Radio Receivers

How To Operate

How To Make

Radio Digest
PROGRAMS
Illustrated
Reg. U. S. Pat. Off. and Dom. of Canada
CHICAGO, ILLINOIS

Radio Receivers

How to Make and Operate

PUBLISHED BY

Radio Digest
PROGRAMS
Illustrated

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Foreword

Three years ago the Radio industry was in its infancy. Today it ranks sixth among the greatest industries of our country. This wonderful growth in Radio is the Twentieth Century marvel. No longer is Radio considered a fad or novice. It is conceded to be a real necessity for the instruction, entertainment, enjoyment and betterment of the world.

Out of this wonderful development of Radio comes a very strong demand for a real authoritative reference book, written so as to be easily understood. This demand brings out this book called: "Radio Receivers—How to Operate and How to Make." This book, step by step, takes you through the theory and practice of Radio. It is an assemblage of facts and hints from actual everyday practice. It is compiled and edited by the technical staff of Radio Digest. It supplies the demand for a book covering every phase of Radio, from a simple explanation of Radio reception to a technical explanation of the different parts of the set, which leads to the best reception possible.

Should you desire to construct your own set, you will find this book invaluable. It gives hook-ups of the best reliable circuits, with full instructions as to how to build the set. It covers a wide range—from the simple single tube to the more complex nine tube. It also gives the necessary instruction for the better class of Crystal receivers, with complete diagrams. It gives a list of the parts required for each set, as well as the approximate cost. All of which makes it a most valuable Radio reference book from the standpoint of constructing sets.

Should you buy a manufactured set, you will find this book a necessary reference guide for your Radio table. It will give you instructions as to how to operate your set to receive the best possible results. It will tell you how to connect and give the proper care to your batteries. It will give you the necessary instruction regarding aerials and ground wires. In short, it will give you all the information necessary for the best possible results in Radio.

This book also gives you a complete list of all broadcasting stations in the country, with their location, call letters, wave length, name of owner and other valuable information. This is the most accurate list of stations that has ever been published. It also gives you a map showing the broadcasting stations, giving at a glance a visualization of how the Radio broadcasting stations are distributed.

In brief, the book covers Radio in as complete and thorough manner as the 122 pages will permit. It gives you Radio from A to Z and has been prepared solely from the standpoint of the Radiophan.

RADIO DIGEST PUBLISHING CO.
Chicago, Ill.

ALPHABETICAL INDEX BY SUBJECTS

Simple Explanation of Radio Reception

"What Is This They Call Radio?"—Chapter I

By P. E. Edelman

A RADIOCAST listener was showing his new set to a friend. "You see that light in the tube?" said he, turning up the filament rheostat importantly. A pause, and then—"It has to be that way."

Everybody knows that Radio is essentially a means of communication or carrying intelligence, and that Radiocasting stations near and far are collecting and sending out information, entertainment, music, sports, lectures, instructions, in fact anything which can be conveyed in interesting manner via sound waves which in turn are converted into and carried by Radio waves.

Anyone at reasonably small expense can install a receiving outfit to hear what is daily Radiocast. The most isolated farm house is as much favored as the big city apartment, and can have the same program at the same time. It is after the children's bedtime Radiocasts are over that most listening is done. The principal efforts of the Radiocasters are centered on the evening hours when the audiences are the largest. You tune in to hear the desired stations and have a veritable modern "Radio Night's Entertainment."

But after the first novelty of listening in has been digested, the Radiocast listener finds out other things. There are new stations to be heard, new kinks of operation to be learned, interferences to get rid of and repairs to be made. The first amazement at Radio achievements is followed by puzzles of variable range, performance, and faithfulness of reproduction. There is a set of Radio conversation terms one must know to understand a more experienced neighbor Radiocast listener, or to follow what the Radio publications are printing. No technical knowledge is required to enjoy Radio, but the usual Radiocast listener picks up a surprising amount of information.

In the first place, one finds that the main programs come from stations located in the centers of population, and that only what is transmitted by a Radiocast sender within the range of the receiving apparatus can be heard.

"What Is This They Call Radio?"

A LOGICAL question for every new fan is the above, but not alone will the new fan, but the Radiocast listener who has been interested one, two or three years, find much of interest in Mr. Edelman's explanations of the intricacies of the ether art. We learn by simple analogy and picture just what is meant by modulation, what Radio is, how programs are "put on the air," and what things are needed in order to hear these programs.

"Condensers are packages to hold electricity," says Mr. Edelman. And so on, through A.C., D.C., Magnetic fields, thermionics and electrons, his article will blaze the way to clearer understanding of the so-called mystery of Radio.

How Radiocasting Is Done

Such a Radiocast station is an establishment for converting sound waves to be carried and transmitted by Radio waves. It will have a studio with one or more rooms fitted with musical equipment, much as in an upper middle class home, except that drapery coverings or other means to stop sound echoes and outside noises are used. Also one or up to a dozen or more "pickups" are distributed advantageously to serve as an electrical ear for the air waves of the respective instruments or voices.

These pick-ups may be microphones, called "mikes," much like those that are used in the ordinary telephone transmitter, or various special forms which can convert air waves into a corresponding electrical pulsating current. The laboratory, or works, of the Radiocast station is usually housed in a separate room and has the apparatus for generating Radio waves; amplifiers to increase the electrical pulsations from the pick-ups and the modulators to cause this electrical pulsating current to mold the radiated Radio waves to correspond to the original sounds or air waves. A speaker, by the mechanism thus provided, may control a power of a horsepower or more in the form of radiating Radio waves, capable of eventually reaching a millon or more receiving outfits and listeners.

The operation of a typical Radiocast station is diagrammed in Figure 1. The main studio may have a branch or portable pick-up station, and jacks are provided for connecting in any or several pick-ups. Thus in churches, several pick-up mikes are used to get every detail of the services. Or again, a studio may receive a program Radiocast from another station and re-transmit the same with its own apparatus.

How Sounds Control Radio Waves

Following through an example, a lecturer at a branch of the studio is talking. As he talks, little

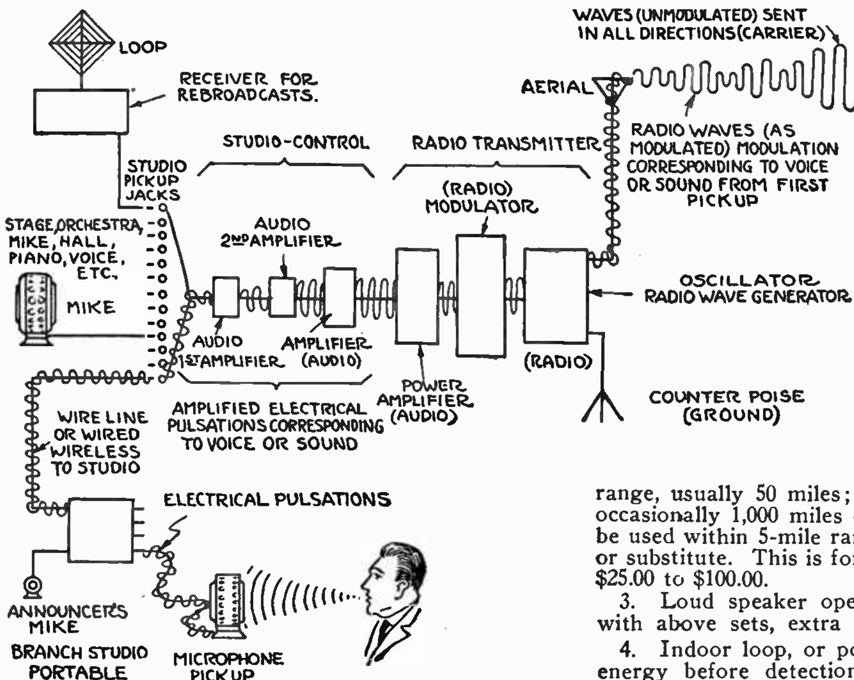

Figure 1

correspond with the electrical pulsations set up by the original sound to be Radiocast. Modulation means much the same as sculpturing, but instead of cut marble, the Radio waves are formed so as to carry the sound or voice waves. The Radio waves are sometimes called "carrier waves" and serve as a medium for conveying the original intelligence.

Now the Radiocast waves travel out in all directions from the sending station. In Figure 2, a section of the earth is pictured, illustrating how the Radio waves can spread out instantly. There is a conducting layer or upper stratum enveloping the earth which is also thought to have influence in reflecting the waves, which waves can be thought of as an expanding disturbance in space. The energy of the radiated waves becomes dissipated with distance, so that only a very small fraction of the original Radiocast energy reaches a receiving station or listening in appartus.

The thing to remember is that Radio is energy and that a Radiocast station sends out a small amount of energy much as the sun radiates light to the earth.

To receive the Radiocast, then, an apparatus is required to absorb a minute fraction of the original Radiocast Radio energy and convert it back into sound waves which can be heard through the receivers or loud speaker.

How Waves Are Received

Figure 3 shows the incoming Radio waves setting

another electrical current which is of the right size, or slow enough to be able to set up motion in a diaphragm. The detector is thus an electrical converter and the new form of electrical current continuing in the receiving outfit is termed an audio current, because it can cause a diaphragm to move and set up air waves in a suitable appartus.

Owing to the small amount of received energy, a receiving outfit usually needs an amplifier to build up the audio electrical currents to sufficient power to operate a loud speaker, and this is accomplished by supplying local energy from a battery which is merely controlled by the converted incoming energy. Finally the diaphragm of the loud speaker is set in motion and reproduces the original puffs of air so that they can be heard. The entire process thus comprises a series of energy conversions from one form to another and back again, much as one would change U. S. money into pounds sterling, then into lire, marks, etc., losing some at each change, or supplying new amounts to be influenced by the old.

Essentials for Receiving Apparatus

For receiving Radiocast programs then, one needs apparatus to intercept the radiated waves, means to tune to particular waves, a device to detect or change the received energy into a form which can operate a loud speaker or headset; also preferably an amplifier and a reproducing device or loud speaker. There are various forms of these devices and combinations.

Some standard types of receiving outfits are here listed:

1. Simple sets using crystal detector and outside aerial. These operate clearly with headset reproduction on Radiocasts from stations within a 25-mile range, occasionally much farther and, reliably up to four miles. Cost $5.00 to $20.00.

2. Simple sets using one vacuum tube detector and outside aerial. Reliable range, usually 50 miles; average up to 500 miles, and occasionally 1,000 miles or more. Most such sets can be used within 5-mile range reliably with indoor aerial or substitute. This is for earphone reproduction. Cost $25.00 to $100.00.

3. Loud speaker operates on two stage amplifier with above sets, extra cost, $30.00 to $100.00.

4. Indoor loop, or portable sets, amplifying Radio energy before detection; reliable range usually 100 miles, average up to 500 miles, and occasionally 1,000 or more miles. $100.00 to $300.00 in cost.

5. Furniture Radio and cabinet combinations, including speakers; reliable range usually 100 miles, average 500 miles, and occasionally 1,000 miles or more; $100 to $400 in cost.

In this grouping are included sets for operation close to local broadcasting stations and permitting cutting through locals.

The Radiocast listener usually gets much information on such outfits from trade advertising, catalogs and instruction sheets. There is a big difference between reliable and occasional range, as any vacuum tube set can at times reach several thousand miles when circumstances are favorable. Some are content to merely hear that a program is going on and decipher the call letters; others want clear reproduction, if only on locals.

Radio may be understood with reference to commonly known things in daily life because the complicated art is made up from understandable principles.

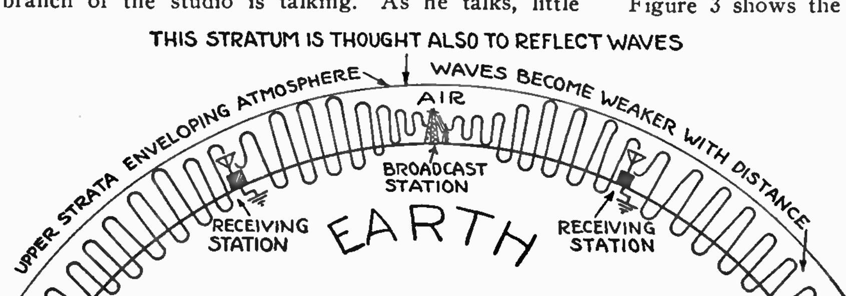

Figure 2

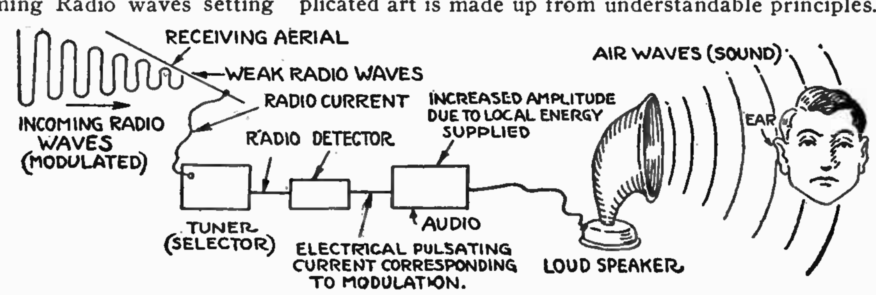

Figure 3

puffs of air or sound come from his mouth and are picked up by the microphone. This microphone has a diaphragm and device to change the air puffs of sound into electrical pulsations. The announcer has a separate "mike" to cut in. An ordinary telephone line, or possibly a wired wireless line, will bring these electrical pulsations into the studio of the Radiocast station. Here the studio control will amplify these electrical pulsations until they are strong enough to work a modulator.

When the Radiocast station is on the air, it has a Radio power unit or oscillator transmitting a continuous series of waves. The function of the modulator is to shape the intensity of these emitted waves to up a feeble Radio current in a receiving aerial. A tuner, or selector, is then used to offer an electrical path of the proper shape and size for the particular Radio waves. The Radio waves have a certain size and the Radio current in the aerial has a certain dimension, and the purpose of the tuner is to adjust a package of the corresponding form to hold this Radio current. After the Radio waves cut the receiving aerial, the received energy is an electrical current and the receiving apparatus now has to change this electrical current into sound waves. Neither the human ear nor a telephone receiver can be directly affected by the Radio current, so a device called a detector is used to change the Radio current into

The Sun is the original Radiocast station, sending waves recognizable as light and heat and comprising tremendous energy. Human beings take a small fraction of such heat energy, convert and control it in suitable form; then use a tiny amount of it to enjoy Radiocasting.

How does Radio fit in with other forms of energy? Heat is a motion in material and can be felt. Light is a much faster wave motion which can pass through space. Sound is a slow wave motion through the air or material, which can be heard. But nature has not provided a sixth sense to directly recognize Radio energy, and an artificial apparatus eye or ear must

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be used. Radio energy is a wave motion which can be considered as extremely long light waves.

Figure 4 illustrates a familiar source of artificial light. Light rays from the hot filament in the lamp pass through the space in the vacuum bulb and can be seen by the eye. Light is a commotion in space in regular wave forms recognized as the colors of the rainbow. There are some kinds of light which the eye does not see but which can be recorded on a photographic plate. The wave lengths of light are all extremely small compared to the greatly larger Radio wave lengths. Radio light or Radio energy travels at the rate of 186,000 miles per second. Referring to Figure 5, it is well known that light does not pass an opaque wall, while Radio goes right through. That is why Radiocasts go into a building or room.

Now, the longest light wave lengths are recognized as the dark reds, and if the eye could see still longer wave lengths, we could see Radio.

Difference of Radio and Sound

The difference between sound waves and light, or Radio waves is illustrated in Figure 6. An electric bell is put in an evacuated jar from which the air is pumped out. The eye can see the bell ringing but the ear cannot hear it, as sound does not pass through space but requires a material conveyor. Sound waves are also of such length that they cannot readily pass through thick walls.

As you talk, little undulations or puffs of air move out from your lips in an assortment of wave lengths governed by your vocal cords. These are recognized as sound because they are in the range which can sympathetically vibrate the ear drums.

Now, vibrations are regular series of waves, and are sometimes called oscillations. Instead of speaking of the distance between successive waves as the wave length, this is also expressed in terms of how many occur in a specified time. Thus, if there are sixty waves or pulsations in a second, the frequency is said to be sixty cycles.

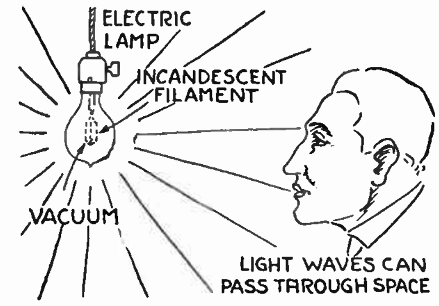

Figure 4

Cycles means how many waves occur in a given time; one second. In light, the waves are very short and since they travel at the rate of 186,000 miles per second, it is understood that there are very many billion of them vibrating each second, so the cycles are a high number. Light comprises an extremely high frequency.

In Figure 7, there are illustrated three widely separated frequencies one can fix in mind. The cycle of day to night, as the earth rotates, is very slow. A similar and much faster example would be the trip back and forth of the pendulum of a clock. The ordinary alternating current supply of a power line has sixty cycles per second. This is slow enough to be heard as a hum in apparatus such as power transformers. All such low frequencies are called audio frequencies if they can be heard.

A Radiocast station uses very high frequency energy, and for a 360-meter wave length this amounts closely to 833,000 cycles per second. In Radio, high frequency energy or vibrations as used in Radiocasting are above audibility and are called Radio frequencies.

Air is not required for the transmission of light or Radio but sound must have air or a material medium. Since sound controls the intensity of Radiocast Radio waves by means of suitable apparatus, the way this is done is important. The common range of audio frequencies is about 16 to 8,000 cycles, and varies according to the ears of individuals.

Heat waves are another form of energy which can be compared with Radio. A hot horseshoe taken from a blacksmith's forge, Figure 8, in cooling down from dull red goes through a range in which the particles of iron or molecules of which it is comprised go through a great commotion, which becomes slower and slower during the cooling. Heat waves are extremely short compared to Radio waves.

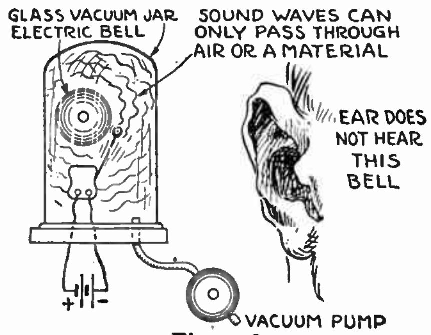

Figure 6

Frequency of Oscillation

Having seen that Radio is concerned with vibrations, it is well to fix in mind what is meant by oscillations. Figure 12 illustrates a clock pendulum 1, having an adjustable weight 2 which the clock-works keep in motion, swinging from 4 to 5 and back again. This pendulum like other material things has a natural rate of travel back and forth, and to change this the weight 2 is moved up if one wants the pendulum to travel faster or down for slower. One trip from position 4 to 5 and back again is one cycle, and the pendulum is said to oscillate or swing between positions 4 and 5. When the weight 2 is raised the length of the pendulum is shorter and the distance between 4 and 5 will be shorter. Now in the case of other oscillations such as Radio oscillations which occur at extremely high rate, an analogous procedure can be carried out to adjust the rate of vibration or oscillation. A further example to fix this point is furnished by a dinner gong or bell. When struck, the gong is set into audible oscillation. Essentially the transmitting aerial of a Radiocasting station is similarly struck electrically and set into high oscillation. Whereas the gong sets up corresponding motion in the surrounding air, the aerial so energized, sets up a similar, but inaudible motion in surrounding space.

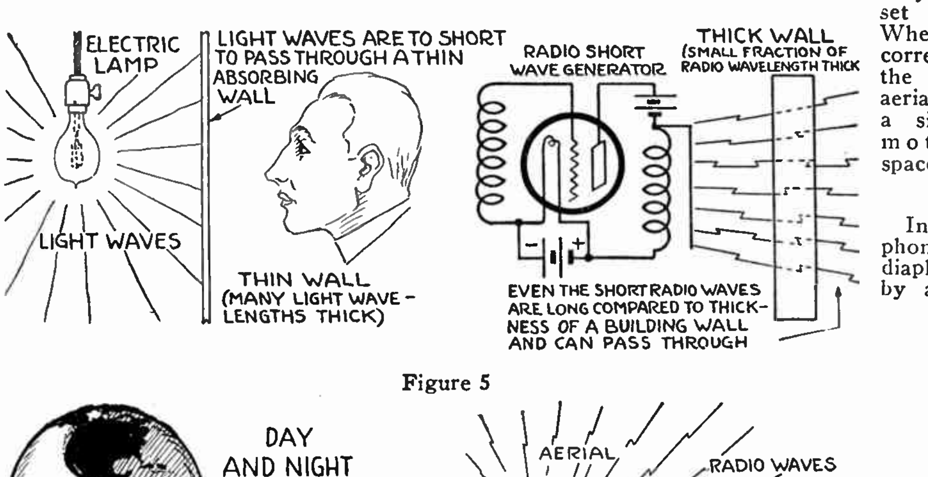

Figure 5

Audio Frequency

In Figure 9, a toy telephone line is shown. Two diaphragms are connected by a taut string. When air waves strike the diaphragm at the right, this diaphragm moves back and forth and pushes and pulls at the string so that the wave motion moves the diaphragm at the left, setting up similar air waves which may be heard. Or if a string is tied between two chairs, a hairpin hung at one end can demonstrate energy transmitted when a ruler strikes the string near the other end. The string can be arranged so that this is seen, or if very short and taut, the wave motion set up will be at a high enough rate to be heard. Audio frequencies are such as can be heard.

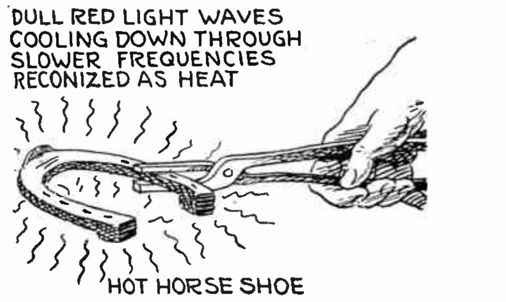

Figure 8

In Figure 11 a diaphragm is shown in circumstances 1 to 5. At 1 the diaphragm is at rest. A voice pushes air against one side of the diaphragm as shown by 2 and air on the other side is pushed out. As shown at 3, the diaphragm will flex back, and in moving in and out set up a series of waves recognizable as sound. Now if this diaphragm were a bell, provided that it could still send out the sound waves from the applied voice, it would also send out its own audio frequency. Diaphragms are accordingly constructed as far as possible to minimize their own natural frequency, so as to transmit the applied audio frequency.

How Sound Is Changed Into Electrical Pulsations

Electrically this is done in much the same way. The diaphragm is arranged to jostle some graphite grains held between two contacts. This device is called a microphone because the path it offers to a current of electricity varies according to the positions taken up by the graphite grains according to the vibrations of the controlling diaphragm. More or less electric current can thus pass the microphone according to the motion of the diaphragm. A battery connects the microphone with a receiver in which an electromagnet gets a variable current supply governed by this microphone. This electromagnet is then used to operate a reproducing diaphragm, so that the electrical means does what the string did in the example of Figure 9. For Radio, there is a substitute for the wire line, the Radio link between the Radiocast sender and receiver.

Radiocasting wave lengths are expressed in terms of meters. This means that the wave is the length stated, a meter being about 3.28 feet. Thus a 360 meter wave can be thought of as a wave about 1,150 feet long.

The Radiocast listener may regard the term "ether" as meaning space. In such sense, ether exists everywhere, surrounding the earth, in it, and in everything in it. Material things which appear solid in reality contain ether or space voids. Consider two bushel baskets, both said to be full, one containing carrots and the other sand. Obviously there are air spaces in the basket containing carrots. Though apparently full there are certainly voids or spaces and pockets of air in the basket containing sand. Going further, one can regard any material thing, as a piece of wire for example, as containing more or less ether or space. Dense materials have less ether voids in such a sense. It suffices here to regard ether or space as extending everywhere.

What Is Meant by Electrons

Explanations of Radio are based on the theory of electrons. The term electrons can be understood as meaning electricity in its smallest unit. Electrons are intimately related to material things and can be moved if proper force is applied. In Radio circuits they are

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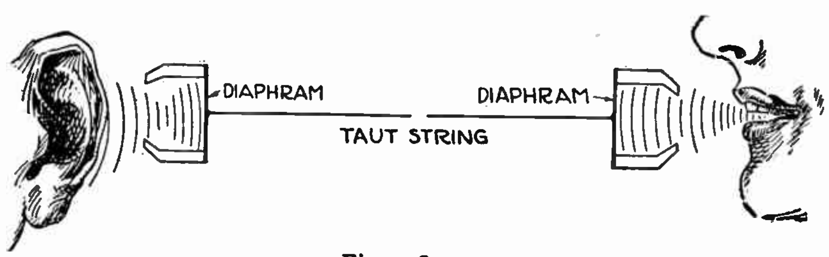


Figure 9

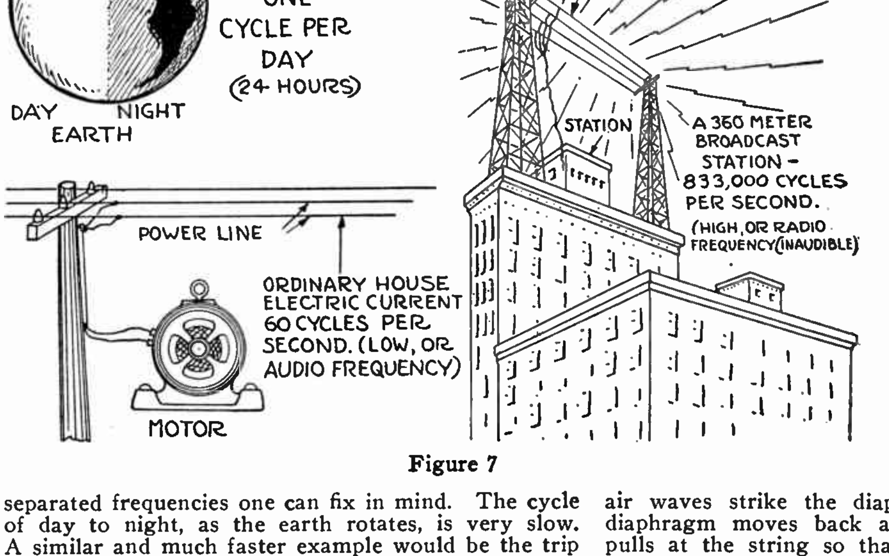


Figure 7

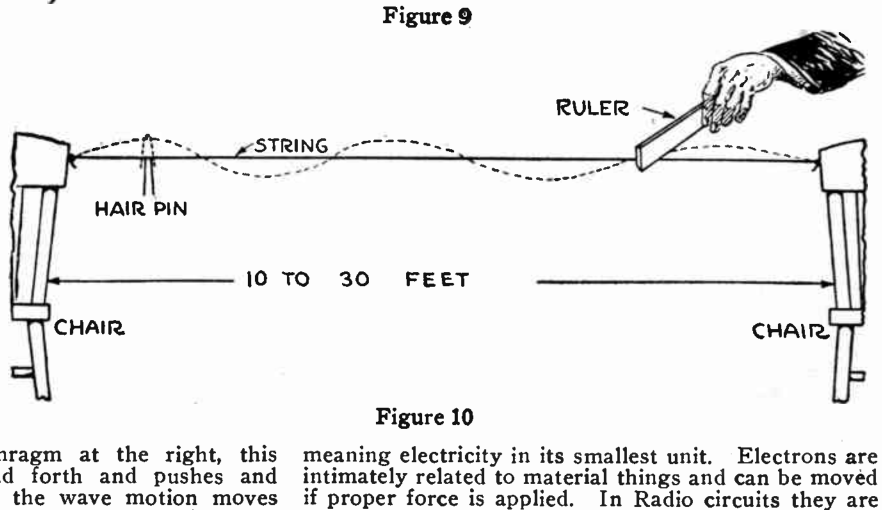


Figure 10

(Continued from preceding page)
moved rapidly back and forth and comprise Radio currents. The enormous number of electrons in even a thick piece of copper wire can be moved almost instantly at tremendous speed when such a driving force is applied.

If you have looked at a razor blade under a microscope, the supposed sharp edge would be seen as a series of rough flaked teeth. If there was an instrument so that one could look into a piece of copper vary some ten meters either way. Some stations give much attention to careful maintenance of radiated frequency.

Transmission in Brief

Radio, it will be recalled, is in a sense, another form of light. It would be possible to set up an oscillating circuit in back of a parabolic reflector, much like a searchlight. But for Radiocasting, an aerial is used. Transmission in all directions is here desirable.

electrical strain between the aerial and the earth, and during discharge, this strain would be thrown back again. At a slow rate, the charge applied would come back, and practically none of the space strain would be thrown outwards so that it could be picked up at any considerable distance.

How Radio Waves Are Set Up

But by increasing the rate of charge and discharge, such ether strains occur at high frequency, and it

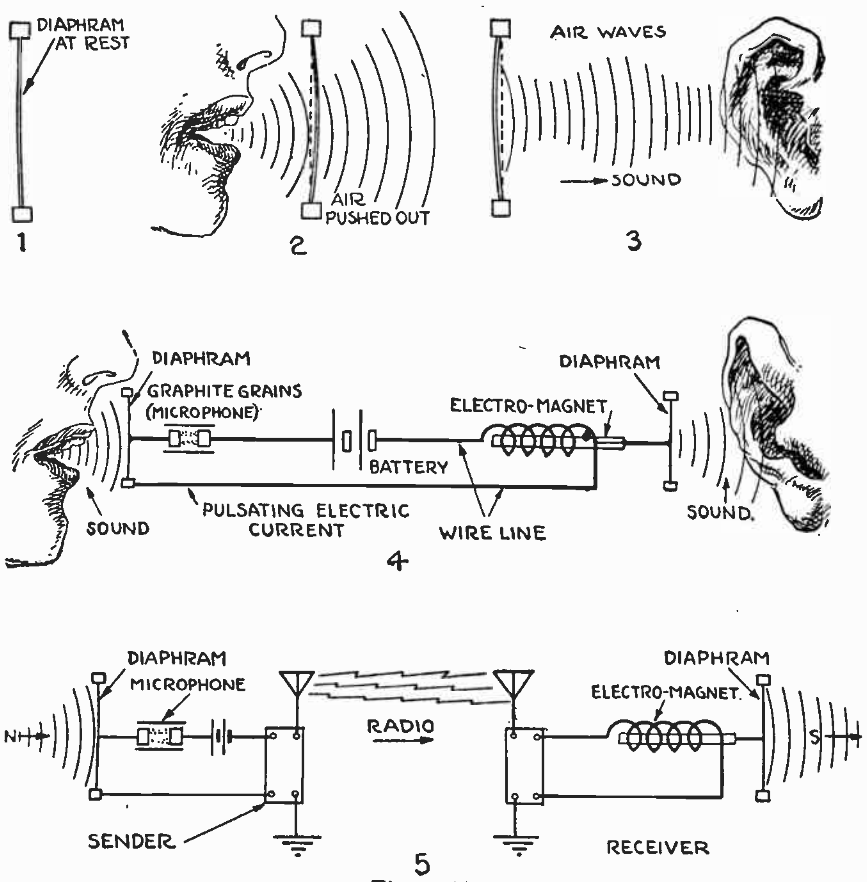


Figure 11

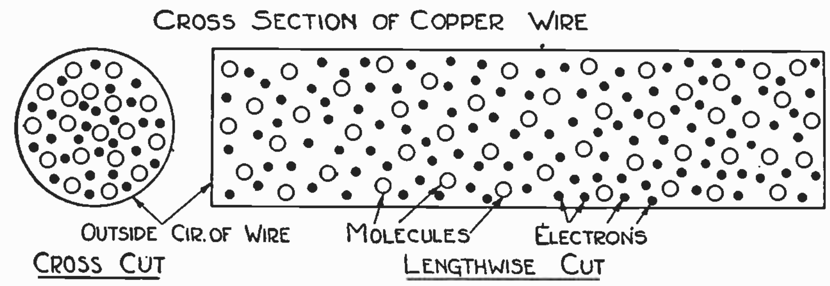


Figure 13

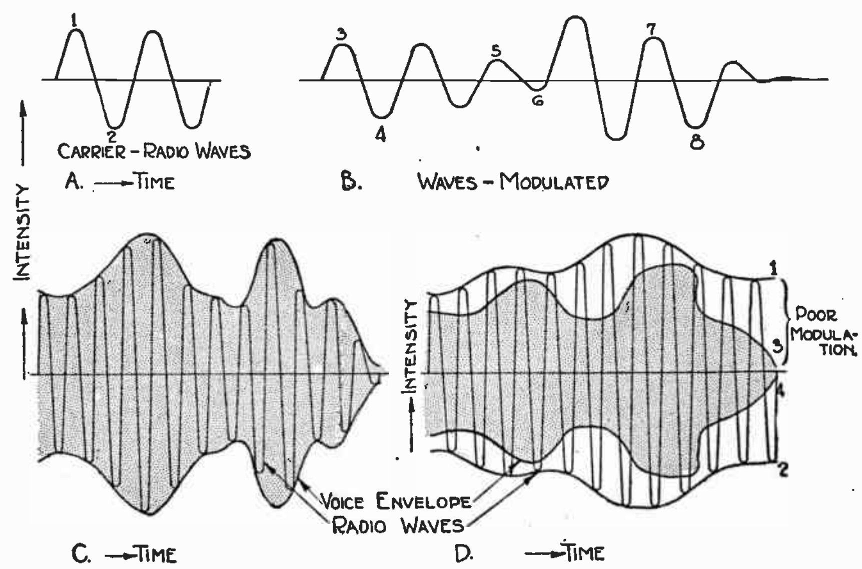


Figure 14

wire and recognize what was there, a crowd of material particles or molecules would be seen intermingled with electrons. If more electrons were poured into this wire the molecules would be moved about violently, and this motion is the same thing as heat. That is what happens when you use an electric toaster.

Electrons in a Wire

Take a look at Figure 13. The motion of electrons through the wire constitutes an electric current. If too much current is sent through the wire, the molecules are made to push out and the wire expands. The number of molecules and electrons present in any material varies according to the kind of material. It is difficult to comprehend how tiny an electron really is, by itself. Although the molecule just mentioned is the smallest physical particle unit, it is comprised of chemical units still smaller, called atoms. Some electrons attach themselves to atoms and govern the nature of the molecules formed, others are free to fly about in and near the molecule. The view is sometimes taken that all matter is made up of electric particles, of which electrons are the atoms of negative electricity. But the picture of Figure 13 is intended merely to fix the term "electrons" in mind. The important point here is that it requires force to move electrons as desired in Radio apparatus and that the motion is an electric current. Another thing is that the action of vacuum tubes depends on a certain type of electron flow.

The reason a listener is concerned with the Radiocasting is because it controls what is heard. If the modulation is poor a strong carrier may be recognized as a whistle but the voice may be scarcely recognizable. In Figure 14, Radio waves are pictured in the diagram.

Explaining Modulation

Modulation is important in Radiocasting. A well modulated small station is preferable to an incompletely or poorly modulated station of larger power. A Radio or carrier wave is represented by chart A, and has a certain frequency, as for example, 600,000 cycles. At B the same carrier wave is shown with the same frequency, but with intensity varied or modulated. At C a voice wave envelope is shown modulating a series of waves. At D poor modulation is illustrated. At the point in the voice envelope 3-4, the radiation is too much, as shown by 1-2. Many Radiocast stations now operating have good radiation, as their carrier waves can be picked up clearly at great distances, but the modulation is imperfect. The effect is that poor modulation is the same as a much weaker station with better modulation, and the quality is imperfect.

The main Radiocasting at the present time is carried on within a range of wave lengths amounting substantially to 300 to 550 meters, with a few lower. Some reradiocasts are conducted on about 100 meters. Seldom do the Radiocasting stations adhere strictly to the assigned or supposed wave lengths and in some cases a station stated to operate at 380 meters will

This aerial consists of a span of wires insulated from the earth. When the aerial is charged and discharged rapidly by high frequency alternating currents, electrical compressions are set up between it and the earth. This compression sends waves traveling outward in all directions, much like the waves from a stone thrown into water.

The alternating current used to charge the aerial must be of high frequency, and is termed "Radio frequency." For comparison, two common frequencies are here tabulated, with the corresponding wave length:

Wave Length	Frequency
300 meters	856,628 cycles
200 meters	1,499,100 cycles

The cycles are sometimes expressed in units of a thousand cycles, called "kilocycles." It is even possible to produce Radio wave lengths of only ten meters (frequency 29,982,000 cycles), and for labora-

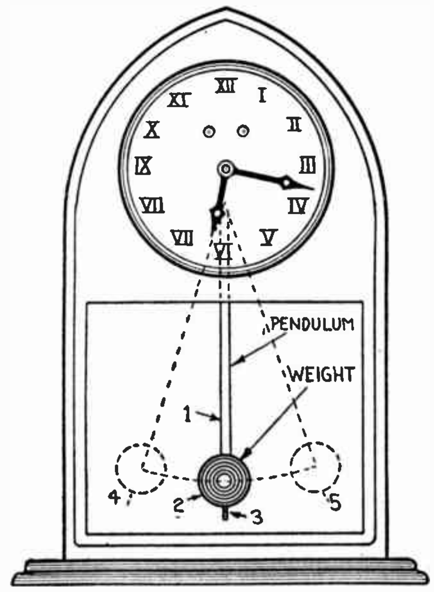


Figure 12

tory purposes, down to a fraction of one inch. But the higher powered stations all use the lower frequencies. Strictly speaking there is no sharp boundary between Radio frequencies and audio frequencies as the transcontinental high powered telegraph stations use frequencies as low as 10,000 cycles, closely within the range of human ears.

Suppose, for discussion, that only a low frequency 60 cycle alternating current was applied to an aerial. Then each time the aerial is charged, there is an

is impossible for any one of the strains to collapse before the current has discharged and is again building up. The new strain can then oppose and push off into space what is left of the first one that did not have time to collapse. This effect continues rapidly in a continuous series of ether or space compressions which travel outward as Radio waves with the speed of light, namely 186,000 miles per second.

These waves travel outward, losing amplitude as the energy becomes dissipated and absorbed. A very small part of the original energy reaches a receiving set, at the same frequency it was transmitted.

The high frequency is used then because it causes a large part of the applied energy to be thrown off from the aerial as Radio waves. The important point to remember is that each particular Radiocasting station radiates a particular frequency of Radio waves continuously while it is on the air, and that it is the sound waves to be transmitted which govern the modulation or intensity.

It is well established that transmission is better at night time than during the day, and that it varies from time to time, season to season, and in different localities. Thus transmission over water is usually better than over land. In the far south Radio is less reliable than in the middle north. In some mountainous districts or near mines, distant stations from certain directions can scarcely be heard, while others much farther away are very distinct. In cities, the Radio results an outfit can give will vary from one section to another. There are certain districts termed "dead spots" where reception is very difficult. The reason for variations is being studied slowly and is thought to be due to atmospheric and natural changes, changing reflections and refractions, location of clouds, or other particular causes.

Owing to variables, the operation of Radio or a particular outfit cannot be reliably predicted for a locality not previously tried. This is the basis for the distance claims made for tests under favorable circumstances and the opposite disappointment with poor results from the same equipment elsewhere.

Range of the Transmitter

The necessity for long wave lengths, where great distances are to be covered, such as in transoceanic communication, is due to the fact that absorption of energy is much less on long wave lengths than on short wave lengths. The nature of the intervening country between transmitting and receiving stations is an important factor with relation to the strength of the signal and the distances it can be received, the greatest distance for a given amount of power being obtained over water. Lofty buildings with steel frameworks, or a section of country containing ore deposits absorb a considerable amount of the signal strength and consequently restrict the range of the transmitter. Communication during the winter months may be carried on with less power and greater reliability, due to the absence of serious electrical atmospheric disturbances.

Simple Explanation of Radio Reception

"The Mystery Inside the Set"—Chapter II

By P. E. Edelman

THE FIRST thing noticed in most receiving sets is the coil or inductance which is used for tuning. Inductance coils are also used in amplifier transformers, headsets, and loudspeakers. Inductances serve important purposes in Radio. An inductance is like a springboard in that it can take up and throw back Radio energy.

Looking at Figure 15, an ordinary bar magnet is illustrated. A magnet, as is known, attracts or can pick up pieces of iron. One end of the magnet is called the north pole and the other the south. Invisible lines

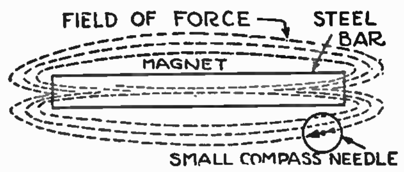


Figure 15

or a field of force extend from one pole of the magnet to the other. That this is so can be seen by moving a small pocket compass needle near the magnet, for this needle will be moved and pointed by the force of these magnetic lines or field. A magnet sets up a field of force.

Coils and Magnetism

From Figure 16 it will be seen that a coil of wire wound on a paper tube can serve as a magnet. Current

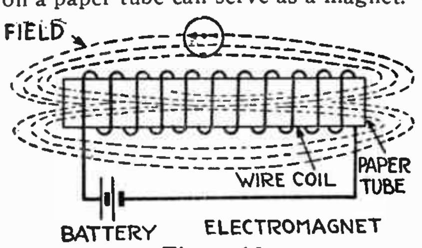


Figure 16

from a battery through such an air core coil makes the coil act much the same as the magnet of Figure 15. A field of force is set up in and around the coil, and is called an inductance.

Now if a current of electricity through a coil makes it act like a magnet, what would happen if a magnet were thrown through a coil of wire The reverse would occur and a momentary flow of current would be set up in the coil. Any time a magnetic field strikes through and cuts a coil of wire, a current is set up in the coil.

The various coupling coils, tuners, etc., used in Radio sets are often in the form of transformers, called couplers, variocouplers, etc. In Figure 17, transformer

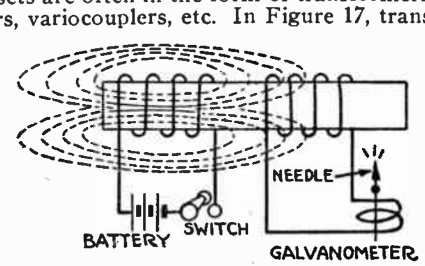


Figure 17

action is shown. Suppose a second coil 2 is brought near coil 1, as illustrated in Figure 16. Then if a current from a battery is thrown through coil 1, a magnetic field of force is set up in and around it. Part of this field of coil 1 will, however, extend through and cut coil 2, thus setting up a current in coil 2. The current in coil 2 will be set up according to the current set up in coil 1. If the battery current were sent through coil 1 in the opposite direction, a similar change of direction of the current set up or

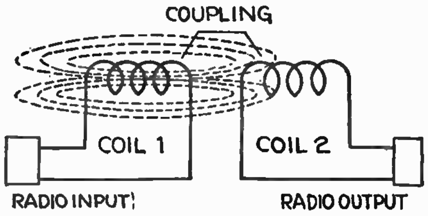


Figure 18

induced in coil 2 would occur. A galvanometer may be used to show this and comprises a coil of wire whose field can influence a small compass needle The induced current in the coil sets up a field and moves the needle.

The term coupling means in a sense the connection between two coils by a magnetic field of force. Though the two coils are electrically insulated, the field of force from one can cut the other, to induce a current in the second coil. The amount of coupling will be a maximum when the two coils are as close together as possible, and a minimum when they are widely separated or at right angles. This is shown in Figures 18 and 19. In Figure 19, two coils at right angles to each other have very small coupling so that only

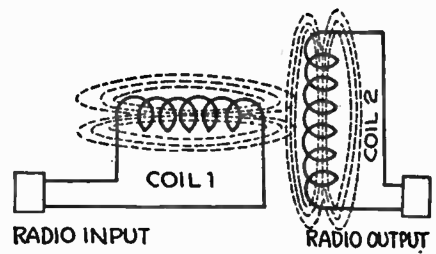


Figure 19

a weak or negligible current is set up in the second coil by current through the first one.

Transformer Action

The ratio of turns of the two coils may also be varied to affect the coupling, but usually this is done to change the ratio of the induced current and voltage. If coil 1 carries a changing current of one ampere

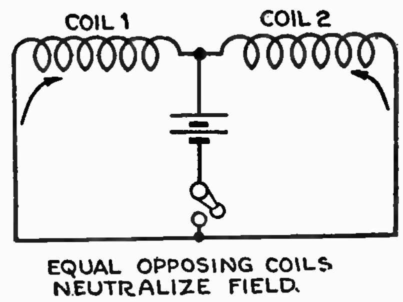


Figure 20

and ten volts and has 100 turns of wire, and coil 2 has the same dimensions, a current of one ampere, and ten volts will be induced in it when the coupling is close. But if the second coil contained 200 turns, the current would be one-half ampere with twenty volts. In all cases, a steady direct current through one coil will not set up a current in the second coil. The current is always changing. A changing current sets up a changing magnetic field. If this change amounts to a full reversal from one direction to another, it is called an alternating current. An al-

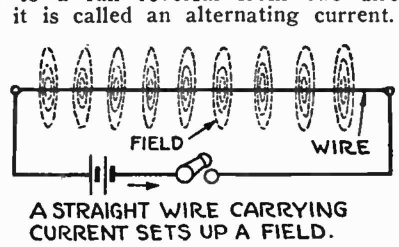


Figure 21

ternating current or even a fluctuating current will set up a corresponding alternating or fluctuating field of force and can induce a similar current in a second coil which is coupled to it.

If the input is Radio current, the output from the second coil will be Radio current of the same frequency. If voice current is sent through one coil, the second coil coupled to it repeats voice current.

If two coupled coils are each supplied with the same current as illustrated in Figure 20, the field of one will oppose the field of the other, and this can be arranged so that one field neutralizes the other.

A wire acts like a coil and has inductance.

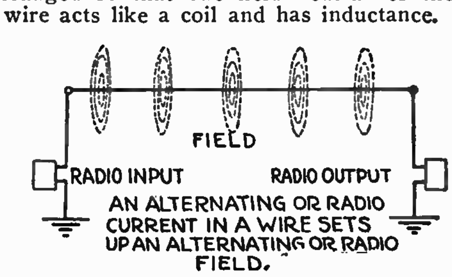


Figure 22

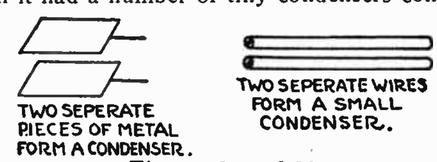
Inductance so far has been mentioned as in a coil. But a straight wire also has inductance. The longer the wire the more inductance it has, so you will see that in a sense inductance is a length dimension. When current is sent through a wire as illustrated in Figure 21, a circular field of force is set up around the wire. If a fluctuating or alternating current supply is used, a similar field is set up. The distance at which such a field can be detected depends on the power used. The field set up by an ordinary low frequency power line can be detected vigorously up to say 100 feet from the wire, but if the wire were carrying high or Radio frequency current, the field set up would be detected much further.

If a Radio current, Figure 22, is carried by a wire, a rapid Radio field is set up around the wire. If the wire is arranged as an aerial, part of this field will be thrown off as waves.

Inductance is practically never found without a condenser effect termed capacity. Two pieces of metal separated, form a condenser, as illustrated by Figure 23. These two pieces of metal could be two wires as in Figure 24. The two wires might even be two successive turns of a coil, to form a very tiny condenser. Any such condenser acts as a temporary storage package or little tank for electrons.

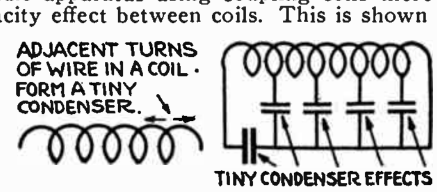
Condenser Effects in Coils

A coil, as in Figure 26, acts at Radio frequencies as though it had a number of tiny condensers connected.



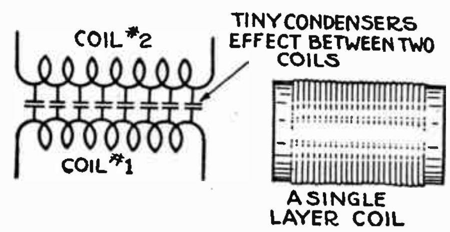
Figures 23 and 24

This is spoken of as the capacity effect of the coil. In Radio apparatus using coupling coils there is also a capacity effect between coils. This is shown in Figure 27. For instance, there is a marked capacity effect between the primary and secondary windings of most transformers used in Radio sets.

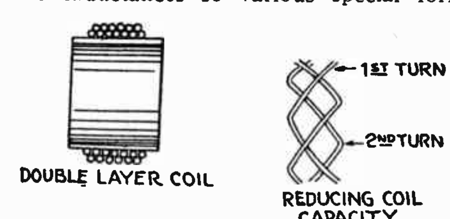


Figures 25 and 26

The single layer coil, Figure 28, is popular in Radio receivers because it is simple to make. It has a very small capacity effect. When two or more layers are wound, Figure 29, there is a large jump in the capacity effect. Capacity effects are usually not wanted in Radio inductances so various special forms are



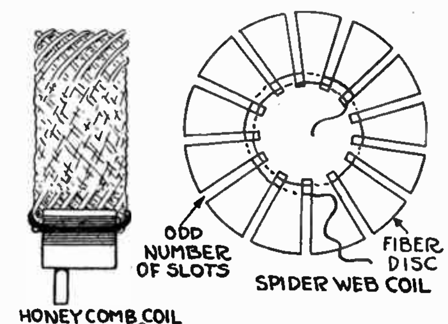
Figures 27 and 28



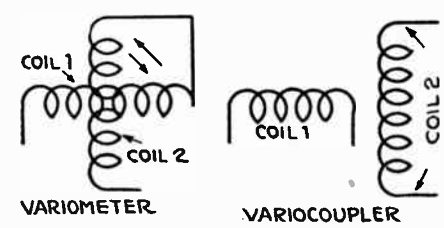
Figures 29 and 30

made to reduce capacity. Thus, Figure 30, one turn is wound on so that it will not be in direct contact with the next turn. There are various windings called honeycomb, basket ball, sine, curkoid, etc., designed to minimize capacity effects.

Figure 31 shows a honeycomb coil. A similar coil called D. L. or duo-lateral, alternates the spacing of successive layers. An easily constructed coil is the spiderweb, Figure 32. It is wound on a disc with an



Figures 31 and 32



Figures 33 and 34

odd number of slots. Successive turns come on opposite side of the disc.

Variometer and Variocoupler

A variometer is a name for two coupled coils which are connected together. The inductance is varied by

(Continued on next page)

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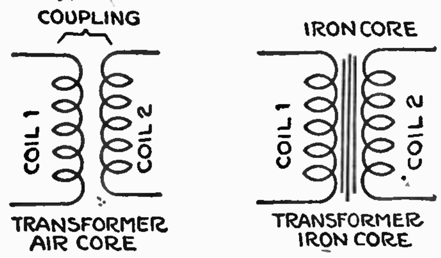
turning one coil with respect to the other so that the fields of each coil aid or oppose. Variometers find much use in so-called regenerative sets which require a variable inductance. A variocoupler is much the same but has the two windings separate for use in different circuits. Such circuits are said to be coupled magnetically, and dials are arranged to adjust the posi-



Figures 35 and 36

iton of one coil with respect to another. A split variometer is simply one in which a tap is taken out between the two coils or the coils used separately.

The coupled coils, Figure 35, form an air core transformer. Such transformers are used for connecting Radio amplifiers. The coupling is said to be close or tight if the two coils are close together, and loose or weak if the fields of the two coils are much separated. Transformers for audio frequency currents usually are wound on iron cores. This is done to increase the inductance as the presence of iron in-

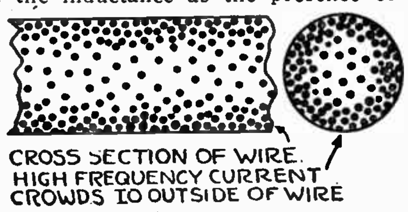


Figure 37

creases the magnetic field concentration set up by the current in the windings. This increase is very considerable. In order that the iron itself may not act as a coil of wire and absorb current by induction, the iron used is made up in thin sheets or laminations which are cut as little as possible by the field, and alloys such as silicon steel are much employed to further reduce the current which can be set up in the core itself. In Radio transformers, powdered iron or tissue thin sheets must be used if iron is to have any effect at Radio frequencies, as desired.

High Frequency Current on a Wire

Whereas direct or low frequency current goes through a wire by pushing the electrons instantly, a high or Radio frequency current does not go through the whole wire but only the outside shell of it. As

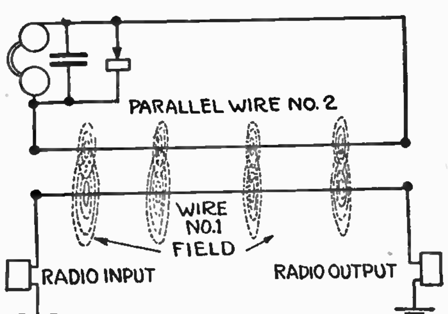


Figure 38

fast as the high frequency starts through the wire it is pushed out again, so must flow at the surface layer. This is clearly shown in Figure 37.

Parallel wires act much like coupled coils, in that a current in one wire, Figure 38, sets up a current in the other. Sometimes nearby electric wires induce steady or momentary interference or transient currents in Radio apparatus, and that is why listeners can hear power line hum, signal buzzers, elevators, motors, etc., in some localities. When the two wires cross at right angles as in Figure 39, the effect is minimized and that is why it is well to locate an aerial on this principle where possible, in a locality where a nearby power line may induce such current on an adjacent aerial wire.

