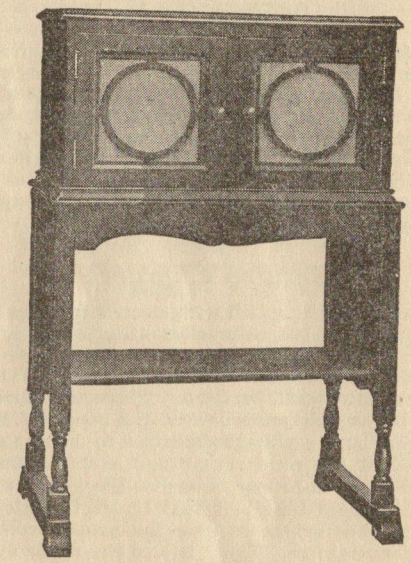
Battery Chargers

Most homes are supplied with electricity from the central station with 110 volts alternating current, usually at 60 cycles. In order that radio storage batteries may be charged from this current some form of rectifier and voltage reducer must be used. There are three main types of battery chargers now on the market. Mechanical chargers have a vibrating contact to make and break the circuit at the proper time and a step-down transformer to give the proper voltage. Electronic rectifiers, using the vacuum tube principal for rectification and a step-down transformer to give the proper voltage are built in various sizes. There is also the electrolytic rectifier which uses a chemical solution, in which two different metal plates are immersed for rectification and either a transformer or series resistance to control the voltage. A choice of any of these devices depends entirely on the preference and pocket-book of the customer.

Cabinets

Cabinets are used to give the receiving set a compact and beautiful appearance, although some radio fans have their apparatus on a board.

The tendency today is toward a self-contained table or floor style radio set. The new dry-cell "A" battery vacuum tubes make possible a cabinet of moderate size and pleasing appearance to hold the radio apparatus, necessary batteries and even the loud speaker. In addition a door or grating is often included so that when it is closed after the station is tuned, even the panel is hidden from view. Such a radio set may be finished so that it is an attractive addition to the furniture of the most handsome living room.



Self-contained Radio Set

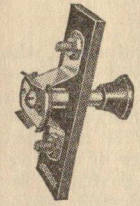
Panels

Radio apparatus is best mounted on some sort of panel with the dials and controls exposed and the apparatus hidden from view behind this panel.

The material used for radio panels is of utmost importance. There has been some tendency to a metal panel but the exacting conditions of insulation and the losses introduced sometimes prohibit its use. The most

common form of panel is one made of insulating material. There are on the market various such preparations and they all have their respective merits and limitations. Radio engineers agree that probably the best panel material is phenol fibre. It is not affected by temperature or moisture within the ordinary limits and is capable of a handsome grained satin finish and attractive engraving. Radio panels are made of solid moulded phenol compositions as well as rubber and even shellac derivatives.

Filament Switch



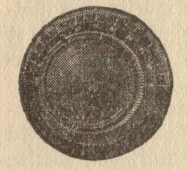
Filament Switch

A convenience which may be added to any receiving set and is often included in manufactured apparatus is the filament switch. It should be connected so as to cut-off both the "A" and "B" batteries when the set is not in operation, so that their life may be prolonged. It affords additional protection to the vacuum tubes. The tremendous advantage lies in the fact that after a station has "signed-off" the switch may be opened, and at any subsequent time, it is merely necessary to close the switch and the station will be heard immediately if it is in operation. The multistats need not be touched for the filament switch positively disconnects the vacuum tubes.

Telephone Jacks

When a loud speaker is used, it is ordinarily connected to the output of the second stage of audio frequency amplifier. Quite often, it is desired to use head phones during the tuning process, but it is not necessary to connect them to the full amplification. A telephone jack may be mounted so that when a plug attached to the terminals to the head phones is inserted in this jack, the head phones are connected to only one stage of amplifier. When the plug is removed, the loud speaker is automatically connected in its proper position.

Knob and Dial



Knob and Dial

Recently the tendency has widely been towards a knob and dial having a large diameter knob. The reason is obvious, when it is remembered that the average radio broadcast listener tunes his set with his fingers at the very outer edge of the ordinary knob. This practice is crude and has the additional disadvantage of undue wear and smear of the engraved graduation on the dial. New style knobs and dials have a knob almost as large as the dial itself and their advantage is apparent.

RECEIVERS

In the selection of suitable receiving equipment, the question is frequently asked: "How far will this particular set receive?" Many answers are proposed in reply to this question, but a large percentage of the answers are quite over-estimated. There is no fixed method for accurately determining the range of any receiver, as the conditions under which the device is installed and operated, are subject to such wide variations; in fact, the range of a fixed installation where all of the component parts of the set—all of the external equipment, such as antenna, ground, etc., remain unaltered, may vary several thousand per cent.