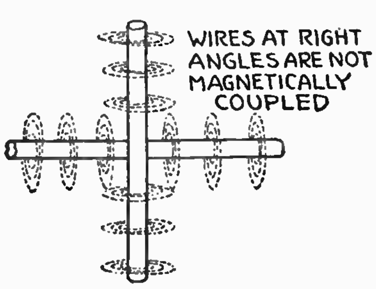


Figure 39

If a coil can induce current in another coil near it, it is reasonable to expect that a coil can in a sense induce current in itself. In circuits, a single inductance coil often has such an effect, which is called "self inductance." In such cases a coil is used as an impedance for temporary storage of Radio energy much as one stores mechanical energy in a clockspring. When the current goes through the coil, a field is set up, but when the field collapses back on reversal of the current, a counter current is sent back on the coil.

The practical unit used to express values of inductances in Radio, is the microhenry, or MH.

Receiving Sets and Condensers

Every receiving set contains one or more condensers. A condenser is a capacity or device for temporarily

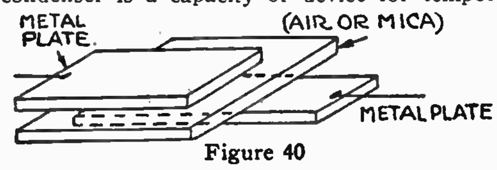
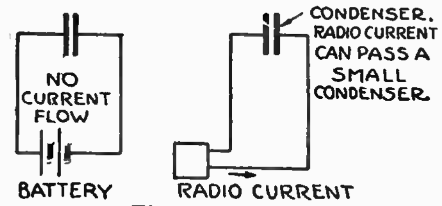


Figure 40

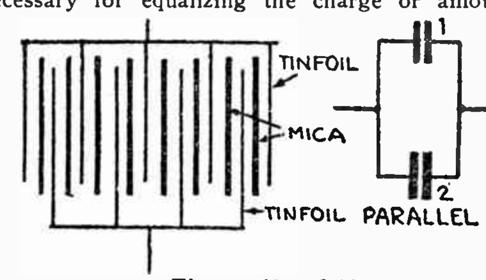
holding electricity. A large condenser holds a big quantity of electrons much as a gallon jar holds water. A tiny condenser can only hold a small amount of electrons, corresponding, for example, to a thimble full of water.

Figure 40 illustrates how any two conducting surfaces separated by a dielectric, form a condenser. The dielectric means the insulator between the metal plates, such as air or mica. When an electric charge is applied, a bunch of electrons rush onto the plate and set up a strain in the dielectric between the two plates.



Figures 41 and 42

One plate is said to become negatively and the other positively charged, which means simply that there is more electricity on one plate than on the other. Both plates want to be discharged or have an equal quantity of electrons, and to do this electrons must be moved, constituting a current. Starting without unequally charged plates, if electrons are added to one plate, it is said to be charged and the other plate has an equally opposite ability to take away this extra charge. This ability to take away the charge from the other plate is called a positive charge. The dielectric is an insulator and prevents the electron flow necessary for equalizing the charge or amount of



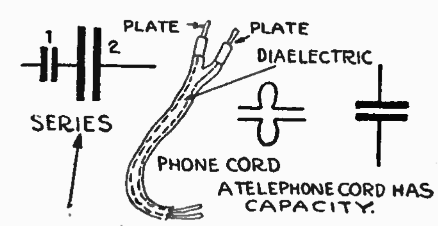
Figures 43 and 44

electrons on each plate. This is then accomplished externally by connecting a suitable circuit around the condenser plates.

Charging a Condenser

If a battery is connected to a condenser, it is charged to the same voltage as the battery can give, but no current can flow through the condenser. If alternating or Radio current is applied to a condenser, it can, however, pass right through. The condenser charges first in one direction and then reversely, following the alternating supply current, thus acting as a temporary reservoir to take and give back electrons in large quantities. This is diagrammed in Figures 41 and 42.

Instead of one plate for each side of a condenser



Figures 45 and 46

there can be a group sandwiched in between insulating dielectric material, as illustrated by Figure 43. Each group acts as one plate.

Two condensers can be connected to make one larger or one smaller condenser. The parallel con-

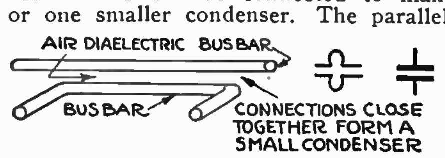


Figure 47

nection to give a larger condenser effect is shown in Figure 44, and the capacities of the two condensers

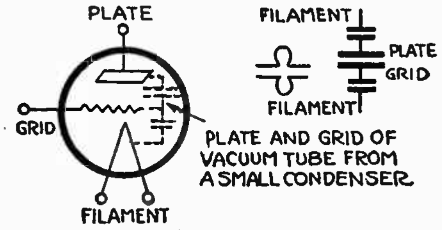


Figure 48

simply add together. In the series connection, Figure 45, the combined capacity is always less than the capacity of the smallest individual condenser alone.

The two wires in a telephone cord such as is used in Radio receiving sets form a considerable capacity, as illustrated in Figure 46. So do two close parallel busbar connecting wires form a tiny Radio condenser, as in Figure 47. Sometimes such tiny condensers can pass considerable Radio frequency current.

Another small condenser is naturally formed in the vacuum tube used in a receiving set, as illustrated in Figure 48.

Different Types of Condensers

The main types of condensers used in Radio sets are, firstly, those using an air dielectric and usually

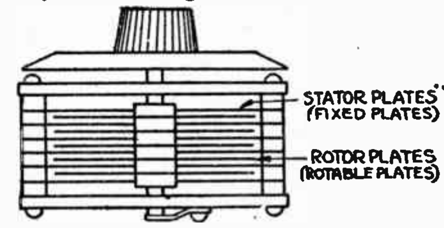


Figure 49

variable or adjustable as to capacity size, and, secondly, those using mica or some other solid dielectric material. The later are more compact and can be fixed or adjustable. Air is the unit in measurement of dielectric capacity, and other insulators, as mica, have a much larger dielectric constant. Thus for the same dimensions mica can hold a greater dielectric strain than air. Some materials, as paper, are not good

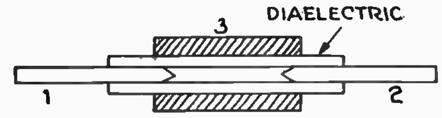


Figure 50

dielectric because they absorb and dissipate energy. Figure 49 diagrams the popular type of plate variable condenser and Figure 50 shows one of the smallest.

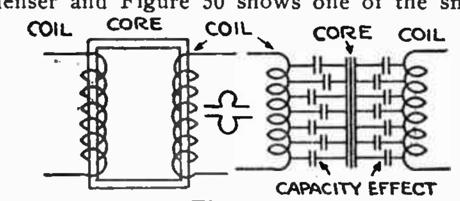
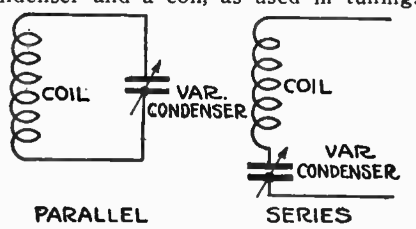


Figure 51

The windings of an ordinary audio frequency transformer have considerable capacity of condensers in and between the windings, as illustrated in Figure 51.

Combinations of Condensers and Coils

Figures 52 and 53 show the two principal connections of a condenser and a coil, as used in tuning. Such



Figures 52 and 53

combinations become adjustable packages to fit certain frequencies. A vernier condenser, Figure 54, is really two, one large and one tiny, so that the size of the frequency container of the condenser and coil combination may be more finely adjusted.

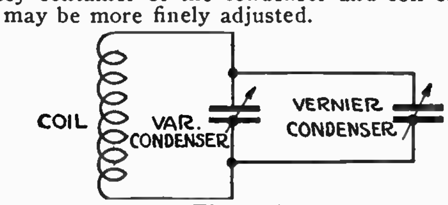


Figure 54

Body capacity occurs when a small condenser is formed by the operator's hand or body and the receiving set. The human body when insulated from the earth makes a small condenser (number 1, Figure 55)

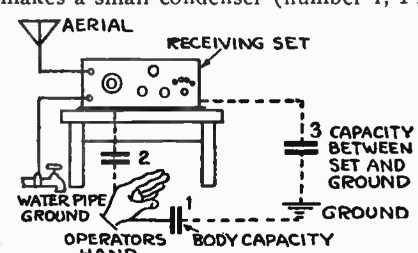


Figure 55

with it. The hand insulated from the receiving set makes a tiny condenser, number 2, with it. The set and its batteries will usually make a condenser, number 3,

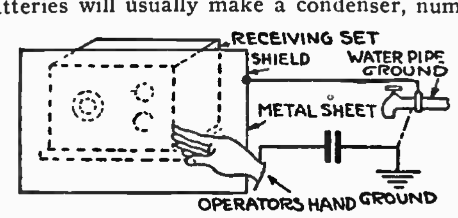


Figure 56

with the ground. This has an interfering effect in tuning some sets and can be avoided by grounding the

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movable plates of the condenser used in tuning the set or by employing a capacity shield. The principle of a capacity shield is shown in Figure 56, where a metal plate is connected to the ground and interposed between the operator's hand (usually back of the instrument panel) and the set.

Electrostatic Field

There is an electrostatic field set up between the plates of a condenser, as diagrammed in Figure 57. Tubes of force extend in the dielectric between the plates. In an aerial, such tubes of force extend between the aerial wire and ground, as indicated in Figure 58. A transmitting aerial sends off a pair of field components, one electromagnetic and the other electrostatic and at right angles thereto. A receiving set employing an aerial operates on both of these components, while one employing a loop, functions mainly on the electromagnetic part of the travelling field, known as Radio waves.

The practical unit used to express the size of condensers or capacity in Radio is the microfarad. Sometimes condensers are spoken of by the number of plates, as 23-plate, 43-plate, etc., but this is less precise than to say .0005 microfarad, .001, etc. Many fixed

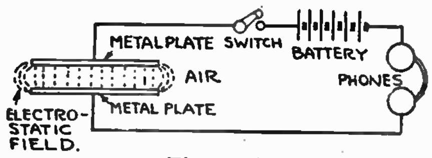


Figure 57

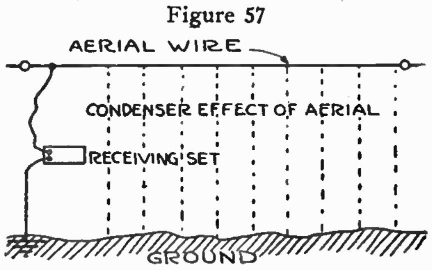


Figure 58

condensers on the market at the present time are inaccurately labelled as to capacity. Good fixed condensers usually are made from mica, compactly compressed and insulated and marked with reasonable accuracy. Good variable condensers are well built mechanically, have carefully rounded plates, and must run true. If one plate touches another, the device is no longer a condenser but a conductor the same as any scrap piece of wire might be. Some manufacturers design condensers with a so-called minimum "phase angle" loss, which simply means that the dielectric is arranged to be as perfect as possible.

Resistances in Radio

When a crowd tries to get home from a baseball game, there is a rush for the gates and only a certain number of people can pass through the gates at a time. Thus the gates have resistance to the flow of the crowd much as a wire offers resistance to the flow of electrons (electric current) through it.

When a battery is connected to a wire, Figure 59, the electrons have to be pushed through the molecules in it. The smaller the wire the harder this will be. Thus any coil of wire, Figure 60, has resistance and acts in a circuit as though it were in two parts, one a coil, and two, a resistance.

A common form of resistance is the rheostat, which is merely an adjustable resistance and, in Radio, usually is employed to control the amount of current supplied

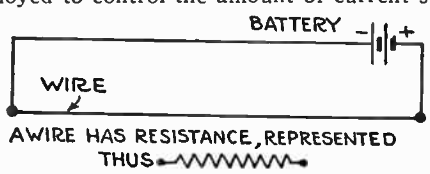


Figure 59

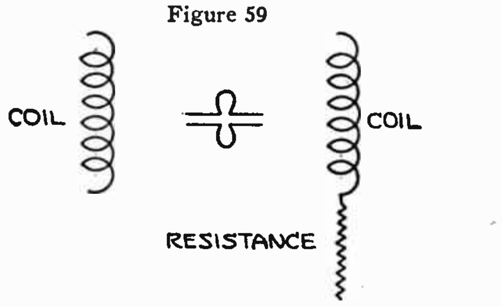


Figure 60

to a vacuum tube filament. A wire rheostat is diagrammed in Figure 61. Instead of wire, graphite discs can be used, Figure 62A. As the pressure on the discs is increased the resistance is decreased. Sometimes grains or powder, as shown in Figure 62B, will be adjusted by means of a plunger, to vary the resistance. Devices using the principles shown in Figure 62 usually give finer regulation than the wire resistances.

The unit of resistance is called the ohm. A form of rheostat now in much use can be gradually varied from less than one-half an ohm to more than thirty ohms.

Very much higher resistances are used as grid leaks. A grid leak may have as much as ten million ohms or as little as 50,000 ohms according to the purpose it is to be used for. A million ohms sound like a great deal but is comprised simply, Figure 63, by a piece of paper soaked in India ink and dried. Variable grid leaks are made in several forms for use as indicated by Figure 64 in combination with a tiny condenser.

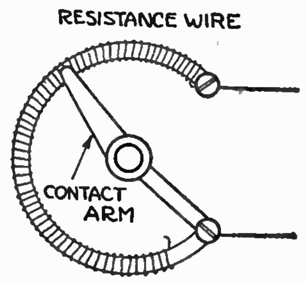


Figure 61

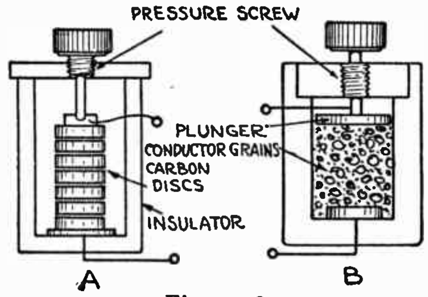


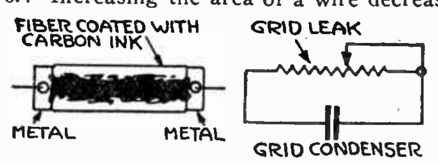
Figure 62

Another form of resistance used in some Radio sets is called a potentiometer. It resembles a rheostat but has a higher resistance, such as 400 ohms, with the switch arm arranged as a movable tap. The principle of a potentiometer is shown in Figure 65.

The resistance, in this case 2,000 ohms, is connected across a battery. A voltmeter or other output circuit is connected between one end of the battery and the switch arm. The voltage across this output depends on the position of the switch arm, so a potentiometer is used to obtain a finely adjustable source of voltage or potential.

Resistance in Poor Connections

If a bus bar is loosely (cold soldered) to a binding post a loose connection having a high resistance may result, as illustrated in Figure 66. A wire 10 feet long has twice the resistance as if it were only 5 feet long, Figure 67. Increasing the area of a wire decreases its



Figures 63 and 64

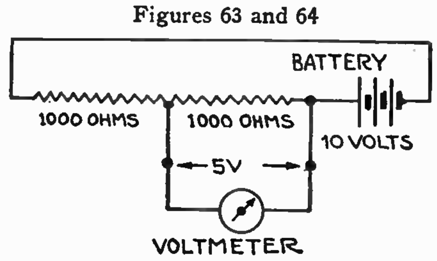


Figure 65

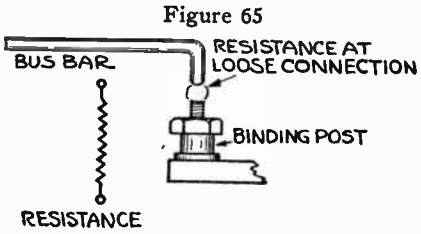


Figure 66

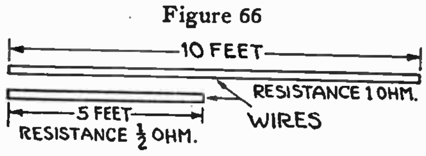


Figure 67

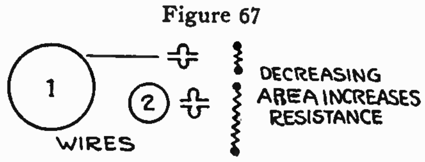


Figure 68

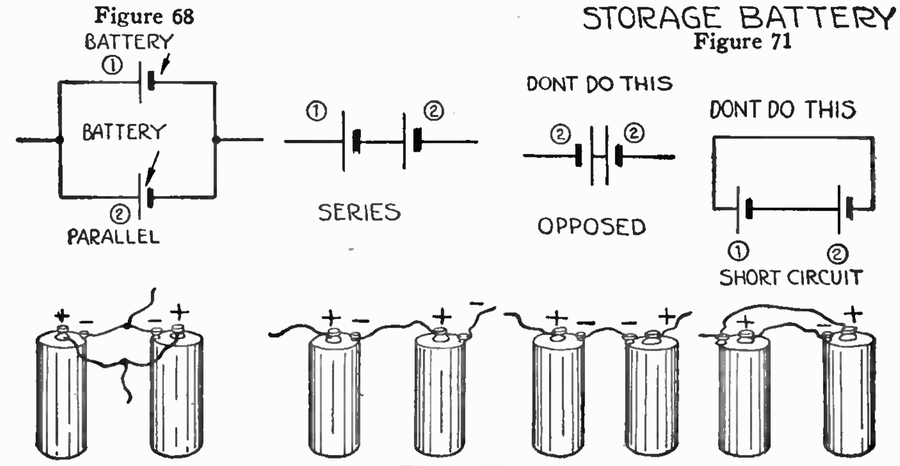


Figure 72

resistance, Figure 68.

A microphone is made up of graphite grains held between two contacts which can be vibrated by a diaphragm, thus changing the resistance.

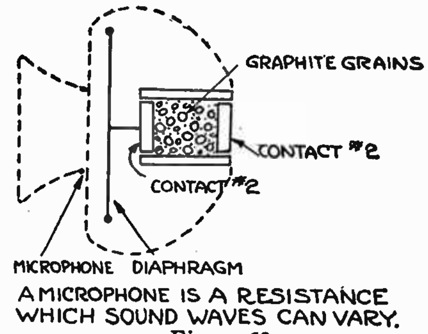
There is a fundamental relation of resistance to current and voltage, called Ohms Law. This is illustrated by Figure 70. When a battery having 6 volts resistance, a current of 1 ampere can flow through this wire.

Current equals voltage divided by resistance—

Or

Resistance multiplied by current gives the potential or voltage.

To put more current through a wire with a fixed resistance, the applied voltage must be raised.



A MICROPHONE IS A RESISTANCE WHICH SOUND WAVES CAN VARY.

Figure 69

Headsets used in Radio are often designated as 2,000 ohms, 3,000 ohms, etc. This is not a reliable measure of the merit of the phones, but expresses the direct current resistance offered by the windings thereof.

The Essentials of Radio Electricity

The mystery inside of a Radio set soon begins to clear when a few of the elementary principles of electricity are recognized.

Batteries are used to supply local electrical energy to operate receiving sets. A battery called an A battery is used to light the filament of a vacuum tube, and a battery called a B battery is used to supply the local plate energy for the vacuum tube.

The principle of a battery is diagrammed in Figure 71. When a piece of zinc metal and a piece of carbon are inserted into a solution of the chemical, sal ammoniac, certain distributions occur in the electrons in the zinc. At the surface of the zinc, at the contact of the zinc with the sal ammoniac and water, at the contact of the solution and the carbon and at the surface of the carbon a quantity of electrons flow, from the carbon plate through an external wire to the zinc plate. A chemical change also occurs during the action and some of the zinc metal goes into solution combining with the chemical electrolyte. Essentially, a battery changes chemical energy into electrical form and the zinc in this case is in a sense burned much the same as is coal in a furnace.

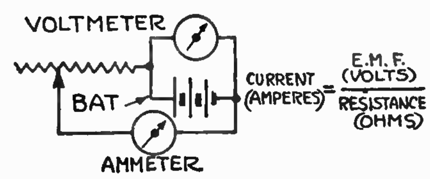


Figure 70

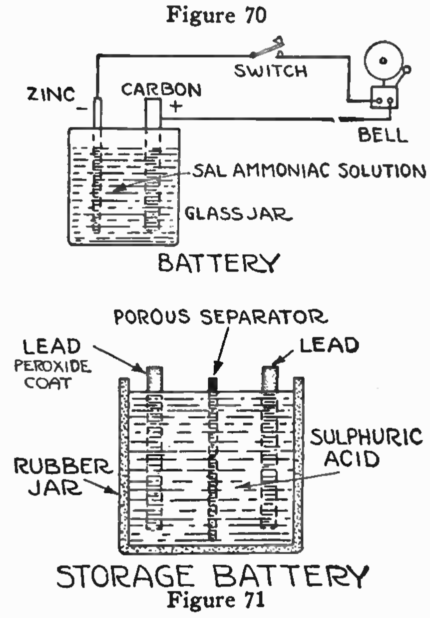


Figure 71

The labels "plus" and "minus" are such as have been arbitrarily established to indicate current flow, as going from the positive plate, carbon, through the wire, to the negative plate, zinc. A dry battery is operated on much the same principle and is really not dry but moist, with the electrolyte in the form of a gelatine like mass. The usual forms of dry cells have the zinc plate outside acting as a container, and also comprise certain auxiliary chemical agents or depolarizers to assist the desired action.

The A battery is called upon to supply a current to heat the wire filament of a vacuum tube, and will run down or become exhausted after a time. The B battery supplies a higher voltage or pressure and is made up of a number of cells in series. These cells are of smaller dimensions because the current required is very small.

Storage Battery

A storage battery, also diagrammed in Figure 71, is used where a steady current is required, and is called so because when run down, the original chemical condition in the battery can be restored by sending electric current through it. In the lead acid type of storage battery two lead plates are separated in a jar of dilute sulphuric acid. One lead plate, the positive, is

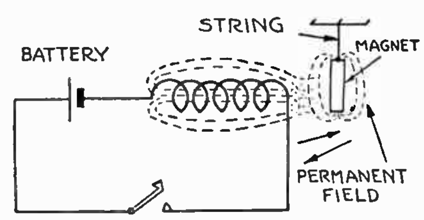


Figure 73

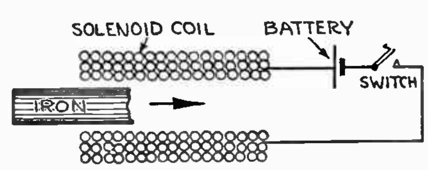


Figure 74

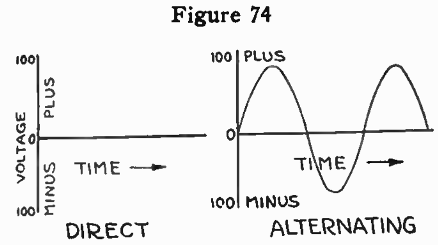


Figure 75

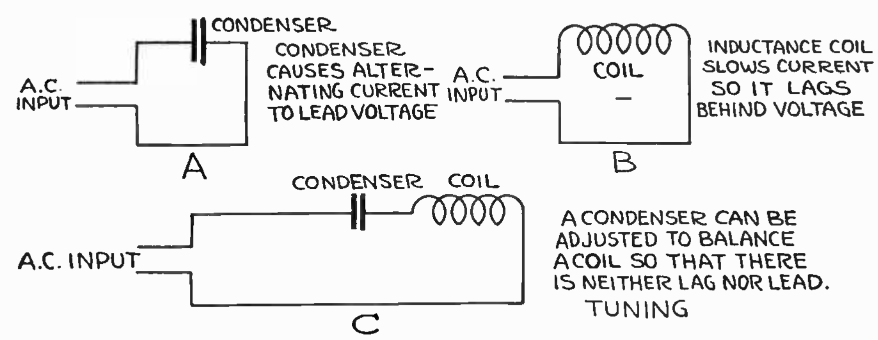


Figure 76

given a surface coating of lead peroxide, a brown appearing chemical. Then when an external wire connects the two plates, a current flows from the peroxide coated plate through the wire to the lead plate.

After a time of use, both plates will get down to the same potential so that the electron distribution in the battery is equalized and there can be no external current flow. Then the battery can be recharged, that is to say, a new peroxide coat can be applied to one lead plate by passing electricity from an outside source through the battery, thus changing the concentration of the electrolyte and the chemical equilibrium in the cell. A storage battery really stores chemical energy rather than electricity. When fresh a dry cell usually affords slightly better than 1.5 volts at the terminals but cannot supply a heavy steady current without rapidly running down.

When freshly charged a storage cell, affords close to 2.2 volts and can give a heavy steady current for considerable time. Batteries also have resistance, called internal resistance. In the case of B batteries made up of a number of cells, this internal resistance has a noticeable effect and sometimes condensers are employed to bypass the battery to Radio currents. In using batteries of the dry cell type, remember that they will run down and must be renewed. As for storage cells, they should be kept charged, and replenished with distilled water from time to time, as advised by the maker's instructions. Dry cells used for A batteries run down oftener than do B battery cells because they furnish a heavier current then they should.

Series and Parallel Connections

Figure 72 shows the two connections for batteries, series and parallel. If two equal cells, 1 and 2, are connected in parallel, that is to say with the positive plate to the positive plate and negative to negative, this gives a battery of twice the effective current capacity but the same voltage as one cell. In a series connection, one positive plate to one negative plate of the other battery, this combination affords a battery of double the terminal voltage of one cell, and the same capacity. In a series connection of one cell goes bad, as often happens in a B battery which comprises several cells in series sealed up into one unit, the entire combination can pass no more current than can go through this one bad cell, for it then acts as a high internal resistance.

Fluctuating Current from Dry Cells

Dry cells used for B batteries will sometimes become polarized or depleted so that the current supply is interrupted or fluctuated somewhat as a microphone operates; that is to say, by this variable battery resistance. This is chemically caused and results in a so-called noisy B battery because a rumbling is heard in the headset from the fluctuating plate voltage. Dry cells run down with time even when not used owing to drying up and polarizing in the cells. A B battery of good construction will sometimes last over a year while a poor one may run down in a month's time.

A battery is shown in diagrams by a long line separated from a short heavier line. If connected to a coil of many turns as in Figure 73, a magnet is formed

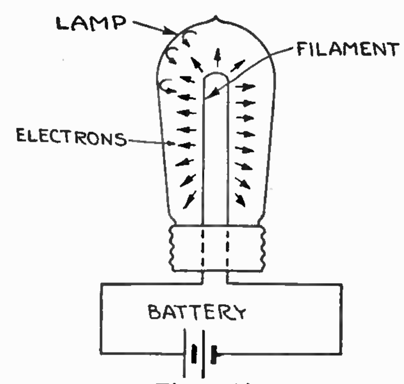


Figure 77

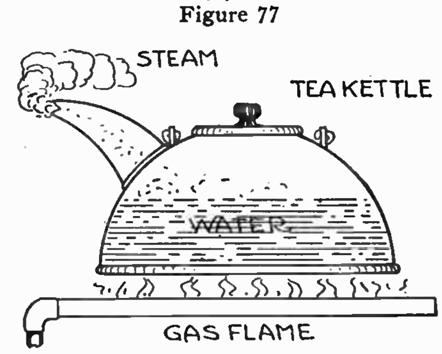


Figure 78

and can be used to attract or repel a permanent magnet. Electric motors are operated on this principle. If an iron core or cylinder is placed in one end of a coil, Figure 74, current in this coil or solenoid will pull the iron core into it. An iron core concentrates the lines of force set up by the coil. Telephone receivers and loud speakers utilize these principles.

Electricity is electricity, whether called alternating or direct. A direct current flows at a steady applied voltage, Figure 75, whereas in the case of an alternating supply, the direction is regularly reversed back and forth. This can be fixed in mind by analogy to two different kinds of saws. A band saw cuts wood by moving in one direction. A buck saw cuts wood by moving back and forth through it.

Lag and Lead of Alternating Current

A direct current flows together in time sense, with the applied pressure or voltage. An alternating current can do this in a circuit of pure resistance or when the capacity and inductance are in proper relation. If alternating current is applied to a circuit containing just a condenser, Figure 76, the current jumps ahead of the voltage owing to the condenser action. If an alternating current is applied to a circuit containing just an inductance coil, the current lags behind the applied voltage because the coil sets up a counter field. If, however, the circuit contains both capacity and inductance, the condenser effect can be made to balance the coil effect so that for a certain frequency the alternating current and the applied voltage act together in time relation. This is called "phase." In tuning Radio sets, a condenser is often combined in certain size with a coil for this effect, which is then called "resonance," i. e., for a certain frequency the condenser effect and coil effect is balanced.

Another form of electron flow is much used in Radio, in vacuum tubes. An ordinary electric lamp with a filament in a vacuum bulb is diagrammed in Figure 77. Besides emitting light rays and heat, such a filament also shoots off invisible particles of negative electricity called electrons. This occurs much as in the case of water evaporating into steam. In a lamp, however, the electrons shoot off and have no special place to go so, after filling up the inside of the bulb and partially leaking back into part of the filament, they form a so-called space charge in the

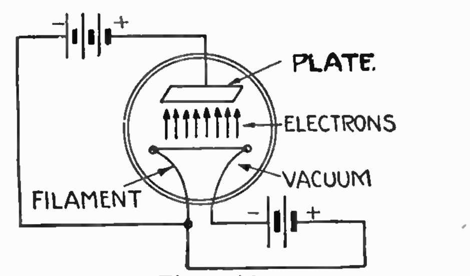


Figure 79

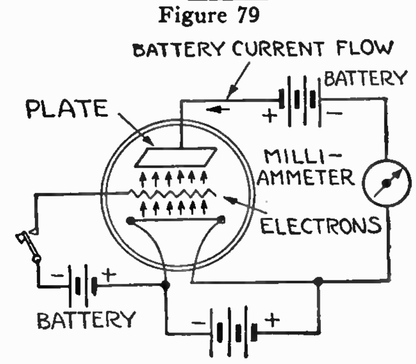


Figure 80

vacuum tube. This is not strange and is comparable to the case of a battery which does not have its plates externally connected through a wire.

When, however, a metal plate is put inside the vacuum tube, the electrons can flow to it. If an external circuit is connected and supplied with local battery so that the plate gets a positive charge, a large number of electrons can flow to the plate. The local battery can then send a current through the space between the plate and the filament.

Figure 80 illustrates the relations in a vacuum tube. The filament is heated and emits electrons which can pass to the positively charged plate. The plate battery can then send a current through the electron flow, this current going between the plate and filament and coming from the battery. A third piece of metal called a grid can be used to regulate the electron flow and thus govern the plate battery flow. Should the grid have no charge, it has no effect. If positively charged it acts like a plate and lets electrons flow from filament to plate. If negatively charged it opposes the negative electron flow, and can even be negatively charged enough to stop this flow. Then no plate current could flow from the plate circuit battery.

Figure 81 should assist in fixing direct current flow in mind by analogy to the water flow shown. A corresponding diagram for alternating current is shown in Figure 82.

From Figure 83 it will be seen that a rubber diaphragm is inserted in the water pipe, representing a condenser in the wire circuit. A direct water flow could only stretch this diaphram in one direction and then the flow would stop so the paddle wheel motor would not run. But an alternating motion on the pump diaphragm (generator supply) will send the water rushing one way, then reversely, and can move the paddle wheel. In electric power work suitable construction in the motor changes the alternating power source into continuous direction motion.

There are other devices which can change an alternating current effect into an equivalent direct cur-

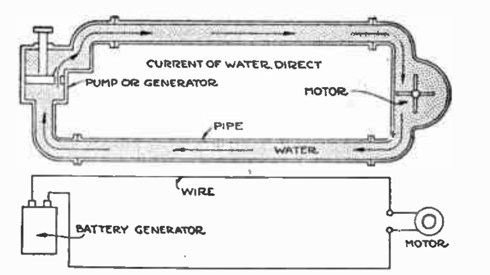


Figure 81

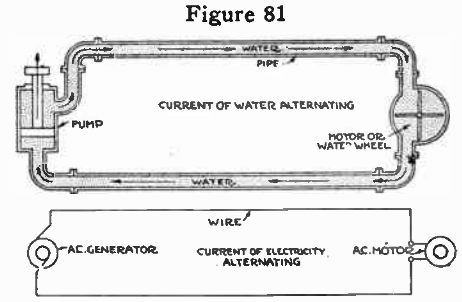


Figure 82

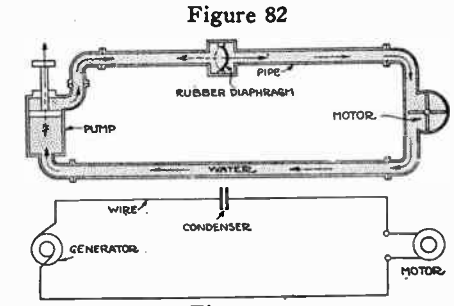


Figure 83

rent result. Such devices are called recetifiers. In Radio a detector acts as a rectifier to let the Radio current change into direct current flow.

Simple Explanation of Radio Reception

"The Key to Radio Circuits"—Chapter III

By P. E. Edelman

The new listener in is soon able to read and understand Radio diagrams when the essential circuits are known. A circuit is a complete path for a flow of electrons called an electric current. A Radio circuit is usually made up of several individual and co-operating circuits.

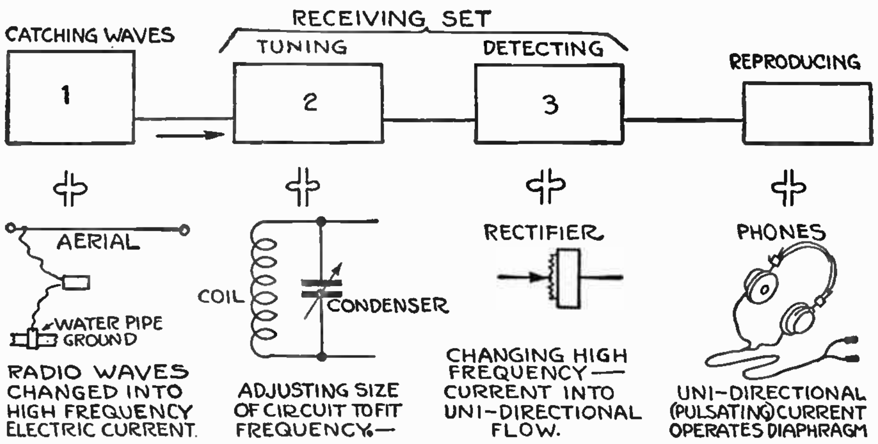
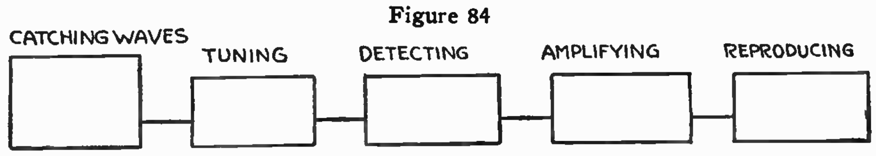


Figure 84



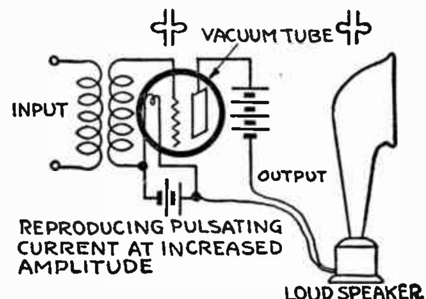


Figure 85

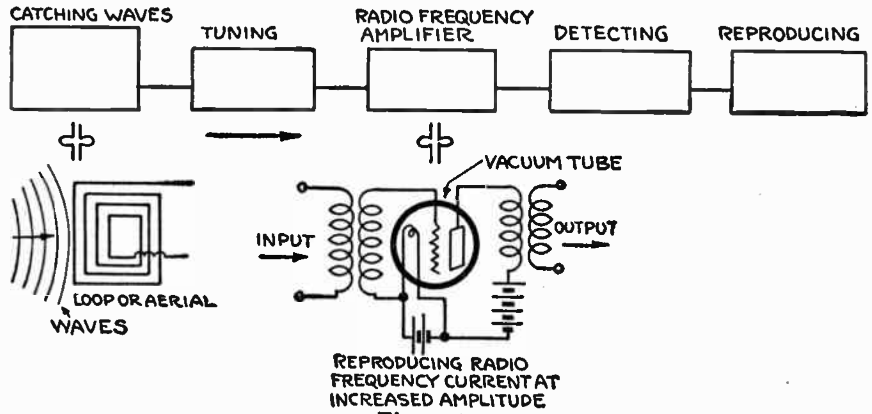
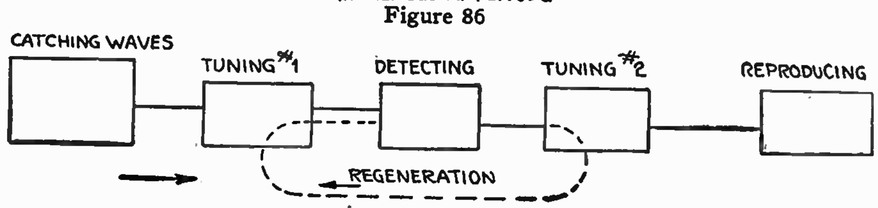


Figure 86



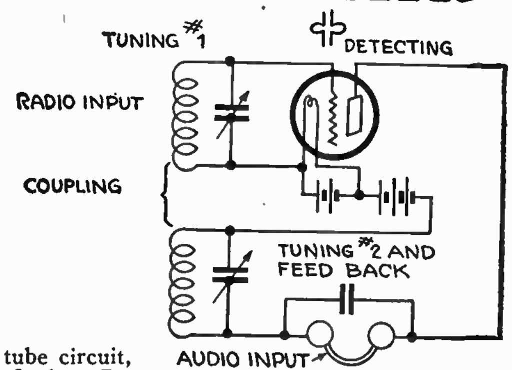


Figure 88

To understand a circuit it is first necessary to know what object is to be accomplished thereby. The purpose of a receiving circuit or system is to catch a portion of the transmitted wave energy and translate it back into the form of sound.

In Figure 84, a simple receiving process is diagrammed. First Radio waves are intercepted or caught. This can be done by means of an antenna wire called an aerial and a ground connection. When the incoming waves cut this aerial they set up in it a high frequency or Radio current. Next, there is placed a convenient and proper sized path for this Radio frequency current. This is called a tuning device, and may consist of a coil and condenser. The purpose of tuning is to fit the receiving apparatus to receive the particular Radio frequency of the particular Radiocast waves desired.

So far, one has merely brought the Radio frequency into the form of Radio frequency current. It is now necessary to change this Radio frequency current from its present form, flowing back and forth at inaudible rate, into a pulsating form which flows in one direction. This is called rectifying. Then this pulsating current can actuate a telephone receiver diaphragm. In a receiving set one deals with electric currents and changes of form thereof.

Now there are variations of this simple process. One can add an audio frequency amplifier to boost the fluctuating current taken from the detector output so as to operate a loud speaker. This is illustrated in Figure 85.

Radio Amplification Before Detection

If a distant station is to be brought in, the incoming

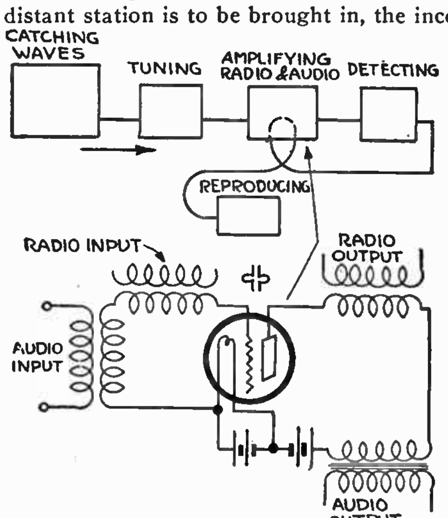


Figure 87

waves therefrom may be too feeble to actuate the detector. A certain minimum amount of energy called the "threshold" value is required before a detector can operate. For this purpose a Radio frequency amplifier or booster is employed. The output of this amplifier will have the same frequency of current flow, but with a much greater value than the Radio input. The difference is obtained from the local source of power or battery used. When a Radio amplifier is used, Figure 86, very tiny and feeble Radio waves can be built up into a form strong enough to operate the detector satisfactorily.

If one can amplify Radio frequency and audio frequency independently, why not together? When this is done in a single unit or vacuum tube circuit, Figure 87, the process is known as reflexing. By proper design of the circuit the two greatly different frequencies, Radio and audio, do not interfer.e. The energy value is thus built up both before and after rectification in the detector. The point to remember is that there can be both Radio and audio frequency inputs and outputs for an amplifying device.

Another method much used is termed regeneration. Referring to Figure 88, a portion of the Radio frequency current from the tuning device number 1 will not be rectified by the detecting unit but will be suitably returned or fed back ahead of the detector. In this way a feeble Radio current can be made to build itself up much like a dog chasing its tail. Electrically, regeneration is accomplished by coupling a plate circuit to a grid circuit, usually tuning both to the desired frequency.

Different Kinds of Circuits

Radio circuits are also spoken of according to the kind of tuning. A single circuit may thus have several circuits, but the tuning is accomplished by one circuit, as illustrated in Figure 89. Such a single circuit really has a tuned aerial circuit, a grid input circuit and a plate output circuit. In Figure 90, the addition of a Radio feedback circuit in the plate output makes a so-called single-circuit regenerative circuit.

Similarly, two circuit tuning means that the grid input circuit is tuned and coupled to the aerial tuned circuit, as shown by Figure 91. The equivalent individual circuits thus made up into a whole are shown in the lower portion of Figure 91.

When three circuits are each tuned to the incoming frequency, as in Figure 92, still better selection or restrictive path for the Radio energy is provided. This might be further complicated with four circuit tuning, etc., but the increasing number of adjustments makes such multiple circuit tuning complicated. In Figure 92, the tuned plate circuit is tuned in connection with the natural condenser comprised inside of the vacuum tube used, by using a variometer as an adjustable inductance.

The number of different forms and combinations of circuits made possible from the principal actions is very large and for example, tuning can be combined with regeneration, with Radio and with audio frequency amplification, as well as with reflex operation. Referring again to Figure 90, it is possible to adjust the feedback so that enough energy is transferred to the grid circuit to set up oscillations, or a powerful locally generated Radio frequency current. The receiving vacuum tube can thus act as a transmitter and radiate considerable Radio energy. That is what happens when neighbors swish the dials of their tuners or receiving sets of this type back and forth.

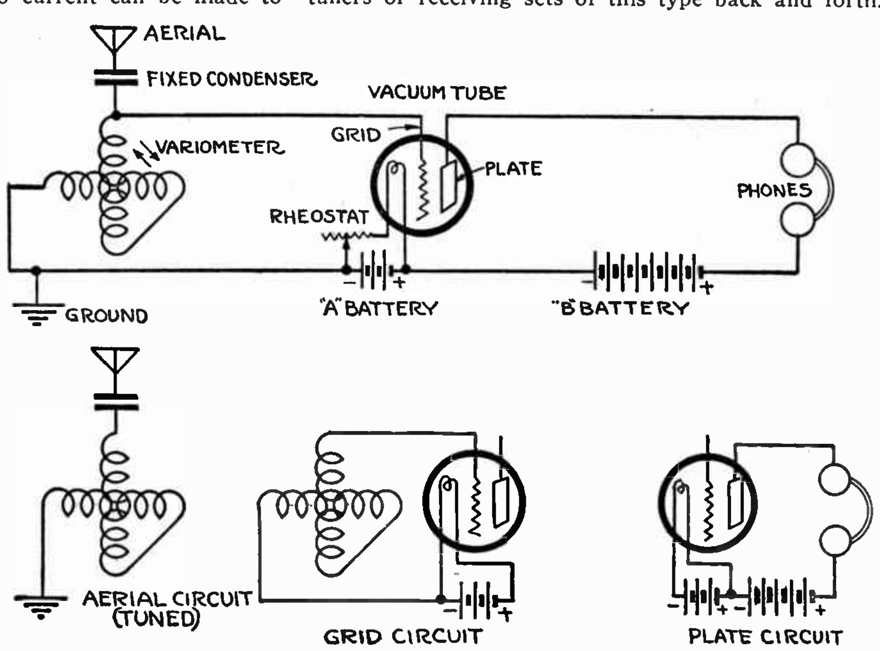


Figure 89

At certain adjustments such regenerative receivers oscillate and generate Radio waves, thus acting as a miniature Radiocasting station.

Such interfering radiation only occurs from certain adjustments of the regenerative type of receiving circuit, and more particularly from the close coupled single-circuit variety. Careful operation avoiding mushy and whistling sounds along with reproduced Radiocasting, or the use of less coupling, or the em-

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ployment of a stage of Radio frequency amplification ahead of the regenerative detector unit, or the use of other types of circuits, will avoid this condition. The present sets in use are largely of the regenerative

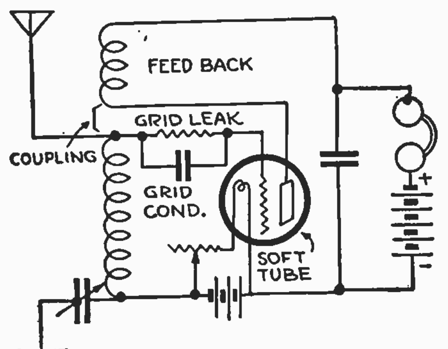

Figure 90

type and thousands are in the hands of people who more or less innocently Radiocast a swarm of interfering Radio waves to neighboring receiving sets.

Radio's Cast of Characters

Just as the enjoyment of a play or motion picture is enhanced by knowing the cast of characters, so is the understanding of Radio increased by knowing who's who among some of the common terms used.

The Radio words and terms most heard are, firstly, the slang class; secondly, the trade name variety; thirdly, the technical, and fourthly, the scientific. Without attempting to print a Radio dictionary, one can point out the gist of terms in common use:

AERIAL. This means the insulated wire used to radiate or intercept waves.

ALTERNATING CURRENT. This term is usually written A. C. It is a current that goes in one direction, stops, and reverses in recurring cycles. Pulsating or fluctuating current is a current flowing in one direction but varying from time to time in amount.

AMPLIFIER. This usually refers to the circuit used to amplify Radio or audio frequency current, but sometimes means the vacuum tube used for this purpose.

AMPLITUDE. Means the measure of the value or energy in a single wave of any wave motion.

ANTENNA. Means the overhead aerial wire, lead in and ground wires combined; the antenna circuit.

AUDIO FREQUENCY. Means vibrations within the range the human ear can hear, usually below 10,000 cycles, and more particularly between 16 and 6,000 cycles per second.

AUDION. The first trade name given to the three electrode vacuum tube.

CAPACITY. The size or electron holding ability of a condenser.

CONDENSER. A device for holding electrons.

DETECTOR. A Radio frequency rectifier or device for changing Radio frequency current into direct flowing current.

ELECTRIC CURRENT. A flow of electrons. It occurs substantially instantaneously.

ELECTRON. May be considered as raw electricity in its tiniest unit.

E. M. F. Electromotive force, or voltage, in electric terms means the same thing as head or water pressure in hydraulics.

ETHER. This is a word used to designate what is left after taking all known material substances from space, and can be regarded as space. Radio waves extend through the ether in the form of expanding fields of force.

FREQUENCY. The inverse of wave length and means the vibration or recurring change of wave energy. Radio frequency is thus an extremely high rate of vibration.

GRID. This refers to the controlling electrode of a vacuum tube.

GRID POTENTIAL. Means the E. M. F. applied to the grid for control purposes.

GRID LEAK. The resistance used to discharge the grid condenser slowly.

GRID CONDENSER. The tiny condenser used with the grid leak to control the grid of a vacuum tube for detecting purposes.

GROUND CONNECTION. The connection made with the earth, often by connecting a wire to the water pipes.

HARMONIC. The overtone of the fundamental vibration and can occur at Radio frequencies also. There is a tendency of any frequency to set up harmonics.

HENRY. Usually expressed as millihenry or microhenry, and is a unit measuring value of inductance.

IMPEDANCE. The resistance in addition to the direct current resistance value of a coil or conductor. It is caused by the reversed E. M. F. set up by magnetic lines of force collapsing back through the coil or wire. At Radio frequencies large values of impedance can be set up, and this action is sometimes referred to as choke coil action.

INDUCTANCE. Usually describes the action of a coil of wire.

INDUCTION. The transference of energy via lines or tubes of force without direct electrical contact or circuit.

KILOWATT. A thousand watts, the unit of electrical power, and the term microwatt means a millionth of one watt.

LOOP. A coil or inductance used to intercept Radio waves and usually comprises ten to twenty turns of wire on a frame two to four feet in diameter. It is directional.

LOUD SPEAKER. Device for reproducing electric pulsations in form of sound waves.

NEUTRALIZING. Opposing two fields of force to give substantially zero effect. Two coils can be connected in opposite sense or a coil can be combined with a condenser to accomplish this action.

PHONES. The ear pieces or headset used in reproduction.

POTENTIOMETER. A resistance device for obtaining gradual differences of E. M. F. or potential.

PATENT. A limited monopoly granted by the government for alleged new and useful improvements. Infringement means the use without the owner's permission of the invention or idea claimed.

PHASE. The time relation in electrical circuits.

RADIOCAST. Intelligence in form of sound waves carried by Radio waves and transmitted in all directions.

RADIO FREQUENCY. This is the vibrations in wave form, or electrical current alternations, occurring in the range usually limited by 10,000 cycles up to 4,000,000 cycles per second.

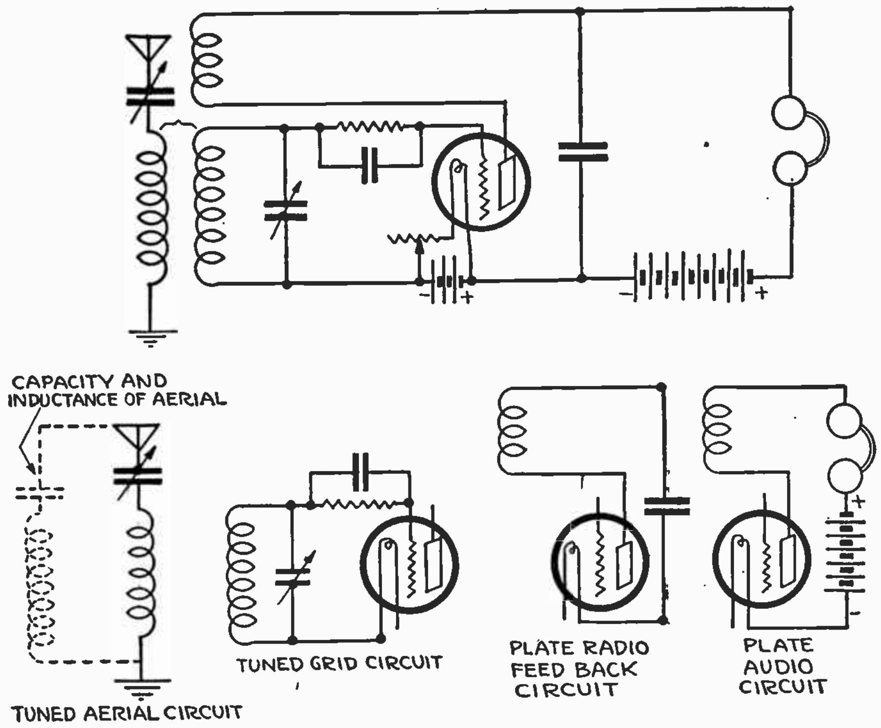

Figure 91

RADIOTRON; TRIODE. Present-day names for the same thing, a Radio three-element vacuum tube.

RECTIFIER. Aside from its meaning in detectors refers to a device for changing alternating current into direct flowing current. For charging storage batteries, rectifiers are of magnetic, or electron bulb, or chemical types.

REFLEX. Relates to the double use of vacuum tube amplifier at both Radio and audio frequencies.

REGENERATIVE CIRCUIT. A circuit employing the principle of a tuned plate or grid circuit feedback.

RESISTANCE. The opposition offered by a circuit or wire to the flow of current.

RESONANCE. The term applied when a circuit is adjusted to exactly fit a certain frequency.

RHEOSTAT. An adjustable resistance for controlling current.

SQUEAL, HOWL or WHISTLE. Undesired audio frequency currents set up in certain sets.

STATIC. This defines the natural interference from discharges, thunder storms, and electrical changes in the atmosphere, which transmit Radio energy to the receiving set.

SUPER-CIRCUITS. Super-heterodyne, super-regenerative, etc., are names for combination circuits. The super-heterodyne changes the incoming frequency before rectification. The super-regenerative circuit modifies the grid potential to permit the use of increased regeneration.

TRANSFORMER. This is a magnetic device for transferring energy via the field of force set up in a coil. In Radio special forms are used for power, amplifying, telephone, and tuning purposes.

TUBES OF FORCE. The electrostatic field set up by the condenser action.

TUNING. The process of adjusting a circuit to fit a certain frequency. This is done by altering capacity or inductance.

VACUUM TUBE, ELECTRON TUBE, THERMIONIC TUBE. Other terms for the combination of a filament, grid and plate in an evacuated bulb. Such a tube can be used as a detector, oscillator, generator, or amplifier, according to the connections made with it.

WAVE LENGTH. The distance from crest to crest of two adjacent waves. Sound waves are relatively short, but travel slowly and so have moderate frequency. Radio waves are usually longer, but travel much faster and so have higher frequency.

WAVE TRAP. A combination of inductance and capacity used to absorb a certain frequency, for tuning purposes.

WIRED WIRELESS. Communication in which Radio waves are guided by a wire line in one direction and limited by it.

ZERO BEAT. Two oscillating currents that have the same frequency and do not heterodyne. Heterodyne means that two sources of oscillation slightly differ in frequency and set up a third frequency which is the difference of the two. A local frequency can be setup in a receiving system to heterodyne with an incoming frequency, and the resulting third frequency may be either audible or inaudible (Radio) frequency.

A Few Minor Expressions

There are a few minor common expressions which are much used but hardly accepted.

B. C. L. Radiocast listener. Sometimes called listener.

BIAS. A term for the potential or E. M. F., placed on a grid of a vacuum tube for control purposes.

BROAD. Tuning which is not limited to one frequency but covers a band of several frequencies.

BUS WIRE. The connecting wire used in wiring a circuit.

CONTROL. The manipulation or dial twisting, in adjusting tuning circuits.

CRYSTAL. The mineral used in crystal detectors and is often spoken of as the whole thing.

FADING. The swinging or temporary disappearance of incoming Radio waves due to natural reflections, atmospheric conditions, or other causes. Signals sometimes fade, and then reappear.

FIELD OF FORCE. The influence in space set up by an energized circuit or coil.

FILAMENT. The electron emitting hot wire in a vacuum tube.

HAM. A comical term for an amateur Radio operator.

HEAVISIDE LAYER. The upper strata of the atmosphere from which Radio waves are sometimes said to be reflected.

INSULATOR. A substance which greatly resists or cuts off the flow of current, as porcelain, hard rubber, etc.

JUICE. A careless expression for electric current.

LEAD-IN. The wire connecting an aerial to a receiving set. Lead wires, describe the connection between a tapped coil and a control switch.

LOAD COIL. An extra inductance added to a receiving set to raise the wave length range to which it may be adjusted.

LONG WAVE. A Radio wave from 2,000 to 20,000 meters, or lower frequency.

MAGNET WIRE. Insulated wire used in winding coils and is further described as scc., single cotton covered; dsc., double silk covered, with numbers in B&S, brown and sharpe gauge, or size.

NATURAL WAVE LENGTH. The inductance of a coil with its self capacity which resonates at a certain natural frequency. The same term is applied to the natural combination of capacity and inductance of an aerial or other circuit.

PERK. Slang for operate, or oscillate.

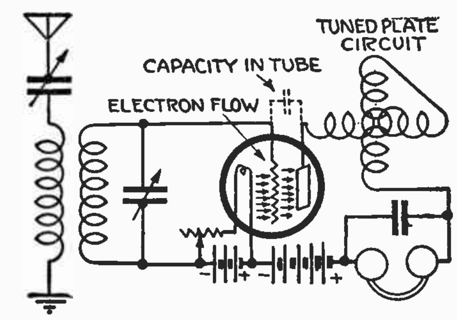

Figure 92

PICKLE TUBE. Slang for dry cell filament operated vacuum tube.

ROTOR. The movable winding and stator means the stationary winding of a variometer or variocoupler.

SHARP. Relates to tuning which is selective or limited closely to a particular frequency.

SHORT WAVE. Radio waves from 10 meters to 200 meters.

SPAGHETTI. The tubular insulation sometimes used to cover wires in a receiving circuit.

TAPS. The portions of a coil lead off for adjusting its effective size.

TIGHT COUPLING. Two coils close together. Loose coupling means that the two coils are arranged with less of the magnetic field of one cutting the other.

The Shorthand of Radio

By shorthand of Radio, the picture representations of diagrams is meant. There is another Radio shorthand concerned with language, and the usual Radio telegraph message will be transmitted as a series of special abbreviations.

The diagram representations of apparatus parts and their typical appearance is shown in the accompany-

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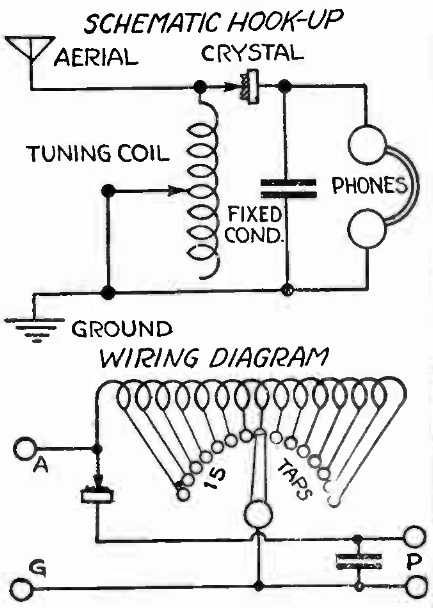


Figure 93

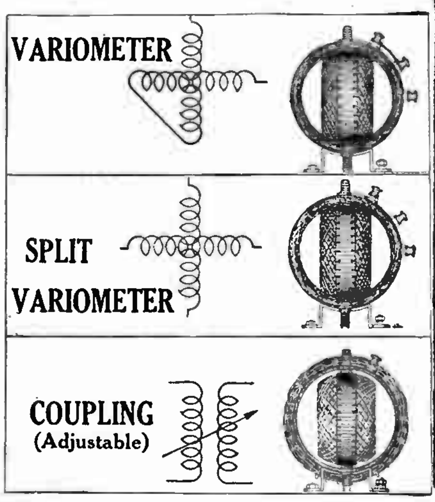


Figure 94a

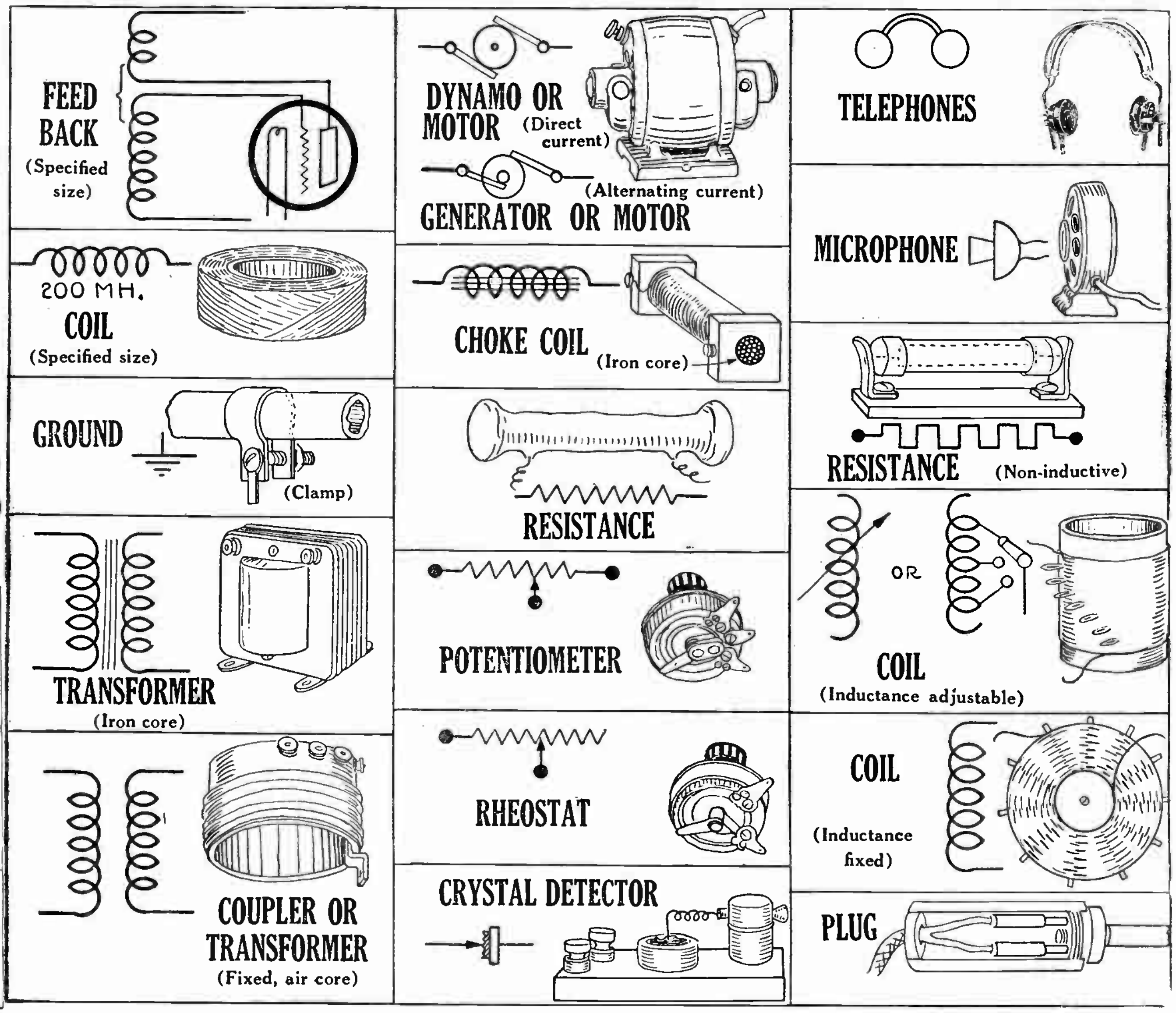


Figure 94b

(Continued from preceding page)

ing figures. Sometimes diagrams are shown with pictured parts, but it is then difficult to follow the connections, as location of binding posts are not usually related to the function of the part connected. Consider a vacuum tube. The best photographic illustration fails to show the connections to be made as clearly as the diagram symbol.

In Figure 93 a simple receiving set circuit is shown in two forms, one diagrammatic, and the other schematic. The purpose of a schematic diagram is to illustrate the principles of the circuit rather than exact dimensions, as in a working drawing. A plan diagram attempts to show the location of the parts, holes to be drilled, dimensions of cabinet, etc.

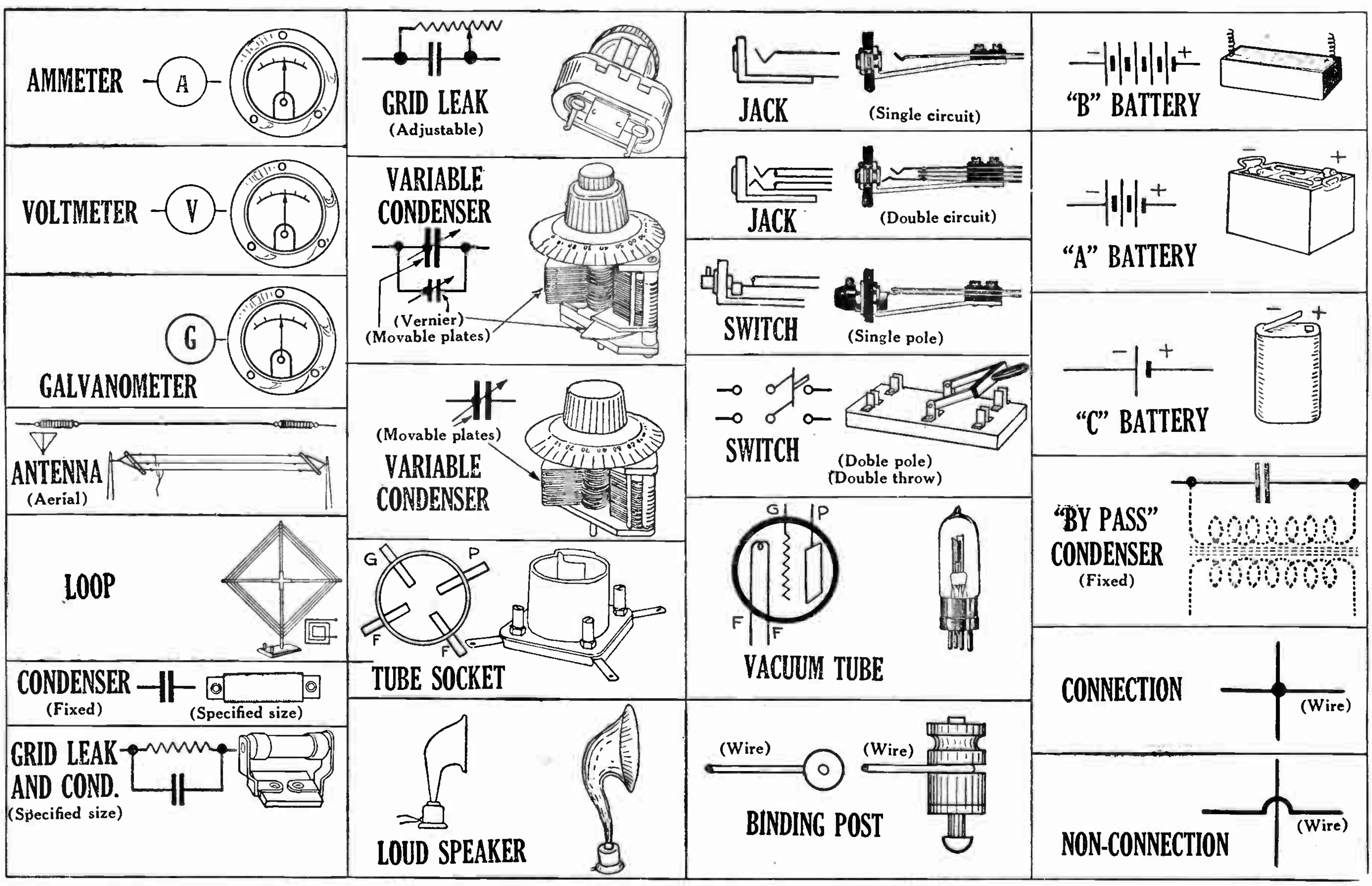


Figure 94c

Simple Explanation of Radio Receivers

"Vacuum Tubes and Aerials"—Chapter IV

By P. E. Edelman

MODERN Radio apparatus is centered around the device called a vacuum tube. Its function is to convert, change, or amplify electrical energy.

It consists, Figure 95, of three elements in a tube or evacuated container. The filament or heater serves as an electron emitting surface. The grid is spaced therefrom and serves as a control member or valve to govern the electron flow from the filament. The plate is placed outside of the grid and is a piece of metal which can receive the electrons coming from the filament.

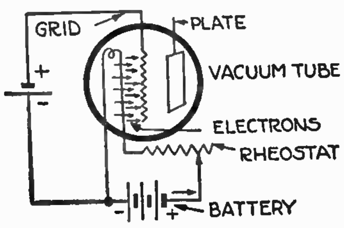
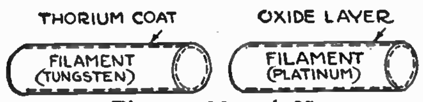
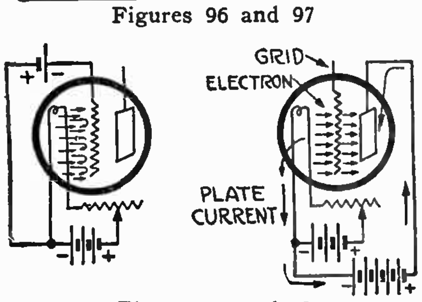


Figure 95

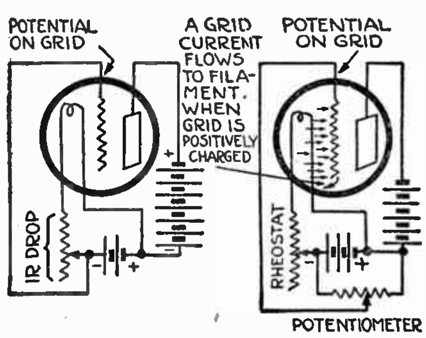


Figures 96 and 97

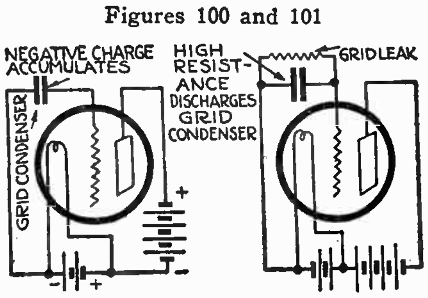


Figures 98 and 99

The filament, Figures 96, 97, consists of a fine resistance wire which heats up upon passage of a current through it. Most filaments in use today are treated to increase the electron emission. The well-known type illustrated by Figure 96 consists of the metal tungsten fused with a small portion of the element thorium. The thorium is then driven to the surface by heat treatment. A thoriated filament has the same electron emitting ability as a common tungsten wire of greater diameter which requires more current for heating. The type of filament of Figure 97 comprises a platinum ribbon coated with oxides, baked thereon. Electrons are better able to escape from such an oxide coat than from the surface of the platinum wire alone. The heating pushes the electrons out from the surface of the wire.



Figures 100 and 101



Figures 102 and 103

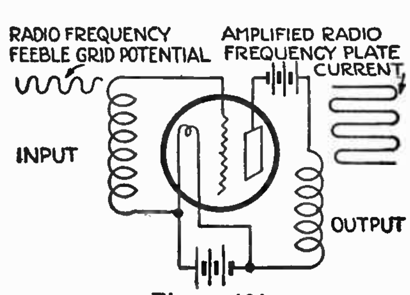


Figure 104

As shown in Figure 95, the tube is using the grid as a plate because the grid has a positive battery connection. Electrons are negative electricity and are attracted to a positively charged surface or repelled by a negative charge.

It is necessary to recognize what goes on in a vacuum tube to comprehend the action in a receiving set.

Figure 98 shows the grid negatively charged and returning or pushing electrons back to the filament.

Figure 99 illustrates the grid without charge from external circuit, so that electrons reach the plate. Then a battery connected to the plate can supply a current which will flow through the space between the plate and filament, now filled by electrons. This plate current will increase if the emission of electrons from the filament is increased or vice versa. This plate current will also be controllable by applying a smaller or larger charge either negative or positive to the grid, because this will then control the electron flow.

Putting Potential on Grid

A simple way to put potential on the grid is to let the rheostat controlling the filament current be included in the grid circuit. A so-called IR drop or potential, set up by the current flowing through the rheostat, can then reach the grid. Such a potential is used as a control for the action of the vacuum tube. It could be obtained from a grid leak resistance or from a potentiometer or a separate battery. This is shown in Figures 100 and 101.

Figure 102 shows how a grid condenser lets a negative charge accumulate on the grid from the electrons, by condenser action. Figure 103 shows a high resistance called a grid leak is used to allow such a charge to disperse away slowly.

Alternating Potential Applied to Grid

If then the potential applied to a grid controls the electron flow to the plate, what will alternating potential do? From Figure 104 it will be seen that an alternating input potential or frequency will cause the plate current to vary at the same frequency. The plate current, however, gets energy from the local battery and will contain greater energy at this same frequency than was applied to the grid. This is amplifier action. Also if a fluctuating potential is applied to the grid (Figure 105) the plate current will repeat the same fluctuations.

By coupling back the plate circuit to the grid circuit regeneration sets up oscillations. Power can be radiated from such a circuit combination. This is shown in Figure 106.

The circuit of Figure 107 illustrates detector action. The Radio frequency current from the tuner sets up a Radio frequency potential on the grid. The function of the grid leak condenser is to maintain an initial potential on the grid favorable to the detector action.

Detecting means rectification. The vacuum tube must let one-half cycle pass better than the next half cycle, otherwise the tube will only amplify the Radio frequency input. That is what a tube connected for detector action does, as the reversing frequency find a good path in one direction and a very poor path back. The plate current then gets a series of half cycles at Radio frequency, which means current flowing in one direction. The windings of the phones then smooth this out into a voice current as originally carried by the incoming frequency. This is illustrated in Figure 108.

With a soft tube, or a tube containing some gas, such rectifier action is possible without the use of a grid condenser. Or with hard tubes, sufficient plate current will usually permit detector action without the grid condenser.

Special types of vacuum tubes are used for power purposes, for rectification only, for special circuits, etc. Figure 109 shows a tube with plate but no grid. It can act as a rectifier.

Figure 110 diagrams a tube with two grids, so that all three actions, detection, audio amplification, and Radio amplification occur together in the one unit.

The essential points are that a potential can be applied to a grid as a steady potential or a fluctuating one, or as a frequency, Radio or audio, to control local energy supplied as plate current.

Practical Pointers on Vacuum Tubes

The sensitive tubes used as detectors mean that a very small incoming Radio frequency impressed on the grid can control the plate current. Poor detector tubes require a much larger initial energy to operate the grid.

If the plate battery is connected to the filament, it will send a large rush of current through and burn it out. Don't!

A soft tube means one containing some gas. It will work better as a detector because more critical, so that smaller grid energy is necessary for operation.

Vacuum tubes on the market, even of the same type and make, vary considerably from one another, due to variations in manufacture, but on the average, perform with reasonable uniformity. Sometimes changing tubes around in a set will improve the operation. Do not have the battery ON while changing tubes as this may result in burned-out filaments.

Catching Radio Waves

To operate a receiving set it is necessary to intercept sufficient of the available Radio energy coming from a small Radiocast station, so that the detector will operate. There are several methods of doing this.

The most generally used means for catching Radio waves is the outside aerial. It enables more energy to be put into a receiving set than can be had from substitutes such as the indoor loop.

Probably the best form of aerial for Radiocast reception is a straight wire about 100 feet long suspended to clear nearby objects, as indicated by Figure 111. This can be done as in Figures 112, 113 or 114.

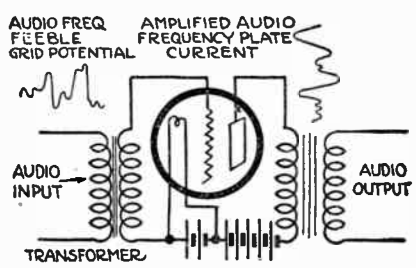


Figure 105

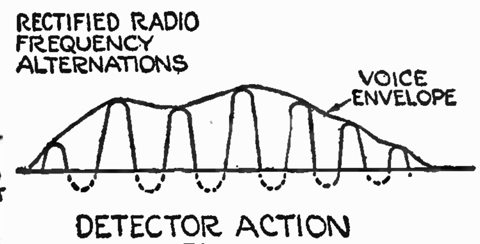


Figure 108

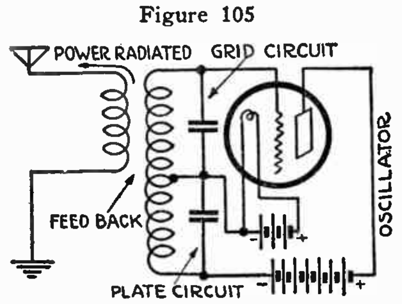


Figure 106

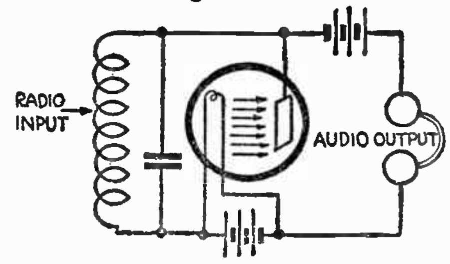


Figure 109

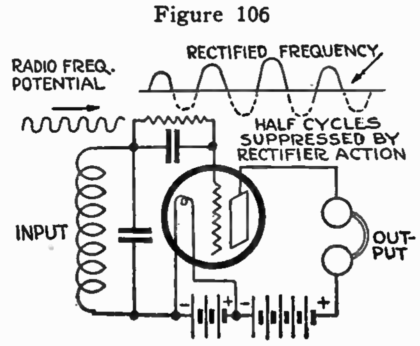


Figure 107

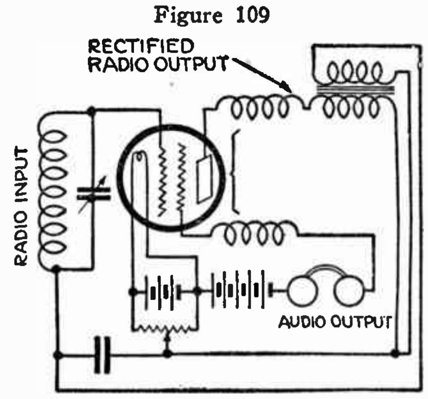


Figure 110

The aerial wire should preferably be stranded, and the wire should be put up in a substantial manner. The lead-in wire must not touch the roof and should be insulated from the building. It can be brought into a room by means of an insulating bushing in a board, as shown in Figure 115. The underwriters require lightning arrester installation and permit an indoor ground connection. There is usually very little danger from lightning caused by an aerial, and more accidents

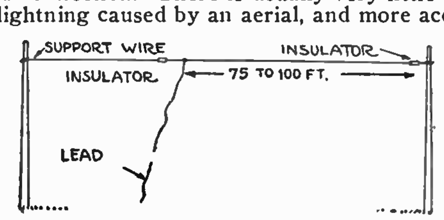


Figure 111

occur from careless stringing of wires which can short circuit by touching power lines.

There is no advantage in using more than one wire in receiving, but it is important to have this well insulated and clear from metal roofing, etc.

Where an outdoor aerial is not feasible, good results can be had with a well constructed indoor aerial. Insulated wire is preferred for use in an indoor aerial, and may comprise from 25 to 100 feet concealed behind picture moulding, as illustrated in Figure 116. For novelties, there are several other types of indoor aerial. Sometimes connection is made to a buzzer or telephone line.

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In many localities a so-called antenna plug gives good results. It consists of two small mica condensers to insulate the line from the receiving set, but allow Radio frequency to pass. When an antenna plug or socket attachment is used as an aerial, the wiring in the building acts as the aerial wire. Sometimes this operation is not feasible because of the kind of wiring or excessive interference from interruptions in the lighting circuit, making noise in the reproducer of the receiving set.

Phantom and Loop Aerials

A so-called phantom aerial is a capacity effect permitting reception by use of a ground connection only. A circuit is shown in Figure 118 which gives good results on local Radiocasting without an aerial, and sometimes over long distances. Usually the receiving set and its connections form a small condenser 2 with the ground.

A loop will not usually pick up more energy than a phantom arrangement as in Figure 118, but has a directional effect. A loop is shown in Figure 119 and consists of a coil or inductance of larger diameter than is usually employed in a receiving set. It gets but little energy compared to what an aerial can pick up, but also gets less interference and permits selection between stations of the same wave length provided they are located nearly at right angles with respect to the receiving station. Usually a loop requires one or more stages of Radio frequency amplification to boost the incoming energy so that it will operate a detector. A suitable circuit is indicated in Figure 120.

A loop acts like a coil. In Figure 121 there are diagrammed three Radiocasting stations and two differing loops. Loop Number 1 is pointed in line with station Number 1 and is at right angles to station Number 2. Waves from station Number 1 will set up current in loop Number 1, but waves from station Number 2 will not. The lines of force in the field sent from station Number 2 thread through but do not cut the wire in loop Number 1.

Another way of regarding this directional effect is that the field of force from station Number 1 strikes the front of loop Number 1 first and the back side later, thus setting up a current in the loop, whereas station Number 2 sends out a wave front which strikes both sides of loop 1 together so that the opposed effects do not send current through the wire in the loop. Loop Number 2, however, will get no energy from station Number 1, but will get some from either station Number 2 or Number 3. For instance in the example shown, loop Number 2 can get energy from station Number 3, but less than if it was pointed towards station Number 3.

The effect is as if the size of this loop Number 2 was the dimension B instead of the dimension A. At right angles, the dimension B becomes zero. If station Number 1 is a local Radiocasting station of 360 meters and station Number 3 is a distant station with a 360-meter wave length, loop Number 2 can be used to listen in to station Number 3 without hearing station Number 1.

Loop sets usually employ Radio frequency amplification but results can be had from a loop with a vacuum tube set on local Radiocasts if suitable connections are made. Usually the loop will be connected through a series condenser to the standard type of receiving set at its terminals marked aerial and ground. This is shown in Figure 122.

Non-directional Loop

A loop will not act as just explained if one end is grounded as shown by Figure 123, but this will sometimes increase the energy available for the receiving set, by phantom action, as shown in Figure 118.

Loops do not work very well inside of steel buildings, especially if the walls contain metal lath. In such cases, when they do get sufficient energy to work, the directional effect is likely to be erratic. Sometimes the loop in a steel building will work on all stations only when located in one corner of a room, cornerwise.

Except for locations within a few blocks of a Radiocasting station, it is not feasible to use a loop to operate a simple crystal type set satisfactorily. A single-tube set employing regeneration will get enough energy from a loop up to a distance of ten miles from a Radiocasting station. The range of a loop can be extended to reach as far as a good aerial by employing two or three stages of Radio frequency amplification.

The larger the size of the loop the fewer the turns used for a given wave length, but bulky sized loops are unsightly so that most loops will be made from 18 inches to perhaps three or four feet in diameter. A suitable size for Radiocast reception with a parallel tuning condenser of .001 mfd. maximum size, is made by supporting 100 feet of wire spaced as turns ½ inch apart on a framework 3½ feet across. The wire used should be number 14 to 18 in size and may be insulated if desired.

In first picking up a station, a loop has to be pointed approximately correctly to get enough energy to operate the set. Reference to a map showing stations will show directions, which may be checked up.

An important point to remember is that after the waves cut the wire of the aerial or loop, a Radio frequency electric current is caused in the wire and flows rapidly back and forth. Essentially the process of catching waves thus comprises the step of changing them from radiated waves to electric waves in the input circuit.

Detecting Radio Waves

Detecting Radio waves requires a device called a detector, which really is a rectifier or means for converting alternating Radio frequency current into direct flowing current. Notice the term "direct flowing" differs from the word "direct" as the latter implies a continuous flow. The output current from a detector is uni-directional but not steady, as it comprises a series of rectified half cycles which must be smoothed out into a steady current fluctuation by means of a condenser or inductance in the circuit to which it is connected.

Detectors are of various types but the kinds in most use today are the crystal rectifier and electron tube rectifier. A crystal detector consists of a metal wire or mineral contacting with a crystalline mineral material, and has the property of letting electric current flow much easier in one direction through it than reversely.

A detector comprises the crystal, its holder, the wire point or "cat whisker," and some means for adjusting the pressure and position of the wire on the crystal. The sensitivity of a crystal depends on the smallest amount of energy which it can rectify as well as its ability to rectify all the Radio energy supplied to it. When two crystals, such as zincite and bornite are used, considerable pressure can be applied to make a more stable detector. There are many mineral and chemical compounds which can be used.

A crystal detector requires no local energy from a battery and operates directly on the Radio frequency input as illustrated in Figure 124. The Radio frequency current flowing in the tuned aerial circuit can flow through the detector crystal, but, with perfect rectification, one half cycle only passes. A condenser is used to collect the direct flowing half cycles from the detector output, and a direct flowing current from this condenser reproduces the original voice current pulsations into the audio output or head phones.

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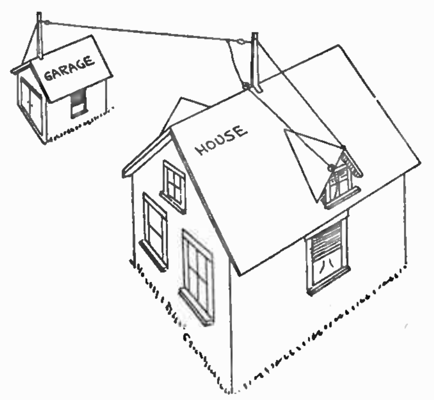

Figure 112

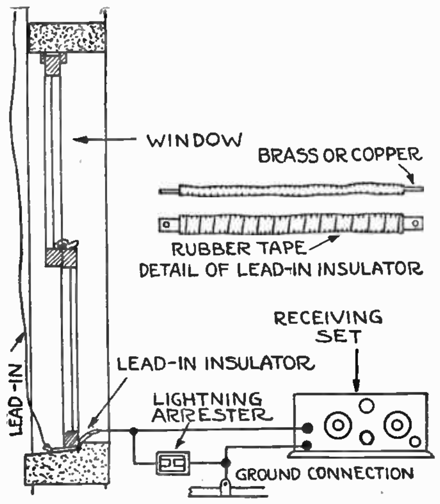

Figure 115

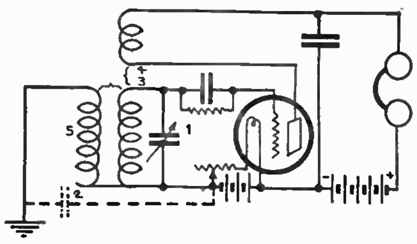
Figure 118

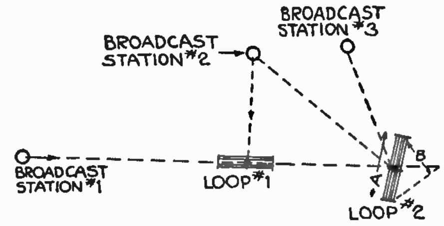

Figure 121

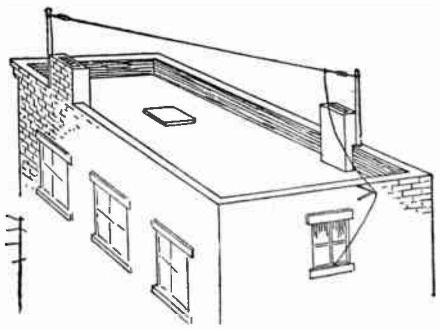
Figure 113

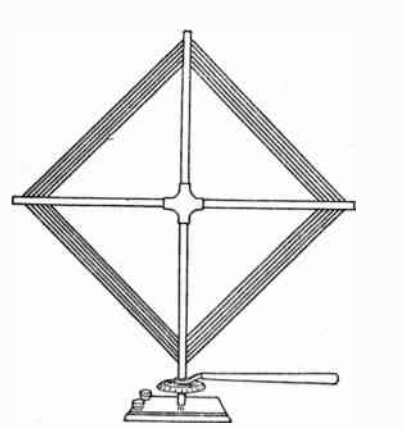
Figure 119

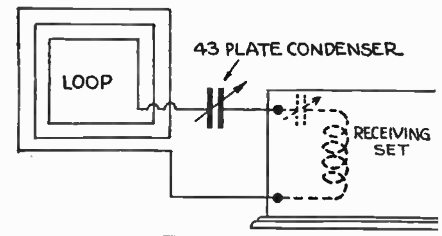

Figure 122

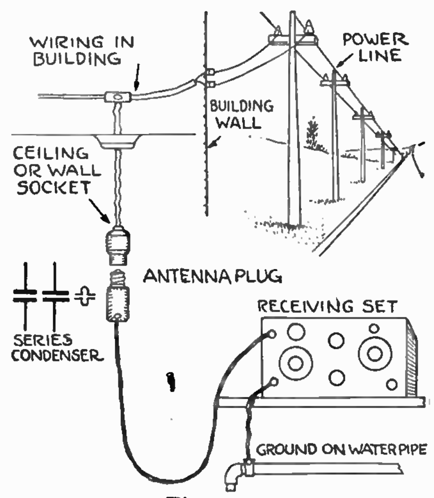

Figure 117

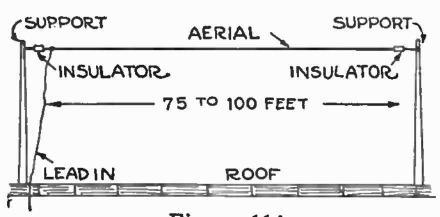

Figure 114

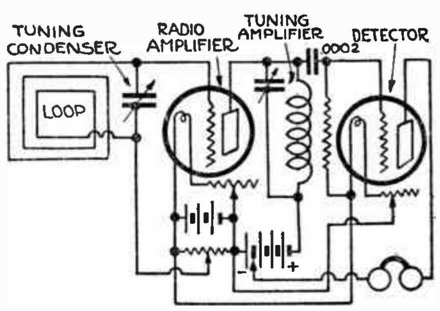

Figure 120

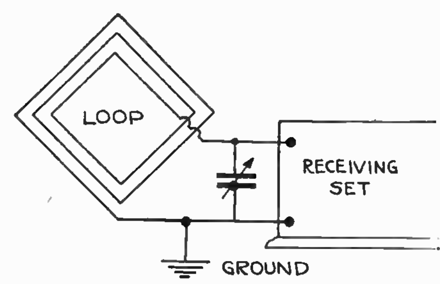

Figure 123

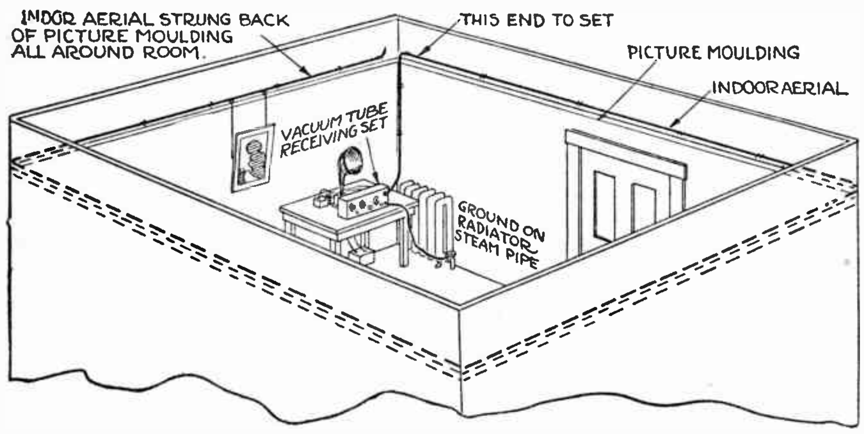

Figure 116

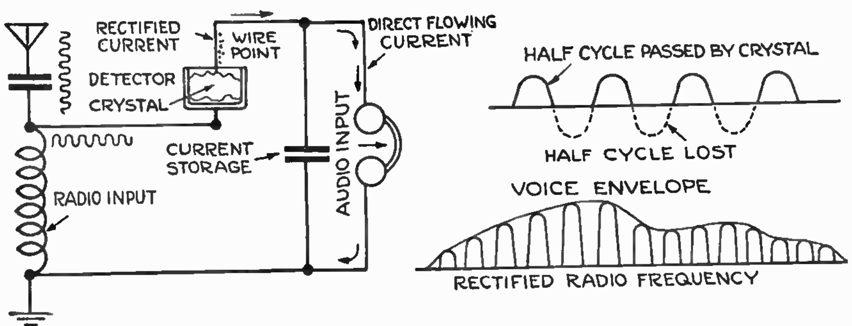

Figure 124

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The reason why the range of crystal set is limited is that it actually operates on the amount of incoming energy received.

Vacuum Tube Detector

The two electrode vacuum tube is little used today and its action is much the same as in the case of a crystal detector. In the three electrode detector tube, aside from rectification there is an energy boosting effect, and in general use of vacuum tubes the detector action is accomplished by a boost in energy value, or amplification.

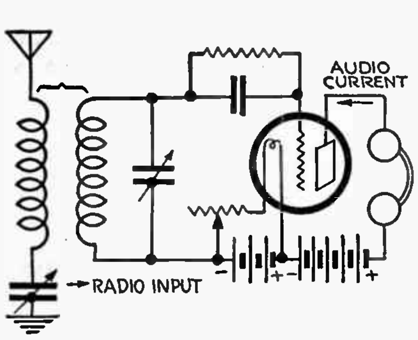


Figure 125

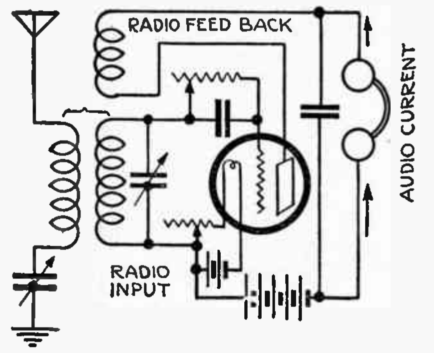


Figure 126

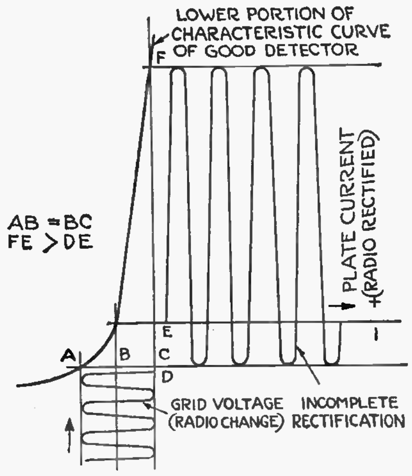


Figure 127

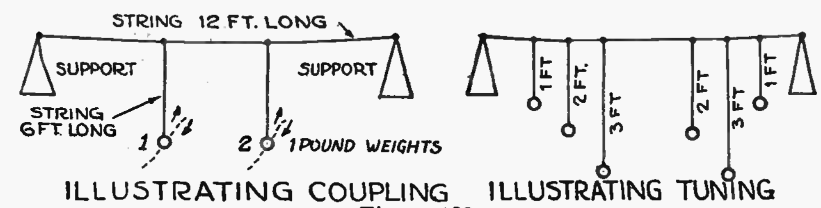


Figure 128

Figure 125 shows a simple audion or vacuum tube circuit in which the incoming Radio frequency energy is partially rectified and partially amplified by repeating into the plate circuit.

There are two general types of vacuum tubes, one highly evacuated (hard) and the other containing some residual gas (soft). The latter are the more sensitive because they can be operated at critical conditions in which a tiny change on the grid means a large change in plate current.

A hard or amplifying tube will work as a detector if the plate voltage from the B battery is increased sufficiently, say to 60 volts or more, as this alters the operating characteristic. This is without grid condenser. Another way to operate hard tubes for detection is to establish grid currents only or in combination with the use of higher plate voltage. The most generally used method, however, employs a grid condenser to insure reasonably good rectifying action. The makers specify instructions for use as a detector. In the case of hard tubes, operating as amplifiers or as detectors without use of grid condenser, the grid circuit is returned to the negative side of the A battery used to light the filaments, but when a grid condenser is used, it is necessary to have the grid return to the positive side of this A battery. In the case of a detector tube or soft tube, using grid condenser, the return should be to the negative side of the A battery.

In the case shown in Figure 126 the detector tube is simultaneously used as an amplifier by means of feedback or regeneration. Hard tubes work fairly well in such circuits but soft tubes are required for best results in circuits such as shown in Figure 125.

At best the detector action or rectification in a vacuum tube is not as perfect usually as in the case of a crystal rectifier. By adjusting the operation so that it occurs at the most favorable condition, as illustrated by Figure 127, at the bend in the characteristic performance curve, the best result is obtained. That is the purpose of the vernier control on the filament rheostat and why also variable grid leaks and, other times, a potentiometer is used, thus obtaining operation on the most favorable detecting portion of the characteristic curve.

Other Types and Combinations of Detectors

The sodion tube is a rectifier in which the beneficial ionization effect of the element sodium increases greatly the sharpness with which the plate current changes with a slight change of grid potential. This makes for a more sensitive detector action independent from regeneration.

Four element tubes are really combined amplifiers and detectors. In any case, the true detector action of the tube determining its sensitivity is the smallest value of Radio current it can operate on and its ability to rectify all of the Radio current input.

Proper Procedure for Tuning

Tuning, while at first difficult to comprehend, is a simple principle. Two different sending stations can each send splashes through the ether to radiate energy to a receiving outfit. Some means is necessary to select the one desired. This is usually accomplished by electrical tuning. This is understandable by reference to mechanical tuning, as in a musical instrument.

By operating the loud pedal of a piano to release all of its strings, one can sing a note with the voice and certain of the strings will respond with the same tone. The other strings will not do this, as the piano string must be in tune for the frequency picked up.

In a mandolin, eight strings are arranged in four pairs. Each pair of wires is tuned to the same note. If one of the wires of a pair is picked, no vibration occurs in any of the wires except the one picked and the other wire of the same pair. Although not touched, the second wire will vibrate as vigorously as the first. If the first wire is stopped with the finger, the second wire will continue to vibrate. The second wire is in tune with the first and coupled to it. The first string corresponds to a sending station and the second wire of the same pair represents a receiving station. The other strings may be thought of as other receiving stations tuned to different frequencies.

The first wire plucked pushes air during each swing to and fro. The pushed air falls on the other wires in the mandolin but the only one it reaches in correct timing to build up motion, is the other tuned wire of the pair. When a differently tuned wire is struck by the wind blast, the tendency to start motion is opposed by incorrect timing of the next successive air blows, so there is no motion.

Weights on Strings Illustrate Tuning

The same principle may be visualized by arranging weights on strings. Figure 128 shows strings arranged to illustrate tuning and coupling. A horizontal string is stretched between two chair supports about 12 feet apart. Three different length strings are tied at one end and weighted to act like pendulums. At the other end of the horizontal string, three other strings corresponding in length are also hung with weights. When one string at one end is set into motion, only the corresponding string at the other end will build up a similar motion, while the others dangle around. If two string pendulums are used with the same dimensions, the principle of tuned coupling is shown, as energy will be transferred by the swing of one pendulum to the other.

Electrical tuning occurs similarly but at much higher frequency. The determination of electrical tuning is comprised in electrical capacity (condensers), and electrical inductance (coils). To increase the frequency of an electrical circuit, either the inductance or the capacity may be reduced. To decrease the frequency at which an electrical circuit can vibrate more capacity or more inductance or both can be put in. This increases the wave length to which it will respond.

The aerial wire itself has inductance and capacity. A coil connected in series with it for simple adjustment, becomes a part of the aerial circuit, so the frequency can be adjusted. When incoming waves strike through the aerial wire electrical current of the same frequency will build up if the aerial circuit is thus tuned to that frequency, otherwise not. Thus it will be appreciated that the aerial circuit may be adjusted to pick up one certain Radio frequency and reject others. In receiving apparatus, this is further extended by additional circuit tuning, and it is possible to tune each individual circuit through the receiving set.

Figure 129 illustrates how a dial setting on a single circuit receiving set can make the detector subject only to Radio frequency of the range tuned to. Suppose you tune to 300 meters. That is the same thing as tuning to Radio frequency of 1,000,000 cycles. If the aerial is short and the circuit has little resistance, the detector will now be affected only by Radio frequency current closely approximately 1,000,000 cycles. Other frequencies can reach the aerial but will only build up feeble Radio currents in the tuned circuit.

If now the aerial is electrically hit by a powerful Radio wave front, the aerial circuit can act like a bell hit with a hammer and oscillations may be caused by forced vibration. A local Radiocasting station may do this or natural pulses called static can act in such manner.

That is why secondary tuning is often resorted to. Referring to Figure 130, dial 2 can adjust the condenser of the grid circuit so that the frequencies accepted from the aerial circuit via the coupling coils, will still further be restricted. If a third dial is used to control the tuning of the plate circuit, further selection is possible.

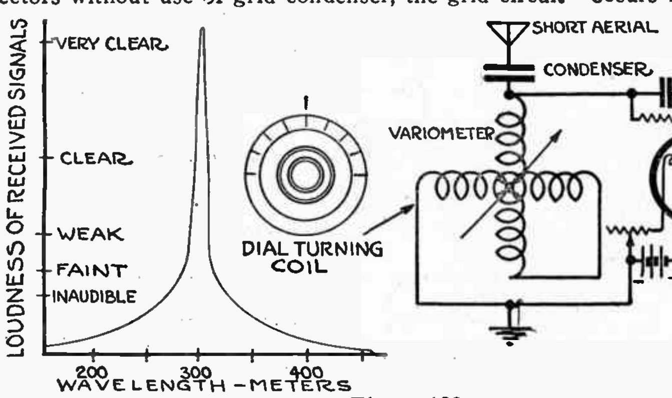


Figure 129

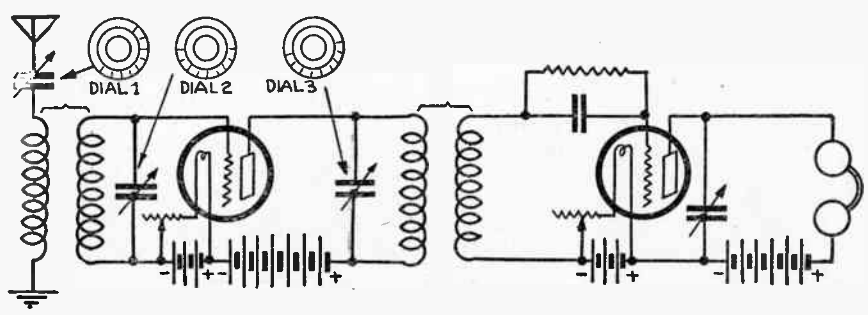


Figure 131

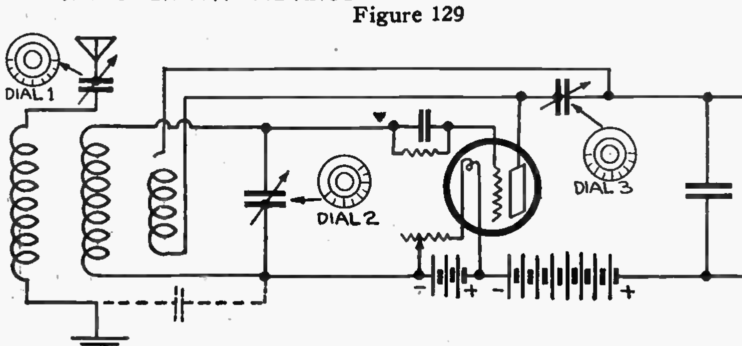


Figure 130

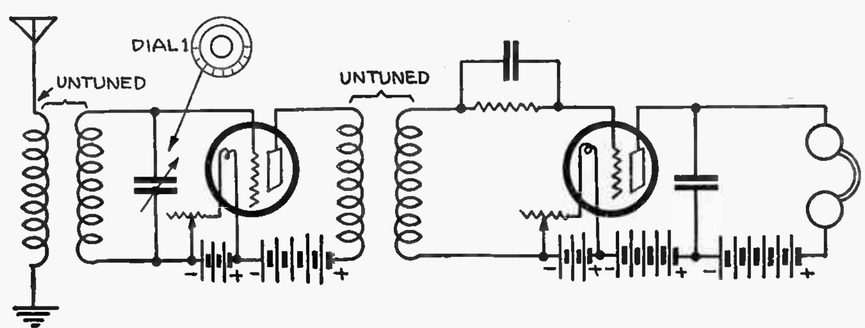


Figure 132

Tuned Amplifier

Figure 131 illustrates a tuned Radio frequency amplifier. Dial 3 adjusts the plate circuit so that a particular frequency is transferred to the detector. Sometimes this is done in two or three stages of amplification, making for fine selection. But if any one stage is improperly adjusted for the desired frequency, a station may not be heard.

Figure 132 illustrates a practical single control for tuning.

Simple Explanation of Radio Reception

"The Factors in Good Reception"—Chapter V

By P. E. Edelman

THERE are various kinds of interference and some of the bothersome varieties are: static; other Radiocasting; spark transmitters; reradiation from neighboring oscillating sets; disturbances from power and signal lines and other nearby transmitters.

This interference angle in Radio limits the all-time reliable range of a receiving set. In practice the use of a short aerial or a loop will enable the listener to avoid interference to a satisfactory extent when a good receiving set is used.

Static or strays affect the detector in a receiving set by means of forced oscillations, despite tuning. An indoor aerial receives less initial energy and a loop, because of its directional effect, is also less affected by strays. Various circuits improve the signal to stray ratio in a receiver. The average listener cannot place a loop down in a well in the earth to get a better signal ratio against static, as shown in Figure 133. It is only in certain localities and for limited times during the year that static prevents full enjoyment of Radiocasting, as the majority of sets can operate on at least local stations regularly, and get programs clearly.

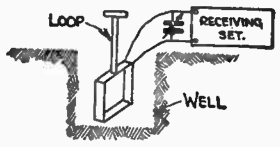


Figure 133

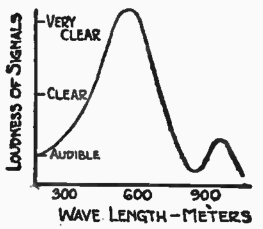


Figure 134

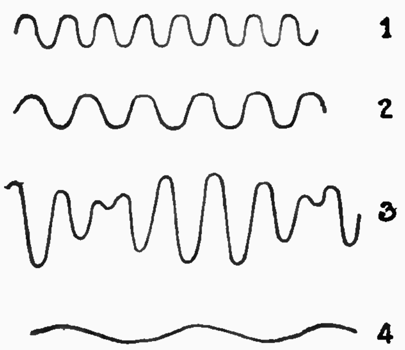


Figure 135

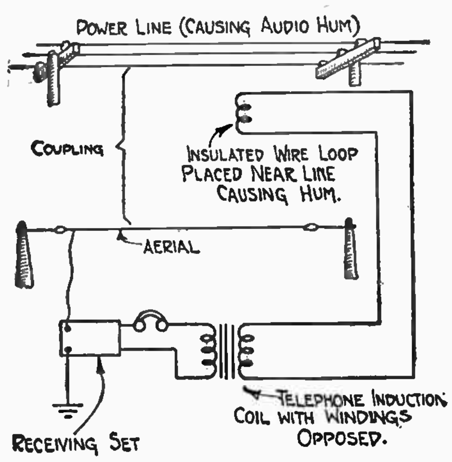


Figure 136

Nearby transmitting stations of the old spark type (non-continuous wave), are difficult to tune out because they transmit over a band of wave lengths and can set up forced oscillations in the receiving outfit. Figure 134 diagrams such condition. By far the most aggravating interference to the listener with a long distance outfit is caused by neighbors using oscillating receiving sets. Such sets set up interference heard as whistling swishes.