Realizing this condition and speaking from a practical operating standpoint, we may state that a sensitive crystal receiver, such as the Crosley Model I, when operated by an average person, will receive stations within a radius of about 25 miles. The single vacuum tube receiver, type V, which is a receiver employing the Armstrong regenerative principle manufactured under that license by The Crosley Radio Corporation, will receive from a distance of about 700 miles. These mileage figures, however, are used as an average for records have been received from users of such apparatus, which show that broadcasting stations have been heard from coast to coast with a single vacuum tube set.

Crystal Receivers

There are many types of receivers, but the principles involved are usually crystal or vacuum tube detection.

The crystal set, the simplest of receivers, depends upon the energy received from the air to operate it. The crystal proper, which is usually a piece of galena or silicon, rectifies the incoming waves so that their corresponding sounds are registered in the head set.

An incoming wave is picked up on the antenna after the antenna-ground circuit has been tuned to the particular station desired and goes through the crystal and back to the ground lead through the phones. In passing through the crystal, this energy is converted into energy of another type, as previously explained, which operates the head set, so that the incoming waves are converted into sound.

Vacuum Tube Receivers

The vacuum tube receiver not only depends upon the received energy, but also upon batteries attached to the receiver for its operation and performance. The same circuit used for crystal receiver may be used for vacuum tube receiver inserting the vacuum tube in the place of the cat-whisker and crystal. The action in such a set would be relatively the same as in the crystal set.

In the set mentioned above, where the tube displaces the crystal, the tube acts merely as a detector. By use of additional tubes, the set may be made to amplify as well as detect.

Regenerative Reception

When a vacuum tube is used as a detector, the result in plate current as explained in another chapter, consists of an audio-frequency pulsating current but in addition to this, there is an amplified radio-frequency current. This means, that the radio-frequency component current in the plate circuit of the tube is of greater strength than that originally picked up at the antenna.

If this amplified radio-frequency current is caused to flow through a coil which is inductively coupled to the antenna or grid circuit of the receiver and certain conditions are fulfilled, there will be induced in the grid circuit of the detector tube a second radio-frequency voltage the same as that which caused the original plate current to be present. In other words, the radio frequency is fed-back to the tube and consequently signals

will be increased in volume. This form of reception was patented by Edwin H. Armstrong in 1912 and is known as regenerative reception. There are licensed for use of this patent number 1113149, various manufactures throughout the country, one of whom is The Crosley Radio Corporation.

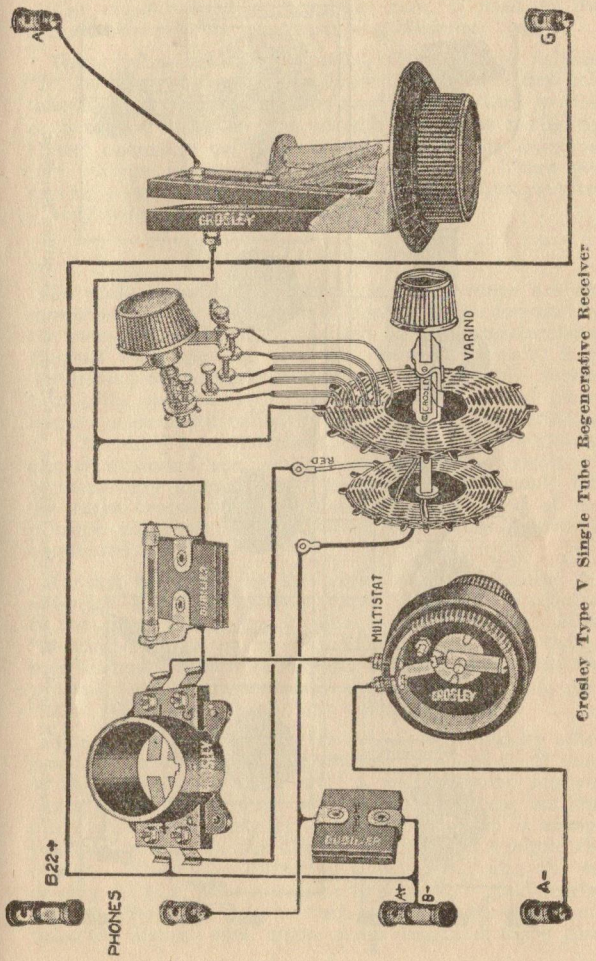
Radio Frequency Reception

For those desiring to reach out and pick up very distant stations, radio frequency amplification is recommended. This amplification is accomplished in some instances by especially designed fixed radio frequency transformers, effective only over a short band of wave lengths or by the tuned transformer type as used in the Crosley Radio Frequency Tuned Amplifier. The amplifier used in this type consists of an inductance, especially constructed, shunted by a variable condenser. It is connected as shown in the illustration of the Crosley Model VI.