When listening to a distant station announcer, one can hear a swarm of tuning whistles transmitted by oscillating sets of neighobors. If you use a regenerative receiver of the autodyne type you do this every time you couple the plate circuit close enough to blur the incoming program, and as partial punishment, your own reception is susceptible to the same thing. But if you are careful not to use too much feedback, your set, especially if it is of the two or three-circuit variety, is still a respectable member in the Radio community. Figure 135 illustrates how a Radiocast frequency 1 can combine with a local frequency 2 of a neighbor's oscillating set, to set up beats 3. These beats may be heard as an audio note 4, or if of certain frequency and correct phase can even oppose the incoming frequency 1. There is a way to prevent such interference at the receiving end but the majority of sets in use today are affected by it.

Power Line Hum and Directional Selection

Simply grounding a receiving set will sometimes stop hum coming from nearby power lines. Sometimes a balancing wire can be used as shown in Figure 136. It is only in certain localities that stopping and starting of elevator motors, etc., will be heard.

In tuning out local stations other than by tuning or frequency selection, the most useful means which can sometimes be employed is illustrated in Figure 137. A loop receiver is directional and as shown, station 1 can be heard while station 2 at similar wave length and station 3 at different wave length are simultaneously Radiocasting.

Use Wave Traps

Wave traps are in the nature of a makeshift to improve the frequency selection (tuning) of a receiver. A simple form consists of a coil and condenser coupled to, in series with, or connected in parallel to the receiving set. Figure 138 shows the series connection. The wave trap is tuned to cut out undesired frequency after which the set is returned to the desired station, provided that it is at a different frequency. Figures 139 and 140 show other connections of this character. Often a distant station can be heard clearly through local stations operating at different wave lengths whereas, without the trap the set is set into forced oscillations so that the local program drowns the others out.

A better way is to use a tuned amplifier ahead of the receiver as for example in Figure 141. This also boosts the energy available for the receiver.

If you already have a set with Radio frequency amplification using fixed or untuned transformers a wave trap can be inserted in series in one circuit as shown by Figure 142.

Probably the best way to work through local stations is to use one or more stages of tuned Radio frequency amplification. Or if you still want to hear a distant station very close in wave length to the local station without too many tuning control dials, the loop is the thing when you are located suitably for the necessary selective pointing of the coil.

The Power Voice of Radio

Amplification may be employed in a Radiocast receiver to amplify at either Radio or audio frequency or both, but it is necessary to avoid distortion in the result. When amplification is employed the original energy received need only be sufficient to operate a grid circuit, as any desired amount of increase can be built up therefrom.

While mechanical amplification is possible, the main reliance in Radio outfits is on electrical amplification, and more particularly on the use of vacuum tubes.

As illustrated in Figure 143, the initial grid voltage on the input is adjusted to take advantage of a straight line portion of the characteristic operating curve of the tube. This requires that the grid be maintained negative in certain amplification circuits, though it is also possible to operate on the positive side of the curve. Any part of the curve can be used if the plate current will repeat without particular rectification.

The coupling means between the stages of an amplifier act to a certain extent as frequency traps, so that careful design is required to avoid amplifying one range of audio frequency much better than an adjacent range. A few curves are shown in Figure 144 by way of example. Curve 1 is for an amplifier which is nearly uniform in amplification over the usual audio range of frequencies, whereas curve 2 is for an amplifier which amplifies better for certain frequencies than for others. With a poor design the amplification change with frequency may be marked as indicated by curve number 3, so that for example, high notes in the orchestra would reproduce very faintly and out of proportion to others.

Radio Frequency Range

Similarly when fixed or untuned Radio transformers are used to couple amplifier tubes, there are certain ranges in which more amplification occurs than at other Radio frequencies. Figure 145, number 2, indicates a good curve for a fixed Radio amplifier, whereas curve number 1 shows the curve usually obtained with one stage of fixed transformer coupling.

Any two coupled coils with very little self capacity or condenser effect can be used as a Radio transformer. Usually such fixed transformers are built as indicated schematically in Figure 146. Number 40 enameled wire may be wound in a series of sections, as shown, on an insulated bobbin which is grooved. With an air core, there is a tendency for such a transformer to become resonant in connection with the self capacity of a vacuum tube, within a certain frequency range. Sometimes a variable condenser is shunted across one of the windings for tuning purposes. The more generally used type of Radio transformer of the fixed variety will have a tissue-thin laminated iron core or one made up of powdered iron. Such a core has two effects, (1) directing the lines of force, and (2) capacity action, such that the transformer so constructed will respond over a wider range of frequencies. The resistance in the windings also assists in keeping the value of oscillating currents minimized in the windings. The dimensions of such transformers are kept small so that the magnetic field will be limited.

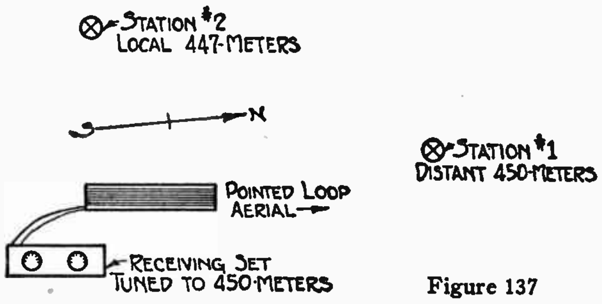


Figure 137

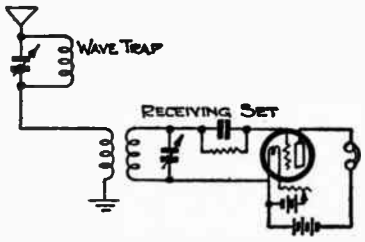


Figure 138

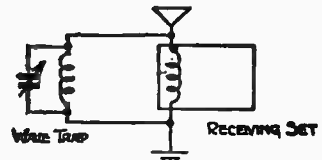


Figure 139

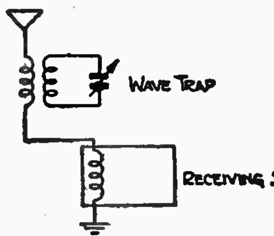


Figure 140

As indicated in Figure 147 two variometers can be continuously coupled so that a transformer built in such manner may have its frequency range adjusted. Another type in much use requires a variable condenser to adjust the frequency range as in tuning circuits.

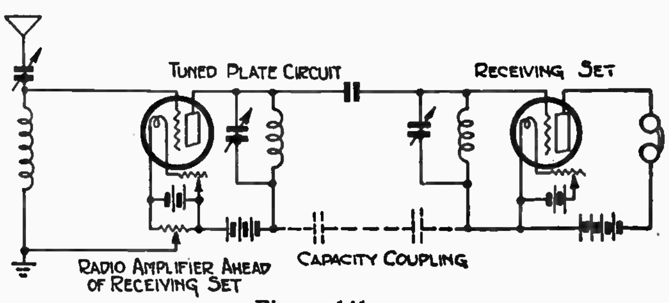


Figure 141

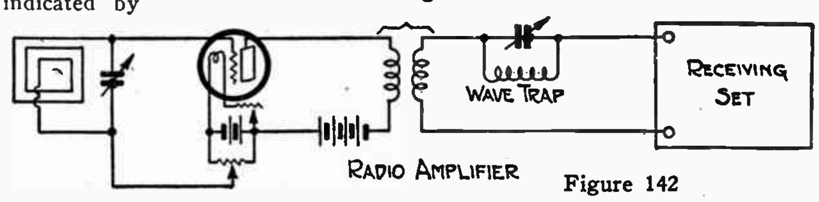


Figure 142

Construction of Audio Transformers

An ordinary type of audio amplifying transformers is shown in Figure 148. The variety shown in Figure

(Continued on next page)

(Continued from preceding page)
149 is surrounded by the iron core so that the magnetic field is limited to the core. Air core audio frequency transformers are possible but would be bulky in size for the same result. A small dimensioned transformer using bent-over silicon steel wires for a core is indicated in Figure 150. Transformers of this type may be mounted close together. Figure 151 indicates the leakage flux or lines of force from one transformer cutting the winding of an adjacent transformer. This causes hum or howl in certain amplifying circuits. Low ratio windings, as 1 to 3, are less likely to cause distortion than high ratios, as 1 to 6 or 10.

Vacuum tube amplifiers are spoken of in terms of stages or steps of amplification. Either a transformer, or an impedance circuit, or a resistance circuit may be used to couple one or more stages. The object of coupling is to convert the plate energy from one tube into an effective grid operating input for the next tube so that amplification will multiply through the stages used. Figure 152 shows transformer input to the first tube and impedance coupling to the second tube. The impedance coil is not in as much favor as the transformer for coupling purposes. Figure 153 shows resistance coupling. The plate current passing through a high resistance causes potential at the terminals of the resistance and this potential is used on the grid of the next stage. Resistance coupling affords exact reproduction of the pulsations in plate current from one stage to the next stage, but the amplification obtained is less per stage than with transformer coupling methods.

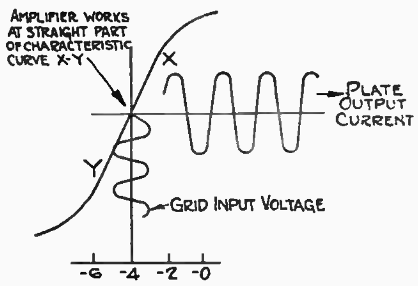


Figure 143

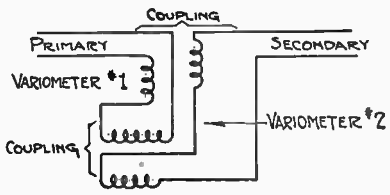


Figure 147

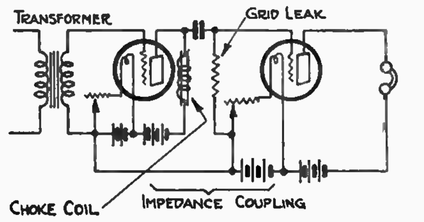


Figure 152

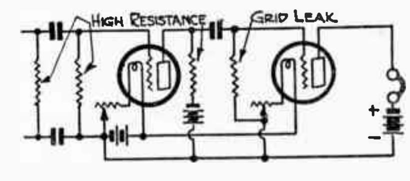


Figure 153

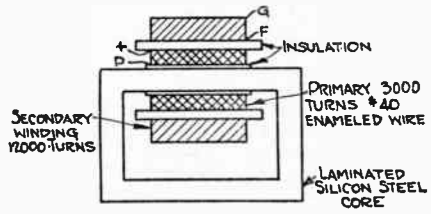


Figure 148

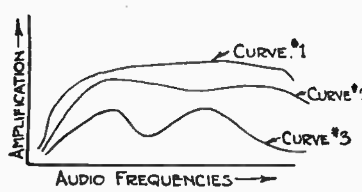


Figure 144

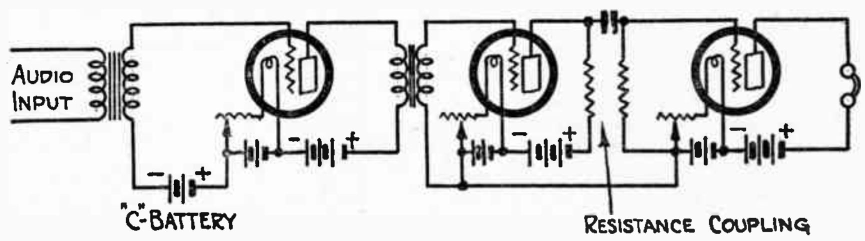


Figure 154

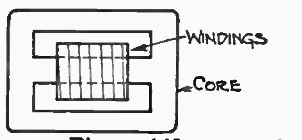


Figure 149

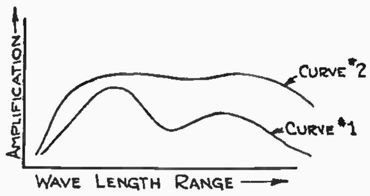


Figure 145

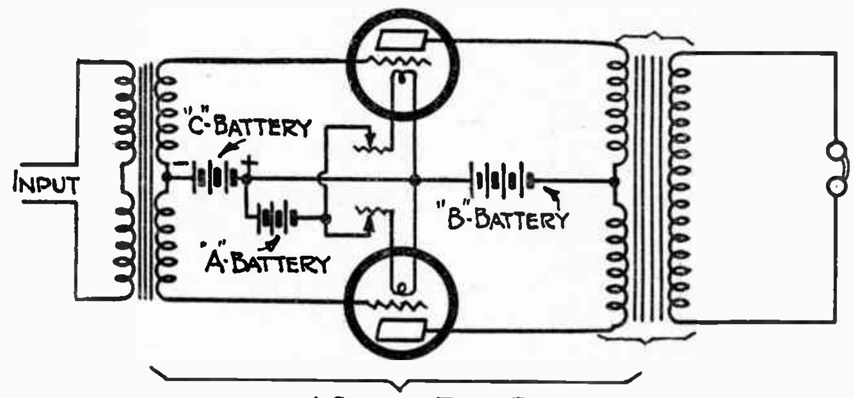


Figure 155

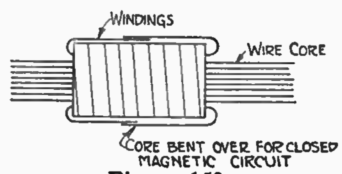


Figure 150

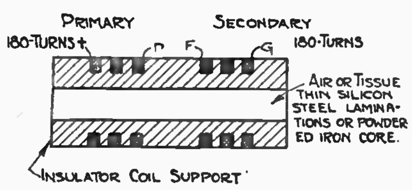


Figure 146

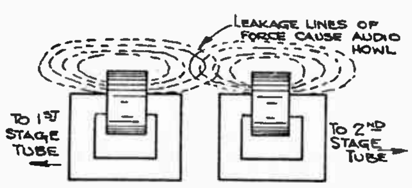


Figure 151

Uses and Benefits of C Batteries

A so-called "C" battery keeps the grid at negative potential to secure a favorable initial operating input condition on the grid. It also insures operation on a favorable part of the curve with minimum consumption of plate current. A C battery will sometimes reduce the volume obtained but clear it up. Figure 154 shows a C battery used in the first stage, though the same C battery might also be connected in the second stage. For a third stage, resistance coupling may be used. Sometimes the third stage of an audio amplifier will be operated on the so-called "push-pull" plan shown in Figure 155. The vacuum tubes are used as one stage and the potentials are balanced so that clear amplification is obtained. A C battery is used to keep the grids at initially favorable potential.

The amount of amplification of a stage of push-pull amplification is not much more than from one tube alone, as such will operate with one tube removed, but the reproduction is clearer. When using two stages of amplification the same B battery can be employed and this is true for three stages if the same battery is not used for supplying the detector tube, but there is an advantage in using a separate B battery on the last stage of an amplifier, particularly if this is the third stage. The last stage of an amplifier can be worked with much higher B battery on the plate than the first or second stages, if a suitable C battery is employed, and such an amplifier is termed a power amplifier, B battery voltages suitable for usual operation are, 1st stage 40 to 60 volts, 2nd stage 60 to 90 volts. If a third stage is used, 90 to 150 volts may be employed but a C. battery is needed for voltages exceeding 60 volts. High voltages are not necessary for ordinary loud speaker reproduction, as 60 to 90 volts suffices.

A plate current of about ten milliampers can be had from the output of a two stage amplifier using 90 volts B battery, and is sufficient to operate the usual type of loud speaker. For so-called power amplification, as much as 5 watts of energy may be sent through a loud speaker if it is built to stand this much, but ordinary headset units will sometimes break down when too much input current is used. Figure 156 shows a push-pull stage combined with an ordinary stage of amplification which requires careful balance for operation.

The purpose of amplification is to get enough energy to operate the desired reproducer such as a loud speaker.

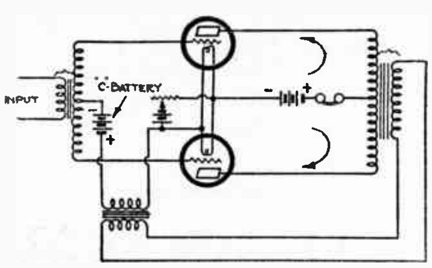


Figure 156

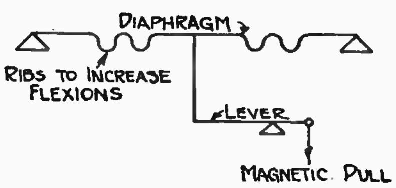


Figure 159

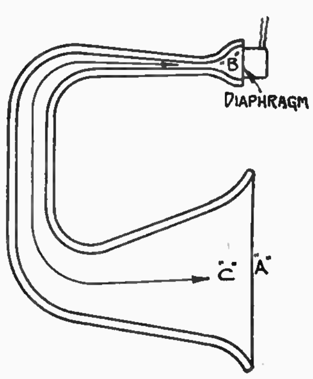


Figure 163

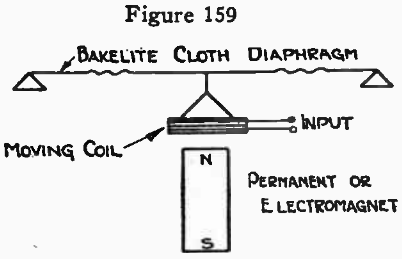


Figure 160

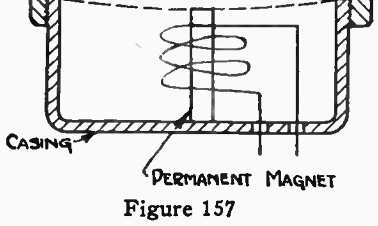


Figure 157

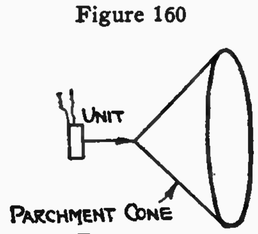


Figure 161

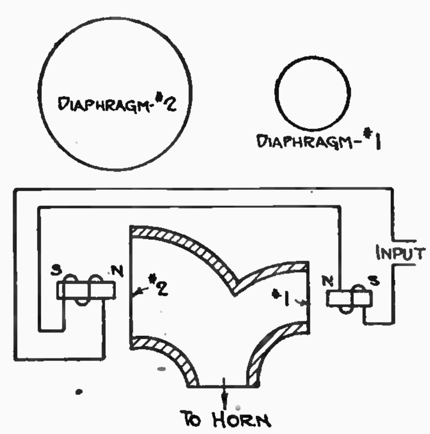


Figure 164

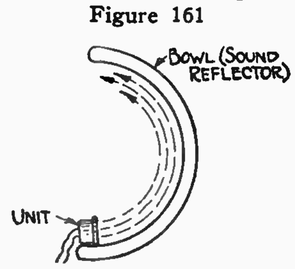


Figure 162

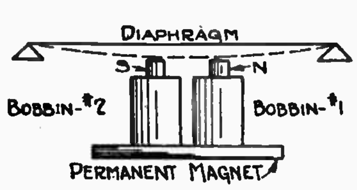


Figure 158

Reproducers of Radio

Everything that has gone before, from the time that the original sound is broadcast until it passes through various carrying and amplifying mediums, aims to actuate a reproducer. Common reproducers are known as headsets or earphones, and loud speakers. The finishing touch of Radio comes at the reproducer where electrical currents are converted back into the form of sound.

Broadcast listeners include some people who are satisfied with getting some distant station, even if not clearly, just to hear that a program is going on. Others are more interested in getting clear reproduction, if only from a much nearer station from which an entire program can be understood without interruption.

An earphone or telephone receiver comprises a diaphragm with electromagnetic means to move it. The diaphragm communicates this motion via the air to

(Continued on next page)

(Continued from preceding page)

the ears of the listener. A simple arrangement is indicated in Figure 157. A large number of turns of fine wire are wound around a permanent magnet carried in a casing. A thin iron diaphragm is clamped against the casing so that the magnet and winding can pull on it via magnetic lines of force. The diaphragm can thus be flexed each time a little changing pulse of current is sent through the winding.

Most earphones are built with double magnet windings as diagrammed in Figure 158. A ring-shaped permanent magnet has poles N and S each carrying a bobbin winding. Two units are connected in series, one complete unit for each ear. In connecting-in additional sets of earphones, the series connection is preferably used. Telephone receivers are very sensitive. That is why you sometimes can hear the carrier of a distant station without getting the voice clear, if at all. In such case your local receiver heterodynes its oscillations with the incoming feeble frequency received, but the incoming frequency is not carrying enough energy to properly actuate your detector or rectifier.

Headsets should be connected so that the battery or plate current aids the magnetic field of the permanent magnets and such makers label the terminals for this purpose. By trial, you can determine which connection gives best results. Some earphones and many types of loud speakers use a mica or other diaphragm connected by a mechanical linkage or lever to the actuating magnetic pulling means, as indicated by Figure 159.

One form of loud speaker unit employs a moving coil and this coil is connected to move the diaphragm. The input current is sent through this coil under the influence of a permanent or electromagnet and operates the diaphragm as usual.

Loud Speakers Without Diaphragm

There are some types of loud speakers using cones or other sound surfaces besides the well known diaphragm. Sometimes a parchment cone is used as in Figure 161. Receiving reproducers of this character usually employ no horn. Other kinds of speakers are built up by using reflecting surfaces. A simple form comprises a unit facing a bowl or sound reflecting surface, per Figure 162.

Most loud speakers employ a horn. A horn has the effect of concentrating and focusing the sound waves so that an apparent amplification results. A horn is indicated in Figure 163. The mouth A is sometimes called a bell and the length B should be carefully curved and tapered to get good accoustical results.

It is possible to use two diaphragm inputs for a horn as indicated in Figure 164 and this might be an advantage if one diaphragm is large and the other small, so as to get more uniform frequency reproduction. Any diaphragm tends to respond to certain frequencies much better than to others, so that the best reproducer is one which minimizes this effect. The natural vibration of a diaphragm can be enhanced to the detriment of reception if a tinny horn with its own natural vibration period is used.

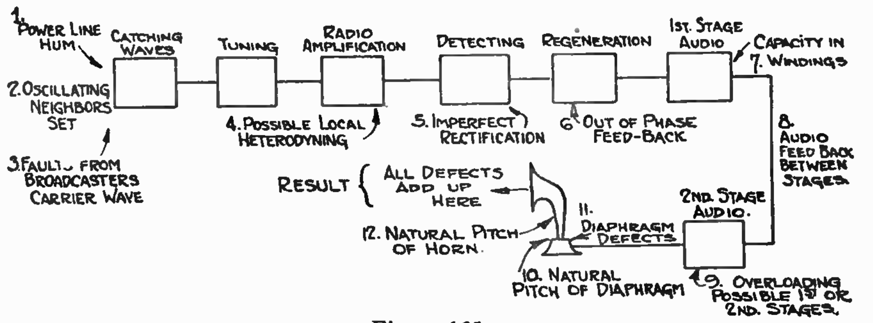


Figure 165

In Figure 165 there is a diagram of the sources of distortion and noise in a typical receiving outfit. One or more or all of these can partially affect or spoil clear reception.

Though your own outfit differs from the example indicated, one or more of the causes may possibly be recognized in any type of receiver.

It should be clear that the various transformations in form of energy employed in Radio, starting from the Radiocaster, and extending to the reproducer, mean loss in form and value. The value is easily made up by supplying local energy via amplifiers but the form loss repeats.

Hearing depends on the individual. Some persons have a range of frequencies within audibility to which others are deaf. Many people hear better with one ear than with the other. The pair of ears was intended for the so-called binaural or directional effect. A sound coming from your right reaches your right ear before it comes to the left ear and you recognize this difference in time value or phase and can thus judge direction.

Constant prolonged use of ear phones is tiring. Do not wear a tight headband nor keep the earphone tightly pressed against your head for long periods.

Simple Explanation of Radio Reception

"The Hero Circuits of Radio"—Chapter VI

By P. E. Edelman

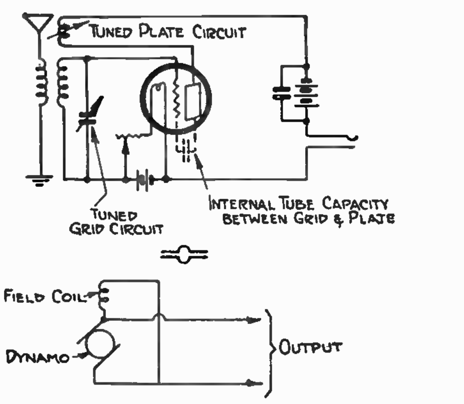
A RADIOCAST listener may wonder where the Greek name circuits come from. Says one, "Old man DeForest started it by calling the vacuum tube 'Audion'." Someone decided "dyne" would sound nice on a new variation, and, so a whole family of "dyne" circuits is begotten. Some of the "dynes," "flexes," etc., would hardly recognize their third cousins of the tribes, so the average listener soon decides that the name is less important than the "works." Another flock of so-called "hero" circuits are named after the designer who happens to publish a circuit. Some writers make sarcastic remarks about such circuits, systems, etc., as they are much press agented or trade advertised, but this is hardly polite. They will tell you for example that the popular Reinartz circuit is nothing but a regenerative hook-up, but overlook the fact that numbers of users regard it as an improvement. The much discussed Armstrong circuit could in the same manner be called, "just another audion circuit."

Regeneration as an electrical principle is very old, dating back to the days of Joseph Henry. The usual dynamo employs regeneration in building up a magnetic field when the armature sends a weak current through the field to react on the armature, etc., etc., over and over again until the field attains full strength. The howling or singing microphone formed by putting a receiver against a telephone transmitter comprises regeneration. Regeneration itself is a principle of nature.

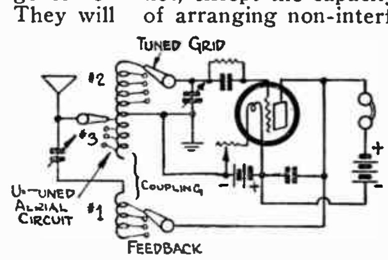
So there is a legitimate field for attempts to improve Radio circuits by new combinations of principles and means. Some of the possible combinations as well as principles in use in various popular circuits will now be pointed out.

What One Tube Can Do

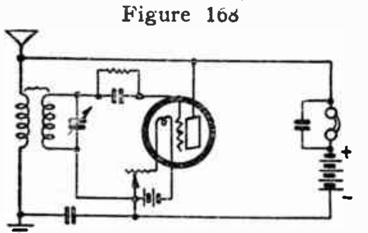
Probably many listeners have wondered why a single tube could not perform all the functions of a series of tubes. Why not amplify, detect, amplify, etc., all with one tube? There is no theoretical reason why not, except the capacity of the tube and the difficulty of arranging non-interfering circuits in correct phase relation. Aside from the cost of the tubes and the upkeep, boiling down of the number of tubes is no special advantage, unless simplicity results.



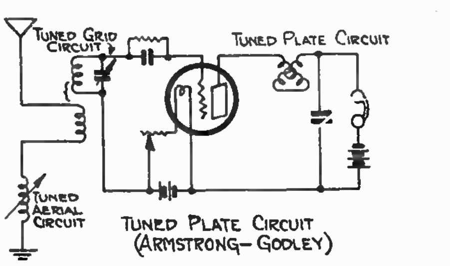
Regenerator
Figure 166



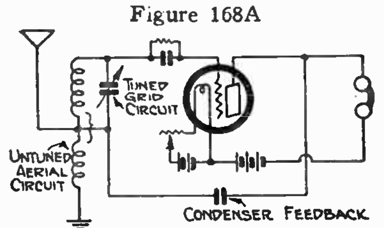
Reinartz Regenerator
Figure 168



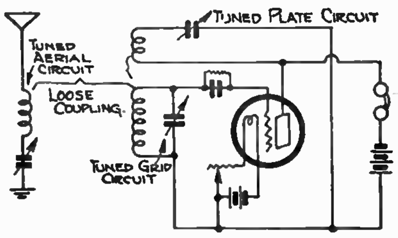
Single Control Regenerator (Re-radiates)
Figure 168A



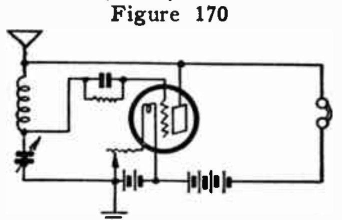
Tuned Plate Circuit (Armstrong—Godley)
Figure 167



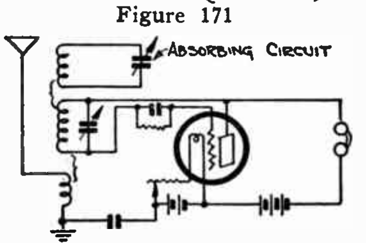
Condenser Regenerator
Figure 169



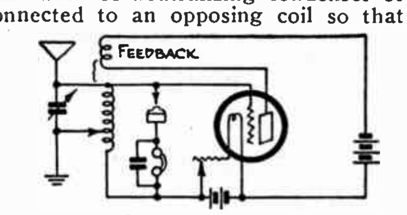
Armstrong-Weagant Feedback
Figure 170



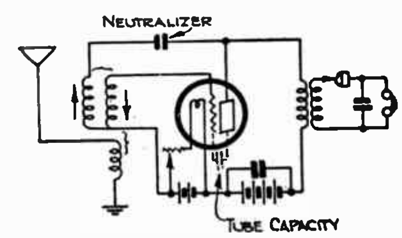
Ultra-Audion (De Forest)
Figure 171



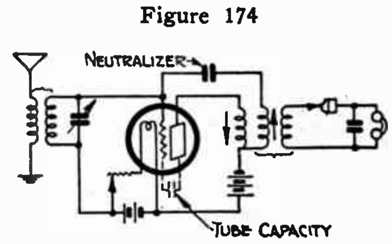
Austin-Absorber
Figure 172



Crystal Detector Added
Figure 173



Rice Neutralizer
Figure 174



Hazeltine—Jones Neutralizer
Figure 175

Figure 166 indicates a typical regenerative receiver with an equivalent dynamo circuit. Feed back can be inductive or capacitative coupling. Such a receiving circuit can be made to radiate energy.

Figure 167 shows a popular type of tuned circuit. Another popular type is indicated in Figure 168, employing an untuned aerial circuit. Probably the circuits of this general kind in use today are a large portion of all the sets in the United States. The form shown in Figure 168A reradiates, as is typical of all such circuits.

Figure 169 shows another form of such a circuit. One way to stop reradiation is to use loose coupling between the circuits, as shown by Figure 170. A sensitive capacity coupled circuit is pictured by Figure 171, and a variation of this type is shown by Figure 172.

One way to add a crystal detector of the fixed type is shown in Figure 173, and other circuits utilizing the amplifying ability of one tube are shown in Figures 174, 175, 176.

Figure 174 also illustrates a well known way to neutralize the tube capacity between the filament and grid of a vacuum tube. A neutralizing condenser of small size is connected to an opposing coil so that the tendency of the tube to self oscillate is stopped.

The neutralizing circuit can be in the plate circuit as indicated by Figure 175. Figure 176 indicates how tuned feedback can be employed after the tube capacity has been neutralized. The output of such circuits can go to additional stages when desired.

In Figure 177 the Radio output is rectified by a detector and put into the grid circuit as an audio current. Another reflex circuit is shown by Figure 178. Such circuits can be made to give nearly the equivalent of one stage Radio plus one stage audio amplification added to a detector.

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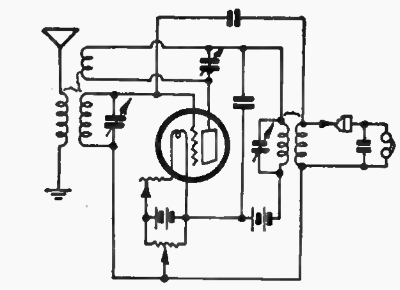
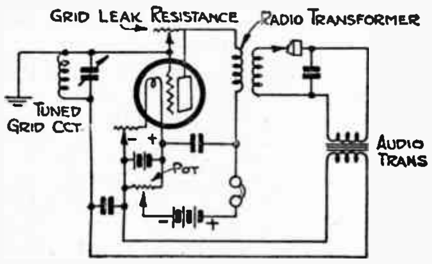
Link circuits are not much used in Radiocast reception but the principle is shown in Figure 179. This will lessen tendency of oscillating receivers to reradiate energy and also affords desirable selectivity.

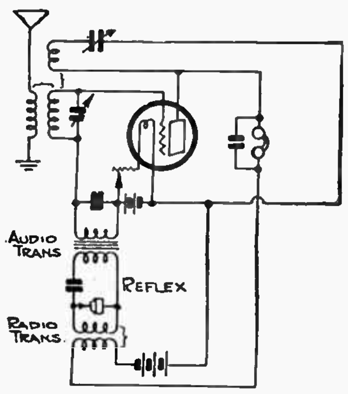
Super One-Tube Circuits

Another class of circuits aims to increase the amount of regeneration which can be used on one tube. Familiar examples are indicated by Figures 180 and 181. In such circuits, a self oscillating circuit is set up in the tube to modify the grid potential to permit using regeneration beyond the point which otherwise would not be feasible. Such circuits are effective when carefully adjusted. The principle of operation is diagrammed by Figure 182. An initial grid potential variation is maintained so that the amount of regeneration may be increased.


TUBE CAPACITY NEUTRALIZED
Figure 176



REFLEX (PHANTOM INPUT)
Figure 177

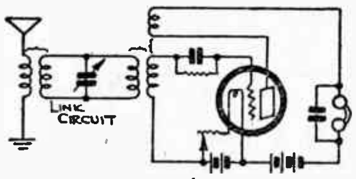


REFLEX WITH REGENERATION (LATOUR RE-DESIGN)
Figure 178

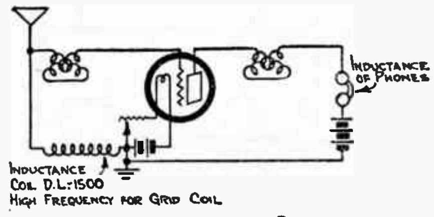
Many circuits pointed out as single tube arrangements can have Radio amplification added ahead or audio amplification afterwards to make the usual forms of multi-tube machines.

Stabilizing Radio Frequency Circuits

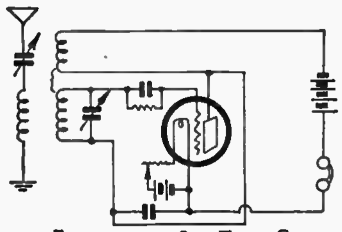
Radio frequency amplifying circuits require some means of stabilizing. Several ways in which this is done in modern circuits will now be shown. Some forms require an adjustment. Thus in Figure 184, grid current is initially passed between the grid and filament for stabilizing purposes. This is accomplished by means of a potentiometer. Sometimes a small condenser C is used to by-pass the resistance of the potentiometer to Radio current. Figure 185 shows series resistance in one of the circuits to limit the current and prevent oscillations building up.

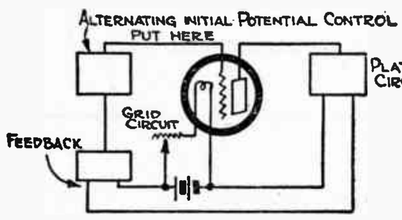


LINK CIRCUIT (REGENERATIVE)
Figure 179



AUTOPLEX ONE TUBE SUPER
Figure 180


FLEWELLING ONE TUBE SUPER.
Figure 181



SUPER-REGENERATION
Figure 182

One tube can do any of the following and so combinations are possible. A diagram of possibilities is indicated by Figure 183.

1. **Amplification, Radio.**
2. **Amplification, audio.**
3. **Self oscillation.**
4. **Heterodyning.**
5. **Detecting.**
6. **Reflexing, Radio or regeneration.**
7. **Reflexing, audio.**
8. **Reflexing of heterodyned frequency output.**
9. **Phase adjusting.**
10. **Super-regeneration.**

To utilize more than one principle, the proper initial operating conditions, grid potential, and plate voltage must be employed. In general, to get loud volume from one tube, the initial plate voltage must be raised so that five to ten milliamperes plate current can flow. This will permit loud speaker output but limits what else can be done at the same time. Complex circuits become difficult to handle.

The aim of the designers for listening apparatus is to please the Radiocast listener. The general aims are to simplify operation, economize initial cost and upkeep, extend the range of reception, increase selectivity, mitigate interference, reduce distortion, and improve appearance.

Figure 186 shows how stabilization is obtained without the potentiometer in some reflex circuits. An audio input circuit feeds back into the first tube from the plate circuit of the second tube. The transformer used for this audio input into the first plate has capacity in each winding and capacity between its windings—condenser effect. In such a circuit, the potential distribution and coupling of proper value can stabilize the Radio amplifier against self oscillation.

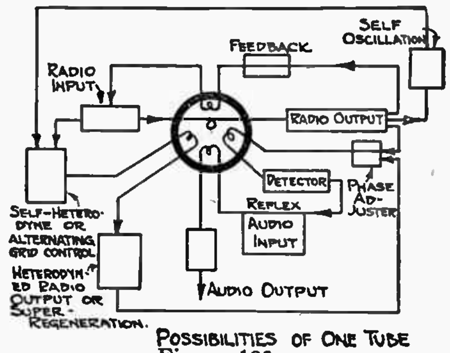
Some circuits use a draw-off circuit or wavetrap, number 1, Figure 187, to take energy from the circuit and stabilize operation. Figures 188 and 189 are examples of coupling stabilization. Some times two or more stabilizing means are combined. Figure 190 shows a very stable form of circuit, automatic in operation.

Figure 191 shows a reversed feedback which may be adjusted to overcome oscillation in the Radio amplifier and permit use of a tuned plate circuit output.

Figure 192 shows another form of stabilization in which non-tuned input coils, number 1, and number 2, are coupled to tuned circuits number 3 and 4. By using very few turns of wire on the input coils the tendency for self oscillation is avoided.

Reflex circuits are of various forms; a simple type is shown in Figure 193. The audio output from the rectifier or detector is fed back as input to the amplifying tube which also has a Radio frequency input and output circuit. Combinations are possible in which two stages of amplification at both audio and Radio frequency are practicable with economy of tubes. Such circuits will cause difficulties if not properly matched up to secure correct phase or time value of the input and output energies.

Figure 194 illustrates the general plan of both input and output with the Radio frequencies separated.



POSSIBILITIES OF ONE TUBE
Figure 183

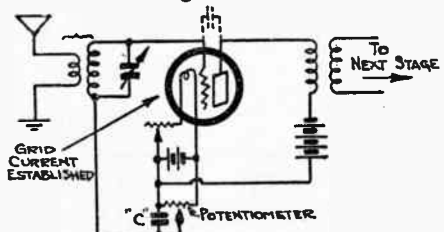


Figure 184

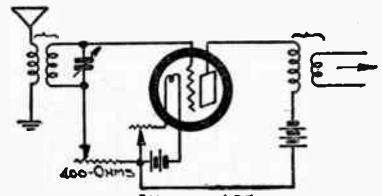


Figure 185

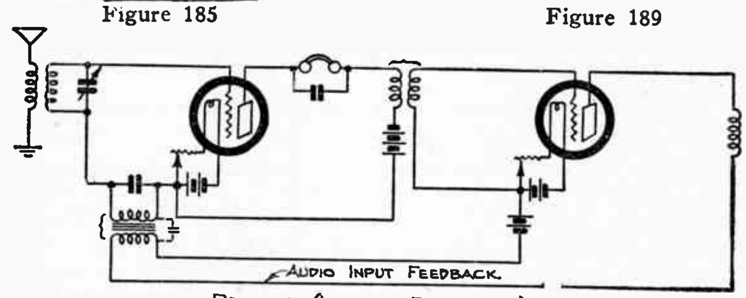


Figure 186 REFLEX (LATOUR RE-DESIGN)

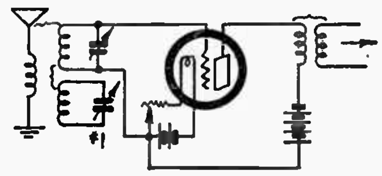


Figure 187

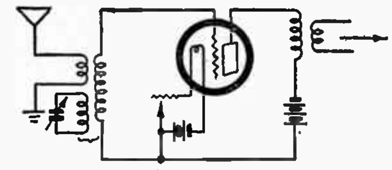


Figure 188

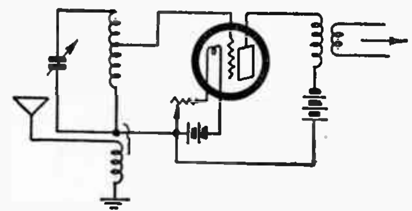


Figure 189

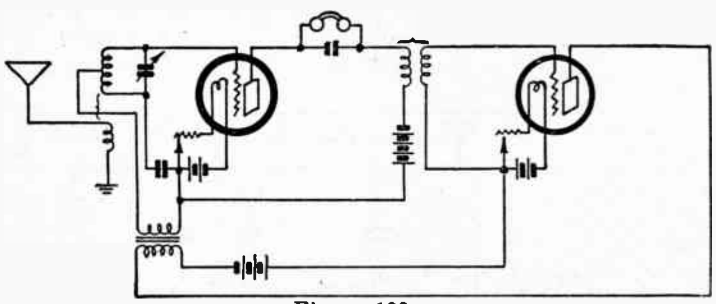
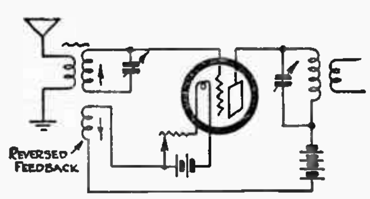


Figure 190



SUPERDYNE
Figure 191

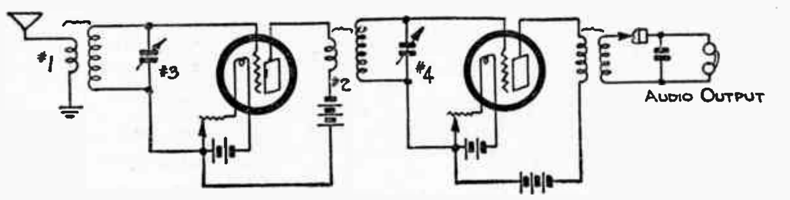


Figure 192

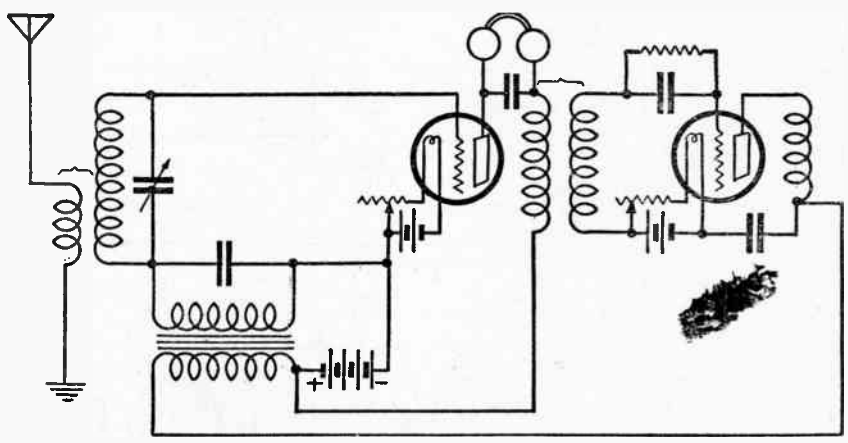


Figure 193

Units of this kind can be connected to similar units or other circuits.

Suppose two tubes are used to afford two Radio and two audio stages. Ordinarily this will not quite equal the operation as if four tubes were used, and with poor design, there will be much energy loss through the capacity in the audio circuits.

A much advertised form of tuned Radio frequency amplification circuit is shown by Figure 195, and avoids self oscillation of the amplifier tubes by means of small neutralizing capacities, which connect opposing windings of coupled coils. For example if the primary coil has fifteen turns of wire the secondary may have sixty

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turns but a tap will be taken off at the fifteenth turn and run to the small neutralizing condenser to oppose the potential of the primary coil acting through the natural tube capacity.

Super-Heterodyne

Another type of circuit designed to get around the difficulty of Radio amplification at short wave lengths caused by intertube capacity between the grid and filament of a tube is called the super-heterodyne. The general scheme is to heterodyne a locally generated Radio frequency with the incoming Radio frequency to change the frequency to a slower Radio frequency which may be amplified. This third Radio frequency is selected at some frequency at which the natural tube capacity has slight if any detrimental effect. The third frequency is then amplified through transformer or resistance or impedance coupled tubes which can amplify the third frequency but have no appreciable effect with the initial high frequency of the incoming waves. Figure 196 indicates one form of this circuit and Figure 197 shows the principle. Usually one dial is used to tune to the incoming frequency and a second dial is used to tune the local oscillator up or down from this frequency by an amount for which the Radio amplifier is designed, in this example 3000 meters or 100,000 cycles. Most outfits of this kind use from 6 to 10 tubes altogether.

Super regenerative circuits are illustrated in Figure 198 and their general purpose is to modify the grid potential to permit increase of regeneration beyond the normal limit. Such circuits usually are difficult to operate without having a high pitch constant note caused by the grid control frequency used.

Multi-tube reflex circuits are shown by Figures 199 and 200. It is sometimes an advantage to have the first stage Radio amplifying only and the last stage as an audio amplifier only. There are combinations withother forms of circuits, and in general the main difference is in saving tubes and operating current to use them. The cost of assembling a reflex circuit is about as much as if more tubes were used.

In Figure 201, I show a possible combination for amplifying two different Radio frequencies in the same tube. One advantage of amplifying at Radio frequencies is that the range is increased and audio frequency distortion losses avoided.

There is such a thing as too much complexity in receiver design. At one time navy designers were favorable to twelve or more control dials, and difficulty was found in training operators to manipulate them.

Three control dials tax the average Radiocast listeners' ability. Two are easier to run. One dial is simpler.

Another thing about very sensitive circuits is that they are sometimes too sensitive for best practical results. In listening to very distant stations with such a receiver you not only get the program but much else; static, reradiating squealers, etc., so that at times the results may be disappointing.

Mechanical Coupling for Simplicity

One way to retain the advantage of multiple tuned circuits with fewer dial controls is suggested by Figure 202 and could for example be applied to the last two tuned Radio stages of a set such as is called "neutrodyne." As shown, two insulated condensers are simultaneously varied to tune two different circuits. In order that slight variations may be taken care of, the motion of one condenser has five to ten degrees play each way before carrying the other to the next position. This can be accomplished as shown by Figure 203 or embodied in the control dial.

Radio amplification and regeneration, reflex and regeneration, tuned Radio and reflex, super-heterodyne and reflex, reflex and super-regeneration and double super-heterodyne.

The operating ability of a tube limits the circuits which can be practically applied. The plate current due to the plate battery limits the output current. A certain minimum operating energy is necessary to actuate the grid and after a certain increase in the energy applied to the grid circuit. the tube overloads, when its limit is passed. The choice of complicated circuits thus depends on various factors and complex circuits are best left to those with the experience to handle such sets.

One general aim is to get maximum output with the smallest possible Radio input. The other general aim is to get loudest clear response in output. Usually these two aims must be adjusted.

Dry cell filament operated tubes such as UV-199 have smaller outputs than storage battery filament tubes such as C-301, but are often more satisfactory for Radiocast sets, as all batteries may be enclosed in the receiving cabinet. The current required for say six tubes UV-199, is less than for two or three tubes such as C-301A, so circuits using UV-199 tubes will usually have at least one or two tubes which perform one function only. Thus the first tube may be a Radio amplifier and the last tube an audio amplifier, with possibly one or two intermediate tubes used for more than one purpose. Such circuits using a tube for one purpose are easier to build and get going and aside from initial tube cost will take no more material parts and assembly time than the average reflex combination.

How Far Can I Hear?

A very popular question is "How far can I hear?" Much over-estimating is done on the subject. It depends on the receiving equipment used, the location, and transmitting conditions.

One thing noticed is that the range is greater at night time than during the day. Stations which are not heard during the day will be clearly picked up in the evening. The rays from the sun are thought to have an ionizing effect on the upper atmosphere so that there is more absorption of the radiating waves during the daytime.

There is a seasonal variation in reception. The winter months afford much better reception conditions than do the summer days. Part of this is due to the fact that less static comes to bother winter reception. Radio can be enjoyed all the year around, and that is why conservative claims should be made for average range at all times rather than occasional records, even though such records can be repeated for many days when factors are favorable.

Reliable range means how far an ordinary Radiocast program can be heard distinctly with tolerable minimum of interference, at any time. The extravagant claims for distance made for some sets are boiled down to a skeleton under such test.

A steel building or a room containing metal lath will greatly cut down the distance range of the usual indoor aerial or loop receiver. Sometimes, moving a loop to an outside room or placing it near a window will make it possible to hear stations which the same equipment fails to pick up in another room in the same building.

(Continued on next page)

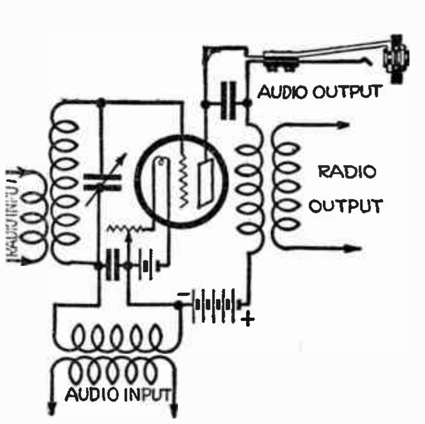


Figure 194

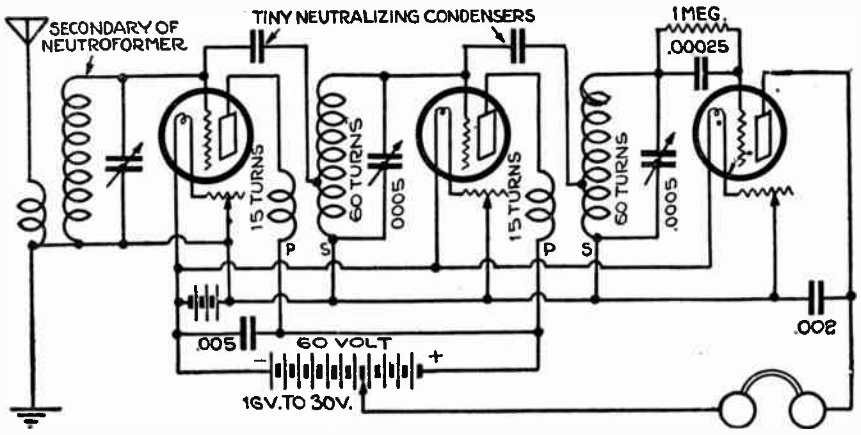


Figure 195

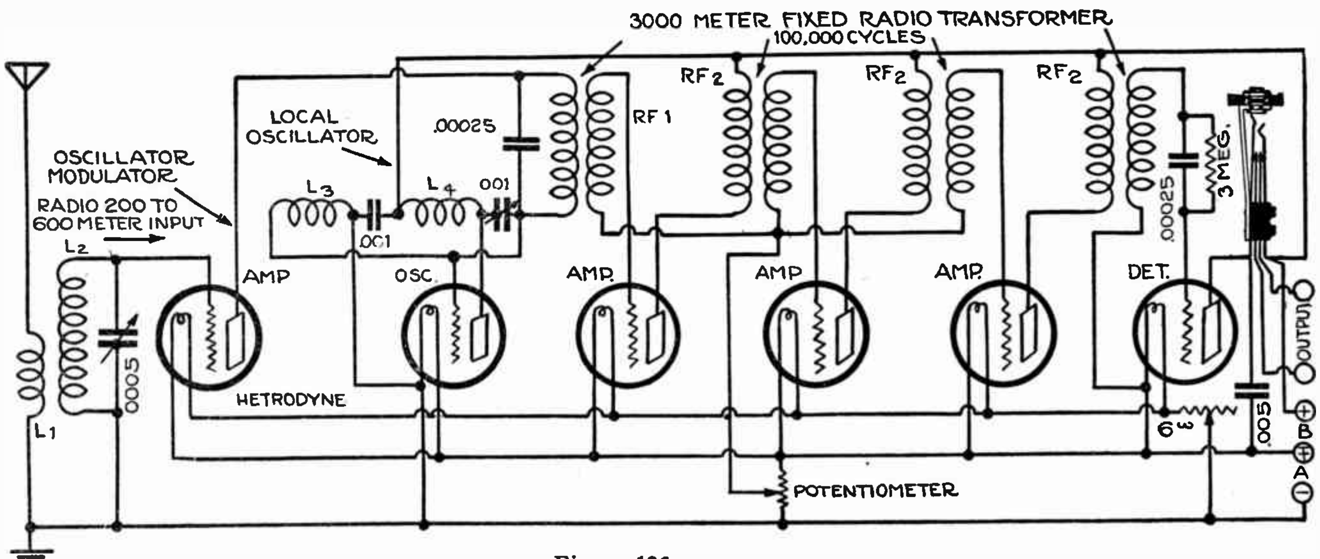


Figure 196

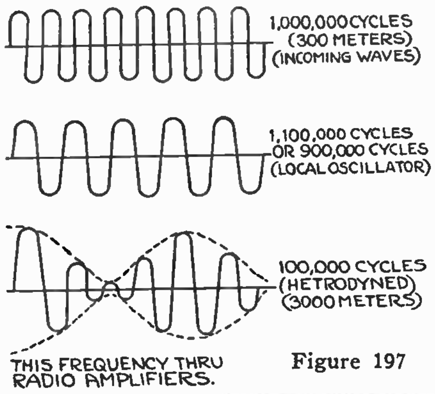


Figure 197

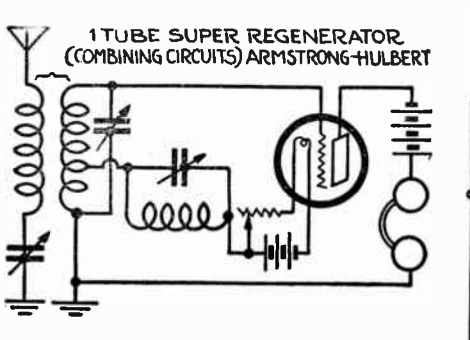


Figure 198a

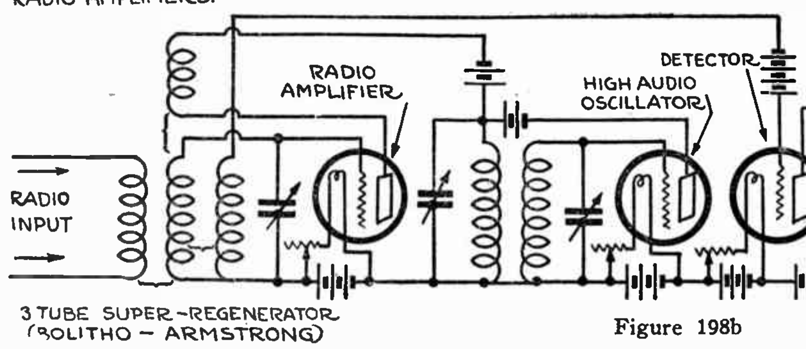


Figure 198b

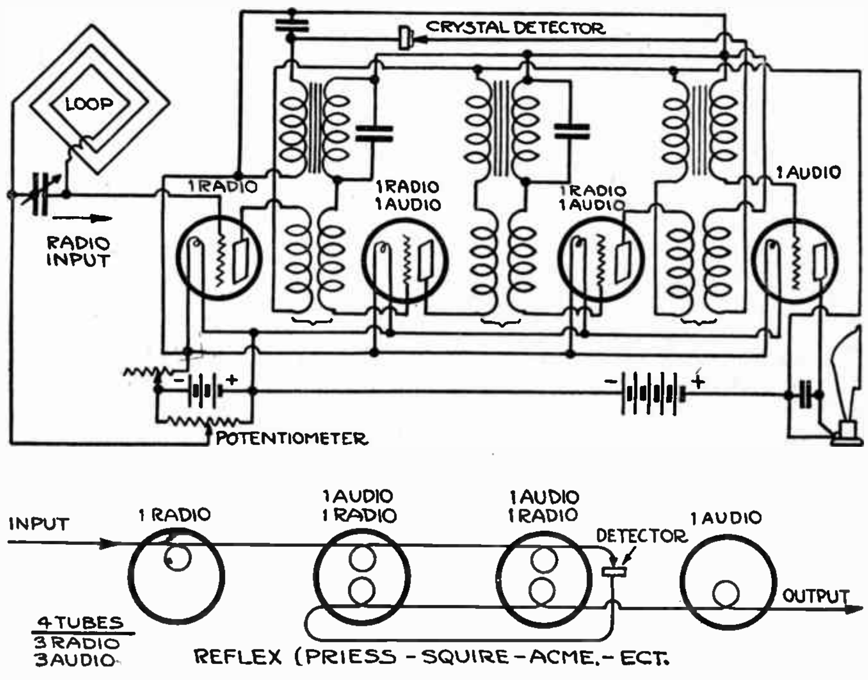


Figure 199

(Continued from preceding page)

Expensive machines have been found unsatisfactory in certain large apartment buildings where the walls form a shielding cage. Sometimes a local elevator motor will cause much disturbance to clear reception.