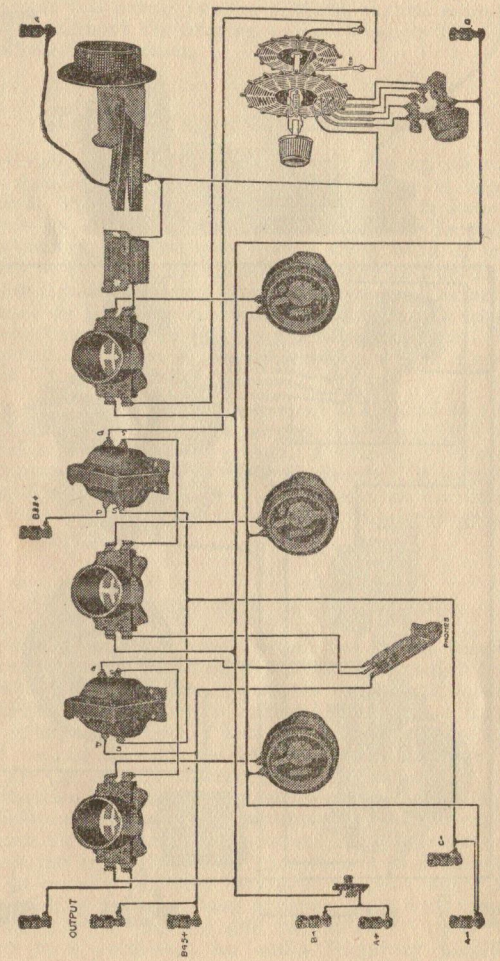
The term radio frequency current is applied to those currents oscillating at frequencies between 20,000 and several million cycles each second. Providing a telephone receiver would vibrate at radio frequencies, it would be impossible to hear the signals or music, as the human ear will not register signals having a frequency greater than about 2,200 cycles.

Audio Frequency Amplification

In audio frequency amplification the signals received from the detector are usually of sufficient strength to be heard only in head sets regardless of radio frequency amplification. In order to increase the signal so that it may be impressed upon a loud speaker or to make it of great volume through the head set, it is necessary to amplify the signals coming from the detector. This amplification is at audio frequencies and adds nothing to the distance from which a signal may be received except, to make the very faint signals audible. One step, including the audio frequency transformer and amplifier tube, is usually sufficient for users of head sets. For those wishing to use a loud speaker, it is necessary in practically every case to add two steps of audio frequency to a receiver. An audio frequency amplifier



Crosley Type V Single Tube Regenerative Receiver



Crosley 3B or 3C Regenerative Detector and Two-step Amplifier Receiver

merely increases the previously detected signal at approximately fifteen times per step, which includes an additional tube and transformer.

The regular hard or amplifier tube is used in the sockets shown in the accompanying diagram.

These tubes must be supplied with a plate voltage "B" battery of from 40 to 120 volts. If the dry cell tube is used, the same may be used for amplifier as well as detector, using on the amplifier possibly a slightly higher operating or "B" voltage than on the detector, this voltage reaching as high as 45 volts. There are several new types of this tube, however, which require a very wide range of operating voltage.

Radio Interference

In radio reception two forms of interference are encountered; one, an uncontrollable interference imposed by the elements and, another, caused by other transmitting stations than the one desired. In other words, it is like having a two-party telephone line with both parties calling the operator at the same time. The former interference, commonly called "static," cannot be controlled as it is caused by atmospheric conditions such as distant electrical storms, etc., while in the early days static interfered very seriously with the weak radio signals, but the large broadcasting stations, being operated at the present time, are so powerful that interference is eliminated.