A different condition exists near some mineral lands, and reception range is much cut down by such local conditions. The same is true for certain mountainous districts and in other instances nearby heavy foliage of trees is thought to absorb much of the incoming energy.

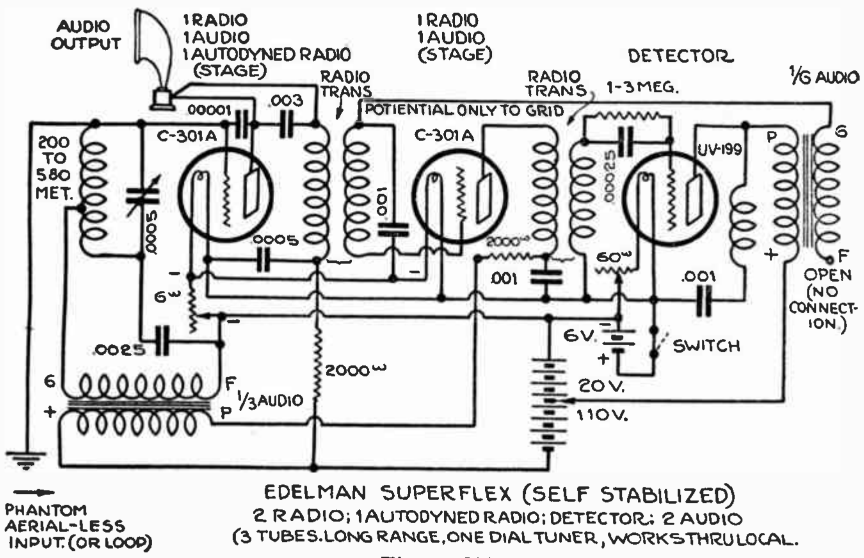
One thing about this "distance interest" is that many thousands of listeners stay at home and reach out for stations even into the wee small hours of the morning, to such extent that some lighting companies trace an increased consumption of lighting current thereto.

Favorable Operating Circumstances

For local Radiocasts up to fifteen miles, using earphones, a crystal set operated from an aerial will suffice. A one tube set can operate with indoor aerial within this range, for earphone reception. One stage

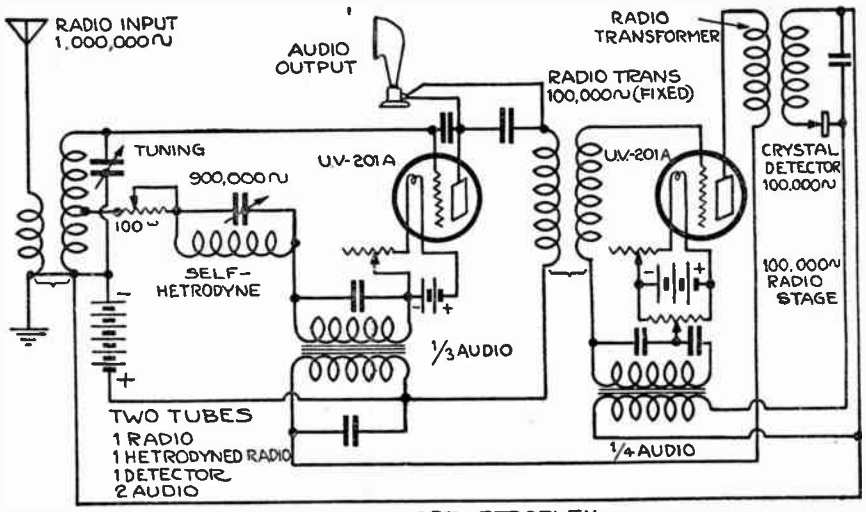
Connecting Condensers

In a vacuum tube receiver employing a shunt variable condenser for tuning the secondary, the rotor plates of this condenser should be connected to the filament for the purpose of reducing the effects of body capacity. For the same reason, if an antenna series variable condenser is used in the primary circuit and connected in the ground lead of the coupler, it is advisable to connect the movable plates to the ground and the fixed plates to the coupler.



EDELMAN SUPERFLEX (SELF STABILIZED)
2 RADIO; 1 AUTODYNED RADIO; DETECTOR; 2 AUDIO
(3 TUBES. LONG RANGE. ONE DIAL TUNER, WORKS THRU LOCAL.

Figure 200



EDELMANS SUPERHETROFLEX

Figure 201

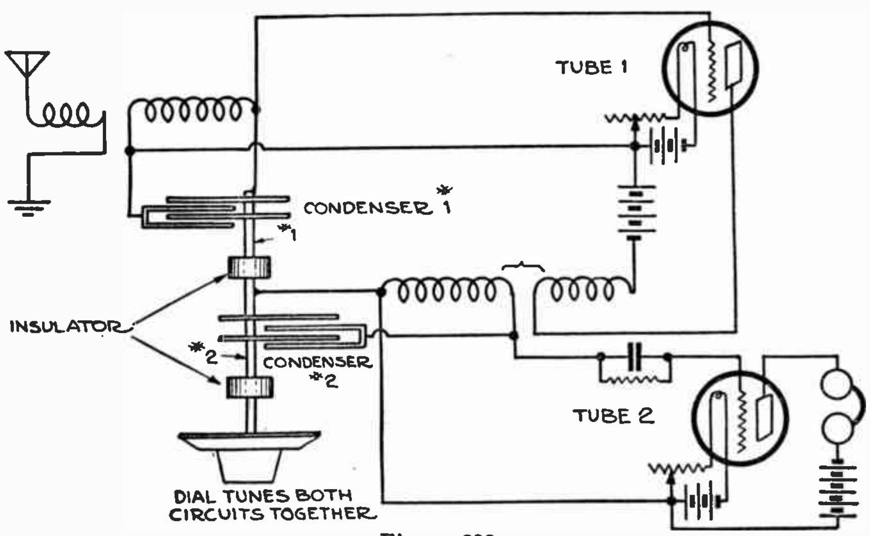


Figure 202

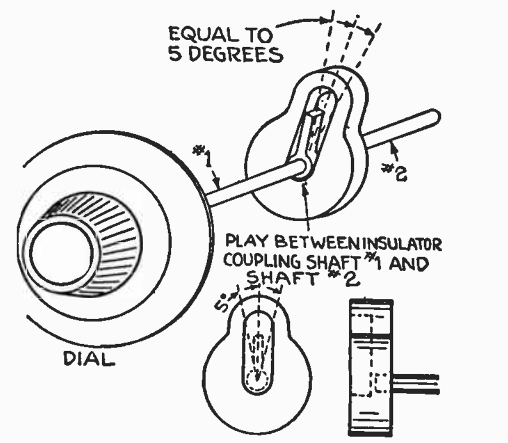


Figure 203

Distance Means Little in Radio

After all, distance means little in Radio. A few hundred or even thousand miles are traversed by a Radio impulse in such a tiny fraction of one second that the difference of a few hundred miles makes little change in the traveling time. Ranges of 3,000 to 7,000 miles are sometimes attained.

There is a certain appeal in the novelty of hearing a distant station. The average listener wants to do this at times, to demonstrate the "powerful ability" of a set to friends, or occasionally to hear a particular Radiocast program. Many old time listeners get the point of view that it is a game to see who can hear the most stations or the greatest distance, but this is usually the viewpoint of the new listener. Others regard distance reception as no more noteworthy than hearing a phonograph re-creation of a voice from a singer, made years ago, with the singer, perhaps, departed. As regards distance reception, an experienced listener can say, "That is nothing much. It has been done before, you know, and over greater distance."

There is a certain interest in logging stations which does much to increase a broadening attitude of mind and acquaintance with geographical centers local customs, and even variations in language used by different sections of the country. Logging means writing down the call letter of the station heard, the time, and the adjustment of the receiving set used. A convenient chart can be prepared or purchased, such as indicated by Figure 204. Many listeners find it interesting to compare the previous evening's log with a neighbor's. A log also permits a chart to be made for setting the dials of a receiving outfit to bring in a certain station, provided that it is operating at the time. After much listening a certain station can be recognized by its announcer's voice or other typical distinguishing feature, without waiting for the call letters.

Radio fishing comprises more or less haphazard twisting of the tuning control dials in the hopes of getting a station not previously heard. Every so often as conditions favor this, a new station can be heard for the first time and some listeners derive much pleasure from such a catch.

Radiocast programs are taking some of the distance novelty from the long range receiving set owners and placing it with the sample crystal outfit owners. It depends on the viewpoint, whether you regard the program or the means by which it is spread as the main thing.

of audio amplification may be added and two stages will permit good volume on loud speaker. Radio amplification is not necessary unless one wishes to use

RECEIVING SET LOG

Station Heard	Time	Dial 1	No. 2	Program
KDKA	8:20 p. m.	20	21	Music, clear
WGR	8:30 p. m.	21	21½	Talk, O. K.
WOS	8:40 p. m.	33	34	Band, clear
KSD	9:00 p. m.	64	66	Singer, O. K.

Figure 204

a small-sized loop within this range. One stage of Radio amplification is sufficient to operate a loop within this range.

For reception within one or two hundred miles, using earphones, a one-tube set works best with outside aerial. Two stages of audio amplification will bring this within good loud speaking range. For indoor aerial or loop operation, one, and preferably, two stages of Radio amplification will be needed.

For average coast to coast range, using aerial, one stage of tuned Radio ahead of one tube set will suffice for earphone reception, though two stages will be better. Two stages of transformer coupled Radio amplification will be required. Audio amplification can be added as usual for loud speaker volume.

For average coast to coast range, using indoor aerial or loop, two or three good stages of Radio amplification are desirable to obtain loud speaker reproduction. Reflex combinations employing four tubes, Radio sets using six tubes, and outfits using eight or possibly ten tubes are also in this class. Foreign Radiocast stations come in range of such outfits. The difference between indoor aerial or loop and outside aerial will commonly be equivalent to one stage of Radio amplification, so it is advisable to use aerial where such an aerial does not get too much other interference.

Phantom or aerialless operation, coast to coast range, requires two good stages of Radio amplification or sometimes three, ahead of a good detector and two stage audio amplifying set.

Use Test Board First

Radio amateurs, when deciding what type of set they wish to build, should never begin by mounting the parts on a handsomely grained panel or installing them in a beautifully grained finished cabinet. Get a plain wooden board and lay out the parts afterward following the diagram as closely as possible as to arrangements of the assembly of the parts.

Difficulties of Litz Wire

Litzendraht, usually called "litz," is recommended for winding coils, but only if the strands are perfect. The high frequency resistance of a coil wound with perfect litz is much less than for one wound with solid wire, but if some strands are broken or imperfect (and it is very difficult to wind a coil by hand without injuring some of the strands) the good effect of the litz is totally lost. Besides, soldering taps on litz is difficult and should therefore not be attempted by beginners.

Swaying of the Antenna

While air currents do not affect the propagation of ether waves between the transmitting and receiving stations, the swaying of the antenna of the transmitting station in the wind frequently causes changes in capacity of the aerial and therefore a change in wave length which may be noticeable at the receiving station. This fact is most evident when the transmitting station is employing continuous waves and the receiver is operating on the heterodyne (synchronous) principle.

Recharging Storage Cells

Both the filament and plate batteries should be tested at regular intervals to be certain that the voltage has not fallen below the value necessary to normal steady operation, as current variations resulting from run down batteries produce harsh notes in the receiving telephones resembling static disturbances. Storage batteries of the lead-acid type need recharging when the potential has dropped to 1.75 volts per cell. When the voltage of a block of B battery normally rated at 22.5 volts has fallen to 15 volts the battery should be renewed.

Neat dial markers may be supplied to any panel mounted receiver by scratching a narrow slot with a knife in the proper place on the panel and then filling the slot with white lead or white water color paint.

Always test a coil for continuity after the winding has been completed. By doing so there can be no possibility of wiring a coil with broken leads into the circuit.

Always consult the manufacturers' directions for the handling of Radio sets. The tubes vary so widely that full information is essential to proper operation.

Simple Explanation of Radio Reception

"Selecting and Making Sets"—Chapter VII

By P. E. Edelman

THE choice of Radio outfits is divided into two types for use with outside aerial and those operating equally well with indoor short aerial or loop. An outdoor aerial equipped set can sometimes be used with indoor wave pickup means but will usually have less satisfactory range. Some sets designed for use with outdoor aerial do not operate satisfactorily with indoor loop, phantom, aerialless or pick-up circuit.

The aerial question is easily disposed of. Using an outside aerial, the best distance range can be had with less equipment, but subject to more interfering disturbances, particularly during the summer months. Some places an aerial is out of the question. The landlord will not allow it. If you do put up an aerial or have one installed, be sure that it is done substantially and protected with lightning arrestor as required by underwriters.

Buying or Making a Set

The next thing to decide is whether you will purchase a complete manufactured outfit or make it from materials or parts. Unless you have some experience or can hire it, a properly selected manufactured set is far more likely to give satisfaction. The difference in cost of assembled parts and parts suitable for assembly is not so wide as was formerly the case, due to increased quantities manufactured. The average beginner can favor the assembled set, even if some neighbor with experience makes it, rather than attempt to build the first outfit. For some, however, the pleasure of making a set and seeing it operate is worth while, and to date it is a fact that a majority of sets in use are wholly or largely home assembled.

Where do all the Radio outfits go? Some reach the "As Is" or second use market. The beginner can sometimes get good operating sets discarded by others but should at least see the set working satisfactorily prior to making the purchase.

Probably the crystal set costing as little as $5 complete with equipment can be favored for earphone reception within five miles of a local Radiocast station. If children smash it, not over $5 is involved. There are no batteries or tubes to buy. The best form to choose is one using a permanent or semi-fixed type of crystal detector, as the adjustable variety are difficult to keep in sensitive condition. Clearer reproduction can be had from a crystal set.

One Tube Set

From $16 to $40, there are available completely equipped, one tube outfits, and dry cell operation is preferable. A tube such as WD-12 or UV-199 can be used. The non-regenerative form may be clearer but most outfits of this kind use considerable regeneration. The sets using feedback and directly coupled to an aerial are the kind which can radiate interference to neighbors. For city use, the non-regenerative one tube set or the one tube set operated on the reflex principle without Radio feedback is to be preferred.

Despite all that may be said, numbers of one tube single circuit sets using regeneration will continue in use until such time as a two tube outfit can be had for the same result at about the same cost, i. e., until tubes are cheaper. The beginner is certain to cause squeals on neighboring sets if the close coupled single circuit regenerative type of one tube machine is used. The two circuit tuned, one tube regenerative set, is preferable. The beginner will usually not tackle a three circuit tuner at first. Too many tuning dials mean that many more chances to miss a Radiocast program.

In order of choice, first a one-tube set for local use, non-regenerative; second, the same reflexed; third, distance two circuit, loose coupled, preferably with additional one stage Radio amplifier.

Two Tube Sets

Two tube outfits of the reflex type will afford best results, as in simple form, one stage Radio, one stage audio and detector can be obtained from two tubes. Using crystal detector two stages of Radio and two stages of audio can be had from two tubes. Two tubes permit use of one stage Radio and a regenerative feedback tube detector outfit for distant program pick-up with earphones.

The usual form of three tube outfit is: Detector plus two stage audio amplifier and this will work nicely with outdoor aerial to operate a loud speaker. Three tubes can be arranged reflex fashion as two Radio and two audio with detector or two Radio and three audio with crystal detector for long distance reception, employing ouside aerial, or intermediate distance with indoor aerial, both permitting loud speaker volume. The best use of three tubes is made in reflex combinations. Two or three tube combinations employing Radio frequency amplification permit satisfactory operation with indoor loop.

Four tubes can' afford one stage tuned Radio, detector and two audio, for aerial operation, or use with indoor aerial. Reflex combinations of four tubes permit long range loop reception with loud speaker output. Six tube sets may be found with three Radio, detector tube. and two audio. Some super-heterodyne outfits use six tubes, up to eight or ten tubes.

The Best Set Money Can Buy

The best set money can buy is also a matter of choice and presumably an unlimited spender would not be satisfied with manufactured cabinets any of the hoi polloi might purchase on time payments. Sums may be spent on elaborate cabinets or hand made hand carved furniture boxes. A very elaborate set might be made to order to fit desire or whim. But it is doubtful if after an expenditure exceeding $500 to $1,000 for one installation, there is any further inducement to get something better for further price increase. Such a set will usually be fitted with special switches and controls for distant reception, volume control, etc., and ordinarily not employ an outside aerial.

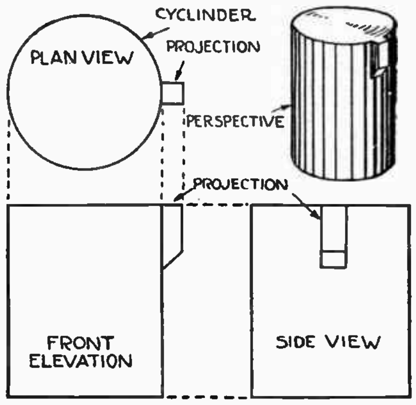


Figure 205

In choosing a set, don't get one requiring a storage battery unless you get a charging outfit to go with it. Or, if you are depending on dry cell operation, don't take a set which requires too much A battery, as run down cells will be a continual nuisance.

Portable Sets

A portable set is desirable, as it can be moved about without disconnecting the wiring to the batteries. A portable set can be installed as a permanent one, but not vice versa. A set which can be carried from place to place is useful in summer. Dry cell operation is preferable.

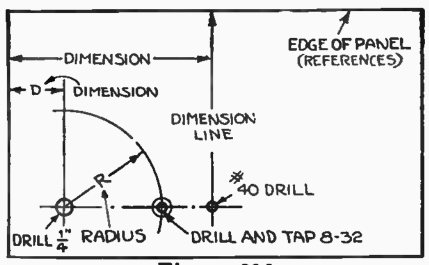


Figure 206

The first set should preferably be one which is moderate in cost and easy to operate. Avoid outfits using too many adjusting controls unless you are willing to learn to use them, otherwise the results will be disappointing.

Tubes to Use

Manufacturers usually recommend the type of tube to use for best possible results. If you intend to use dry cell tubes, ascertain if the set is constructed with correct size rheostats therefor. Tubes designated as detectors or those of the soft variety usually are preferably used for detection though results can also be had from hard tubes. Reflex outfits usually require tubes with large amplifying output. The average listener will choose a tube with standard base, as renewals can be had anywhere. In choosing tubes, it is to your advantage to have each tube tested in a receiving set before purchase, as some makes of tubes vary widely.

Earmarks of Doubtful Sets

Outfits to notice, of doubtful class, will have dials which do not run true, wiring which is not neat, messy looking soldered joints inside, loose parts, flimsy construction, etc. Sets intended for use with dry cell tubes preferably have some shock absorbing socket mounting, as such tubes "ring" when subjected to mechanical shock. If you buy a set or have one assembled for you, be sure to have the terminal posts clearly and correctly marked. Thousands are in use with improper marking, if any at all. Someone not familiar with the set changes the batteries, connects the B battery wrong, and the tubes are burned out. Use the same sense in choosing a Radio outfit as you use in buying your new car.

Making Your Own Set

It is not so much with the idea of saving expense as with the object of exercising a hobby that the average homemade Radio outfit is started. Others make outfits to have the latest to try weeks before manufacturers get production started. Then there are some who will shop around and put together a passably good outfit including many "five" and "ten cent" parts. Assembling today is a different proposition than in earlier days. Well designed parts are available in finished form and often come with blue prints or layouts showing exact manner of assembly.

Thousands of sets are thus built on kitchen table workshops. The tools required are a good soldering iron, preferably electric; a few assorted sheets of sandpaper, a pair of pliers, a medium sized screw driver, a small breast drill with drills, a half round file, a ruler, and a pair of dividers, or compass. When assembly sheets or layouts are given with sufficient details, the parts and the patience or assembly skill are all that is required.

While many others understand how to read blue prints or layouts, a few pointers will help others, who do not. All that a mechanical drawing or layout aims to do is to furnish a dimensioned guide for the builder. Figure 205 illustrates the principle of projection used. Suppose you have a cylinder with a lug as shown in perspective. Looking down on the top of it, you see the plan view. This alone does not give correct idea of length, so a front elevation is drawn to show how it looks this way. A side view completes the mechanical picture, as every important feature can be dimensioned.

Reading a Radio Panel Layout

Figure 206 indicates how a panel layout is dimensioned. The straight edges of the panel are taken as a reference. Center lines (dot and dash lines) locate drill holes. A full sized layout can be drawn on paper and pasted on a panel with removable paste. Or the panel can be marked with pencil lines. A center punch is advisable for pricking drill hole points, in the panel.

Any special parts other than finished pieces will similarly be shown in a mechanical drawing or sketch, though sometimes only a diagram of the general scheme is shown leaving this to the builder's information and skill.

Bare bus bar wiring is preferable as then each wire connector has to be well spaced so as not to touch others. The general principle is to use short connections, with any bends neatly made at right angles. Where two wires must pass it is advisable to do this at right angles to each other where feasible. The Radio frequency carrying wires should be spaced at least ½ inch apart, and special care should be taken to have all connections to the grid or grid circuit well insulated and spaced from the others. Watch the grid connections carefully.

Where only a circuit diagram is available, the first thing to do it to redraw it so that the wiring will be as simple as possible. Then make a list of parts required. From the parts, you can determine which standard size of panel will be suitable. A panel can be polished with fine sandpaper to remove scratches.

It is not advisable to support all parts on the back of a panel alone as this seldom makes a convenient and neat layout. Sometimes a wood back base is used but a sub-base assembly is preferable. Then the parts can be mounted on a supporting base at the rear of the panel, while the filament circuit wiring, etc., can be carried underneath the sub-base. In checking the wiring, the beginner should have a colored pencil to trace off the diagram as the wiring progresses, and check connections from time to time. A telephone receiver in series with a battery can be used to connect various portions of the circuit completed to test through for connections, short circuits, or open connections.

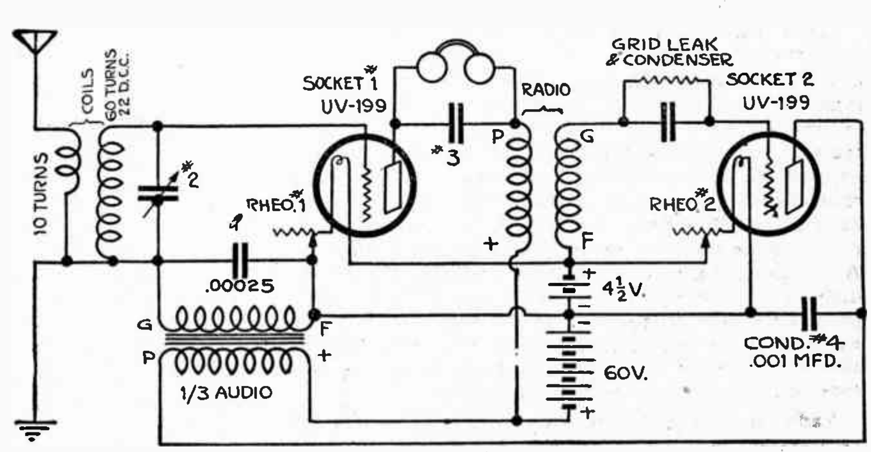


Figure 207

Soldering

In soldering connections. a common fault is to "cold solder" joints. It is necessary to have the parts to be soldered clean and to use a well tinned hot iron, so that the solder flows and can hold the joined parts together.

(Continued on next page)

(Continued from preceding page)

Do not use excess solder nor hold the iron so that drippings can drop on other parts of the wiring. Carefully wipe all joints with a rag to remove the excess flux, when the joint is completed. In soldering condensers, be careful not to over heat the terminals, as the tinfoil may melt away in the condenser.

A good way to wire is to follow the methods observed in the best makes of commercial assembled sets. In following a printed instruction sheet, the exact parts specified may not be available, so it is well to note variations therefrom before marking drill holes.

Assembles are sometimes made on wood bases, or table boards but most outfits will be carried on or back of panels for use in cabinets. There are standard sizes such as 7 by 18 inches, 7 by 12 inches, etc., which can be had all finished to size for use with standard sized cabinets. Two principle materials are hard rubber and bakelite fibre, and care must be taken in drilling not to "split through" as the hole is near the end of the bore.

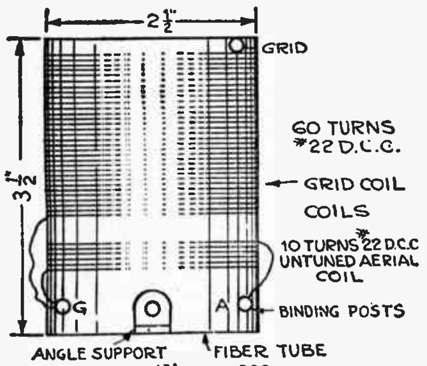


Figure 208

Keep Tube Socket Clear

The tube socket should be mounted so that no connecting wires are likely to be touched when inserting the vacuum tube. Inductance coils should not be mounted too close to other parts or over condensers. The general principle to follow is to keep separate circuits apart and insulated from each other. If you are building an outfit for the first time, it is advisable to tackle one for which the layout and instructions are rather complete instead of attempting to follow just a circuit diagram. One reason why so many homemade machines work nicely is that they are built as copies of carefully planned models.

Figures 207, 208, 209, 210 show, in form which should now be clear, an example, "How to build a two tube reflex set."

Regardless of the kind of a set, a Radio outfit requires upkeep. Even a crystal set requires a crystal replacement or occasional attention to the aerial and ground. Tube sets require replacement of burnt out tubes but the principle thing to watch is the batteries. More complaints about operation are due to run down batteries than most other causes.

Even manufactured sets are sometimes defective, due to wires coming loose during transportation. After checking up connections with the manufacturer's instructions, the first thing to do when the set refuses to work is to see if the filaments of the tubes light when the rheostats are turned on, then to check if there is plate current flowing from the B battery. The presumption is favorable that a manufactured set is O. K. so do not start to "rip the works" open until you are sure there is a defect. Many a set has been found O. K. when the wrongly connected B battery is connected properly with positive terminal feeding toward the plate circuit. When the negative wire is wrongly connected to the plate side of the plate circuit, no current flows.

Another point is that to receive Radiocast programs even with a perfect set with correct connections, you have to tune the circuits by turning the dials to the proper position so that the station Radiocasting can come in.

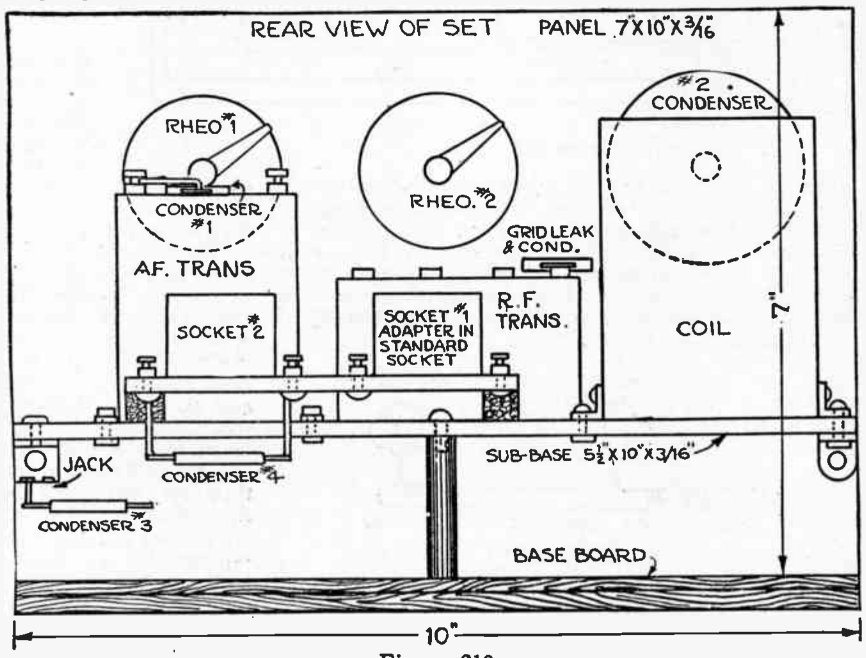


Figure 210

If a condenser fails to tune a circuit, it may be short circuited. This can be tested with phones in series with the fixed and movable plates and a small battery. If your coils are home designed, the size may be incorrect to reach the wave length desired with the condenser used. Too long an aerial prevents hearing short wave stations with some sets.

If you hear weak signals but are unable to amplify them further with the two stage amplifier, one of the tubes used may not be making good contact with the plate prong of one socket. Imperfect grid contacts are also likely to occur due to faulty construction of tube bases or use of poor socket contacts. Test this point by trying a new tube in the same socket.

Best Way to Test Batteries

The best way to test a B battery is to use a voltmeter. If this instrument is not available, a five watt 110 volt lamp can be briefly connected across each B battery unit and it should light up if the battery is O. K. If it does not light, the battery may have a little service left, as this can be determined by connecting a loud speaker across it. A loud click should result. Even the smallest B battery can light a 10 watt 110 volt lamp to a dull red, when fresh. If the filaments of your tubes appear to be lighted O. K., but the loud speaker volume drops way off, it is time to test the B batteries.

Failure of the A battery will usually show by the filaments lighting faintly if at all. If you are using dry cells, it is time for renewals. It may be that the filaments have been left burning over night, or several days, as it is easy to forget to turn the battery current off when through using the set. Multi-tube sets run dry cells down faster than do single tube outfits so if renewals are frequent you may be operating too many tubes on one set of dry cells.

It is not good to let a storage battery run down too far as the plates may be damaged. If you use a charger, throwing the switch for an over night charge once or twice a week, with an occasional addition of distilled water to cells to make up for evaporation, should keep the battery O. K. at all times. Storage batteries are now little used for filament lighting on one tube sets, but are preferable for multi-tube outfits of certain types.

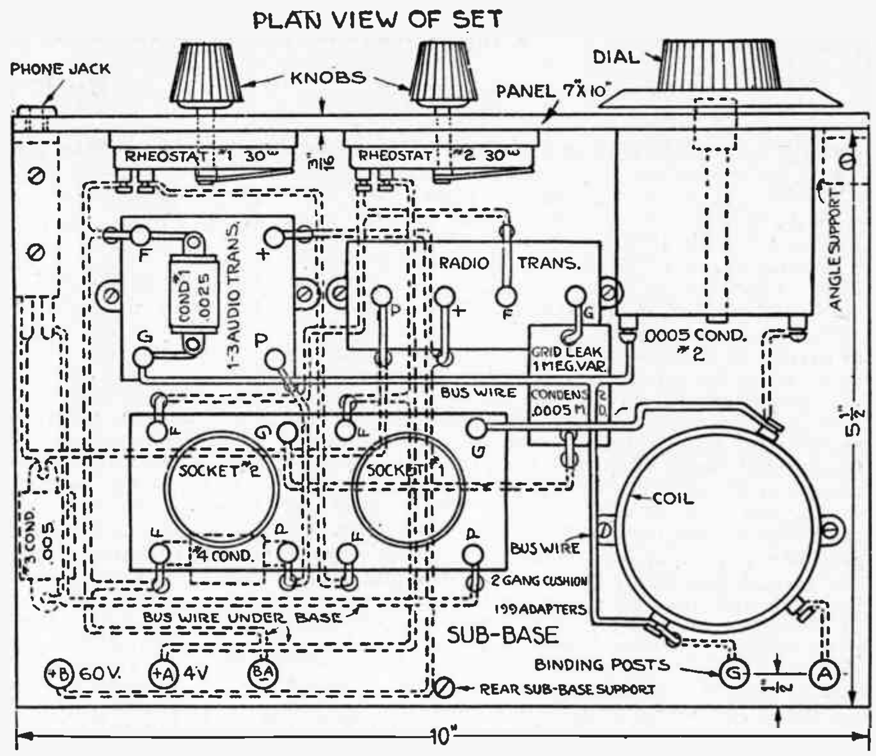


Figure 209

If you are using a voltmeter for testing, each cell of the storage battery should be able to register from 2 to 2.2 volts if your voltmeter is accurate and the battery is well charged. Any cell on open circuit will usually show voltage so this is not a reliable test.

A dry cell on short circuit test with ammeter across its terminals for a brief time will show 20 to 30 amperes when fresh. Dry cells on dealer's shelves sometimes deteriorate whether used or not, and cells which show only 10 to 15 amperes on such test are likely to have short operating life. Don't accept old dry cells.

The fact that a filament of a tube lights is not a true test that it is O. K. A better way is to insert the tube in the socket of an operating set and compare its performance to the tube removed to permit this test. Owing to variations in tube manufacture, one tube may require different rheostat adjustment than another to make this a fair test. Sometimes tubes have bases with contacts which do not make good connection with all the prongs of the socket, but otherwise the tube is O. K. It is not always advisable to pull up a tube socket contact prong to accommodate a faulty tube base.

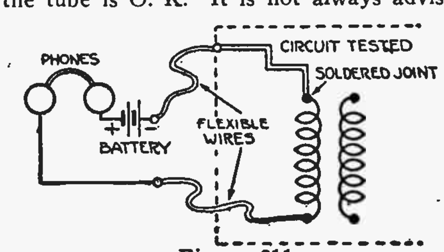


Figure 211

The main replacement items in a set are thus the batteries and tubes. The other parts of an outfit should have a long operating life as there is little to wear out. Once in a year or so it may be necessary to clean off some of the contacts or wipe away accumulated dust.

Maintaining Aerial and Ground

It is also advisable to give the aerial and ground the "once over" as contacts may become poor, wires may partially wear away, or there may be short circuits against a tin gutter, etc. If you use some form of ground clamp, it should be taken off, the contact surfaces cleaned, and replaced about twice a year, because such contacts tend to oxidize and take on resistance therefrom.

There is another class of changes which are in the nature of improvements. If you have a single circuit regenerative set, a stage of tuned Radio amplification can be added to cut out reradiation and increase operating range. An audio amplifier can usually be added to any set. A third stage audio amplifier can sometimes be attached to a set where extra loud reproduction is wanted.

Repairing Phones and Loud Speakers

It is not advisable to attempt any repairs on phones or loud speakers. They seldom get out of order. The connecting cord may break at or near one of the tips, and can be soldered together. If dropped on to the floor, some of the permanent magnetism may be lost. Sensitiveness will also be lost if the diaphrams are bent. Careless handling will, once in a year or so, cause caps to come loose or break. A safe rule is to leave repairs on headsets and loud speakers to expert repairmen. Do not connect a headset to the output of a power amplifier as this may jar the parts loose. A headset is designed to operate on weak currents, not powerful current changes.

In using phones or loud speakers which do not have the terminal cords marked to show positive and negative leads, it is advisable to try reversing the connections and use the one which gives best response.

Condensers, Coils and Other Apparatus

Fixed condensers may become short circuted. In some circuits considerable potential is applied to fixed condensers in output circuits. Replacement is the best procedure in case this happens. Without short circuiting, a fixed condenser will sometimes become loose or partially short circuited through a high resistance leakage path, and cause noisy results. If replacement of fresh B battery and cleaning of tube socket contacts does not stop the noise, a fixed condenser may be the trouble. If solder flux is left around a fixed condenser joint, there may be a resistance leak formed thereby. Variable condensers will sometimes accumulate dust enough to provide a leakage between the plates. Care must be used in cleaning the plates, as they must not be bent. There are thin cleaning brushes available for this purpose.

Heat changes will sometimes loosen the windings of coils, variometers and other apparatus. A varnish made by dissolving celluloid strip in acetone can be used to refasten loose windings.

Locating Short Circuits

Another trouble found in some sets is caused by one or more bus wires loosely touching others or coming loose during use, to form short or open circuits. Loose wires can be found by carefully moving each bus wire gently with the fingers. A wire just resting on a contact instead of being fast soldered will then come loose, and can be resoldered. Battery connections or the wires to the binding posts of the set may work loose and cause trouble, so it is advisable to look these over when the set does not work up to the mark.

In changing over from storage battery operation to dry cell tubes, especially if you use tubes like UV-199, employing adapters, there is a chance that the adapters will make poor contacts in the tube sockets, so this must be checked. Owing to small current consumption such tubes have higher resistance and require more resistance in the controlling rheostat. It is important to use the right value of rheostat resistance. Another point in changing to dry cell tubes is that a C battery may be needed unless you reduce the plate voltage formerly used on the storage battery operated tubes.

Simple Explanation of Radio Reception

"The Listener-In and the Home Radio"—Chapter VIII

By P. E. Edelman

THE majority of Radiocast listeners have come into existence as such since the fall of 1921. Radio telephony was carried out on a more or less commercial and experimental scale for many years previous to this, but aside from an extra experimental concert now and then, very little Radiocasting was done before 1916. The present popularity is due to organized effort to Radiocast programs of general interest.

One who listens only to Radiocast is, at times, likely to narrow to the view that Radio is good for nothing else. Radio as a means of communication has been very important for nearly two decades. Previously there was no way to communicate over distances to and between ships at sea nor over inaccessible regions. Commercial Radio telegraphy has played very important parts in military and naval intelligence communication, and in every day traffic is right now giving cable lines a close race for leadership. Radio may yet give line telegraphy and telephone systems a good run to maintain leadership. Even today much wire line communication is done on the Radio or the wired wireless principle. Essentially Radio circuits are used and the wire merely serves as a guide for the carrier current. Systems of multiplex telephone and telegraph communication depend on the use of wired wireless or carrier waves.

Radio also shows prospects of automatic control or teledynamics. Battleships have been operated at a distance via Radio waves. Aeroplanes can be so controlled. Signatures and photographs have been transmitted via Radio waves by using suitable light sensitive cells to change light variations into electrical modulating currents. The possibility of motion pictures transmitted via Radio waves has also been demonstrated. Radio provides a carrier for transmission of intelligence and can be used to convey any form of controlling or regulating current. All that is necessary is a device to change the first form of energy into electrical pulsations which can modulate a transmitted series of Radio waves, and provide a receiving device to translate back into useful form, or reproduce the original kind of energy effect, as desired.

The Amateur Radio

Much of the present Radiocasting can be traced and is due to the efforts of amateurs. It was amateurs who first demonstrated the value of transmission on short wave lengths and worked out apparatus suitable thereto. There are possibly twenty thousand amateur transmitting stations working today. With an outfit costing possibly as little as two hundred dollars, an amateur operator can talk directly with others in all parts of the country and with many foreign countries. They have an organized relaying system and can eventually cover most every civilized center in the world. Most such communication is conducted by code and abbreviated spelling. The code is easy to learn. Amateurs use wave lengths usually under 200 meters.

A different use of wired wireless has been tried to perform the function of Radiocasting. Instead of sending out the waves in all directions, they are directed by the transmitter over the wires of a power line system to paid subscribers. One advantage is that simple receiving apparatus suffices, requiring "push button" only to get the program. It is less likely to be interferred with by outside interference. If the transmitter supplies sufficiently varied programs and includes reradiocasts by wired wireless, subscribers may be satisfied. It is well to remember, that in the United States where line telephones are in by far the greatest per capita use, telephone apparatus is rented, whereas in some foreign countries, each subscriber to service has to purchase his apparatus. Certain foreign countries are tending to go into the Radiocasting question on a similar basis.

It is possible for a local Radio station to furnish programs intercepted from distant stations, so that nearby listeners with simple apparatus can eventually hear anything going on, by asking for it. Even when this is extensively done, there will remain some listeners who prefer direct reception independent of an intermediate operator at a reradiocasting station. Reradiocasting can, however, satisfy a large public by providing any of several different kinds of programs at will.

As conducted today, Radiocasting has just grown. Most Radiocasting stations aim to please their listeners and many will follow out suggestions of listeners or even grant special requests when convenient. A listener must take what is Radiocast or leave it but can have a voice in the general character of what is transmitted as well as certain special numbers on programs. The industry resembles the early days when it was considered so wonderful just to see any sort of flickering moving picture that no attention was paid to possible perfections in directing technique. The toy days of Radiocasting are passing.

Why Radiocasters Do It

Why do they Radiocast? Some do it because it pays. Others to help the continued sales of apparatus and parts. Others for pure publicity or propaganda or paid advertising returns. Others, really, for much the same reason that a public speaker goes on the platform. They like the idea of talking to a vast audience and enjoy the thrill of having listeners. In general, Radiocasters get as much benefit as the listeners do, or more, or else close up shop. Anything which can be conveyed to ears is suitable material for consideration for Radiocasting. More and more it must gain importance in spreading intelligence, news, information, education, and dramatic readings as well as music and lighter entertainment.

It seems that an impressario of Radio will develop to more fully perfect the technique and utilize the possibilities of Radiocasting. In the motion picture industry, Griffith and others introduced changes much as may be looked for in Radiocasting. Present day announcers, good and bad, have just taken the matter up. Some at best are a mixture of introducers, program arrangers, toastmasters, and play the part of host to the Radio audience. Others are entirely lacking in anything above mediocrity and disappoint the public. Satisfied listeners make a Radiocasting station gain in influence just as do the subscribers to a periodical which pleases its readers.

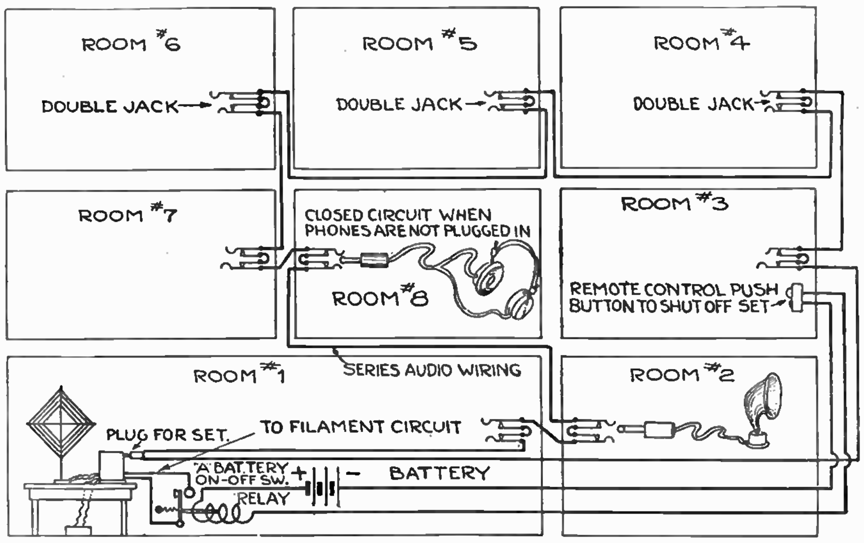


Figure 212

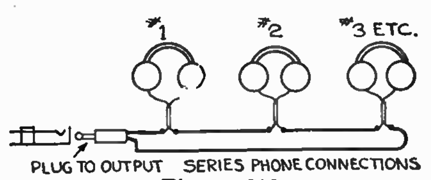


Figure 213

The best lecturers usually reach small audiences compared to the numbers which are instantly within hearing via Radio. The instruction possibilities of Radio have hardly been touched to date. The time is coming when the necessary diagrams and illustrations will be printed in newspapers or publications along with announcements of such programs so that the speaker at a Radiocasting station can talk to listeners with reference to the illustrations placed in their hands. No lecturer can do much more, and the best educational facilities can thus be made available to hundreds of thousands of the public, however isolated. Agricultural information is already spreading to a greater extent than may be supposed by such Radio extension courses from western Radiocast stations.

Specialized Radiocasters Coming

Specialized Radiocasting can be looked for much as certain theaters specialize on plays or operatic productions. There will be the varied programs and jerky changes from one class of Radiocasting to another, but the time is coming when certain stations will give more attention to directed programs of pretentious character.

Only certain kinds of plays are suitable for satisfactory Radiocasting. There may develop an art of rewriting stories suitable for Radiocasting, as previous attempts fall short of the mark. Motion pitures convey talk by printing heads and sub-heads. The stage depends largely on talk assisted by scenic effects, stage lightning, etc. A Radiocast can vary modulation and the character of tone effects, interposed imitations of bells, trains, etc., to surprising advantage, once the possibilities are assembled by a Radiocasting directing genius.

Despite opinions of some in the phonograph trade, Radio is influenced by and influences phonograph, and indeed, other forms of sound reproduction. A record conveys the music via grooves formed in a material disc. The Radio conveys the music via modulation in Radio waves. Anything suited for reproduction by records is also well within the scope of Radio transmission. For many listeners, there is a supplemental value, records affording repetition at will, while the living voice Radiocasting supplies the variety of changing interest. One or the other forms of entertainment does not go out of public favor as long as it meets public requirements. If Radio grows in popularity it must be because in a measure at least, the public is being pleased.

The entertainment value is likely to remain uppermost in Radiocasting. Next to essentials for maintaining life the desire for amusement or entertainment crowds out even supplementary necessities.

Economics of Radiocasting

The value of Radiocasting from a typical large station depends on the number of listeners reached. One toll station is said to charge a fee of $10 per minute for Radiocasting paid material, but open faced advertising is not meeting great favor with the listening public. Listeners have no great objection to the general publicity form of advertising indulged in by many Radiocasting stations and their contributing financial subscribers, but the intended effect is often spoiled by too much repetition. Sometimes this is due to an extent which listeners term "earsores." A Radio engineer has computed the value of fairly good Radiocasting from a large station at $25 per minute, based on the operating cost of probable apparatus used in listeners' outfits. Why waste $25 on a lot of poor announcing or repeating advertising which loses its intended effect thereby? A Radiocasting station costing $50,000 annually for upkeep, amounts to less money than an average of 200,000 listeners spend for upkeep and purchase of receiving sets, so much of the economics of Radiocasting points to the value of pleasing listeners. Even a small Radiocasting station costing as little as $10,000 complete, can count on perhaps ten thousand interested listeners. The program is the thing that counts.

Figuring a Radio station radiating 1000 watts, it is evident that as few as 50,000 listeners using average loud speaker sets with possibly only 1 watt output, means that the listening apparatus power amounts to 50,000 watts, so that even on a power basis, the listeners are the important end of Radiocasting.

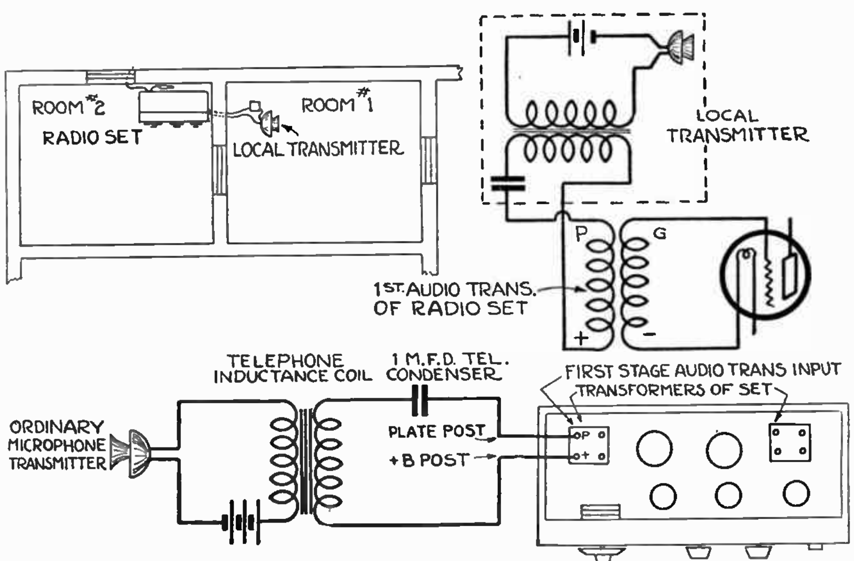


Figure 214

Listeners Can Vote for What They Want

Listeners can express approval or dislike for a particular program much as an audience applauds or politely withholds applause. Postcards are a common way to express opinion of Radiocasting and the average station receives thousands daily. Some stations read off favorable opinions telephoned or telegraphed

(Continued on next page)

(Continued from preceding page)

to them, but this becomes monotonous as indulged in by some Radiocast announcers who seem to like themselves. Seldom do announcers read off telegrams of criticism if they get any. The main indication of a program is the applause received, and curiously enough, a good program often fails to draw deserved applause.

The entertainment value of a receiving apparatus is recognized as one of its principal functions, and can be enhanced by certain novel uses.

Figure 212 shows how audio output wiring can be

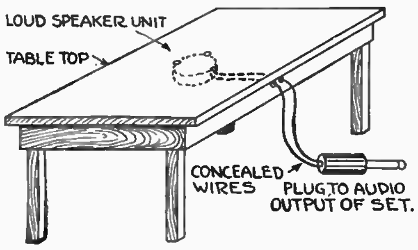


Figure 215

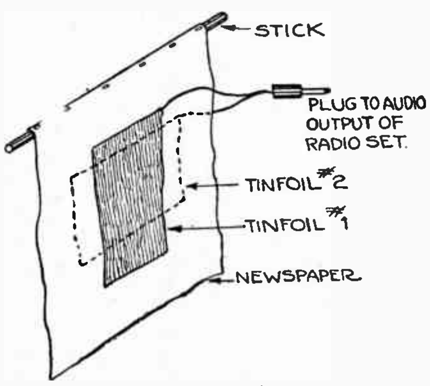


Figure 217

arranged to distribute the program to any or all parts of a house or apartment. By using double jacks, all phones or speakers used will run in series connection. Remote control to stop or start the set by turning filaments on or off is also possible as shown.

The new listener getting a special program of interest to a neighbor will often invite others in to hear. Figure 213 shows how several sets of phones can be connected in series when a loud speaker is not available or the signals are too weak to operate such a speaker.

Giving a Radio Party

Instead of talking further about technical features of a Radio set, a few interesting uses will be considered. A Radio party is an ordinary party livened up by use of Radio interest. The invitations can be "Come on over, and bring your loud speaker along." Favors based on Radio interest may be used. Games featuring the same interest can be devised. Refreshments can be designated as "Vacuum tube ice," etc. Perhaps a local Radiocaster will have a dance program and grant a few special numbers for your particular party by request.

Interest is likely to turn to the Radio dance at such a party, so be sure to have plenty of loud speaker output to give good clear volume. It is well to have someone at the tuner to omit undesired announcers' advertisements, etc., if the station heard uses such small talk between numbers. Also it is desirable to have a supplementary source of music such as a phonograph, player piano, or small orchestra, for variety between numbers, according to the size of the entertainment. If you have a program dance, suitable numbers can be termed "Radio Glide," "Wave length fox trot," etc.