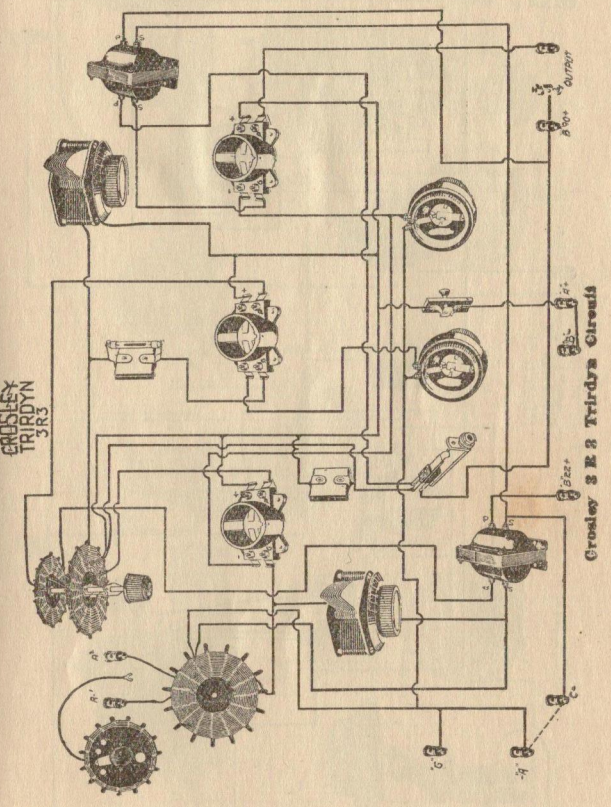
Do not be misled by the advice of those lacking familiarity with this subject where it might be offered, to the effect that a "trick" circuit or special method of "hooking-up" the parts, will eliminate static or that a new instrument will reduce its volume because at the present time no dependable apparatus has been perfected which will obviate this difficulty.

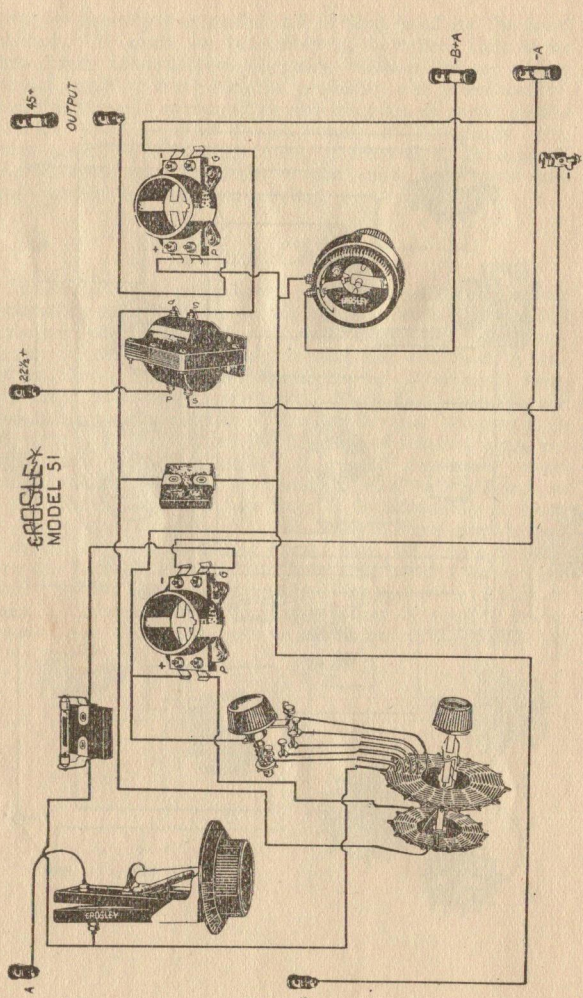
The second class of interference, that caused by other transmitting stations is not difficult to eliminate if none of the stations is a local one. A well designed receiver tunes sharply and since no two broadcasting stations operate simultaneously on the same wave, it is always possible to tune in the desired station and exclude the others. When a local station is operating and the receiving set is at least a mile or two away, a good receiving set should be able to tune a local station out and bring in distant ones whose wave length is more than

fifty or seventy-five meters off of that used by the local station. It must be remembered, however, that some broadcast transmitters illegally radiate on a rather broad band of wave lengths probably not intentionally, but due to local surrounding objects such as metal smoke stacks, towers, steel frame work of buildings, etc. This condition is rapidly being corrected by broadcasting stations with the help of the radio inspectors and government information service.

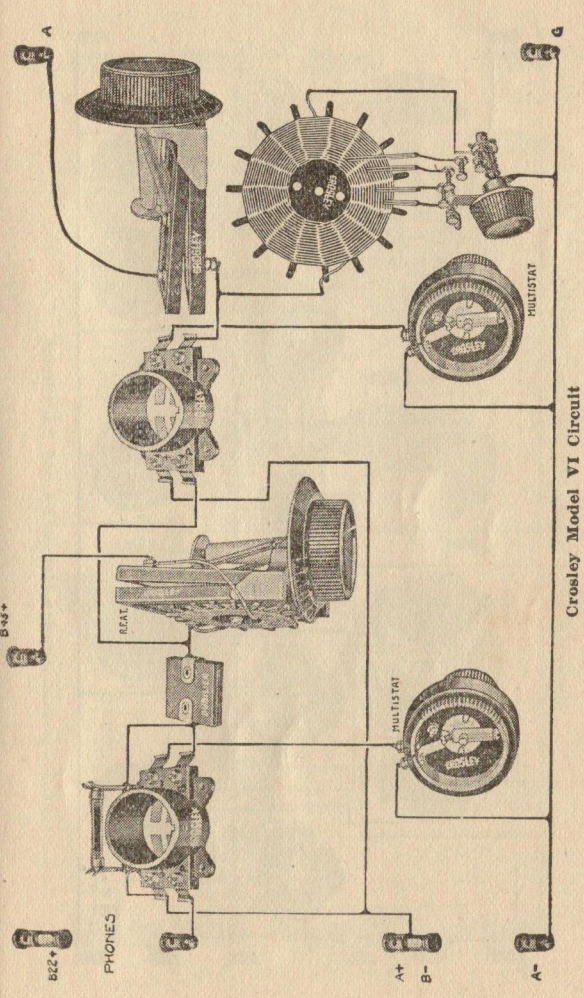
Freak Circuits

Various radio periodicals are continually publishing ostensibly new and marvelous radio circuits guaranteed as a sort of "cure-all" for all radio difficulties. In a majority of cases, when such circuits are analyzed by experts the circuits are found to be little more than standard hook-ups re-arranged. Such descrepancies are not altogether the fault of the publication because it is often very difficult to see the likeness of the two arrangements and with the limited time and personnel available, such things will slip through. Before wrecking an outfit that is already working, it is advisable to have someone who understands radio analyze the contemplated circuit. By this it is not meant that all freak circuits are worthless, for if this had been said several years ago, radio would never have reached the point to which it has now developed. Experimentation is always to be encouraged but it is best to purchase extra parts for such work.