Much humor can be put into a stunt party by connecting a local transmitter to operate through the loud speaker as shown by figure 214, if one of the party is talented in that direction.

Radio Guessing Contest

Another stunt is to have an operator go fishing for long distance stations which will come through on the loud speaker O. K. and the guests are asked to guess

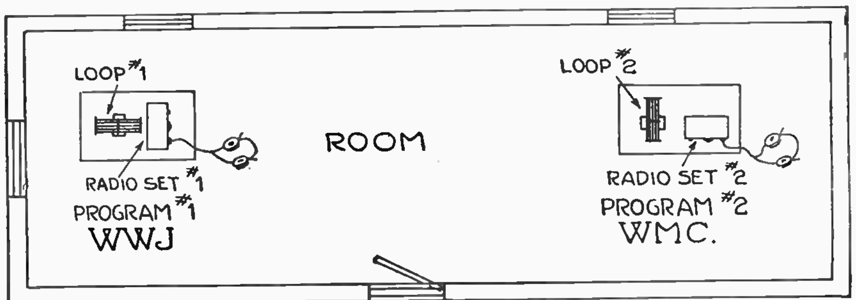


Figure 216

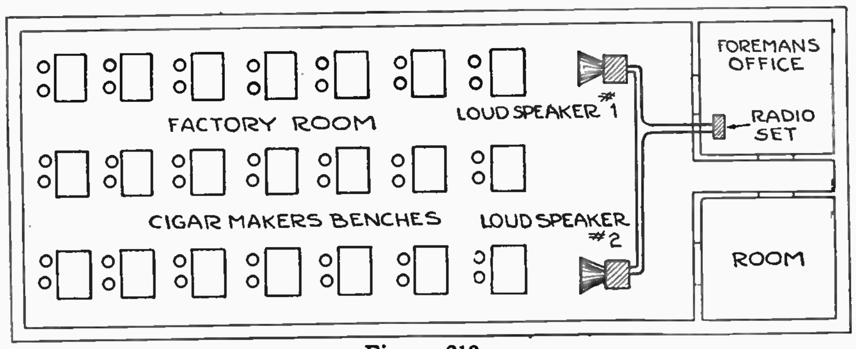


Figure 218

ahead of the announcer, what station is Radiocasting and to estimate the air line distance. A prize can be given for the best list of answers. The thing about this

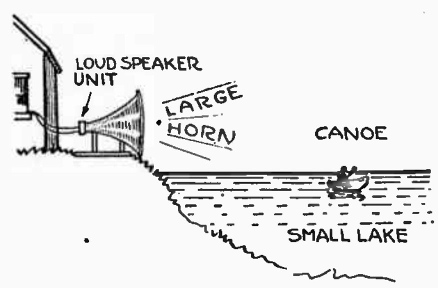


Figure 219

is to have a wide variety and keep changing stunts so that interest does not lag.

In sections where the ancient Chinese time killer game draws much attention, a Radio novelty can be tried once by using "Radio Fishing" in place of dice, to determine position of players, or suits to follow. Probably you will not want to try this more than once, as the interest depends on the novelty. You can make up your own schedule for this.

Running a Home Radiocast. "Station I. C. U."

A transmitter can be arranged in one room per figure 214, to fake a fun Radiocast through the loud speaker of the set, and possibly some of the guests can be induced to entertain with specialties on "ukes," etc., under guise of Radiocasting. Just enough of stunts to be interesting without prolonging to boredom, is the life of a Radio party. A good amateur humorist can put up a children's story with good spirited reference to guests that can make much laughter.

Guessing games can be based on giving only correct titles to numbers on a program, with the regular announcer cut out by the receiving set operator. When a set of phones is used with a loud speaker, the set operator can cut off the speaker during the Radiocast announcing. For real novelty, make up your own list of stunts along this line, and keep them "snappy."

You can put your phone receiver or loud speaker near an ordinary telephone line transmitter and send the Radiocast program over ordinary telephone line to any friend you wish to call up for this stunt. The audio output can be sent even ten miles clearly in this manner. The loud speaker may also be concealed from view, or back of a ventilating grating, etc. You can mount the loud speaker underneath a table to make a talking table, as indicated by Figure 215.

Getting Two Programs Separately in One Room

Figure 216 indicates how two loop sets can be used in the same room to get two separate independent programs simultaneously without interference between them. If a loud speaker is used, music from one station can be softened down to an accompaniment for a dramatic reader from another station. Also two loop sets permit different members of the family to use earphones to hear programs they want while others hear different programs.

If you have a phonograph with recording attachment, you can use your loud speaker to record certain portions of an incoming Radio program. Doing this commercially would infringe copyrights but it is all proper as an experimental stunt for private amusement. A medical doctor might have part of a program of certain special interest recorded in this manner. Or, as a stunt, if your means are not limited, you can record part of a program and use it for various private purposes. Thus if a lecturer on the art of speaking is giving good vocal illustrations of pronunciations, a record might be made for some local school.

Figure 217 indicates how a talking newspaper can be made for use in place of a loud speaker. It comprises a condenser with loose plates from tinfoil. Ordinary phones can be shunted across this "condenser" so that plate current will get to the tube in the receiving set as usual.

Distributing Audio Output

Figure 218 shows how the audio output can be distributed to various rooms in a hospital, or to a large room occupied by cigarmakers or other manual workers. There are various useful applications along this line. Usually one stage power amplification will be necessary to obtain sufficient volume for use in a larger room, and seldom will more than two extra stages of power amplification of the audio output be required.

Figure 219 indicates how a loud speaker can be used to reflect programs over a small lake for canoeists, etc.

For summer use, one can take a portable set along with other camp equipment. A loop receiving coil or a flexible aerial is a desirable choice. The flexible aerial can be thrown over any convenient tree or pole, but no pole carrying power currents, should be approached for this.

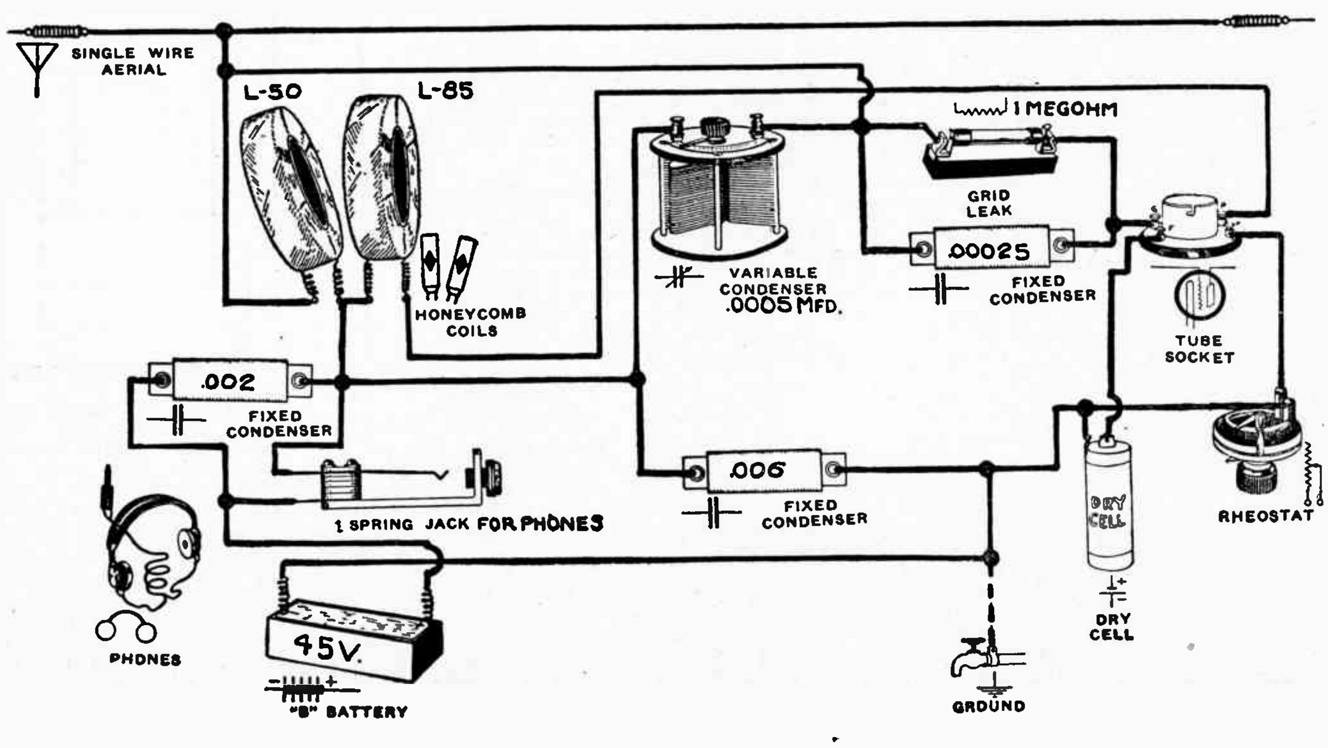
A variety of uses for a carry-along set, which can be taken in the rear seat of the car, are obvious.

Hook-up That Takes Objectionable Howl Out of Flewelling

READ what one Canadian fan has to say about a Flewelling set he built: "This set, which I have constructed, gives me real satisfaction; when properly handled in tuning it does not whistle, squeal or howl. I can listen to programs Radiocast from Dallas, Texas, quite nicely. With two honeycomb coils of 50 and 85 turns its range in meters is wide enough to cover all Radiocasting stations up to 600 meters.

"The tube I use is the smallest of our Canadian peanut tubes. As a dry cell tube I think it is equal to any other on the market. From 22 to 40 volts on the plate is sufficient. The set is wired with No. 12 bus wire. No insulation is used. The panel is lined with copper foil and grounded. As a result there is practically no body capacity. The tuning is done with the vernier rheostat. The aerial is 90 feet long, including lead-in; single wire and 30 feet high.

It is probable that with a 'hard' tube and high plate voltage greater volume would result, but I doubt whether it would reach any farther. The only new thing about it is the filament ground. When the ground wire is clipped on the filament post the tube will stand more current without 'spilling' and so get better volume."



Simple Explanation of Radio Reception

"Interesting Advanced Circuits"—Chapter IX

By Thomas W. Benson

THE advent of reflex circuits seemed to promise something radically new, but a consideration of their principle of operation will show that there is really nothing new in the phenomena. We have seen from previous chapters that a tube can be used to amplify at both Radio and audio frequencies. Since amplification in both cases is accomplished in a similar manner, it should be possible to amplify both frequencies simultaneously, the real problem being to keep the frequencies separate to prevent interaction and a jumble of sounds instead of music.

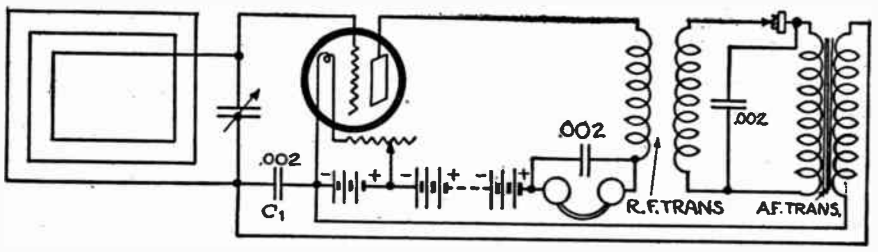


Figure 220—Simplest form of one-tube reflex to show principles of operation

Luckily this is readily done; the simple reason is that they differ so greatly in their frequency. To handle the two frequencies in the same circuit, use is made of two other principles that should be familiar to the reader. The first is that a condenser will permit a high frequency current to flow through it; the other is that a large inductance will choke a high frequency current but permit direct current to flow through. By using these two instruments we can devise a circuit that will handle both Radio and audio frequency currents without interaction.

When only one tube is used we can then have one stage of Radio frequency amplification and one of audio. For detection, use must be made of another tube or a crystal detector. For the reason that a crystal detector gives clearer reception, is cheaper in construction and maintenance and in the the fixed types requires no adjustment, crystal detectors are usually employed.

Assembly of Parts on Single Tube Reflex

Let us see, then, how these various instruments may be assembled to use a single tube for both forms of amplification at the same time. Referring to Figure 220 we find a loop aerial with a variable condenser across it to tune to the waves desired. The received currents are fed directly into the tube as in a Radio frequency amplifier, connections being made to the grid and to the filament through the condenser C 1. This condenser will pass the Radio frequency currents without difficulty.

When signals are being received, the plate current will be varied in accordance, with a step up in intensity, but still inaudible by reason of their frequency being above audibility. These currents flow through a Radio frequency transformer and the condenser across the phones in the plate circuit. The transformer then induces currents in the circuit containing the detector which is required for detection and rendering the signals audible.

This circuit includes a condenser and audio frequency transformer; according to the operation of the detector, currents at audible frequency will flow into the primary of this transformer. The output of the transformer is now fed back into the grid circuit of the tube by its connection across the condenser in the grid circuit. This condenser will not short the low frequency audible currents; therefore the audible currents are impressed on the grid circuit and again amplified. The audible currents in the plate circuit will not flow through the condenser across the phone; hence the signals are made audible.

Condenser Must Be Mica Dielectric

There are, however, numerous little details that make or mar a circuit of this type. Take, for intance, the condensers. They must be of the mica dielectric type to prevent loss of current or variation in capacity. It has been said that the small condensers used, usually .002 mfd., will not pass audio frequency currents. As a matter of fact the amount of current a condenser will pass depends on the frequency of the current; so some current will flow at audible frequency, but not enuogh to make much difference as far as short circuiting the phones or secondary of the audio frequency transformer. So when a circuit of this type does not function properly it is advisable to try different capacities at these points. The capacity should be such as to pass all the Radio frequency current and little or none of the audio frequency.

Nothing definite can be said about the transformers; some seem to function perfectly and others give little or no results. They should be of the shielded type to prevent feed backs and howling. Often a plate voltage too low will cause reflex sets to work improperly; a high plate voltage should be used to obtain good results. Since hard tubes are used in these circuits exclusively, the voltage may be pushed as high as 120 volts without harming the tube. Too much voltage on the plate will be indicated by the tube turning blue.

The very nature of the circuit using, as it does a feed back phenomenon for its operation, makes it very prone to self-oscillation. Self-oscillation of the circuit can be prevented to a large extent by adding a potentiometer. This instrument is also valuable in that it serves to bias the grid to a proper amount to put the operating range of the tube on the steepest part of its characteristic curve and thus give the greatest amplification.

Better Way to Bar Oscillation

A better method of preventing oscillations is to add a variable resistance in the plate circuit to stabilize the tube. This resistance should have a range of 500 to 2000 ohms. One of the old type B battery potentiometers serves the purpose nicely, or one can be made using the lead from a medium hard lead pencil for the resistance and arranging a slider to move over the lead and thus vary the resistance. The effect of the resistance is to damp out any oscillations in the circuit, since a circuit will not oscillate when its ohmic resistance is four times as great as its radiation resistance.

The detector is likewise important; it is necessary to employ a type of detector that will not burn out with strong signals passing through it. Some form employing iron pyrites will give good results.

In Figure 221 is shown a circuit embodying the refinements mentioned above. It will give very good results when its operation is mastered. A potentiometer is shunted across the A battery to bias the grid, a fixed condenser being connected from the contact arm to the battery terminal to prevent change of tuning when the arm is moved. The resistance is also shown in the plate circuit to prevent oscillations.

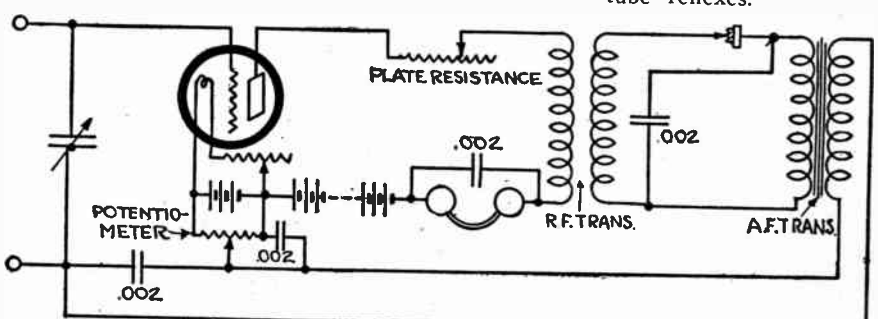


Figure 221—One-tube reflex with refinements for best operation

Any type of hard tube capable of standing 60 to 80 volts on the plate can be employed in this circuit, but the tubes using 1.5 volts on the filament will not function very well, particularly in reflex circuits containing two or more tubes. This is due to the fact that the plate current in these tubes is limited by their construction; when the tube is required to do double work the maximum signal intensity is not as great as in a hard tube capable of carrying larger plate currents. In single tube reflexes the dry cell tubes give fair results, but where amplification is carried further in two and three tube sets they do not function well.

In beginning to experiment with reflex circuits the experimenter is advised to mount the instruments temporarily in the position they will occupy in the finished set and to test the circuit thoroughly before assembling the set. When good results are obtained the set can then be permanently wired.

It should be remembered that the selectivity of the set depends entirely on the tuning apparatus used with it and the height and length of the aerial. The circuit shown employs a loop aerial because this is the simplest arrangement; good work can be done with this device. It gives freedom from static and selectivity due both to its small size and the ability to utilize the directional effects of this form of aerial. Where greater range is desired with an outdoor aerial it will be necessary to use a variocoupler to obtain selectivity, with condensers in both aerial and secondary circuits to obtain close tuning and selectivity.

Having mastered the principle of reflex circuits as applied to one tube it is not difficult to apply the same principles to two or more tubes with an increase in range and volume. Previously we found that audio frequency amplification was not usually practicable beyond two stages. Therefore two tubes in a reflex circuit permits the highest amplification at audio frequencies and is practically the only circuit in which the full reflex action is obtained in all tubes.

Two Tube Reflex Circuit

In Figure 222 is shown a two tube reflex circuit giving two stages of Radio frequency amplification and two at audio. In this circuit two Radio frequency and two audio frequency transformers are used to couple the tubes and detector as shown in the diagram. As in the one tube circuit, the waves are picked up on a loop aerial and amplified by the first tube and passed on at Radio frequency to be amplified by the second tube before being detected. During this operation the transformer and headphones are practically shorted out of the circuit by the condensers across them.

After the Radio currents have been detected and reduced to an audible frequency the condensers no longer act as bypasses by reason of the current being of lower frequency. The audible signals are now impressed on the grid of the first tube and amplified by both tubes in the usual manner. The audio frequency currents of course flow through the Radio frequency transformers but due to the few turns on them they have little resistance and no appreciable coupling effect.

The selectivity of this circuit depends entirely on the tuning apparatus used; therefore when used with an outdoor aerial a vario-coupler or other form of loosely coupled tuner must be employed. It will be found advisable when using a vario-coupler to mount the rotor from an inch to two inches above the stator windings to obtain looser coupling and greater selectivity. This circuit could be modified to increase its selectivity and signal volume by using tuned Radio frequency coupling between the tubes instead of the transformer coupling. This adds greatly to the tuning and amount of apparatus required and for that reason is more suited to three tube reflexes.

Adding Radio Frequency

The addition of a third tube to a reflex simply adds a stage of Radio frequency amplification to the set and thereby increases the range. To obtain maximum results it is advisable to use tuned impedance coupling as it is more efficient than a transformer coupling. A circuit using three tubes with tuned coupling between the first tubes is shown in Figure 223. It will be seen that the use of a Radio frequency coupling makes it rather difficult to feed the audio currents back into the grid of the second tube.

As in the usual tuned coupling circuit use is made of a fixed inductance of about 50 turns shunted by .0005 variable condenser. This circuit is coupled to the grid of the second tube through a small fixed condenser of .00025 mfd. capacity. It is impossible to connect the secondary of the transformer, after the detector, directly to the grid of the second tube because it will drain off the Radio frequency currents from the grid and render the tube inactive. To overcome this, use is made of another tuned circuit consisting of a variometer and fixed condenser of .002 mfd. capacity connected between the grid and filament. The secondary of the audio transformer is shunted across this condenser with a 10 milhenry inductance in series with it.

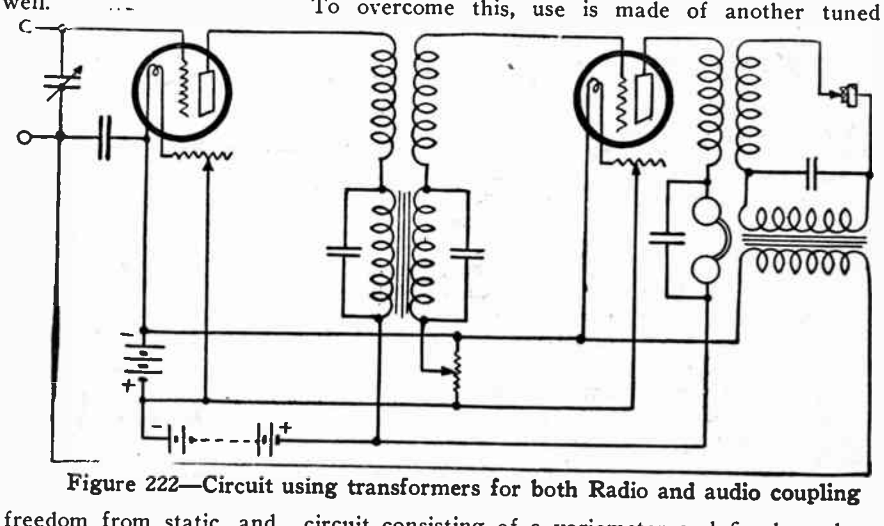


Figure 222—Circuit using transformers for both Radio and audio coupling

The purpose of this inductance is to choke back any Radio currents that would have a tendency to leak through the transformer secondary. It will be noted also that two potentiometers of 400 ohms resistance are employed. One of these serves to control the potential of the grid of the first tube; the other serves in like manner the grid of the second tube. By means of these potentiometers maximum amplification is obtained.

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Three Steps of Radio Frequency

The circuit is identical in principle with the others described with the exception that Radio amplification is employed three times and audio but twice. This circuit is ideal for long range work, giving as it does the maximum effect of reflex operation. It will be found very selective even when used with an outdoor

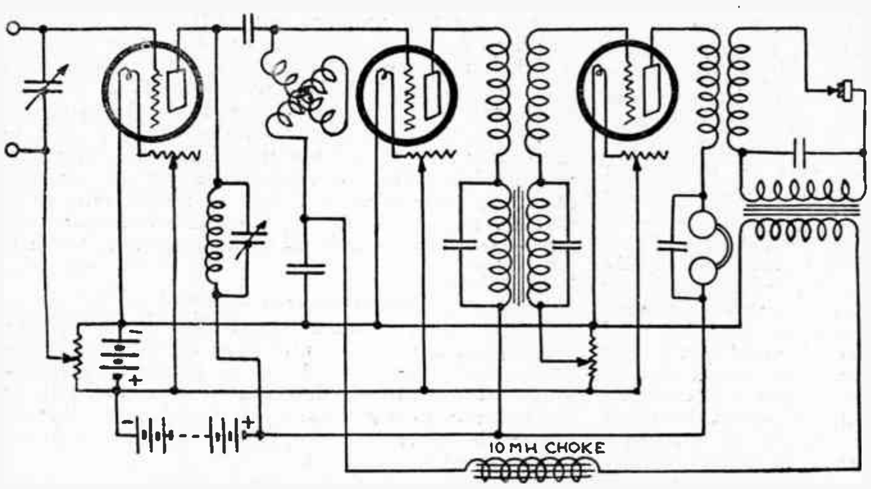

Figure 223—Three tube reflex using tuned Radio frequency amplification

aerial provided a loose coupled tuner is used. This is due to the tuned coupling used for the plate circuit of the first tube and grid circuit of the second tube which are tuned to obtain full signal strength.

It is entirely practicable to couple the first and second tubes with a Radio frequency transformer and thus eliminate the tuned circuit, but on the score of selectivity and greater amplification obtained with the tuning arrangement their use is advised, for then one can receive most from the set. Selectivity is vital in sets of this type for the amplification is so marked that any interference becomes a great annoyance.

Reflex sets may be built employing four or even five tubes, but in this instance the extra tubes act as Radio frequency amplifiers or one of them is used in place of the crystal detector. The latter arrangement removes one of the features of the reflex operation, namely, its quietness and clearness when properly operating. A poor reflex set is made worse when a tube is used as a detector.

Grimes Inverse Reflex

So far we have considered what might be termed the straight reflex; that is, one in which amplification at Radio frequency is carried on in succession by the tubes and the audio currents returned to go through the amplification stages in the same order. It is very apparent with this arrangement that the last tubes will be carrying the greater values of both audio and Radio currents. Thus the first stages may be working away below capacity while the last stage is working up to capacity or may not even be able to handle all the current, thus limiting the output. To overcome this the Grimes circuit was devised; it is termed the inverse reflex.

The inverse reflex differs from a straight reflex in that the currents at Radio frequency pass through the tubes as usual but the audio currents are amplified in reverse order. The effect of this is that the first tubes of the set carry weak Radio currents but large audio currents, while the last tubes have large Radio currents and weaker audio currents. This results in a more even distribution of the load between the tubes; the limiting effect of the tube is not so noticeable.

In Figure 224 is shown the inverse reflex. In this circuit the currents at Radio frequency are passed from one tube to the other flowing from left to right. After detection, however, the audio currents are fed back into the grid of the third tube to be amplified. The amplified audio currents in the plate of this tube are then fed back by a audio transformer in to the grid of the second tube to be amplified again.

The phones are in the plate circuit of the second tube; so the signals are made audible after the second stage of audio frequency amplification. A 400 ohm potentiometer is connected in the grid circuit of the first tube to stabilize the circuit and prevent it from oscillating. Another feature of this circuit is the condenser by-passing the B battery thus further preventing reaction between the various frequencies. The condensers in this circuit as well as the other circuits are all of .002 mfd. capacity and have a mica dielectric.

There have appeared many modifications of these circuits; as a matter of fact, after one has mastered their principle, it is a simple matter to devise circuits; for we have at our disposal several methods of Radio frequency coupling and two of audio frequency. By introducing different methods of coupling between the various tubes a great variety of circuits may be devised. The aim has been, however, to keep the circuits simple and efficient.

Operation of Reflex Circuits

A few words as to the operation of reflex circuits. The filament rheostats are not very critical and verniers are not really necessary. This is due to the use of hard tubes and high voltage on the plates. The sets are prone to howl which may be due to several things; experimenting may be necessary before they are quieted. Adjustment of the potentiometers may cure the howling or reduce the plate voltage. Poor transformers or tubes may be the cause. Try shifting the tubes around. Interference between leads or feedbacks between the transformers will often cause howling. Separate the transformers as much as possible. Try different values of bypass condensers and the insertion of resistances in the plate circuits of the tubes in an attempt to steady their operation.

The results are well worth the effort, for with a reflex one obtains everything possible out of the tubes in use.

Super-Regeneration

The construction of the one-tube super regenerative set offers no great difficulties; it is much simpler than the plain regenerative in operation. The set to be described is intended particularly for use with a loop aerial and will be found ideal for portable work or for one who does not want to erect an outdoor aerial.

The loop aerial need not be described in detail; an aerial of 12 turns mounted on 3-foot spreaders will serve the purpose nicely. It may be interesting to note that many are using, with excellent results, strips of copper 1/8 inch wide for constructing aerials.

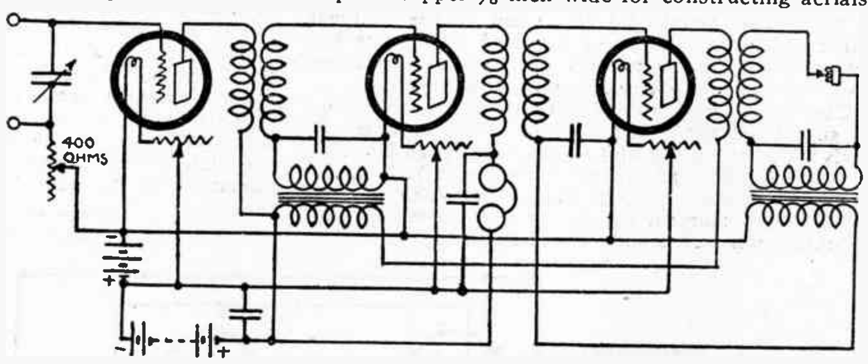

Figure 224—Inverse reflex balancing load between the tubes

The metal strip makes a better appearance than wire.

In Figure 225 is given a top view of the assembled receiver, which shows the relative position of the various instruments, a very important factor in the operation of the outfit. At the left of the panel is mounted a .0005 variable condenser, preferably fitted with vernier control. At the right side of the panel is mounted a variometer which serves to tune the plate circuit to obtain regeneration. The filament rheostat is mounted in the center of the panel.

On the base, attached to the back of the panel, we have a tube socket in the center with a small fixed condenser at the rear.

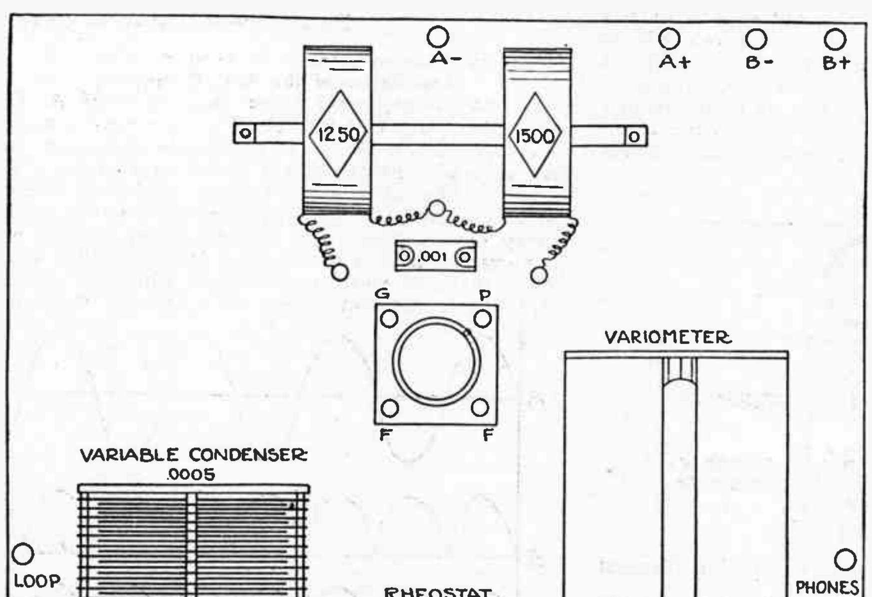

Figure 225—Layout of instruments for one tube super

The two honeycomb coils are mounted on a frame made from strip brass at the rear of the baseboard, so that they can be moved back and forth to control the coupling between them. If desired a two-coil honeycomb mount may be used for the purpose.

The instruments are wired according to the diagram shown in Figure 226, which gives the actual layout of the wiring. Binding posts are provided at the back of the board for connecting with batteries and aerial.

Any hard tube capable of standing 60 volts or more on the plate can be employed in this circuit, but a tube using six volts on the filament will give the best

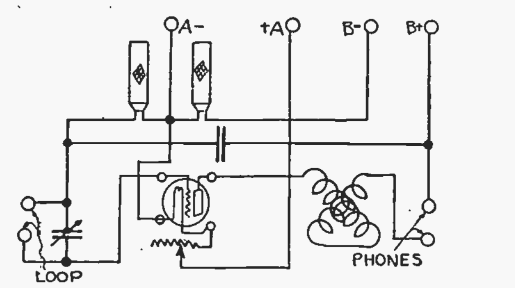

Figure 226—Diagramatic circuit for one tube super

results. The small tubes using 1½ volts on the filament will work, but the larger plate currents possible with the larger tubes give louder signals.

Operation of the Set

As to the operation of the set—after checking the wiring and connecting the batteries, phones and aerial, light the tube filament. Slide the honeycomb coils towards each other on the brass strip; a high-pitched whistle will be heard in the receivers. Should the whistle not be heard, reverse the leads to one of the honeycomb coils; if this fails adjust the voltage of the B battery and filament brilliancy till the whistle is heard. This is the controlling or variation frequency generated by the honeycomb coils; it serves to check the regeneration of the tube and keep it from going into a howling state. The intensity of the whistle is reduced to a convenient amount by sliding the coils apart until the whistle does not annoy.

Now an attempt should be made to pick up a broadcasting station by varying the grid condenser and plate variometer. These two instruments act in the regular manner; resonance points between the two will be noted by a slight roar as in the usual regenerative receiver. After picking up a station and getting it as loud as possible by the adjustment of the plate variometer and the honeycomb coils, the instrument may again be adjusted to obtain the clearest and loudest reception. Proper adjustment of the coils can be obtained only by experiment, but when once found the adjustment can be fixed. A simple method is simply to tape the coils to the brass strip, if this method of mounting is used, or wedge the two-coil mount so that the coils will not jar out of position. The pitch of the whistle can be controlled by varying the capacity of the small fixed condenser until it is not bothersome and maximum signal strength is obtained.

When once properly adjusted this little receiver will be found very efficient, suited to one of moderate means who must get the most out of one tube. Audio frequency amplification may be added, but a filter is necessary to keep the oscillation of the tube from paralyzing the amplifier tube; this makes the set rather complicated.

The Flewelling Circuit

We now come to a consideration of the Flewelling circuit, which has received not a little attention during the last few months and has been refined down to a very simple device. Many descriptions have been published as to how to construct the sets, so we will confine ourselves to a discussion of its operation; this may assist those who have difficulty in operating the set.

The Flewelling circuit operates on the same principle as the Armstrong super in that a controlling frequency exists in the circuits for the purpose of checking over regeneration and howling. The method of obtaining this frequency is remarkable in its simplicity.

Considering the circuit without the tickler feedback as shown at A in Figure 227, we find the original De Forest ultra audion circuit using a condenser in the lead to the filament, which is also in the plate circuit. As we learned under regeneration, a condenser so situated will lead to a regenerative effect; thus the tube in such a circuit will be kept in oscillation. The frequency of these oscillations depends on the inductance and capacity in the grid circuit.

Regeneration of Set

It was also found that regeneration built up excessive negative charges on the grid, tending to block the tube, which was eliminated by connecting a grid leak across the condenser. When this leak was too

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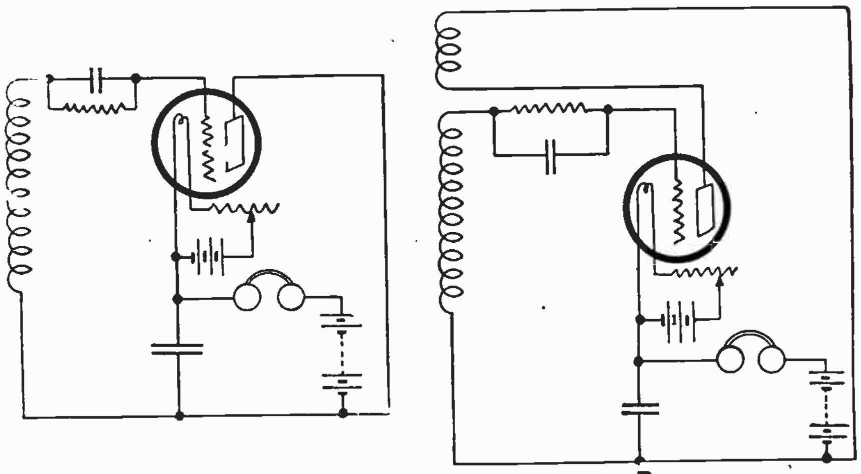
small the tube would block for an instant and, when the charge finally leaked off, would operate again. This action gave rise to clicks in the telephone receiver. And therein lies the secret of the variation frequency of the Flewelling circuit. By properly adjusting the grid leak the tube blocks and frees itself



A B

Figure 227—Analysis of Flewelling circuit to show principles of operation

at a high rate, giving rise to the well-known "super" whistle. It is this blocking or checking effect that permits high regeneration in the Flewelling circuit without the howling and screaming of the tube.

The connection from the positive of the B battery to the grid circuit is required to bias the grid; that is to obtain the proper grid potential for best operation. This positive potential acts so as to drain the negative charges from the grid and prevents the tube blocking at too high a frequency.

Having a variation frequency in the circuit, we have but to add a tickler feedback to obtain signal regeneration as in the regular Flewelling circuit shown at B, Figure 227. The operation of the set depends then on obtaining a proper variation frequency by a careful adjustment of the grid leak.

Varying Condition of Grid Leaks

As a rule the grid leaks on the market have the bad habit of changing their resistance with changes in humidity and temperature; we have a set that works beautifully except when visitors drop in. A method to overcome this defect to a great extent is to make use of a homemade leak consisting of lead pencil lines or celluloid or thin formica; when the proper adjustment is found, paint the leak with collodion to keep out moisture. Final adjustment of the set can be made by tapping the B battery for the lead to the grid. A set that functions very poorly can often be tuned perfectly by adjusting the positive biasing potential obtained from the B battery.

Thus we see that all a regenerative set needs to make it "soup" is a variation frequency that will check the regeneration before it gets too strong. Two methods are now in use, the Armstrong using a tuned frequency and the Flewelling using the blocking effect in the tube. There surely ought to be another method that is better and simpler; the announcement of that method will be the one great event of the coming year in Radio.

A. C. on Tube Filaments

This may seem a rather advanced subject to be considered in a beginners' series, but experience has shown that minds not too close to a given subject often conceive the greater improvements. Witness the rise of Radio broadcasting when many amateurs made the greatest discoveries. Let us therefore discuss the difficulties yet to be overcome in the using of alternating current from the house lighting mains in a Radio set.

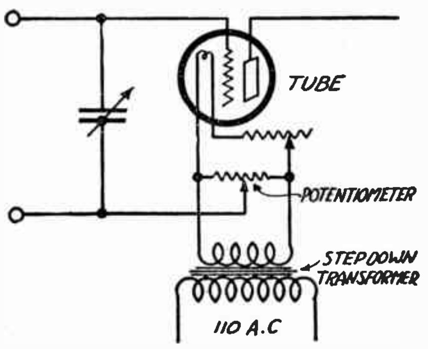


Figure 228—How A. C. is used in lighting filament

The possibility of simply connecting into a convenient socket as a source of energy for the filament and plate circuits of the Radio set is not beyond reason; in fact, it has been accomplished in an experimental way but by methods too complicated for the ordinary man. Its realization would solve many of the harassing problems, particularly the upkeep, of the larger receiving sets.

Noise Caused By Break in Current

We have found from previous chapters, if not by actual experience, that any disturbance in the steady flow of the filament or plate battery current would give an annoying sound in the phones. Were we then to attempt to use an alternating current, with its constant change in voltage and direction of flow, there would be encountered a loud hum in the phones or, properly speaking, a roar.

The reason for this action when A. C. is used on the filament will be apparent from a consideration of Figure 228. Here is shown an arrangement that is often used for the purpose and has operated successfully for many experimenters. It consists of a step down transformer, the primary being connected to the A. C. mains, the secondary having the rated voltage output needed for the tube filament. A rheostat in series serves to control the filament brilliancy. Now were we to connect one side of the secondary circuit to the filament terminal the polarity of this terminal would be rapidly changing from negative to positive; with each change a variation in the grid potential would result. The plate circuit would then be affected and a roar would result. To offset this effect use is made of a potentiometer connected across the secondary of the transformer. The purpose of this potentiometer is not to vary the potential of the grid as usual but to locate the electric center of the filament circuit. When the potentials at the end of the potentiometer are continually changing it is apparent that at some point on the resistance there would be no change in potential as to the center of the filament.

Source of the Hum

This circuit will work but it is impossible to eliminate the hum because, though we locate a point on the potentiometer where there is no potential difference with the center of the filament, there is a difference between that point and the sides of the filament, hence the hum. For those troubled by storage batteries this arrangement may prove very satisfactory on local stations where the signals are strong.

The transformers should have a rating high enough to supply all the tubes in use. Allow 6 watts for each UV-200 or C-300 and 1½ watts for each UV-201A or C-301A. The allowance for other tubes can be readily calculated by multiplying the volts required by the rated filament current to give the watts. The potentiometer, of standard construction, may have

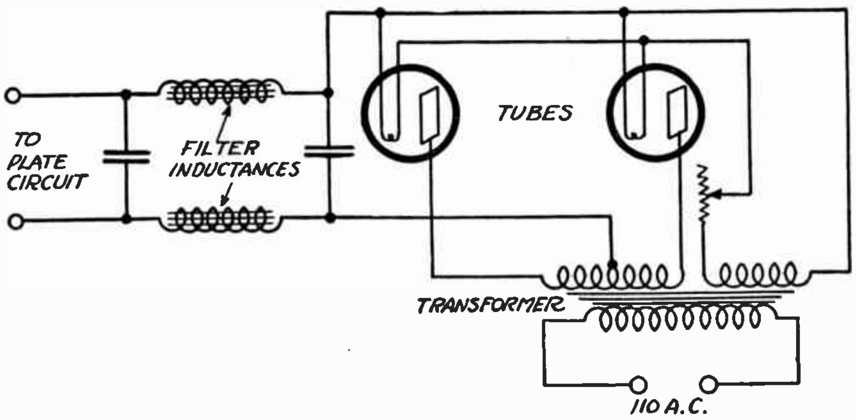


Figure 229—Using A. C. on the plates

200 or 400 ohms resistance as desired.

Application of the A. C. Current

We may now consider the application of A. C. to the plate circuit of the set. Here we have a more difficult problem, for it is absolutely necessary to have a steady direct current. The first problem is to rectify the alternating current; make it direct. For reception the electrolytic rectifier is not a satisfactory device, principally because it lets a little of the unwanted half of the cycle to leak through. Use then is made of electronic rectifiers which are nothing but two element tubes. We learned early in

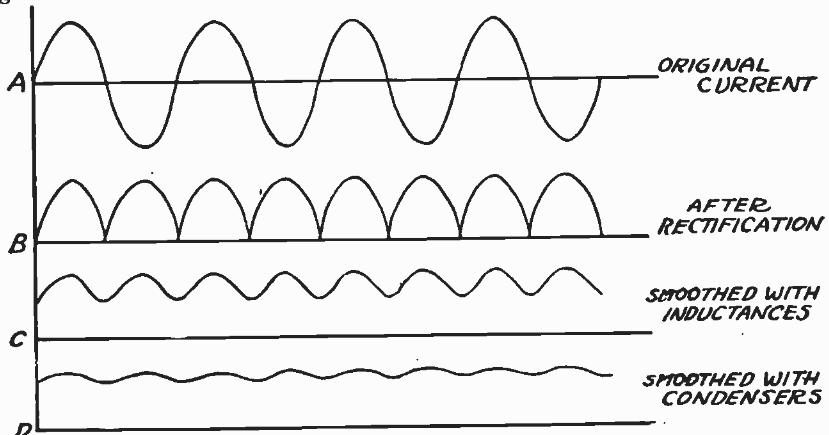


Figure 230—Showing various stages in converting A. C. to D. C. for use in plate circuits

the series how a vacuum tube functions as a rectifier; we can put this principle to use in rectifying current for the plate circuit.

The circuit for accomplishing this is shown in Figure 229. A special transformer having a tap in the center of the secondary winding is employed. The outer terminals of the secondary winding connect to the plates of the two element vacuum tubes, the filaments of which may be lighted from a winding on the same core as the tapped secondary. The tap on the secondary forms the negative terminal, the positive being the filaments of the tubes. The action of the arrangement is simplicity itself. Consider the current as flowing in one direction in the primary circuit. At that moment one end of the secondary will have a positive potential, and the other negative, in relation to the center tap. The tube, having its plate connected to the positive terminal at that instant, will permit current to flow to the filament, thence to the plate circuit of the set and back to the center tap. The other tube will not permit current to flow. However, when the current reverses, the other tube permits a flow of the current while the first one checks it. In this manner the alternating current is converted to a direct current; but it is pulsating.

Direct Current Obtained

This action is shown in Figure 230. At A is shown the original alternating current; at B the lower halves of the cycles are turned up, so to speak, giving a unidirectional current flow; but it rises and falls in voltage with each half cycle. Before it is suitable for use on the plate of a tube it must be smoothed; the ripples must be removed.

Here again we have recourse to a well known effect to obtain a given result. We also learned that an inductance acts to resist a change in the strength of current flowing through it. Were inductances inserted as shown in the illustration, when the voltage tended to rise, the inductance would cause it to lag; when the voltage falls, the inductance again would act to keep it flowing. The result then would be to "smooth" the wave form, giving something like the wave shown at C. Still this is not smooth enough for our purpose; so use is made of condensers. As shown (Fig. 229), a condenser is connected on either side of the two inductances. These condensers act as a reservoir for the electricity. When the voltage builds up the condensers ahead of the inductance it is charged and as the voltage falls off, it discharges back through the inductances into the circuit. The other condenser acts as a reservoir from which energy is drawn for the plate circuit. It is kept constantly charged by the current from the transformer, the plate circuit drawing current as required for the operation of the tubes.

Voltage of the Transformer

The overall voltage of the transformer should be twice that required for the tubes, for the voltage of only half of the winding is used at one time. Its rating may be very low; 10 watts is sufficient in an efficient transformer. The inductances used in the filter should be very high, 2 to 5 henries, while the condensers should be of 4 mfd.

The explanation here, covers the principles at present used in applying alternating circuits to vacuum tubes. But they are not finding wide application as yet. The art is still young. For cheapness as to first cost and portability the batteries are far ahead but with the more common use of Radio sets in places of amusement, stores and restaurants, the A. C. set is as sure to come as the generator distanced the primary battery as a source of power. The solution of the problem is a challenge to the entire experimental field for to it has gone many of the successes of the past.

At the present time there are quite a number of devices being introduced on the market, all designed for the purpose of eliminating both the A and B batteries. Some even plan on using the illumination current for supplying the antenna and ground connections. Such devices are as yet in the early stage of development and much remains to be done in the improvement of efficiency value and the lowering of their cost.

In some cases sets are now being placed on the market in which all this has been incorporated and no further accessories than tubes and loud speaker are required.

This problem of source of direct current supply without pulsations also presents considerable interest to the transmitting engineers because the same factors effect the quality of the broadcasting. Their current requirements run to much higher potentials however and require more elaborate equipment. In addition the item of expense is not as limited as for the receiving set accessories. The solution of the problem in one field will help solve the other.

Simple Explanation of Radio Reception

"The Long Range Dozen"—Chapter X

By Thomas W. Benson

RADIO receivers at present seem to be featuring two things—tuning and amplification. Increased efficiency in the tuners means greater selectivity and less difficulty in finding desired stations. Increased amplification assures greater range and increased volume. The word "amplification," whenever mentioned, must be qualified with a phrase to determine which of two types of amplification it is, for in Radio there are two kinds.

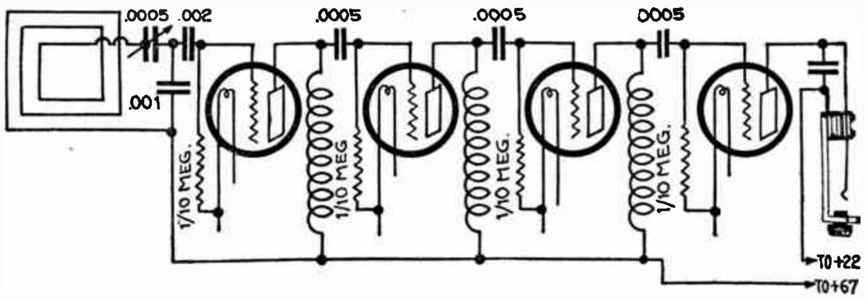


Figure 231—Three stages of untuned impedance coupled Radio frequency amplification.

In a previous chapter we discussed audio frequency amplification which is inserted in the circuit after the signals have passed through the detector and are in the form of impulses occurring at audible frequencies. Such amplifiers, properly designed, will increase the volume of programs, clearly and faithfully, up to tremendous strength; they do not, on the other hand, increase the range of the outfit.

Increasing Range

The range of a receiver is governed by "threshold value" necessary to actuate the detector. For every detector, whether crystal or tube, there is a certain minimum amount of energy essential to the passing of signals. Very weak signals do not affect the detector and are never heard. If they could be strengthened before they were impressed on the detector, the range would be greatly increased. That is the purpose of Radio frequency amplifiers and it is surprising to consider the number of methods of coupling tubes that have been devised to accomplish this.

Neutrodyne, superdyne, Radiodyne, sunset, Abele, phusiform, Rice, CR-12, transformer-coupled, impedance-coupled, resistance-coupled, capacity-coupled, super-heterodyne—each is a method of hooking up vacuum tubes to get efficiency from them as Radio frequency amplifiers. Every one of these methods has something in its favor; also, every one of them has some more or less important drawback. Neutrodyne and super-heterodyne have been taken up elsewhere, but the rest can be discussed here.

The filament circuits of tubes connected as Radio frequency amplifiers are identical with the filament connections of those used for audio frequency work. The plates of all tubes connect to the plus B battery terminal. The grids must be connected to a coupling device and then to the filament circuit as in the case of audio frequency amplifying tubes. Only in the matter of coupling units do these Radio frequency (R. F.) amplifiers differ.

In Figure 231 we have a circuit showing four vacuum tubes, the fourth being the detector. The first three tubes, it will be seen, are connected together by inductances. These inductances are wound so they offer sufficient opposition (impedance) to current oscillating at frequencies between 50,000 and 4,000,000 per second, to prevent these currents from passing through them; yet, the direct unvarying current from the B battery readily passes to the plate. The principle is that the variations in the plate current of the first tube, since they are at Radio frequencies cannot pass through the inductance A and choose what is, to them, an easier path and go through the .002 condenser to the grid of the next tube. This continues through each tube until, when signals have reached the detector, they have tremendous volume and a powerful signal will be heard.

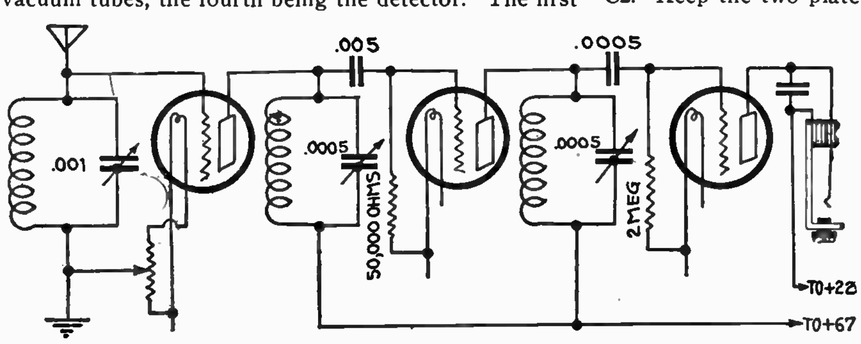


Figure 232—Two stages of tuned impedance coupled Radio frequency amplification

Figure 232 also shows an impedance-coupled outfit, but in this case the impedance is tuned. Such a circuit gives much greater amplification per tube, but, since each circuit must be tuned with great care, it is difficult to control. It is also likely to be very unstable and to oscillate at any moment. The theory here, is that each circuit is tuned exactly to frequency of the incoming signal, at which setting it offers 100 per cent opposition (known as "infinite impedance") to the signals and, as in the case of the untuned impedance hook-up, the signals choose the easier path to go to the grid of the next tube.

The Rice System

The Rice system, shown in Figure 233, while remarkably simple and easy to build, came after many of the more complicated circuits. Fans will do well to experiment with this system, although the writer cannot say just how many stages would prove practical. The writer's set contained a 100-turn honeycomb in the aerial connected in series to a 5-plate variable condenser. The secondary circuit contained a 50-turn honeycomb shunted by a .001 vernier variable condenser. A large variocoupler could be substituted for the honeycombs. The inductance in the plate circuit is a 100-turn honeycomb, spider web, G-R or other coil. Both tubes are hard tubes, either 199, 299, 201A or 301A. Careful initial adjustment of the grid leak is necessary, although it is said that the action here is not that of a grid leak.

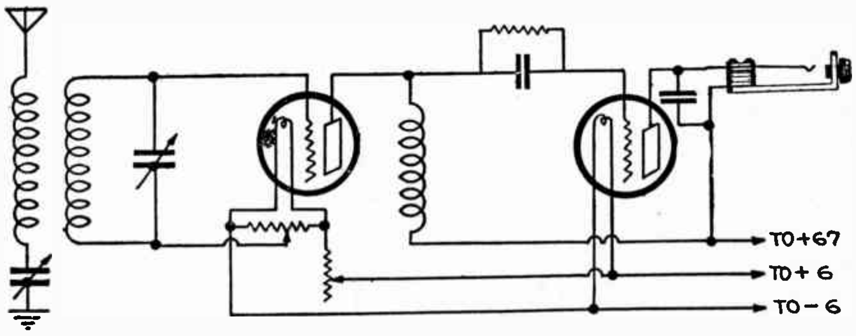


Figure 233—The Rice system seems to present little difficulty in either construction or control.

A very interesting circuit is the one employed by French amateurs and shown in Figure 234. This is a combination of tuned Radio frequency amplification and regeneration; most important, it cannot reradiate. Once the taps on the coupling coil B have been set, it will be found perfectly feasible to calibrate the scale of condenser C2 in wave lengths. For the fan who would like to try this, the following suggestions are made. Use two hard tubes; coil A is about 70 turns with an average diameter of 3½ inches; C1 is either .0005 or .001, depending on the antenna used; coil B is 40 turns wound single layer on a 3½-inch tube, tapped every two turns and set at right angles to A; C2 is .0008 or .001 mfd. Once the three taps on coil B have been set, they require no more adjustment and tuning is chiefly a matter of swinging the calibrated condenser C2. Keep the two plate circuit taps between the grid tap and the lower end of the coil.

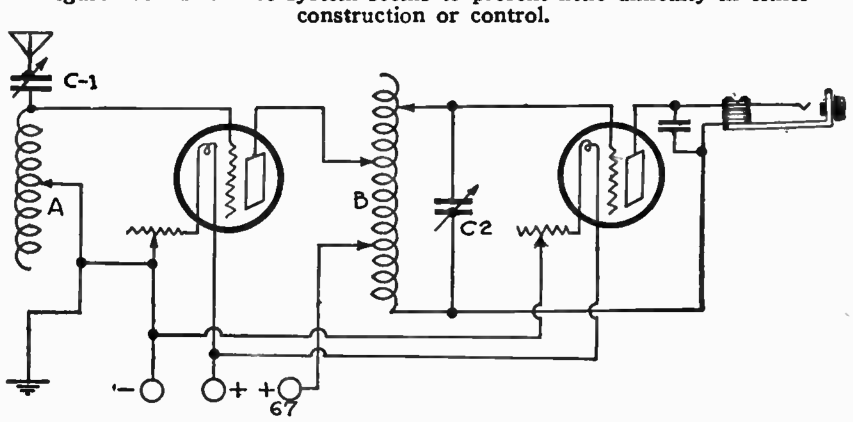


Figure 234—The French amateur's equivalent of the American "ham's" Reinartz—the Abele

The Sun Set

In Figure 235 we have a novel and distinctly different circuit devised by Captain Anatole Gollos and called the "Sunset." Sharp tuning is obtained by coupling the antenna circuit to the first tube by a single turn of wire, L_2, which is wrapped around L_4. Ordinarily this would result in loss of volume, but this loss is more than offset by the fact that the single stage of Radio frequency amplification operates at peak efficiency and without introduction of resistance into the circuit.

Those who would like to do some experimenting with this hook-up should use a tube 9½ inches long and 3 inches in diameter and wind 64 turns of number 18 dsc. wire at one end. This is the inductance called L_3 in the diagram. Leave ⅛ inch on tube and wind 16 turns, then one turn of litzendraht, and continue the 16 turns with 16 more. The two 16-turn sections compose the inductance L_4, and the single turn of litz is L_2. After completing L_4, leave ⅛ inch and wind 64 turns, forming L_5. Since the two variable .00025-mfd. condensers shunted across L_3 and L_5 are always at identical settings, they may both be mounted on a single shaft. To do this, get a piece of rubber or bakelite tubing that fits over the rear end of the shaft of one condenser and the front end of the shaft of the second condenser, and fasten with setscrews It will be found convenient to place the dial controlling C_2 and C_3 in the center, with C_4 to the left and C_5 to the right.

Cotton Circuit

Where the above had a multiplicity of parts and controls, we now come to one (Figure 236) with a minimum of parts and controls. This was first assembled by Mr. Cotton of Boston and gives truly marvelous results. The use of fixed couplers eliminates controls, seemingly without much loss in efficiency due to not tuning circuits to resonance.

The couplers may be made by winding 52 turns of wire on a 3-inch tube and slipping over this a short tight-fitting tube on which are 6 turns of wire constituting the primary. To cover the entire broadcasting range the secondaries should be shunted by vernier .0005-mfd. condensers. In laying out this set, place the first condenser at left of the panel with the first coupler behind it. The next condenser and coupler are about 3 inches to the right and between them is the Radio frequency tube. The detector and audio frequency amplifiers are placed to the right of the second condenser and its coupler.

Altering the Peak Efficiency

In circuits using untuned transformers to couple the tubes, the chief difficulty has been that the transformers had a peak efficiency on a certain wave length and much lower efficiencies on other wave lengths. The hook-up shown in Figure 237 is a method of altering the peak efficiency of the transformers to the wave length on which it is desired to receive. In addition to the usual primary and secondary windings, there is a third winding, one end of which is always connected to the grounded or negative side of the filament battery. A switch whose center top is also

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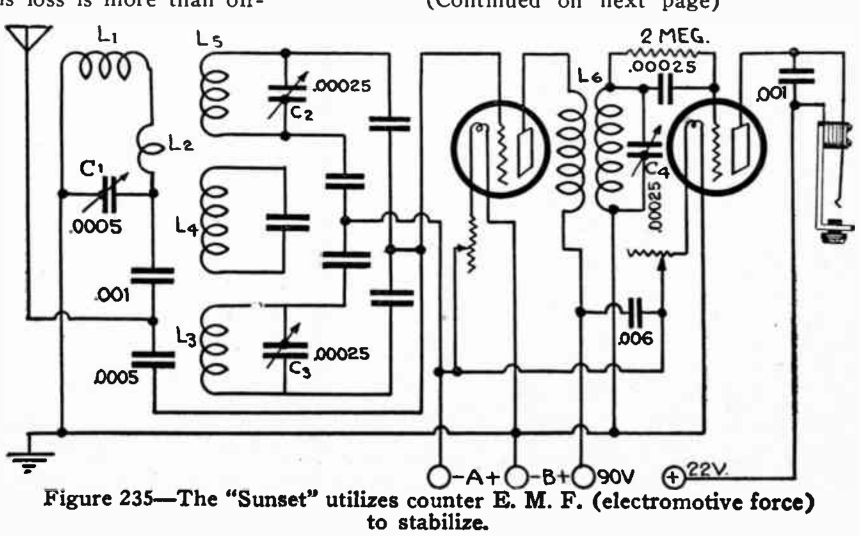


Figure 235—The "Sunset" utilizes counter E. M. F. (electromotive force) to stabilize.

(Continued from preceding page)

connected to the grounded side is used to short-circuit more or less turns, which changes the impedance and hence the resonance point of the transformers. A resistance is introduced into the grid circuit of the first tube to prevent its oscillation, while a C battery keeps the grid of the second tube at the proper point of its characteristic curve.

The Radio amateur has undoubtedly done more to advance Radio technically than any other single group in the art. Limited in the amount of power he can use for transmission and in the wave lengths on which he can talk to his friends, he has developed reception to its present high plane—and learned much. The circuit shown in Figure 238 is typical of this. Such a set is not one for the average fan to attempt to build with any assurance of success. Its controls are many, its operation unstable. Probably only its inventor can operate it, or some other very experienced amateur. But it has possibilities and this is the status of all circuits when first brought out.

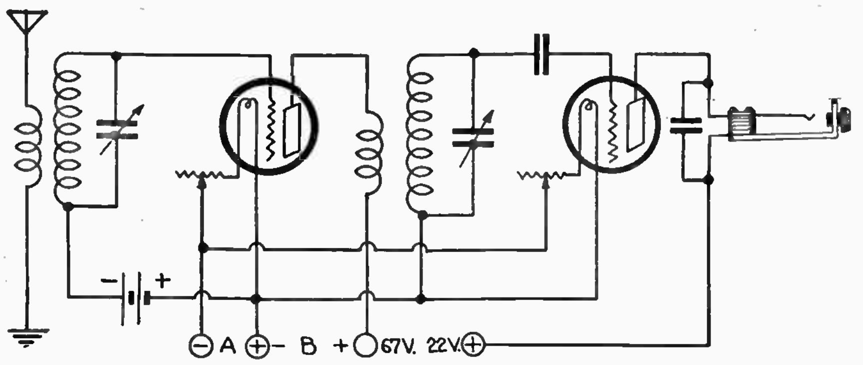


Figure 236—The fixed coupler receiver permits a stage of R. F. with but one control.

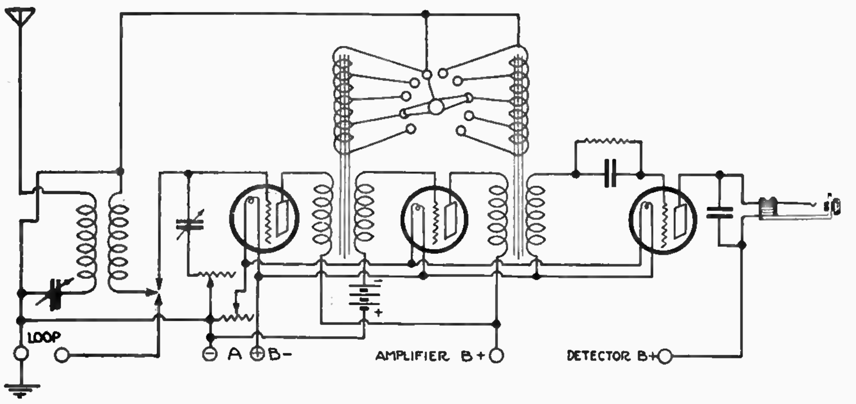


Figure 237—The "peak efficiency" of the R. F. transformers may be shifted to any frequency.

Three Stages of Radio Frequency

This circuit, which we will call the "1XP" from its designer's call letters, contains three stages of variometer-coupled, tuned Radio frequency. There is no need for a double circuit tuner, as the selectivity is remarkable and without re-radiation. The inductance L_1 consists of a tapped inductance, either 60 turns on a 4-inch tube tapped every 10 turns, or one of the new basket-weave type. Condenser C_1 is .0005-mfd. The variometers L_2 should cover the 200 to 600-meter range and be wound to contain air cells and of basket winding.

Condensers C_2 are .001-mfd. mica insulated, while C_3 is also mica, but only .0005. The grid leaks are very important, that on first tube being capable of adjustment as low as 10,000 ohms. It will be found that, once the grid leaks have been adjusted so that oscillations do not occur at any setting of the dials, most stations will be heard in the first third of the first variometer's rotation, in the middle third of the second variometer's arc, and in the last half of the third variometer's rotation. Properly made of good parts, this set should be surpassed only by a good super-heterodyne.

Condensers Between Grid and Plate

An interesting set was brought out some months ago, utilizing the circuit shown in Figure 239. The coupling units between the tubes have variable coupling between the primaries and secondaries, and each unit should be tuned. The small condensers between the grid and plate of each Radio frequency tube require but little adjusting and are for neutralizing the inherent capacity of the tubes that is the cause of oscillations. This leaves but three adjustments in tuning, namely, the variable condenser and the two transformers. It should be mentioned that these transformers are of a most unusual type, and the ordinary variocoupler or adapted variometer would not give good results.

The English amateurs and experimenters having been limited for many years to reception only, have naturally developed receiving sets to extreme sensitivity. In the matter of receivers, they surpass us to some extent. An excellent English hook-up is shown in Figure 240, including not only detector tube, but also one stage of Radio frequency amplification. To adapt this to American equipment it would probably be necessary to insert neutralizing condensers across the grids and try several other well known methods of preventing uncontrolled oscillations. The inductance in the plate of the first tube is a 50-turn honeycomb or other coil that can be varied in its relation to the feedback coil, which is also of 50 turns. The plate coil of the second tube is a 50-turn coil; all three variable condensers are .001-mfd. capacity. Both of the fixed grid condensers shown are .00025-mfd.; the first grid leak will probably be about 2 megohms and the second about half that. Both should be variable. It has been suggested for any type of Radio frequency amplification—and the writer would certainly advise it on this set—that three sets of B battery be employed; 67 volts on the Radio frequency amplifying tubes (three batteries), a separate battery of 22 volts on the detector, and 90 volts (four more batteries) on the audio frequency amplifiers. Eight B batteries may seem a rather heavy initial investment, but it will be found that the detector B will last more than three times as long as it would if used for triple duty, while each of the others perform far more than twice as long as it would if employed in the usual hook-up.

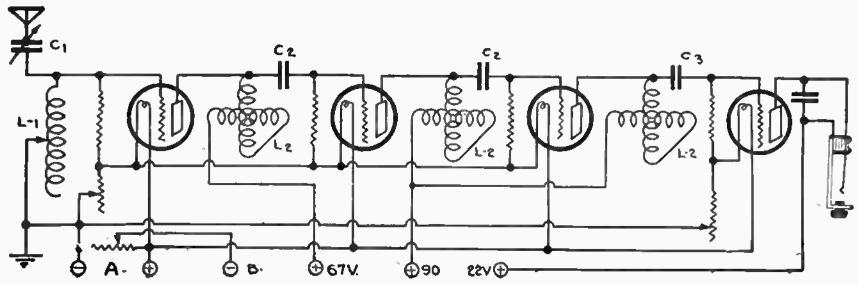


Figure 238—Type of tuned impedance R. F. amplification designed by Leon Bishop, 1XP.

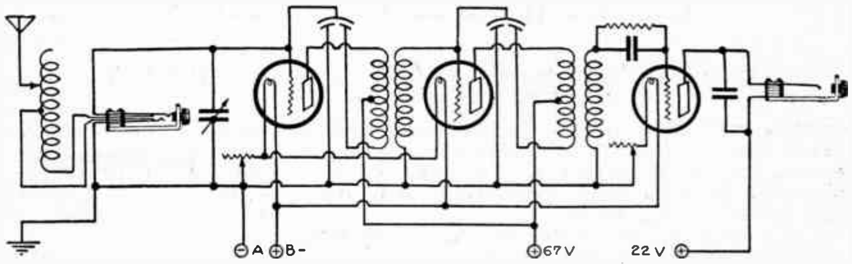


Figure 239—The tubes are prevented from oscillating by splitting the primaries of the transformers and introducing small condensers.

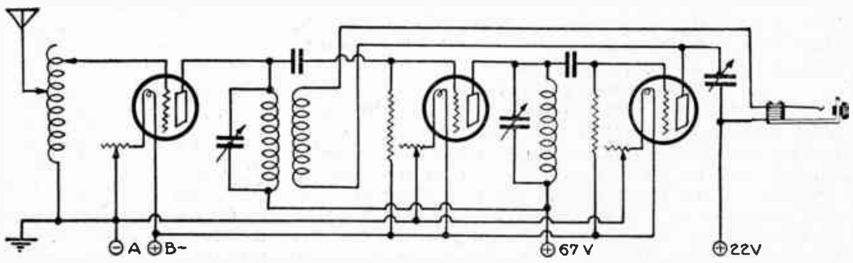


Figure 240—Regeneration includes not only detector but a step of R. F. amplification as well.

Radio Frequency and Regeneration

In Figure 241 is shown the first successful combination of Radio frequency amplification and regeneration. The experienced reader will recognize at once the presence of two variometers, but the method of connecting the windings will puzzle. Here not only is the rotor split from the stator, but the two halves of each are separated.

In the variometer, which precedes the first tube, a lead is taken from the mid-point of the stator and connected to the antenna; one end of the variometer is led to the grid, while the other passes through a variable resistance to the filament circuit. This gives the effect of a transformer with half the winding in the antenna circuit and all of it in the grid circuit, and a doubling of voltage results at once.

Split Stator and Rotor

The second variometer has no mid-point leads, but stator and rotor are split as shown. Tightly coupled to the stator is a coil of 25 turns which acts as the primary of a Radio frequency transformer and passes energy into the variometer, here utilized as the secondary. With units of the proper constants, this set functions well on a 20-foot antenna, a greater antenna seemingly making little if any improvement.

The tendency of the first grid circuit to oscillate is checked and controlled by the variable resistance inserted between the variometer and the filament circuit, and this first tube may be brought right up to a point just below the "spill-over." All the amplification of regeneration is thus gained. With the proper units, the fan can construct such a set and add two stages of audio amplification which will give surprising volume on distance.

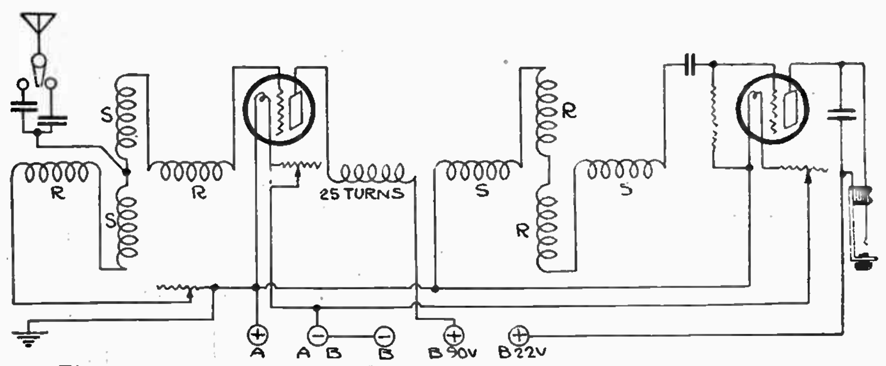


Figure 241—This hook-up was the first practical combination of regeneration and R. F. amplification.

Three Stages of Radio Frequency

Figure 242 shows a hook-up which, in the writer's opinion, is surpassed only by the super-heterodyne. The loop arrangement is that used by Grimes on the inverse duplex. There are three stages of transformer coupled Radio frequency amplification. Iron cored transformers may be used because, while they are broad, they pass more energy, and selectivity is gained by the loop and the circuit which couples them to the detector.

The circuit shown, including the three inductances A, B and C, is the triple honeycomb coil hook-up, in which A is usually led to antenna and ground. A and B will each be 50 or 75 turn coils; C, the next smaller size. C^2 and C^3 are .0001 mfd. each, as is C^1. The leads to C may have to be reversed to secure regeneration, but once determined are left alone. With two stages of audio frequency amplification, a six-tube set is acquired that is marvelous in results. True, it has three condenser controls, two couplings and the loop switch, but once the owner learns approximately where various wave lengths are found, tuning is not difficult. It is a set for the man who, looking through the programs, sees one to which he would like to listen for an hour without interruption.

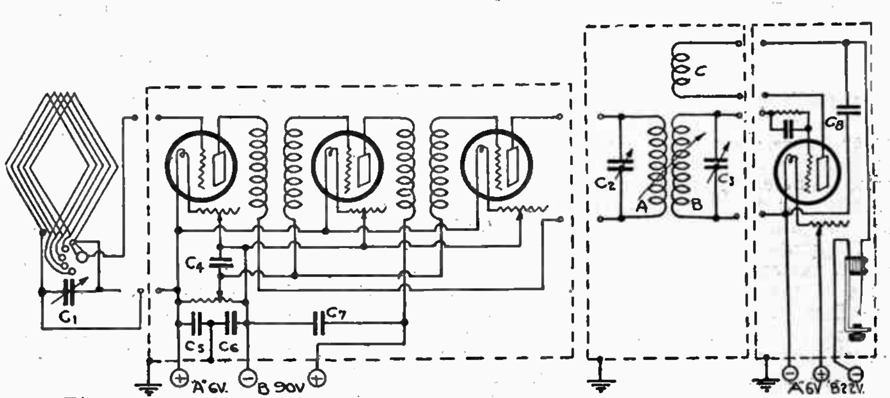


Figure 242—This hook-up is remarkably sensitive and, once learned, a pleasure to operate.

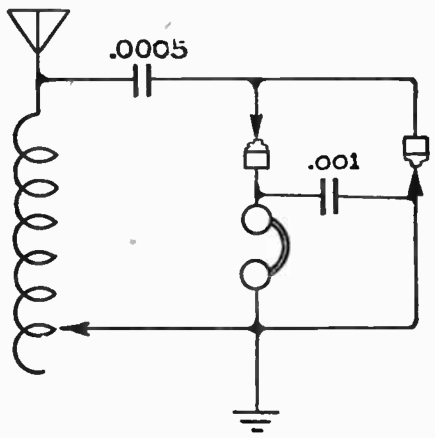
The series of circuits presented in this chapter give the experimenter all the range desired for the development of any efficient simple or multitube circuit. The theory in each case has been demonstrated as practical but much can be done in the line of further improvement for the development of a final circuit that will meet the demands of the most exacting and critical fan. The opportunity is his, to work toward the goal he aspires to.

How to Make a Double Crystal Receiver

Use of Two Crystals in Set Helps Increase the Volume

THE crystal receiving set is one of the oldest, most generally known, and most reliable types of receiving sets, and hundreds, if not thousands, of crystal sets, have been described in printed literature, but, strange to say, I have not yet seen any crystal set that is perfect, or, rather, as nearly perfect as it is possible to make it. I am submitting to the readers the following specifications, and ask them if this is not as nearly perfect a set as it is possible to produce.

The crystals which are now available serve only as rectifiers and not as amplifiers, and must obtain all their energy from the aerial. This great absorption of energy results in broadness of tuning, so that a tapped inductance will be amply sufficient, without any additional provision for fine adjustment. A small fixed condenser may be used in the aerial, and the ground



connected directly to the switch arm, as shown in the circuit diagram.

Tapping the Inductance

In tapping off the inductance, instructions usually tell you to tap off the coil at regular intervals, as

List of Parts

2 Crystal detectors @ $1.00	$2.00
1 Panel 4x8	.70
1 Fixed mica condenser .0005 mfd.	.40
1 Fixed mica condenser .001 mfd.	.40
Materials for coil	.50
1 Switch arm and taps	.50
Binding posts, bus bar, screws, etc.	.60
Total cost	$5.10

every ten turns, for instance. This is wrong. The proper way to tap off a coil is to have successive taps increase the wave length by the same fraction. Since the wave length is proportional to the square root of the inductance, and the inductance is approximately proportional to the square of the number of turns of wire, it follows that the wave length is directly proportional to the number of turns of wire (assuming that they all have the same diameter). The coil should therefore be tapped off so that the total number of turns of wire increase by the same fraction each time, and not by a fixed number of turns. For a crystal set the tuning will be sufficiently fine if each successive tap increases the number of turns by about one-fifth or one-sixth, while if a variable condenser is used in series with the aerial, the increase may be as much as one-third or one-half the total number of turns.

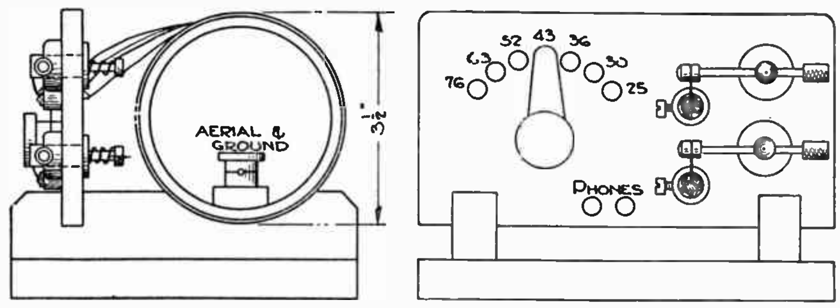
Number of Turns on Coil

In the set shown in the illustrations, I have designated the dimensions and number of turns which have been found most satisfactory. The construction, as shown, is easy to build, and many of the details are left to the ingenuity of the builder, but one hint must be given, and that is, to solder the wires to the switch point before the coil is secured to the base, as otherwise it will be difficult to get the soldering iron in between the coil and the panel.

There are two crystal detectors used in this circuit. These are arranged in reverse order, as shown in the circuit diagram, and will be found to make the set much more reliable than if only one were used. Since a crystal acts only as a rectifier, each crystal can use only one-half of the wave. Now, if the conductivity of the crystal in the other direction would be absolutely zero, then the energy from the other half of the wave would merely be sent back into the oscillatory circuit to add to the energy of the next wave. But actually the conductivity of a crystal is not absolutely zero in either direction. It is merely greater in one direction than in the other. If, now, another crystal could utilize that half of the wave which the first crystal cannot use, then substantially all the energy of the waves would either be rectified to audio frequency or returned to the oscillatory circuit. This may be done in the manner shown on the illustrations.

If the crystals are properly adjusted, reception will be perceptibly louder than if only one crystal is used, and even if one of the crystals is not very sensitive, so as to serve merely as a resistance, the set will still function as well as the ordinary single crystal receiver.

LOCATION OF PARTS ON PANEL



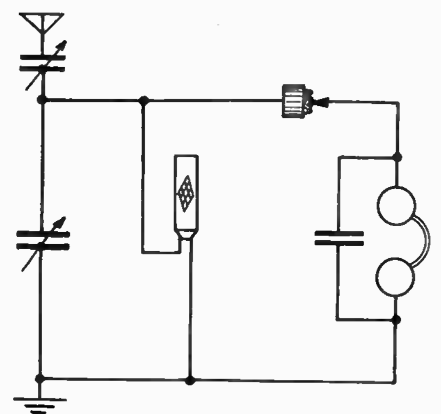
Each crystal detector consists of a central pivot drawn in by a spring, a cat-whisker stem slidable through a transverse hole in the end of the pivot, and a ring or washer of insulation material surrounding the pivot and having a transverse slot for the cat-whisker stem to rest in.

Long Distance Crystal Receiver

IN THE early part of 1922 the writer began to experiment with Radio reception and by the end of the year had some very gratifying results in being able to use a loud speaker on a simple crystal set for local reception—about three miles. Sounds came in strong enough to be heard all over the room.

One evening after WOC had signed off, I sat a while with my headset on, reading the paper, when I heard some music, and presently the announcer with a nasal tone now so familiar, came in saying, "This is KSD, the St. Louis Post-Dispatch." I heard this station until it signed off for the weather forecast, and then tuned in Louisville. Kentucky.

My list of stations contains the following: KSD, KYW, WBAP, DWAF, WDAP, WEAH, WFAA, WGM, WGR, WGY, WHA. WHB, WHAS, WJAZ, WLAG, WLW, WLAS, WMC, WOAW, WOC, WOR. WOS, WSB, WSY, WWJ, WLAT, WOI, WJAX, WOQ, WEY and KDKA.



I consider the results I have had to be very good, especially as I have been able to pick up some of the stations very consistently and without interference.

The most remarkable part of it all is that it has been done with a very simple crystal set made at a low cost. Describing the set I shall begin with the aerial, of which I have 200 feet stretched between three trees, forming a sharp triangle open at the base, 40 feet above ground. Two lead-ins are used at the base of the triangle. I have tried different aerials and have found that less than 150 feet is not effective. A straight wire is not so good as one made to form an angle with at least 75 feet on each side. It was found that with a single wire running north and south I received from the north, west and south, but could not reach east. However, as soon as I ran the wire angular toward the northeast, I had no directional difficulties.

I annealed the wire before putting it up and consider this important. Two lead-ins are also important. Aerial and lead-ins should be made of number 14 braided or stranded wire. The ground runs from the

List of Parts

1 Panel 7x10	$ 1.20
1 Variable condenser .001 mfd.	3.50
1 Variable condenser .0005 mfd.	2.25
1 50-turn honeycomb coil	.75
1 Crystal detector	1.25
1 Fixed condenser .002 mfd.	.50
1 Cabinet	2.25
Total cost	$11.70

set to a water pipe and is clamped to it to form a good contact. The set itself consists of a primary 43-plate condenser, a tuning condenser of 23 plates, a honeycomb coil of my own make, a .002-mfd. phone condenser and a simple crystal detector with a synthetic crystal.

In operation, the primary condenser is closed and the secondary condenser is used for tuning. A little practice will soon enable the operator to find the proper position for the primary condenser, which will depend upon the length of antenna. It will be noted that there are only two controls, namely, the two condensers. These need not be of the vernier type, although a vernier on the secondary condenser may be helpful. A test buzzer will be of aid in finding a sensitive spot on the crystal unless a fixed detector is used. I do not recommend the use of galena as it seems to lose its sensitiveness in a short time.

The hook-up diagram shows the simplicity of the set clearly. It can be mounted on any kind of a panel or in a large cigar box. Any good 3,000-ohm headset may be used. Amplification may be added as desired.

Effective and Actual Heights of Aerial

Apparently the height makes very little difference to most Radiophans. A high aerial will pick up more Radio frequency energy than a low one, but the high aerial, besides being able to pick up fainter and weaker signals, collects static which interferes with reception, so that too high an aerial should be avoided.

It is the effective height of an aerial that counts and not always the height above the ground. If an aerial is 10 feet above a grounded tin roof, the effective height would be 10 feet and not the 50 or 60 feet from the earth.

The aerial has a marked influence on the selectivity of the receiving set and the possibilities in this direction must be taken into account. If the aerial were erected in an open space clear of any obstruction, the problem would be completely simple, but, as it is, we usually have to make the best of conditions as we find them. The element of the aerial which determines its ability to pick up or give off signals is termed its effective height. This does not mean the height from the ground to the topmost point, but is the average height from the ground terminal to the center of its exposed aera.

For an aerial consisting of a straight vertical wire the effective height is approximately two-thirds of its actual height; while for an aerial having a large flat top structure the effective height is very nearly the actual height. The only purpose of the flat top element of a receiving aerial is to give greater effective height for a given actual height.

Beginners' Aids

To obtain the most out of a newly-purchased receiving set, it is necessary to learn a few rudimentary principles of operation. What to do and what not to do should be memorized.

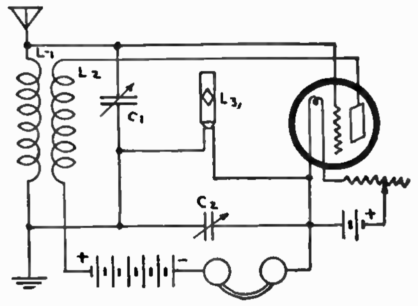
If you have a crystal detector, keep the fingers off the mineral. Handling it leaves a greasy surface and it is more apt to collect dust. It is best to keep it covered and if you must handle the crystal, do so with a pair of tweezers.

Don't attempt to find out what is inside of your head receivers. Many poor results can be traced to the fact that the individual was too inquisitive and opened the receivers by unscrewing the cap. In doing so, you will bend the diaphragms and almost surely ruin the phones. The diaphragms are made of very thin metal and are easily bent if handled. You may also injure the winding, as it is wound with wire as fine as hair.

If you have purchased a complete set, don't handle it roughly, as you may loosen a connection inside the cabinet.

Don't try to change any of the wiring if you are unfamiliar with the working of it.

"Naciremen" Latest Easy Super Hook-Up



THIS hook-up is a new single tube receiving circuit, known as the Naciremen. This circuit was developed in the laboratories during a series of experiments with a large number of receiving circuits. This new circuit is not suitable for wired Radio because of its tendency to reradiate, but it is probably the last word in a simplified single tube set for receiving news and music from the present Radiocasting stations.

PARTS REQUIRED

1 Variometer or variocoupler, L1 is the rotor winding, L2 is the stationary winding.
2 23-plate condensers, preferably with verniers (C1 and C2).
1 750-turn DL or honeycomb coil or its equivalent (L3).
1 Tube, WD-11, UV-201A, or other hard tube.
1 Tube socket.
1 Filament rheostat (R).
1 A battery, 1½ to 2-volt for WD-11 tube; 6-volt for other tubes.
1 B battery, 45 to 90 volts for WD-11; 45 to 135 volts for other tubes.
1 Pair phones.

The circuit is being published with full details in the interests of amateurs and the public who may wish to listen to the programs now in the air. The set is super-regenerative and full credit should be given to E. H. Armstrong for the discovery of this principle, of which this may be considered an extremely simplified form. The circuit requires a minimum investment in parts. Practically every amateur already has everything necessary to try out the circuit. It will be noted that all resistances, grid leaks and grid condensers have been eliminated and no filter circuits are required. Any amateur can connect up one of these sets in an hour or two and the results will surprise the most hardened Radiophan.

Almost any metallic structure which may be picking up Radio waves may be used as an aerial. Connection to a bed spring, wire window screen, steam radiator or fire escape is often all that is necessary. A short overhead aerial, a length of wire strung across the room, concealed behind the picture moulding or under the carpet, will also serve.

List of Parts

1 Variometer	$ 6.00
2 Variable condensers .0005 mfd. vernier	11.00
1 Honeycomb coil, 750 turns, mounted	2.40
1 Single coil mount	.50
1 Tube socket	1.00
1 Rheostat	1.00
1 Panel 7x14	2.25
1 Cabinet	3.00
Binding posts, bus bar, screws, etc.	1.00
Total cost	$28.15

Tuning is accomplished by rotating the movable coil of the variometer or variocoupler until the tube oscillates. Then adjust condenser No. 1 until the station desired is heard, finally adjusting condenser No. 2 to the frequency of oscillation which brings in clear speech and music. A second fine adjustment all around will increase the volume and some regulation may be secured with the filament rheostat.

Protection for Filaments

The Radiophan is apt to experience disappointment when he finds that the high voltage leads from the B battery have been accidentally connected across the filament posts of his receiver and one or more tubes are burned out. Although the normal life of the average filament is considerably more than 1,000 hours, it requires but an instant to destroy this delicate filament when excessive voltages are applied to its terminals.

When filaments are shorted across a 20, 40 or 60-volt battery in new condition, the burnout requires but a fraction of a second, and unless the user happens to be inspecting the tube at the instant of the flash, the damage would not be discovered until the set was used again. It is a very easy matter to protect tube filaments by either of the following means:

Insert a 100-ohm (noninductive) resistance for each 22-volt block or B battery in the circuit next to the positive terminal of the B battery. This resistance may be left permanently in the circuit without any effects whatsoever in the normal life of the receiving set.

Probably the most convenient form of resistance is a 25-watt, 100-volt tungsten lamp which will provide sufficient protection for plate voltages up to and including 100 volts. This resistance automatically increases with the current so as to act, in effect, as a protective ballast lamp.

One Tube Long Distance Receiver

By Leon W. Bishop, 1XP

ONE of the most interesting circuits for a single tube that may be constructed for vacation use and which may be used in car or at camp and requires little or no aerial, is the phantom receptor. The circuit is the adaption of two Armstrong principles which really produce distance and clarity for a small constructional cost.

The success of any circuit depends upon the constants used, particularly this one which would seem to be a standard regenerative circuit but is completely changed by a large tickler and variable grid leak.

This circuit has been designed for the new wave bands of 2,000 to 550 kilocycles (150 to 545 meters) and includes the amateur. The circuit is more efficient on the shorter wave bands so it is possible to get the class A stations as loud as the class B, which is not possible with other types. Due to great flexibility the circuit will work equally well on phone, CW, ICW, and spark which will insure you of all classes of service no matter where you are.

Works Excellent on Short Aerial

When using this one tube circuit in a car with a 4-foot aerial it is equal to a three-stage Radio frequency amplifier and detector. Due to the short aerial used it is possible to receive through bad static (QRN) and for this reason alone is of considerable value during the summer months.

The two best tubes to use are the UV-199 and UV-201A. The rheostat should have the resistance advised by the makers of the tubes. The B battery can be anywhere from 45 to 90 volts. The two fixed condensers .00025 and .002 mfd. should be of the mica dielectric type. The variable condenser should have from 17 to 23 plates (.0003 to .0005 mfd.)

List of Parts

1 Variocoupler to be rewired	$ 6.00
1 Variable condenser .0005 mfd.	4.50
1 Variable grid leak with .00025 condenser	2.00
1 Fixed mica condenser .002 mfd.	.75
2 Switch arms and points @ 75c	1.50
1 Rheostat	1.00
1 Tube socket	1.00
1 Panel 7x10	1.75
1 Cabinet	2.75
Binding posts, bus bar, screws, etc.	1.50
1 Vacuum tube, three element	4.00
3 Dry cells @ 50c	1.50
3 Medium size "B" batteries @ $1.75	5.25
1 Pair of head receivers	7.00
Total cost	$40.50

How to Make Leak

The variable grid leak is important and should be variable over a range of from 50,000 ohms to 5 megohms. Several commercial types that were tried did not have the range claimed, so it might be advisable to build your own.

For that purpose purchase a ten cent roll of black picture binding paper tape whose dull black surface is slightly conductive and whose resistance can be readily lowered with an extra soft lead pencil. This grid leak can be arranged with a sliding arm or switch and contacts but it must be variable over a wide range and capable of fine adjustment.

Coupler Special Also

Like the grid leak, the coupler is of special design and the following values should be adhered to. The best combination to use is the rotor and stator of a standard coupler wound as follows. The tube (stator) should be wound with as large a wire as possible. Starting with 20 turns on the rotor side of the tube, tap every 10 turns until you reach 120 turns, which will leave 11 taps.

The rotor is also a real job for it is tapped in a similar manner. Start on one side of the rotor with 40 turns and tap off every 10 turns until you have wound on 120 turns and you then will have 9 taps. These taps can be passed through the rotor shaft to switch points on the panel or a switch may be mounted on the rotor. Fine wire may be used on the rotor to accommodate the necessary 120 turns.

A warning is given against the use of shellac on the windings. Firm windings may be obtained by drilling holes at each tap off and binding the wires in them.

Do not use honeycomb coils. Either double or single switch arms may be used. The 180 degrees mounting type of rotor can be used. Do not tap the coils any coarser than 10 turns, but finer if possible.

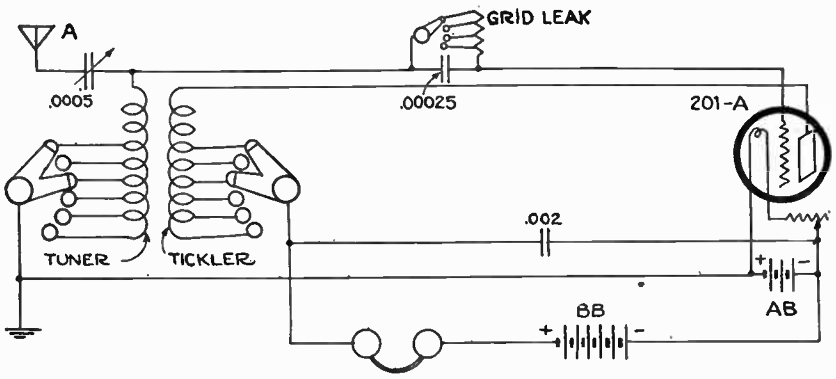
Operation of Circuit

The best antenna or collector system is to connect the variable condenser at point A to a good ground. No other connection is necessary. There are five adjustments on the set; the grid tuning coil, the tickler coil, the coupling, the grid leak and the antenna condenser. The filament rheostat is not critical so this is not regarded as an adjustment.

As the tickler coil and grid leak are increased, a super-regenerative condition will be met. The pitch of this note can be varied by the grid leak and should be adjusted until it is above the point of audibility and only a slight hiss is heard in the phones. At this point a wonderfully sensitive condition exists for all classes of phone and CW and will tune in contrastingly clear as compared with any single tube circuit.

A given wave length is tuned in by means of the variable condenser and grid circuit tuning coil. The tickler and grid leak are merely adjusted to conform to this condition. The resistance of the grid leak should be so arranged that it will give out a bad screech as it is increased and follow through an intermediate series of pure notes until it passes out of audibility, with a range of adjustment on either side.

The correct polarity of the tickler coil in the plate circuit will have to be tried out by reversing the leads until the best results are obtained.



Can Be Used as Transmitter

This is a standard circuit and may be used as such with an aerial and ground by reducing the tickler coil turns with the switch. With an aerial and ground the circuit can be used for transmission with a power tube and increased B voltage. All classes of super results may be obtained which makes it an ideal vacation outfit.

There are several aerial combinations that work well. One of the most interesting is to connect the point G to ground and touch the moistened finger to point A. For apartment houses two combinations can be used: (1) Connect the point G to ground and the point A to some metal object or a small aerial in the room: (2) Just connect the point A to ground.

To operate the set in a car connect the point G to the frame of the car through the steering wheel and the point A to the metal top or a small aerial in the top of the car.

When camping out the best collector seems to be a wire from the point A to a ground connection about 6 or 8 feet from the set. A short aerial may also be used.

If this is a super it is far superior to anything you have ever tried before in that line and it may be due to the fact that there are no large coils, condensers, or resistances to impede the real action of what a super might be if given a chance.

Mechanical Theory

You have often turned the variable condenser of a standard regenerative set up to zero and received an awful howl in the phones and said that the tube was spilling over. This is a negative charge that accumulates on the grid and leaks off in minute discharges which can be governed by a grid leak. These charges are negative so we can assume that the grid is negative most of the time and that an impressed EMF on the grid circuit would tend to build to infinity during the interval the grid was negative. This seems to prove out, as only a short aerial is required.

As the wave length is halved the amplification is squared by virtue of the increased frequency as compared with the rate of leakage. This may account for the marked results on the shorter wave bands.

This circuit is the result of a year's experimental work on the ultra regenerator which was originally published in a Boston newspaper August 22, 1922. The work was carried out at Radio Station 1XP.

Hints About Soldering of Radio Connections

Three things must especially be remembered while soldering. It is always important to have the surface or surfaces to be soldered perfectly clean. Emery cloth or a fine file may be used in some cases. Unclean surfaces do not permit the solder to flow freely.

The second point to bear in mind is to tin the surfaces properly. This is done by first applying a soldering flux, such as rosin, acid or paste, to the surfaces, and then the well-tinned iron is run over them. This will leave a thin coating of solder on the surfaces, thus making them ready for the connection.

The final operations should not be attempted unless the soldering copper is of the proper heat. It should never be heated above the point where the solder begins to turn gray. To tin the iron, dip the end in the soldering flux and rub a piece of solder on the surface. A thin coat of solder will remain on the soldering tip.

When soldering, the iron is placed on the surfaces to be joined together. When the solder has melted around the parts being soldered, the iron is removed and the solder will quickly set. Care should be taken not to jar the pieces while the solder is setting and also to allow only a minimum amount of solder to flow; thus preventing an unsightly joint.

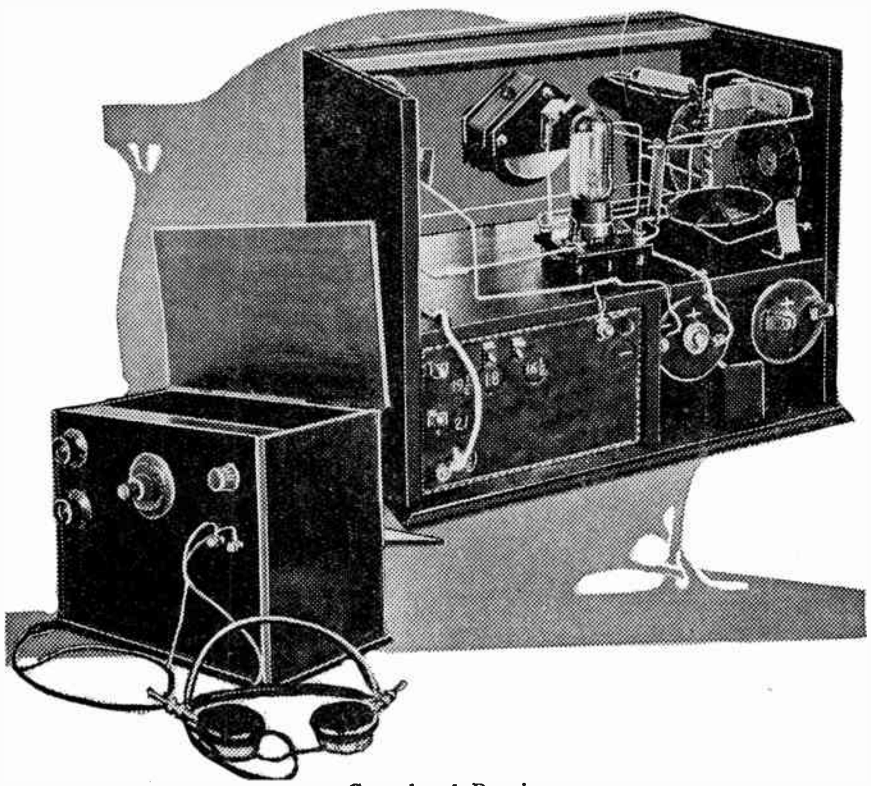
Lighthouse Keeper's Single Tube Radio Set

Compact and Popular Portable Kit

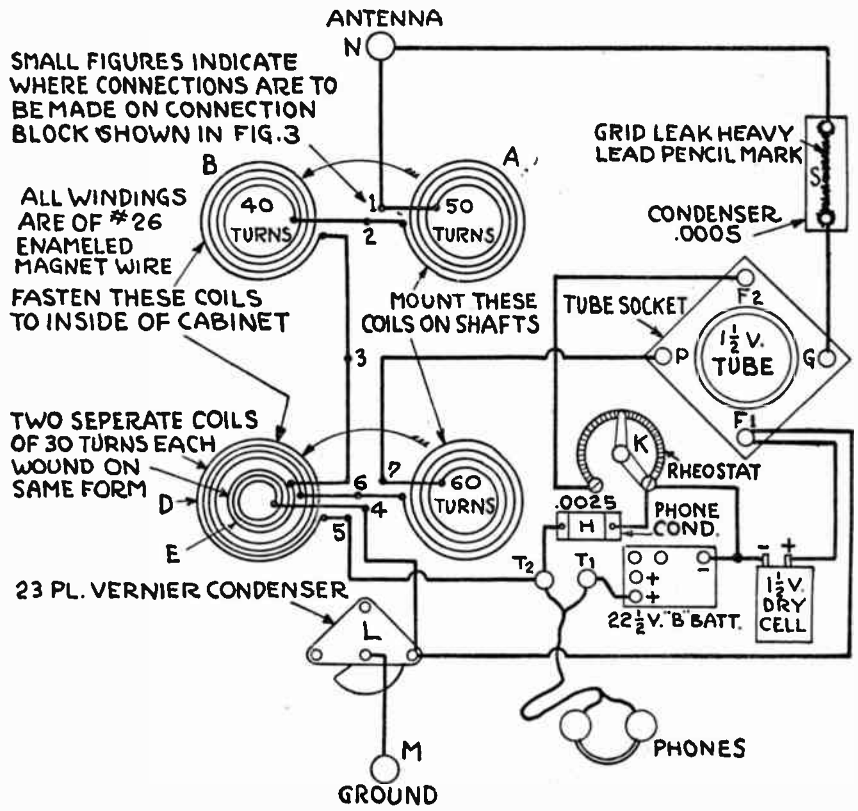
By S. R. Winters

A PORTABLE Radio receiver, representing a cash investment of only $37, and so simple in structural details that a person with the slightest elemental knowledge of electricity can assemble the parts, has been designed by A. W. Tupper, assistant engineer of the Lighthouse Service, United States Department of Commerce. Furthermore, the set is compact, the cabinet, instruments, and dry-cell batteries weighing barely 15 pounds. A single vacuum tube is used, which, besides the headphones, is the only expensive unit used.

This receiving equipment was designed especially for keepers of lighthouses—those lonely guardians of property along our 44,000 miles of coast line. One of these lighthouses, for instance, is perched on a rock in the Pacific Ocean, miles from land. The installation of the receiving set about to be described on this rock, will dispel the isolation by bringing civilization—music, church services, financial reports, lectures, etc., —into mid-ocean by the magic of the invisible electro-magnetic waves.



Completed Receiver



Detailed Circuit Diagram

Adapted for Universal Use

This compact Radio receiving set, perfected fortunately, is not limited in usefulness to the lighthouse. It is equally adapted to home, office or field, where inexpensiveness, simplicity, compactness, and long-distance reception are sought.

The opportunity for the farmer to display his mechanical skill in making and assembling the parts entering into the construction of the Radio telephone equipment is not to be discounted. The city dweller, too, who is swinging away from electric circuits involving cumbersome units and bulky storage batteries, will appreciate the possibility of erecting and assembling a set of such light weight that one person could easily carry cabinet, instruments, and batteries anywhere he might go.

The materials necessary for building this simple form of regenerative circuit have been so explicitly outlined by the Lighthouse Service that even the size and number of screws are specified. Fortunately, some of the materials are likely to be found around any home which houses a person with a mechanical turn. Moreover, the various parts indicated are not suggested for use on mere theory, but these sundry units have been tested for several months and their suitability established beyond a doubt.

The simplicity of the assembly of the instruments is not likely to be marred except in one possible instance, namely, the making of the proper connections of the two spider web variometers or coils. This obstacle may be avoided, however, by faithful adherence to the diagram or hook up illustrating one part of this series of articles.

Materials Necessary

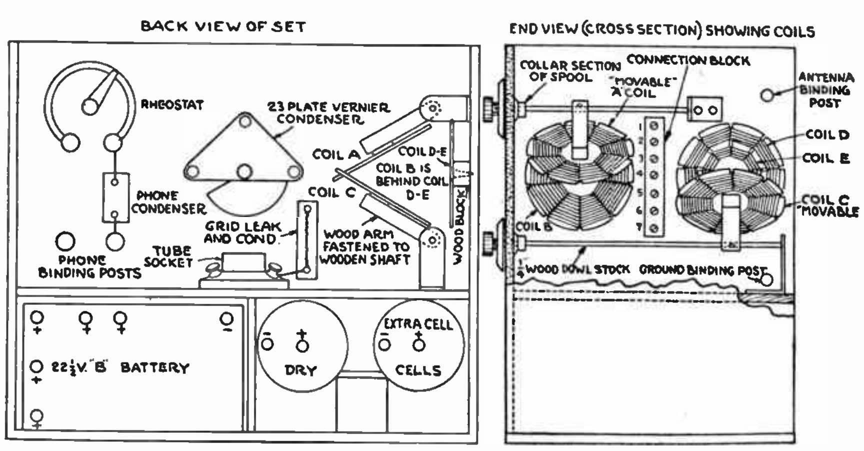
The materials required are the following: One 1½ volt vacuum tube for detecting the Radiophone signals, type WD-11 being used by the Lighthouse Service; one vacuum tube receptable; one pair of headphones; one 22½ volt B battery; one dry cell battery; one 23 or 43 plate variable condenser with vernier; one telephone condenser of .00025 mfd. capacity; one grid condenser of .0005 mfd. capacity; one grid leak; one piece of fiber or hard bristol board about 1/32 inch thick and 8 inches square; ¼ pound of number 24

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $37.00

gauge enameled magnet wire; 7 feet of tinned copper hook up wire or heavy bell wire; one rheostat for controlling the filament of the vacuum tube, one piece ¼ inch diameter dowel stock, 8¼ inches long; three or four pieces of tinfoil for covering back of panel; four binding posts; four machine screws No. 6, about ½ inch long, with nuts; one piece of brass, about 1/16 inch thick, 5/8 inch wide, and 6 inches long, for making end supports for coil shafts; three dozen copper or brass wire terminals; one dozen number 4 round head brass wood screws, 3/8 inch long.

Materials for Cabinet

This homemade Radio receiving set involves the building of the cabinet as well as assembling of the instruments contained therein. Therefore, the materials for making the container are quite specific. Obtain a piece of dry close grained wood, about ¼ inch thick, 13 inches long, and 10¾ inches wide, for the front or panel. Bakelite or other insulating material



Interior Views

may be used if preferred. The remainder of the cabinet may be of any kind of wood, although the model receiving sets built by the Lighthouse Service is of white pine, 3/8 inch thick.

The dimensions of the other pieces for the construction of the cabinet are as follows: Bottom and top, 14 inches by 8¾ inches; two ends, 8¼ by 10¾ inches; back, 13½ by 6 inches; hinged back or door to the compartment containing the batteries, 13½ by 4¾ inches; shelf, 7¾ by 12¾ inches. The other essentials for securing the cabinet in position include four pairs of small brass hinges and screws and some 1¼ inch wire brads; six brass screws, number 6, about ⅞ inch long, for securing the back in place; and soldering material.

Making the Cabinet

The construction of the box or cabinet involves the making of a groove, ¼ inch wide and ⅛ inch deep, in each sidepiece near the front into which the front board or panel is slipped. Any kind of wood, about ⅜ to ½ inch thick, will do. The panel should, preferably, be a piece of close grained wood ¼ inch thick.

The rheostat and condenser are put on the board, in order to be certain that the holes are in their true positions, after which the instruments are removed and the panel is put into an oven. Heat should be applied thoroughly as a means of expelling moisture, but caution should be exercised lest the panel be scorched. While the panel is still hot, a coating of thin shellac is applied on both sides, to the edges and in the holes. The panel is permitted to dry for 24 hours, after which two more coats of shellac are applied at intervals of 12 hours. Positive instructions are issued not to paint this panel with ordinary paint; a spirit stain or water color stain being applied if color is desired.

Applying Tinfoil

Once the third coat of shellac is dry, the inside portion of the panel that is above the shelf is covered with tinfoil, which may be attached to the panel by means of shellac. While the latter is in a moist condition, any tinfoil that may be dangling through the holes of the panel is cut away, in order that no metal parts of the condenser, rheostat, binding posts, or any of the wiring or wire terminals, may come in contact with it. The panel is then placed in position, the instruments are properly fastened, the coil shafts are inserted with the coils mounted thereon, and the tube socket is secured to the shelf.

Making the connections of the two spider web variometer is likely to cause trouble in the wiring of this simple form of regenerative circuit. Even this apparent difficulty may be surmounted if the diagram of the Lighthouse Service is faithfully followed in detail. A. W. Tupper, assistant engineer, who is responsible for this self-contained receiver, is extremely cautious about one point; that is, each pair of coils should be assembled so that when they are together and observed from one side, the wire in each will be turning in the same direction.