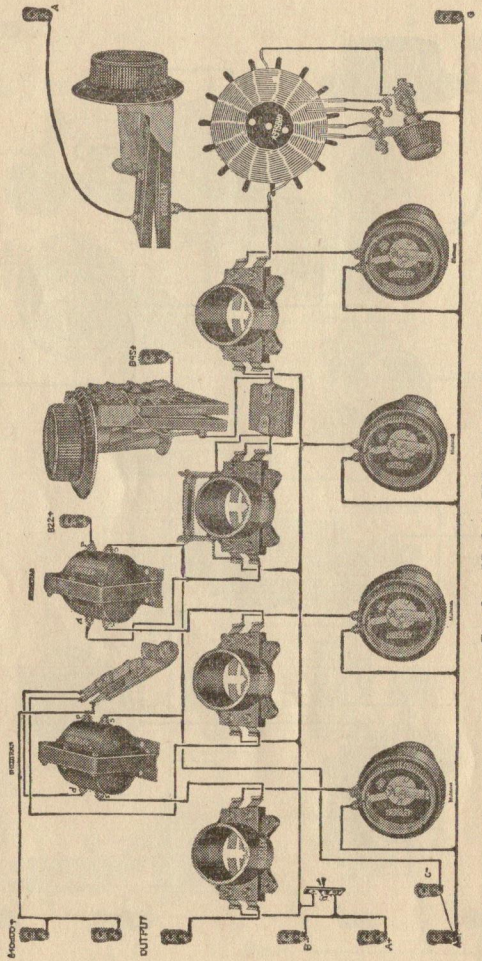




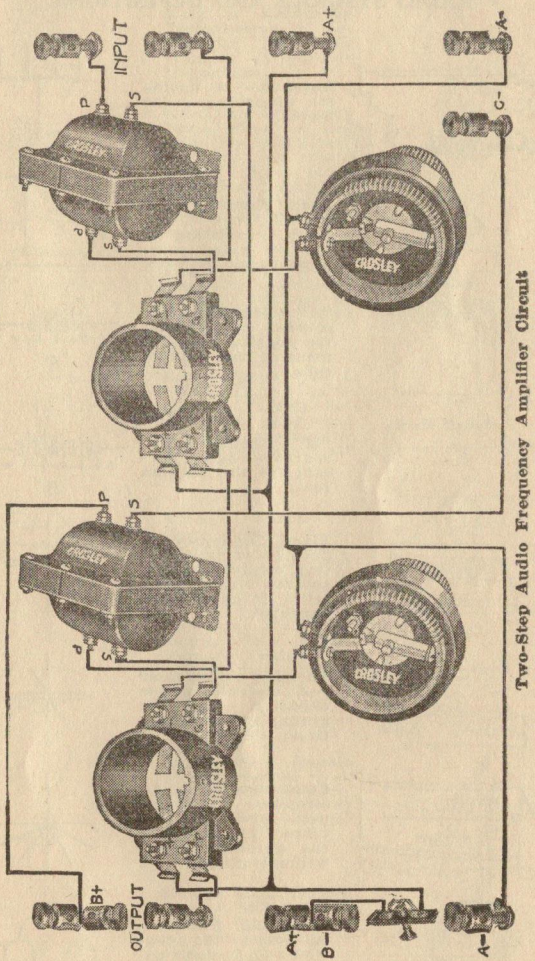
Crosley Model 51 Circuit



Crosley Model VI Circuit

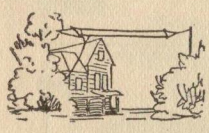


Crosley Models XJ and XL Circuit

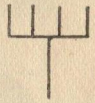


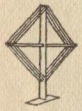
Two-Step Audio Frequency Amplifier Circuit

RADIO SYMBOLS AND DEFINITIONS

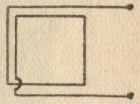


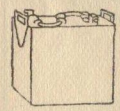
Antenna — A device for absorbing radio waves.



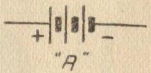


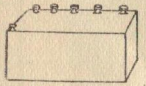
Loop Antenna — A special form of antenna, consisting of one or more complete turns of wire.



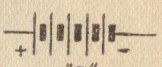


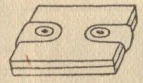
"A" Battery — The source of current for heating the filament of the vacuum tube.



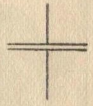


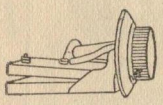
"B" Battery — The source of plate current for the vacuum tube.



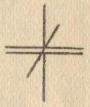


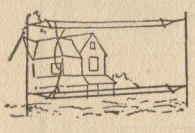
Fixed Condenser—A device consisting of two conductors, insulated from each other. It has a fixed capacity.





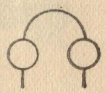
Variable Condenser —A condenser whose capacity may be gradually varied between limits.

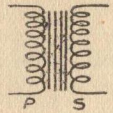




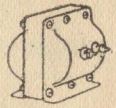
Counterpoise — An electrical conductor used with the antenna to complete the antenna circuit without ground.

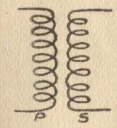
Receiving Phones— A device for converting electrical energy into sound.



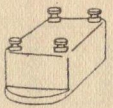


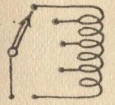
Audio Frequency Transformer—A device for increasing voltages at audible frequencies.



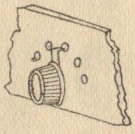


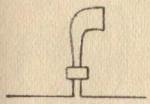
Radio Frequency Transformer—A device for inductively coupling the plate circuit of a radio frequency amplifying tube to the grid circuit of the next tube.



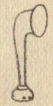


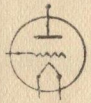
Tap Switch—A device for connecting various portions of the inductance into circuit.



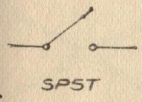


Loud Speaker — A device acting as a receiving phone but capable of producing a larger volume due to a resonant air column.

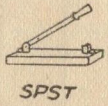


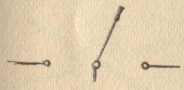


Vacuum Valve — A three element vacuum tube containing filament, grid and plate connection.

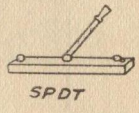


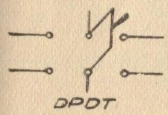
Single Pole Single Throw Switch — A device for opening or closing one circuit.



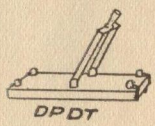


Single Pole Double Throw Switch — A device for connecting one circuit to either of two different points.

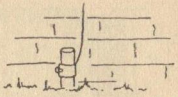


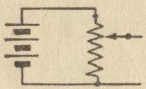


Double Pole Double Throw Switch — A device for connecting two circuits to either of two different points.

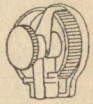


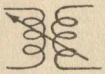
Ground—A metallic connection with moist conducting earth.



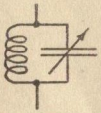


Potentiometer — A device for controlling the voltage on the tubes without changing the voltage source.

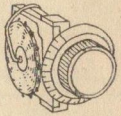


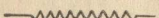


Variocoupler — A coupling inductance by which two circuits may be placed in a variable coupled relation to each other.

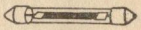


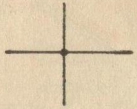
Tuned Radio Frequency Transformer—A device for changing the plate impedance of a radio frequency amplifying circuit.



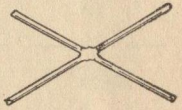


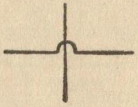
Grid Leak—A resistance of half a million ohms or more which is used to leak off grid charges of the detector tube.



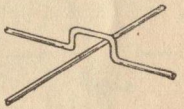


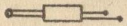
Connection — Two crossing wires making electrical connection.



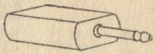


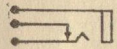
Non - Connection — Two crossing wires insulated electrically from each other.



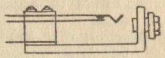


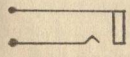
Phone Plug—A device for connecting receiving phones to a portion of circuit or to output instead of by means of binding posts.



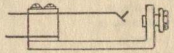


Phone Jack (closed circuit)—The receptacle for the phone plug and permanently connected in the circuit. The closed circuit jack is used to cut in the receiving phones some place ahead of the output.



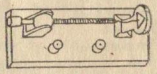


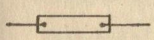
Phone Jack (output) — The output jack is used to make connections to the receiving phones through the phone plug.



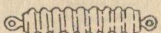
Binding Posts — A device for connecting external circuits to circuits within the apparatus.

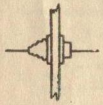
Crystal Detector — Used to rectify alternating current, i. e., to change radio frequency signals into signals to which the receiving phones respond.



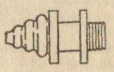


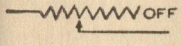
Insulator—A device which will not conduct electric currents.



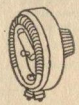


Leadin Bushing—An insulator carrying the conductor in the center. Usually used in carrying the antenna leadin through the roof or wall of a building.





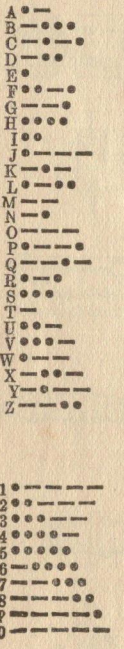
Rheostat—Used for controlling the temperature of the tube filament by cutting resistance in or out of the A battery circuit.



INTERNATIONAL MORSE CODE and CONVENTIONAL SIGNALS

To be used for all General Public Service Radio Communication

1. A dash is equal to three dots
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to five dots.



Period	·– ·– ·–
Semicolon	–·–·–·
Comma	··––··
Colon	–––···
Interrogation	··––··
Exclamation	–·–·––
Apostrophe	·––––·
Hyphen	–····–
Bar indicating fraction	–··–·
Parenthesis	–·––·–
Inverted comma	·–··–·
Underline	··––·–
Double dash	–···–
Distress Call	···–––···
Attention	–·–·–
General inquiry call	–·–·––·–
From (de)	–···
Go Ahead (Transmit)	–·–
Warning (high power)	––··––
Question (please repeat after)	··––··
Wait	·–···
Break (Bk) (double dash)	–···–
Understand	···–·
Error	·· ·· ·· ··
Received (O. K.)	·–·
Position report (to precede all position reports)	–·–·–
End of each message (cross)	·–·–·
Transmission finished (end of work)	···–·–

International Radio Telegraphic Convention

List of Abbreviations to be Used in Radio Communications

	Question	Answer or Notice
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is.....
QRB	What is your distance?	My distance is.....
QRC	What is your true bearing?	My true bearing is.....degrees.
QRD	Where are you bound for?	I am bound for.....
QRF	Where are you bound from?	I am bound from.....
QRG	What line do you belong to?	I belong to the.....Line.
QRH	What is your wave length in meters?	My wave length is.....meters.
QRJ	How many words have you to send?	I have.....words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20?. for adjustment?	I am receiving badly. Please send 20. for adjustment.
NMQ	Are you being interfered with?	I am being interfered with.
RRQ	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with.....) Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No.....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad?	The tone is bad.
QSB	Is my spark bad?	The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is.....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	.....	Transmission will be in series of 5 messages.
QSH	.....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for?	Collect.....
QSK	Is the last radiogram canceled?	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is.....degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with.....?)	I am in communication with..... (through.....)
QSP	Shall I inform.....that you are calling him?	Inform.....that I am calling him.
QSQ	Is.....calling me?	You are being called by.....
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at.....o'clock?	Will call when I have finished.
QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wave length of .....meters?	Let us change to the wave length of .....meters.
QSZ	.....	Send each word twice. I have difficulty in receiving you.
QTA	.....	Repeat the last radiogram.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

BROADCASTING STATIONS

Call Letter	Broadcasting Station	City and State	Wave Length	Kilo Cycles
CFCA	The Star	Toronto, Ont.	400	750
CFCN	W. W. Grant	Calgary, Alta.	440	682
CKAC	LaPresse	Montreal, Que.	430	697
KDKA	Westinghouse	Pittsburgh, Pa.	326	920
KFI	E. C. Anthony—Herald Examiner	Los Angeles, Cal.	496	640
KFKX	Westinghouse	Hastings, Neb.	286	1120
KGO	General Electric Co.	Oakland, Cal.	312	960
KGW	The Oregonian	Portland, Ore.	492	610
KHJ	Times-Mirror	Los Angeles, Cal.	395	760
KLZ	Reynolds Radio Co.	Denver, Cal.	360	833
KSD	Post-Dispatch	St Louis, Mo.	546	549
KYW	Westinghouse	Chicago, Ill.	536	560
NAA	U. S. Naval	Radio, Va.	435	690
PWX	Radio Corp. of Cuba	Havana, Cuba	400	750
WBZ	Westinghouse	Springfield, Mass.	337	890
WBAP	Star-Telegram	Fort Worth, Texas	476	630
WBAY	Amer. Tel. & Tel.	New York City	492	610
WCX	Free Press	Detroit, Mich.	517	580
WCAE	Kaufmann & Baer & Press	Pittsburgh, Pa.	462	649
WCAP	C. & P. Tel. & Tel. Co.	Washington, D. C.	469	640
WCBD	Zion	Zion, Ill.	345	870
WDAF	Star	Kansas City, Mo.	411	730
WDAP	Chicago Board of Trade	Chicago, Ill.	360	833
WDAR	Lit Bros.	Philadelphia, Pa.	395	760
WEAF	Amer. Tel. & Tel. Co.	New York City	492	610
WFAA	News & Journal	Dallas, Texas	476	630
WFAK	West. Radio Corp.	Denver, Col.	360	833
WFI	Strawbridge & Clothier	Philadelphia, Pa.	395	760
WGI	Amer. Research Corp.	Medford Hills, Mass.	360	833
WGN	Zenith-Edgewater Beach	Chicago, Ill.	370	811
WGR	Fed. Tel. & Tel. Co.	Buffalo, N. Y.	319	940
WGY	General Electric Co.	Schenectady, N. Y.	380	790
WHAS	Courier-Journal	Louisville, Ky.	400	750
WHAZ	Rennselaer Poltech Ins.	Troy, N. Y.	380	790
WHB	Sweeney School	Kansas City, Mo.	411	730
WHAM	Democrat & Chronicle	Rochester, N. Y.	360	833
WHX	Register-Tribune	Des Moines, Ia.	400	750
WIP	Gimbel Bros.	Philadelphia, Pa.	509	590
WJAX	Union Trust Co.	Cleveland, O.	390	769
WJAZ	Zenith-Edgewater Beach	Chicago, Ill.	448	670
WJY	Radio Corp. of America	New York City	405	740
WJZ	Radio Corp. of America	New York City	455	660
WKAQ	Radio Corp. of Porto Rico	San Juan, P R.	360	833
WLS	Sears-Roebuck	Chicago, Ill.	345	870
WLW	THE CROSLEY RADIO CORP.	Cincinnati, Ohio	423	709
WLAG	Cutting & Washington	Minneapolis, Minn.	417	720
WMAQ	Daily News	Chicago, Ill.	448	670
WMC	Commercial Appeal	Memphis, Tenn.	500	600
WOAI	So. Equip. Co.	San Antonio, Texas.	385	779
WOAW	Woodmen of World	Omaha, Neb.	527	570
WOC	Pal. School of Chiro.	Davenport, Ia.	484	620
WOO	Wanamaker Store	Philadelphia, Pa.	509	590
WOR	Bamberger	Newark, N. J.	405	740
WOS	State Bureau	Jefferson City, Mo.	441	680
WRC	Radio Corp. of America	Washington, D. C.	469	640
WSAI	U. S. Playing Card Co.	Cincinnati, Ohio	309	970
WSB	Journal	Atlanta, Ga.	429	700
WTAM	Willard	Cleveland, O.	390	769
WWJ	News	Detroit, Mich.	517	508