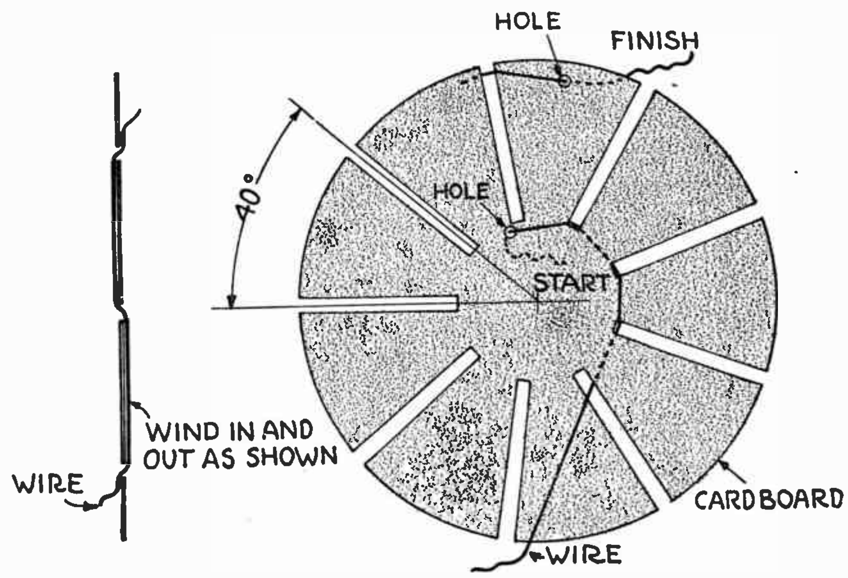
An arrow marked on each coil near the center on both sides will unmistakably indicate the direction in which the wire is turning in passing from the center, or start of the variometer, to the outside. Then, when the two variometers are assembled, arrange them

(Continued on next page)

(Continued from preceding page)
so that the arrows on each pair of coils are pointing in the same direction. In the absence of arrow markings, it is difficult to ascertain in which direction the coil is wound after its completion. A margin of 8 inches of wire at the beginning and completion of the wiring is reserved for making connections with other instruments.

Winding of the Coils

The coils are made by cutting each slot within ½ inch of the center, using number 26 enameled magnet wire. Number 24 wire may be used for this purpose



The Winding Form

but the completed coils will then be considerably larger, a condition not consistent with the snugly built box or cabinet already described. This is to say, the depth of the case would have to be greater.

The coils D and E, as indicated in one of the diagrams, are threaded around the same spider web in this fashion: Start at center, wind on 30 turns and secure end of wire by passing it twice through a small hole punched near the edge of the slot, pulling wire through taut each time and leaving a loose end 6 inches long.

A piece of thin wrapping twine which has had a coating of shellac is covered with paraffin is wound thereon in two turns. This prevents contact between coils D and E. Then, begin winding coil D. The wire is made secure by passage through a small hole near the edge of the slot, as before. Thirty turns are wound on coil D, making sure that the windings are in the same direction as those of coil E. Also 6 inches of loose wire is left at the completion of this coil for making connections with instruments.

The edge of the cardboard is trimmed off to within ⅛ inch of the wire windings, and all four of the loose wires are passed through small holes near the edge of the cardboard. A little slackness in the wires that have to pass from the inside over the rest of the windings is permitted, in order that they may not rub together.

In winding the various coils it is well to mark each of the wires with a paper tag; otherwise, their identity cannot be established once the coils are put in position. To illustrate, identify the wire coming from inside of the coil E with the letter combination I-E, the one from the outside of the coil E with the letters O-E, and so on. This system will lessen the labor.

The coils are mounted on shafts fashioned from wood which are ¼ inch in diameter. A piece of ¼ inch dowel stock will meet the requirements. These shafts are passed through holes in the front panel of the cabinet and are provided with knobs for turning them. The latter, with dials on them and provided with set screws, may be purchased. But, to make the set a real homemade one, one-half of a common thread spool will suffice, the other half being inserted on the inside of the panel as a thrust collar to steady the shaft in its correct position.

The other end of the shaft is sharpened to a flat cone-shaped point to fit into a hole drilled in the spring-brass elbow, as indicated in one of the diagrams. This hole is restricted to a size of ⅛ inch or possibly a bit more, so that the shaft will not slip through. The brass elbow is so located that it will press on the end of the shaft and cause the spool thrust collar to force itself against the panel with sufficient friction to hold the coil in any position in which it may be placed by turning the knob on the receiving set.

Coil Mounting

The coil is held securly on the shaft by means of a wood strip, ½ inch square and 2 inches long, with a hole drilled in one end fcr the passage of the shaft. A pin through the strip and shaft will hold the former rigidly to the latter, provided the shaft fits the hole snugly. The coil is fastened to the wood strip with a small flat head wood screw; tacks or nails may be substituted, but are not recommended by the Lighthouse Service, since they will eventually work loose.

List of Parts

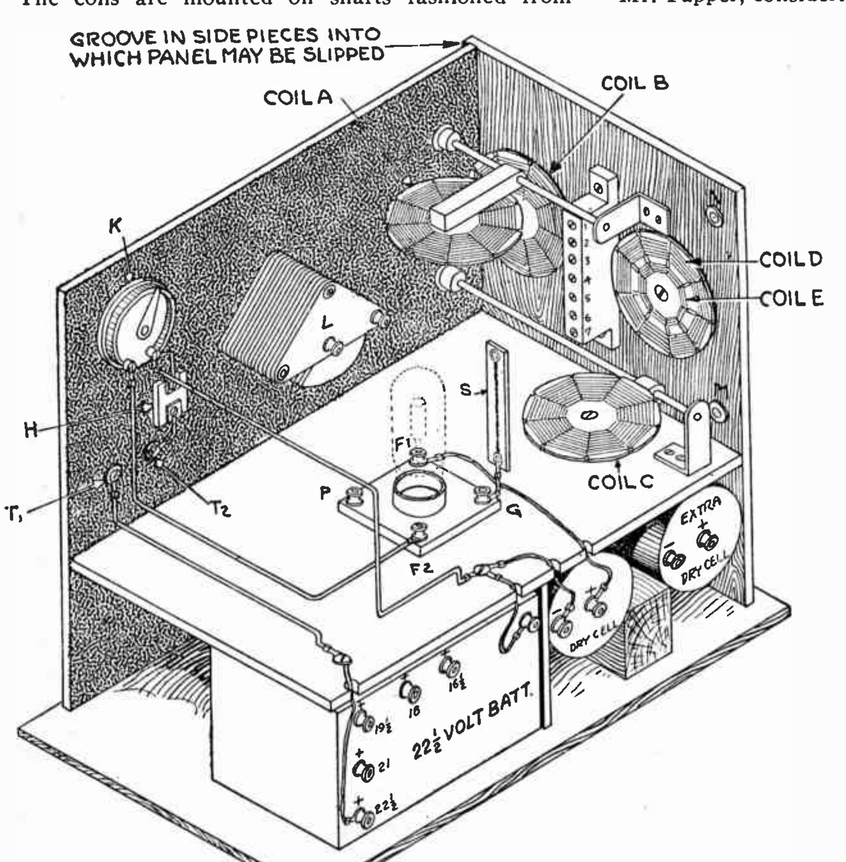
1	Variable condenser .0005 mfd. vernier	$ 5.50
1	Vacuum tube 1½ volt type	4.00
	Materials for four spiderweb coils	2.50
1	Variable grid leak with .00025 mfd. cond.	1.75
1	Tube socket	1.00
1	Rheostat	1.00
1	Pair of head receivers	7.00
1	Fixed mica condenser .0025 mfd	.50
	Dials for varying coupling of coils	1.00
1	22½ volt "B" battery	3.00
2	2½ volt dry cells	1.00
1	Panel 12x14 trim to size specified	2.85
1	Cabinet	4.00
	Shelf, binding posts, screws, etc	1.75
	Total Cost	$36.85

The stationary coils are fastened to the side of the cabinet by means of a flat head wood screw passing through the center of the coil. A tiny block of wood, through which this screw passes, is stationed behind each stationary coil in order to hold it about ⅞ inch from the side of the cabinet. The stationary coils are so located that their centers will be on the same line with the centers of the movable coils when the latter are closed down against the stationary coils.

Kind of Wire Used

Mr. Tupper, considering that there would be keepers of lighthouses, rural dwellers, city dwellers, and others without any knowledge of wiring diagrams, has outlined in the minutest details the hook-up of this $37 Radio receiving apparatus. Reasonably heavy wire is specified for the various connections so that it will retain its position once properly placed. At present regular Radio bus bar may be used. Heavy tinned copper wire may be obtained from electrical stores and other mercantile establishments handling Radio equipment. In the absence of this kind of wire, the sort used for door bells, although not so neat, will serve. The neat appearance of this wireless set may be preserved by extending the wires in straight lines, making right angle bends when necessary to form contacts with the proper points.

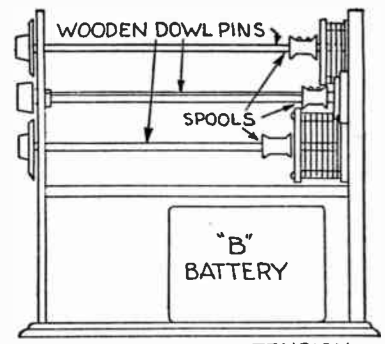
Preferably, copper or brass wire terminals soldered to the ends of all connection wires should be used, if they can be obtained. Otherwise, a tiny piece of thin brass or copper is soldered to the ends of the wires, the bit of brass or copper being provided with a slot to fit the shank of the screw or binding post where the connection is to be made. The ends of all wires leading from the four coils have a common meeting point at a



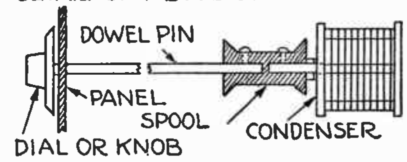
Rear Isometric View

wood block, provided with seven small round head brass screws, under which the terminals or ends of the wires are secured.

The wiring connections, as outlined by Mr. Tupper, are as follows: Starting at the antenna binding post N, extend a wire to connection 1 on the connection block. Then connect the inside wire of the movable coil A to the same connection. Give the wires from the movable coils a couple of turns around the wooden shafts before bringing them to the connection block. Now, connect the outer wire of coil A and the inner wire of coil B to connection 2. Then bring the outer wire of coil B and the outer wire of coil E to connection 3. Be sure to get the outer wire of coil E.



DETAIL OF ABOVE EXTENSION



Cross Section View

If the wires leading from the coils have been marked as previously suggested, there will be no difficulty in leading the wires to their proper places. Next, bring the inside wire of coil E to connection 4, and make a heavy wire connection from 4 to the binding post on the variable condenser L, which connects to the fixed plates of the condenser, and from this last point run a wire to connection F on the electron tube socket. Apparently this is a long wire, but in reality it is quiet short. Next bring the outside wire of coil C and the inside wire of coil D to connection 6; the outside wire of coil D to connection 5, and the inside wire of coil C to connection 7.

Connecting Telephone Condenser

The next step in the wiring is to connect the telephone condenser H (which is .00025 mfd.) by short pieces of stiff wire and some small bolts and nuts between the telephone binding post T_2 and the right connection on the rheostat K, according to the indications in diagram. From the same telephone binding post is extended a stiff wire along the inside of the front panel and over to connection 5 on the connection block. Then, put in a heavy wire from the central binding post connected to the movable plates of the condenser L to the ground connecting binding post M. Next lead a heavy wire from telephone binding post T straight back, and fasten it to the shelf by a screw through a terminal on the end of the wire near the left-hand notch in the edge of the shelf. Under this same screw connect astrip of flexible lamp cord, or a piece of brass picture wire having a terminal soldered to the opposite end and sufficiently long to reach any of the positive terminals on the B battery. Then, connect the P, or plate terminal, of the vacuum tube socket to connection 7 on the connection block.

Connections for Rheostat

Now give attention to the rheostat, and from the left terminal, as shown in the diagram, extend a heavy wire down, then straight back, then across the F_2 terminal of the socket of the electron tube. From the other terminal of the rheostat (to which one side of the telephone condenser has already been connected) run a wire straight back, then straight down to the shelf about 1 inch from back edge, then across to a point about halfway between the negative connection on the B battery and the dry cell battery. The end of this wire is secured to the shelf, and soldered to it near the end are two flexible wires with terminals on the ends. These wires pass through the notches in the edge of the shelf, one to the negative terminal of the B battery and the other to the negative or outside, terminal of the dry cell or A battery. The following step is to connect the F_1 terminal of the electron tube socket by a flexible wire, with terminals soldered to each end, to the central or positive binding post of the dry cell battery.

Then, on the final lap of wiring, connect one side of the grid condenser S to the G terminal of the electron tube socket with a short strip of wire bent at a right angle, making the grid condenser S stand vertical, after which connect the top of the grid condenser by a stiff wire to the aerial binding post N. The wires are secured to the grid condenser by tiny screws with nuts through eyes bent in the end of the wires or through terminals soldered to their ends.

The apparatus for the reception of Radio signals is hooked up for operation except for the addition of the grid leak. This is made by obtaining a strip of photographic film or heavy paper and cutting it to the size of the grid condenser S. A hole is perforated in each end to correspond with the holes in the condenser where the connection wires are attached. If a photographic film is used for this purpose, first scrape off all traces of the picture. Then roughen the surface

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(Continued from preceding page)

of the film and, using a soft pencil, draw a heavy wide mark around both holes, and a heavy line from one hole to the other. Fasten the film or heavy paper to one side of the grid condenser by the screws with which wire connections have already been made, making sure that head or nut of each screw touches the pencil mark.

Once the receiving equipment is adjusted in resonance with a Radiocasting station, give the grid leak a trial by adding to the density of the pencil lines or erasing them partially until the maximum strength of signals is obtained. The use of the grid leak depends on the quality of the vacuum tube employed for detecting the incoming wireless signals. Some types of tubes require no grid leak, while others do not function satisfactorily without a heavy, broad pencil mark.

Trace the Connections

Before placing the WD-11 or other detector tube in its socket, examine carefully the electrical connections. Then the headphones are linked to the binding posts T_1 and T_2, and the proper wires are connected to the B battery. That is to say, connect one to the binding post identified as negative and one to the binding post marked 22½.

Connect the proper wire to the binding post of the dry cell battery, but do not connect the center binding post until the following test has been made: Twist the rheostat to full on position; take a small strip of tinfoil, about ⅛ inch wide, and touch one end to the F_1 binding post and the other to the F_2 binding post on the lamp socket. If the 22½-volt battery has been rigged up so that it is across these terminals, the tinfoil will melt immediately. If no tinfoil is available, place a piece of bare wire across the terminals and then elevate one end and observe whether or not there is any sparking.

If there is a spark, a wiring connection has been improperly made. Under this condition, if the detector vacuum tube is inserted in the socket, the high voltage electric current at once burns out the filament and a $6.00 investment is wasted.

Testing Set

If this test fails to reveal a spark or does not melt the tinfoil, disconnect one wire to the B battery, connect the wire from F_1 to the center binding post of the dry cell battery, twist the rheostat to off position, insert the WD-11 or other type of detector tube and slowly turn the rheostat to on position. A faint red glow should be evident when the rheostat is about three-fourths on.

If this does not happen, examine the hook-up from the dry cell battery to the rheostat and to the tube for loose connections. If there are no such, connect the B battery, clamp the headphones on your ears and turn the rheostat until a faint glow in the filament element of the vacuum tube is observed. Then tap the vacuum tube lightly on the side with your finger, so as to produce a very slight jar.

If all the connections have been properly made, this slight tapping will cause a discernible ringing sound in the headphones. Keep both coils wide open, 90 degrees apart, when making the test just indicated. Then hook on the aerial and connect with the ground, and with the rheostat about one-half on or a little more, bring coil C gradually toward coils D and E. This move should introduce a gradually increasing hissing or popping in the telephones, provided the electrical connections are properly adjusted. This test, preferably, should be made after 8:00 p. m. when the ether is fully charged with song and story. The condenser is turned so that only a small portion of the movable plates are between the fixed plates when this test is made. If no hitch has developed, the set is ready.

Adjusting to Resonance

The following procedure is outlined for those who experience difficulty in tuning in the instrument: The aerial and ground wire, of course, should be both connected. That both batteries should be connected to the receiving instruments is self-evident, as well as the time-honored caution that the headphones should be connected to the binding posts.

The two coils or spider web variometers should be set at about 45°, or one-fourth open. The variable condenser is set with the movable plates about halfway between the fixed plates. The rheostat is turned until a slight hissing noise is heard in the headphones, or until the filament element of the vacuum tube sheds a faint red glare. In the absence of a hissing noise, move coil C in the direction of coils D and E until a sound is heard. Then, turn the knob of the condenser slowly back and forth as far as possible.

If Radio signals are in the air which may be intercepted by this apparatus, two whistles resembling the chirp of a bird will be heard as the point is passed on the dial where you should stop turning the condenser. Make an effort to set the condenser between these two little whistles.

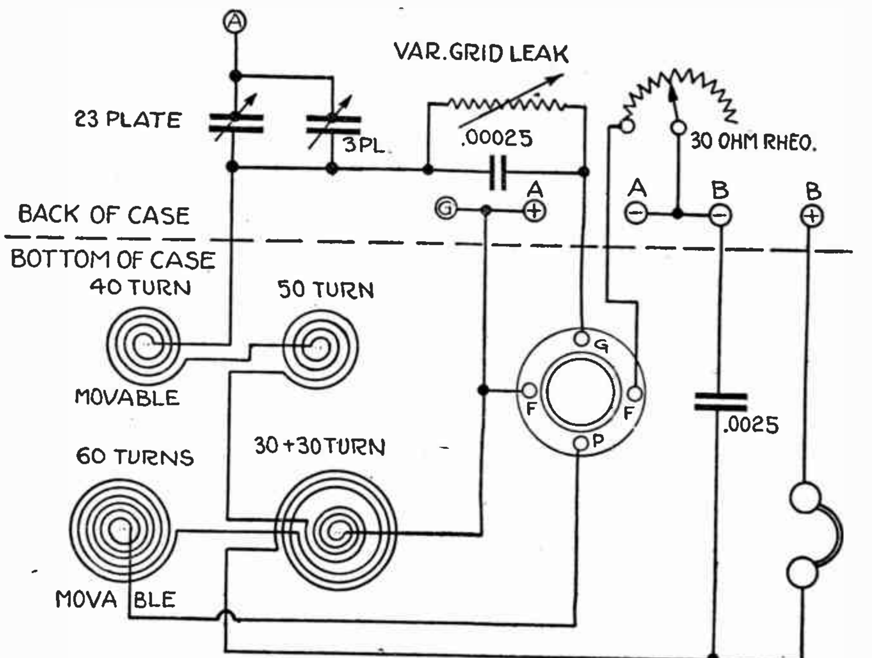
Tuning In Set

After attaining this desirable point, put into action the vernier knob of the condenser which shifts the single plate, or move coil A a bit one way, then the other. If music or voice is heard, turn the rheostat controlling the filament of the vacuum tube as a means of reducing the consumption of electric current. Moreover, squeals and hissing are caused by excess of current in the filament. If a clear Radio signal is not received by these means, open the coil C a little farther; or, if the signal is extremely faint or no signal or whistle is audible, close up coil C a bit more. Other changes suggested include variation of the B battery voltage by linking the positive connection to the other battery taps. Some vacuum tubes operate satisfactorily on 16½ volts, while others do not function well on less than 40 volts. This latter voltage is obtainable by connecting two B batteries in series. Movements of coil A will alter the tuning of this wireless set completely. Thus this coil may be employed in conjunction with the condenser for tuning. The wider you open coil A the more you will have to throw in the condenser. This is to say, the more it will be necessary to turn the movable plates between the fixed plates.

Testing Out Circuit

If you have followed instructions for wiring this electrical circuit, and then find it is as unresponsive as King Tut, the engineering division of the Lighthouse Service is likely to blame loose wire connections or even the omission of a tiny wire for the trouble. Hence, a method of testing the hook-up and locating the difficulty is suggested:

First, remove the vacuum tube, then disconnect the



Detailed Circuit Diagram

B battery, but leave the dry cell battery in its position.

Connect a wire about 15 inches long, to the negative binding post of the B battery and another to the 22½-volt binding post. Secure the end of one wire to the aerial binding post. Then, when each of the following points is touched, a spark should be produced. Connections 1, 2, 3 and 4 on the connection block, the fixed plates of the condenser, the positive or central binding post of the dry cell battery, and the F_1 terminal on the socket of the tube. If there is no sparking at these points, there is an open circuit which must be remedied.

If, however, sparking occurs, keep one wire touching the aerial binding post and continue the test at the following points, which should fail to spark: Connections 5, 6 and 7 on the connection block, the movable plates of the condenser, the ground connection binding post M, telephone binding posts T_1 and T_2, the P binding post and the G binding post on the tube socket.

Sparks Show Poor Connections

Sparking from any of these points is indication of an improper wire connection, or there may be a short circuit through either the variable condenser or the telephone or grid condenser. Each of these condensers should be tested separately.

Not infrequently the movable plates of the variable condenser are carelessly assembled, so that in some positions they form contact with the fixed plates. This will spoil the proper functioning of the receiving instruments. Apply the sparking test to both ends of the grid and telephone condensers. If a spark is produced by either, they are worthless and should be replaced by others.

The variable condenser, however, may be corrected by carefully bending any movable plates that touch the fixed plates. The circuits having been proven properly arranged and no signals coming through, there is the possibility of a poor connection in the telephones. Touch one end of the telephone wires to one terminal of the dry cells and the other telephone wire to the other terminal. This should produce a loud, sharp click in the telephones.

Test for Reversed Connections

Finally, one other error may beset the person who builds "his own," namely, the possibility of reversed connections in the coils. For this test, open both coils as wide as possible. With the coils in this position, if all the coil connections are reversed, and the other wiring is correct, Radiocasting or spark stations in proximity to this receiver should be heard. Turn on the rheostat about three-fourths, or until there is a perceptible glow in the filament of the vaccum tube, then, with the coils wide open, turn the condenser until a hiss or whistle is heard. Bring coils A and B as close together as possible and make another attempt to intercept Radio signals with the condenser. If no signals or noises are heard, reverse the connections to coil A. The signals should be stronger with the coils closed than with them open.

If you are convinced that coils A and B are properly located, tune in again as before and bring coil C toward coils D and E. The signal should become louder. If the signal is weaker, reverse the connections on coil E. Still experiencing trouble, restore the connections as they were and reverse connections on coil C.

If again the signal fails to become stronger, keep connections of coil C reversed and again reverse connections of coil E. Do not change connections of coils B or D, as this is unnecessary. The changes suggested exhaust the combinations possible, and difficulties will doubtless be located and remedied.

Body Capacity

Body capacity effect is one obstacle encountered by the use of this one-tube receiver. This, however, may be eliminated for the most part by placing the variable condenser at the back of the case and providing a nonmetallic extension shaft extending through the front panel to which the knob and dial may be attached. This addition necessitates a change of the position of the tube as already outlined. A vernier condenser is not necessary with this receiving outfit, as the A coil is adaptable to fine tuning. The connections are not to be soldered to the fixed condenser. The equipment is best adapted to an overhead aerial having a length of approximately 100 feet.

While Mr. Tupper does not claim priority of discovery or originality in devising this compact receiver, to him is due the credit for a remarkable efficient hook-up or combination of the simpler forms of regenerative circuits. He, on his part, gives acknowledgment to the published articles in Radio magazines, such as Radio Digest, for the key to the clever combination he has successfully devised. With this one-tube set located in Washington, he has been able to intercept concerts and speech from Radiocasting stations in Boston,, Chicago, Detroit, Kansas City, Atlanta, Davenport, and occasionally pick up signals from Havana, Cuba.

Body capacity effect is one of the annoying influences in the operation of some Radiophone receivers. This objectionable action of the body is not restricted to poorly designed electrical equipment. Quite the contrary may be true. A notable case is the extremely popular and efficient Radio unit built by the Lighthouse Service.

Eliminating Body Capacity

This one-tube receiver, operated by dry cell batteries, until recently was a decided victim of body capacity effect. Even now, the complete elimination of the latter was not accomplished without a radical rearrangement of the instruments in the cabinet and, in one or two instances, the replacement of units in which it could not be overcome. The method by which the designer effected elimination of body capacity effect offers suggestions to other operators of Radio instruments who are similarly afflicted.

This outfit had heretofore employed a WD-11 tube. UV-199 is used in the modified set. The main tuning condenser has been removed from the ground circuit and inserted in the aerial circuit. Furthermore—and this is a marked departure—the instruments have been taken from the front part of the cabinet and placed in the rear, with the exception that the phone binding posts remain on the front.

Instruments in Rear

Mounting of the instruments in the rear compartment of the container is accomplished by the use of wooden extension rods. The latter are of dowel stock, obtainable at a hardware store. These extension rods, running from the rear to the front of the cabinet, constitute an arrangement whereby the electric circuit is removed from the proximity of the operator's hands. The rods may be secured to the shafts of condensers and other instruments by means of spools. The household sewing bag may be invaded for this purpose, since a spool on which thread has been wound is suitable for this use.

A variable grid leak has been substituted for a fixed one. The former is of the following description: A disk is carved from a piece of fiberboard or from an old storage battery jar. A switch lever after the end is cut off, is bent down about ¼ inch and formed into a circle for containing a piece of lead from a lead pencil. The pencil line is made thick at the binding post before assembling the parts. A virtue of this device is that the piece of pencil does not wear out the resistance line. This type of variable grid leak is adaptable to panel or base mounting. If, however, a panel is employed, it is necessary to remove the high polish with a piece of sandpaper before making the pencil line. Connection is made to the center part and the binding post.

Until these modifications were made, the lighthouse set stubbornly refused to withstand body capacity effects. It was the one drawback to its universal popularity as a one-tube, dry cell operated receiver. Various other methods to eliminate body capacity had proven futile.

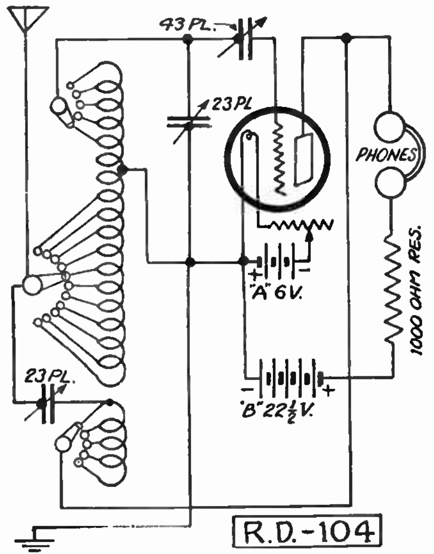
LATEST REINARTZ

THE diagram shows the latest hook-up using a Reinartz coil which is copyrighted by John L. Reinartz. It is a revised form of the old circuit covering the wide range of wave lengths at present used by the Radiocasting stations. It will be noticed that three variable condensers are required, two of .0005-mfd. capacity and the third of .001-mfd. capacity.

The insertion of the 1,000-ohm resistance stabilizes the tube action and improves reception. Only 22½ volts are required in the plate circuit.

List of Parts

1 Reinartz coil	$1.50
1 Variable condenser, .001 mfd.	5.00
2 Variable condensers, .0005 mfd.	9.00
1 1000-ohm. resistance unit	1.00
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
1 Panel 7x14	1.75
1 Cabinet	3.00
3 Multipoint switches	2.25
Binding posts, bus bar, screws, etc.	1.00
	$26.50



It is suggested that the three condensers be placed on the horizontal center line of the panel, one being close to the left hand edge, the other two close together at the right hand edge. Switches are then placed slightly to left of center between condensers one and two.

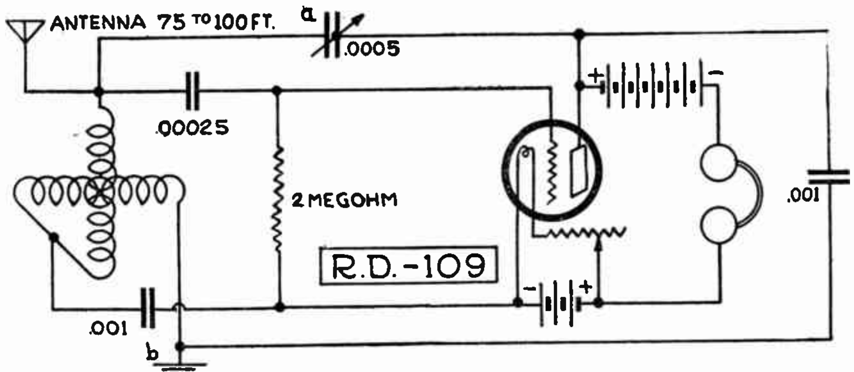
The condenser placed by itself to the left is the .0005 mfd. 23-plate shown in the circuit diagram in the lower left corner. The condenser at right edge of panel is the .001 mfd. 43-plate in the grid lead and the center condenser is the .0005 23-plate shunting the top coil in the diagram. Tube socket is mounted directly behind the 43-plate condenser on the 5x13 baseboard. A grid leak of the cartridge type should certainly be tried across the 43-plate condenser, as without it some tubes would surely choke up.

Super Regeneration

The mere mention of the word super-regeneration gives rise to ideas and dreams of the Master Set that will eventually be evolved from the maze of circuits now in use and make possible the reception from every station on the face of the old world. The theory of super-regeneration is so simple that it is strange it was not thought of long ago. Since the first days of regenerative receivers it was noticed that when the coupling between the tickler and the grid was made too close the set howled. This was due to the plate current feeding back into the grid, the added negative charge on the grid further varying the plate current, which again reacted on the grid more forcibly. In this manner the currents built up to such a strength that the tube went into self-oscillation and howled or screamed. The intensity of this howling was many times that of any signal coming in on the set. And everyone would say, "Gee, if the stuff would only come in like that." And why not?

Since this building up of the currents in the tube is gradual, or step by step, taking only a very small interval of time, it is conceivable that we could permit the tube to build up the currents to a high value and then check the process and let the building up begin all over again. Were this checking to take place at a rate above audibility, the resultant sounds would be unbroken. And this is just what Armstrong did to produce the super-regenerative circuit.

Circuit Using WD-11 and 12 Tubes



This unusual circuit, which is easily adapted for WD-11 or 12 tubes, was submitted by a fan. It covers a wave length range of about 180 to 600 meters. You are cautioned not to run wires parallel, the coupling effects being detrimental to the controls, a vernier variable condenser and a variometer. The rheostat, preferably should have vernier adjustment. If the panel is shielded, the shield should be connected to the minus side of the filament. If the shield is grounded, it will form one side of a condenser with the body through the phones, increasing instead of decreasing capacity effects. Because of its simplicity the circuit will interest many fans for experimentation.

List of Parts

1 Variometer	$6.00
1 Variable condenser, .0005 mfd.	4.50
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
2 Fixed mica condensers, .001 mfd.	.80
1 Fixed mica condenser, .00025 mfd.	.35
1 Grid leak and mounting	1.00
1 Panel 7x10	1.25
1 Cabinet	2.50
Binding posts, bus bar, etc.	1.00
	$19.40

A 7x10 panel will be ample for this receiver. Mount the variometer to the left, the variable condenser to the right, with their shafts at the horizontal center of the panel. The rheostat should be mounted between, and slightly below them, with the tube directly behind it on the 5x9 baseboard. Binding posts should preferably be at the rear of the baseboard and holes drilled in the back of the cabinet for battery wires, but they may be placed on the right and left edges of the panel if the builder prefers.

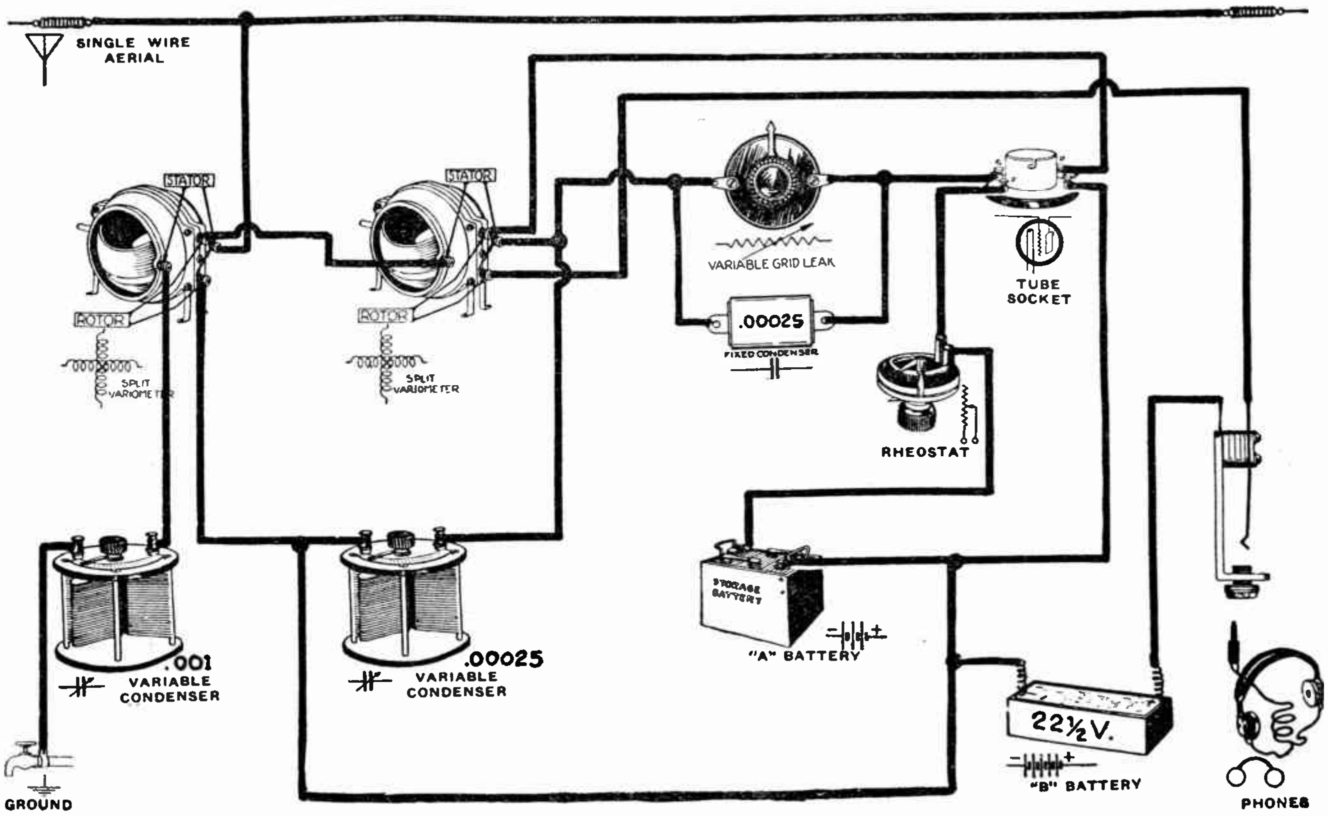
Due to differences in both antenna construction and vacuum tubes, it would be well to try eliminating the .001 mfd. condenser shown in the lower left corner of the diagram and then the .001 mfd. condenser at the right hand side of diagram. The shunting of either might improve the volume or selectivity or distance getting power of the set, but this can only be determined by the owner of each receiver.

Simplex Hook-up for Long Distance

HERE'S a Simplex that requires two variometers, two variable condensers and a variable grid leak. The wiring is simple, the circuit is regenerative and it is quite a little bit harder to tune, but you are all set to do some long distance work. The plate circuit is inductively coupled by means of the second variometer to the grid circuit of the tube. The secondary is inductively coupled to the primary circuit by means of the first variometer. Both these variometers are of the split type, that is, the rotor and stator windings are not connected in series, thus making it equivalent to an untapped coupler with approximately the same inductance value in both windings. The primary circuit is tuned by means of the .001 variable condenser. The secondary circuit is tuned by means of the .00025 variable condenser. The grid leak is variable for best adjustment for various tubes. Only 22½ volts are required for the plate battery. This circuit is very selective and efficient in tuning out local Radiocasting stations. Audio frequency amplification can be added in the manner usually employed in other hook-ups.

List of Parts

2 Variometers	$12.00
1 Variable condenser, .001 mfd.	6.00
1 Variable condenser, .00025 mfd.	4.25
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
1 Variable grid leak with .00025 mfd. condenser	1.75
1 Phone jack, open circuit type	.75
1 Panel 7x18	2.25
1 Cabinet	3.50
Binding posts, bus bar, screws, etc.	1.00
	$33.50



In building this set, the four large dials controlling the two variometers and the two condensers, may very well be placed along the horizontal center line drawn lengthwise of the panel. The antenna circuit tuning condenser should be close to the left edge of the panel, the variometer coupling the primary to the grid circuit coming next. The third unit would be the .00025 mfd. variable condenser tuning the grid circuit and the fourth may be the variometer coupling the plate circuit to the grid circuit.

The variable grid leak is placed on a line above the rheostat close to the right edge of the panel and the tube socket is therefore mounted on the 6x17 baseboard close to the right end. While such a number of controls may at first rather awe the novice at tuning, it will be found that the grid leak and rheostat once set, require only occasional adjustment and that the first variometer will not be used much. Most of the tuning will be done with the .00025 mfd. variable condenser in choosing stations and the second variometer in controlling regeneration. If one has an unusually long antenna, the connecting of the antenna variable condenser in series with the primary of the split variometer will be found to cover the Radiocasting wave length range; but if the aerial is quite short (40 to 60 feet) it may prove better to connect the two ends of the stator winding directly to the antenna and ground and shunt the .001 mfd. variable condenser across it.

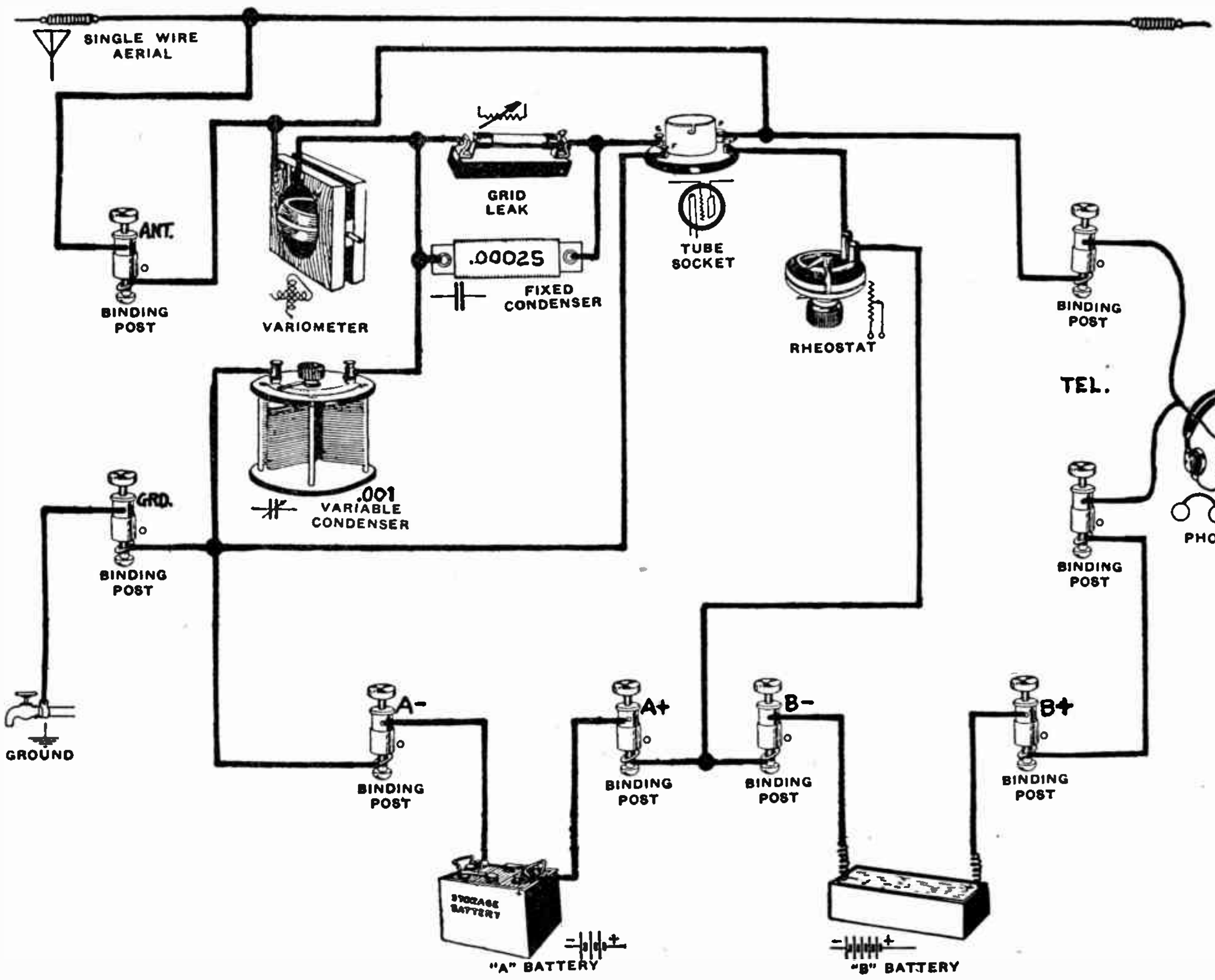
An Ultra Audion Simplex Diagram

THE circuit shown in the above diagram is by no means a new one but it has numerous good points that make it especially attractive for the new fan. Not only is it an extremely efficient form of circuit, but its simplicity and low cost make it an ideal receiver. A two stage audio frequency amplifier is easily attached.

This should be an excellent set for the farmer. The single circuit receiver, of which this is one variation, eventually will probably be prohibited by law in large cities as it causes serious interference with every receiver located near it while being tuned. On the other hand, it gives the greatest distance for initial cost and upkeep of any trype receiver, and the farmer, looking always for the best value for his money, will probably take to it. Its cost, also, is within his means.

List of Parts

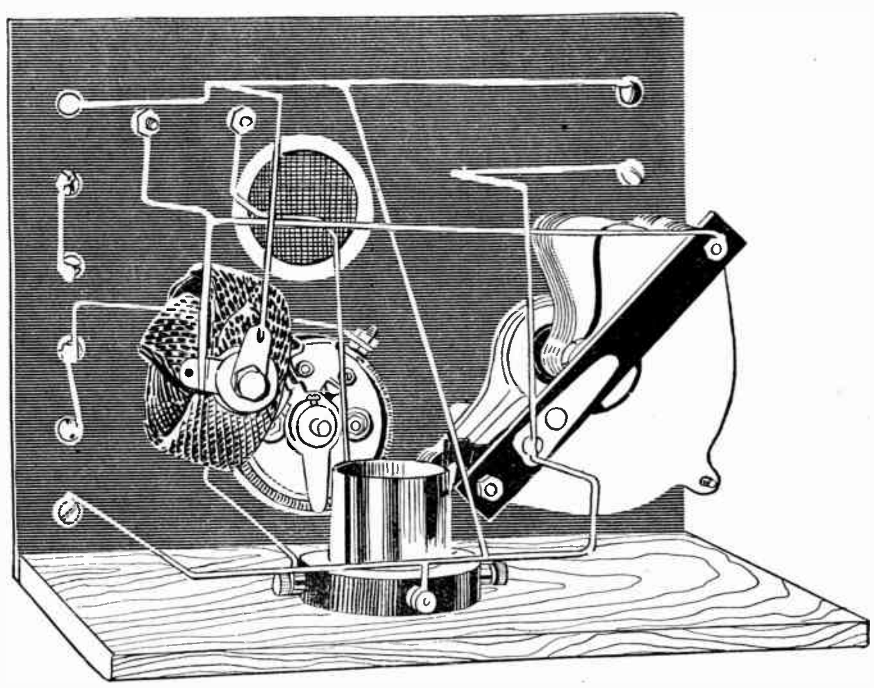
1 Variable condenser .001 mfd. vernier	$6.50
1 Variometer	5.00
1 Tube socket	1.00
1 Rheostat 6 ohms	1.00
1 Variable grid leak with .00025 mfd. condenser	2.00
1 Panel 7x9	1.25
1 Cabinet	2.50
Binding posts, bus bar, screws, etc.	1.00
	$20.25



The other illustration shows an assembled set, mounted on a 7 by 9 inch panel with a 5 by 7 inch baseboard. The apparatus required is one tube socket, one rheostat, one variable condenser (.001 mfd.) preferably with vernier, a variable grid leak and grid condenser (panel mount unit was used) on variometer, and eight binding posts.

While the illustration of the receiver itself shows a variometer of the skeleton type with honeycomb windings and the circuit diagram shows one with wooden forms, this should not confuse the prospective builder. Either of the types shown will do, as would a variometer with bakelite forms or one in which the outer winding is on a round tube. This also applies to the variable condenser, as different types have been shown in the illustrations. For $6.50, one can obtain a very high class condenser, well built, smooth running and of low losses.

A dry cell tube can be used if desired; the B battery is 22½ volt recommended, but this can be increased if UV-199 or C-299 tubes are used. As the diagram indicates, the wiring is very simple.



The aerial need not be a very long one as a single wire not over 60 feet long is sufficient. If a longer aerial is used the condenser capacity may have to be reduced to .0005 microfarads.

Tuning will not be found difficult. The rheostat is turned about half way around so that the filament of the tube grows strongly, but does not show any white or yellow light. Put one hand on the variometer dial, the other on the variable condenser dial and turn both across the scale in the same direction—slowly. If no signals are heard, try turning one to the left and the other to the right simultaneously. When Radiocasting is heard, adjust dials to loudest volume and turn up rheostat until further turning does not increase, but tends to make the signals "mushy."

Headsets

Few Radiophans realize the importance of the headset in the operation of a Radio set. The headset is one of the most important links in the chain between the original sounds striking the microphone at the broadcasting station and the reproduction of those sounds miles away. When one considers that their function is to convert the changing electric currents, picked up with difficulty and nurtured through stages of amplification, into audible sounds, their importance may be more easily recognized. Furthermore a poor headset will cut down the range of set hundreds of miles; many DX records are made in the headset.

The Theory of the Receiver

Briefly the theory of the telephone or Radio receiver is as follows: a thin metal diaphragm is rigidly mounted a fraction of an inch away from a pair of pole pieces. These pole pieces are made of soft iron but are magnetized by one or more permanent magnets mounted in the shell. Around the pole pieces are wound many turns of fine copper wire. The diaphragm is normally under tension from magnetism in the pole pieces. When a current flowing around the windings changes in value of the magnetic pull on the diaphragm will be varied and the diaphragm will vibrate, giving rise to sounds.

Simple in theory but the details demand attention. The iron in the pole pieces must be of the softest grade so that the magnetism will change rapidly with the least change in the current in the coils. The diaphragm must be of a certain exact thickness for it must vibrate to the high notes of the violin and respond as well to the cello. A tiny dent or the least bend in the diaphragm will give rise to distortion or make the telephone more sensitive to one frequency than another. The distance between the pole pieces and diaphragm are of great importance. All these factors must be taken care of to assure proper operation.

Resistance of the Receiver

Now we come to the important part, namely, the resistance. There is a mistaken idea that the resistance determines the sensitiveness of a receiver. A 3,000 ohm phone is not more sensitive than a 200 ohm phone because it has a higher resistance but solely because it has more turns of wire on the pole pieces.

In designing electromagnets the practice is to make the thickness of the winding twice the width of the pole piece. The size of coil in the receiver then is fixed by the size of the pole pieces used. The pull of an electromagnet depends on the ampere turns, that is, the number of turns multiplied by the amperes flowing in the coil. Therefore the more turns, that is, the number of turns multiplied by the amperes flowing in the coil. Therefore the more turns we can get into a given space the greater the magnetic flux. In order to get sufficient turns on the pole of a receiver the manufacturers use very fine wire, for that reason the resistance of a Radio receiver is high.

However, another factor enters the use of receivers with tubes. It is a well known law in electrical practice that the impedance of the output circuit of any device should equal the impedance of the device itself. Therefore the impedance of the receivers should equal the plate impedance of the tube. Impedance as we have learned is the resistance offered to the flow of alternating currents by an inductance as well as the direct current resistance. Therefore the impedance of a 2200 ohm phone for instance is 22,000 ohms on an alternating current of 800 cycles. For higher frequencies the impedance is still greater; it varies with the frequency. In order to meet the above conditions it is common practice to design receivers and transformer with an impedance equal to the plate impedance of the tubes with which they are to be used.

Resistance Does Not Affect Sensitiveness

Realizing then that resistance has little to do with sensitiveness we will consider the important factors in the purchase and care of Radio receivers. The best guide is the reputation of the manufacturer. A cheap 'phone is seldom worth all it costs; so don't hesitate to pay a little more for the best. See that the cases are carefully made, all threads well machined and the caps fit snug and tight, that the diaphragms are perfectly flat and rest on smooth edges of the shell, that the coils have been protected by a covering and the permanent magnets will support the diaphragm on edge. If they fail to hold the diaphragm they are weak and should not be accepted. The simple test for a Radio receiver is to place a piece of paper moistened with the tongue between a nickel and a penny and to touch the 'phone tips to the coins. The current generated by this simple battery should give a click in the phones. If no sound is heard they are useless for Radio work.

There are several types of crystal detectors, some of which are good and others are not. Get several and compare.

A variocoupler should be used when making a crystal set, because this unit can be employed when changing the set to a vacuum tube outfit.

Here is a kink that is a winner to the Radiophans in rural districts who have no water pipes for grounds. Take a common window screen wire, galvanized preferred, and make a cylinder about 4 inches in diameter and about 3 feet long and fill it with charcoal and set it in the ground 3 or 4 feet deep and drive the ground rod right down through it. The charcoal will draw the moisture and will always be wet and damp and will make the best of a ground connection. The ground rod need not be over 6 or 8 feet long. A ⅜-inch galvanized steel pump rod such as may be bought at an implement store makes one of the best ground rods. The ground wire should be soldered to the rod.

Unique Portable Transmitter-Receiver

THIS receiver and transmitter combined, although a single circuit and a re-radiating outfit from the word "go," has output that is not the squealing kind. The wave is an excellent carrier of speech from the telephone transmitter, but is silent when it comes to the much talked of "squawker delight."

During the experiments I tried talking into the receiver of my headset and lo, it was heard at a distance of four miles. Well! I put the loud speaker plug in the jack and talked into the loud speaker, and that was heard, too. A telephone transmitter which came over with Noah in the Arc was hooked in series with the ground and that worked 50 per cent better. The latest addition was a magnetic modulator in the ground circuit and this put the finishing touches to the outfit.

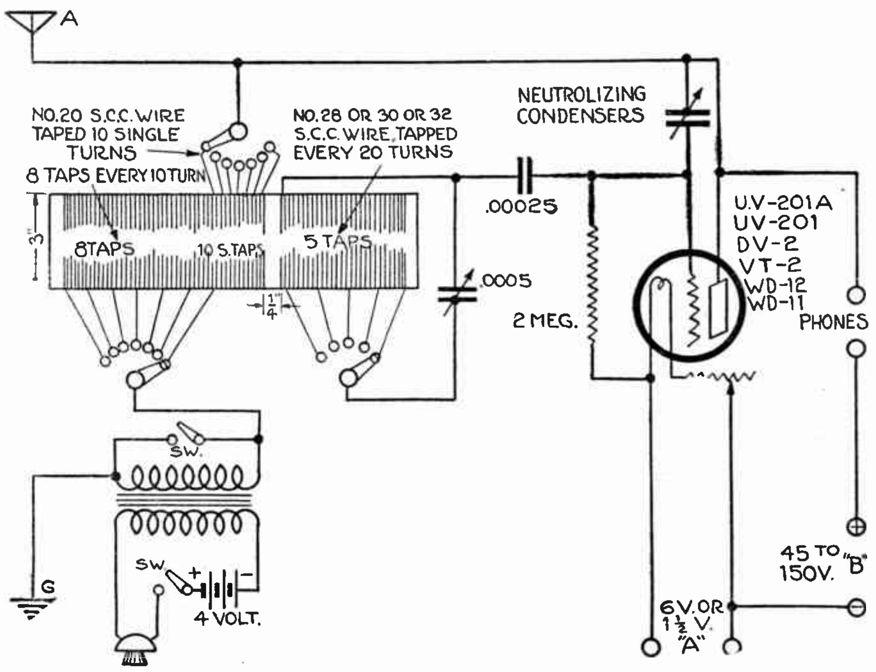
A neutralizing condenser made of three safety razor blades was shunted across the plate and grid. This made the circuit a steady oscillator both for receiving and transmitting. The apparatus in general is composed of cheap material including cardboard tube, wood panel and lots of other junk contrary to Radio engineering. A dear friend of mine (who has more money) constructed a duplicate using the best material money could buy (his money), and from reports he is getting just as good results as I am, so I figure that if there are any "losses" they are going via the antenna where they belong.

The circuit is self explanatory and do not worry if you get more wire on the tube than indicated, or possibly a smaller number of taps; it works any way you put it. There is where some of the mystery lies. It is not on account of location, for this apparatus has done more traveling than a side-door pullman.

List of Parts

1	Variable condenser .0005 mfd. plain	$ 4.50
	Materials for variocoupler	1.50
1	Audio frequency transformer	4.50
1	Grid leak and mounting	1.25
1	Fixed mica condenser .00025 mfd.	.35
1	Rheostat, 25 ohm	1.00
1	Tube socket	1.00
2	On-off switches (across transformer windings) @ 60c	1.20
	Binding posts, bus bar, etc.	1.00
1	Panel 7 x 12	1.50
1	Cabinet	2.75
	Total cost	$20.45

worth trying, for it works just as well with cheap parts as those that cost a fortune. Of course critics are going to put up a holler at this statement, but my advice is try it both ways, and today I can cover as



much distance with a "bell-ringing" 110-volt to 12-volt transformer or a magnetic modulator as they can with some other outfit. Oh, yes, I have tried that, too, and even used an audio frequency transformer as a modulator and that worked just as far, but it, or rather I, "stuttered." In other words, the modulation was of the make and break kind.

It can be made up in a short space of time, but should be made well, not slapped together. One will be well pleased with the performance of this outfit.

However, if one wishes to cover a great distance the plate voltage may be stepped up and by use of a switch, the required amount of current to operate the bulb as a receiver may be applied and high voltage cut in for the transmitting end of it.

Tuning as a Transmitter

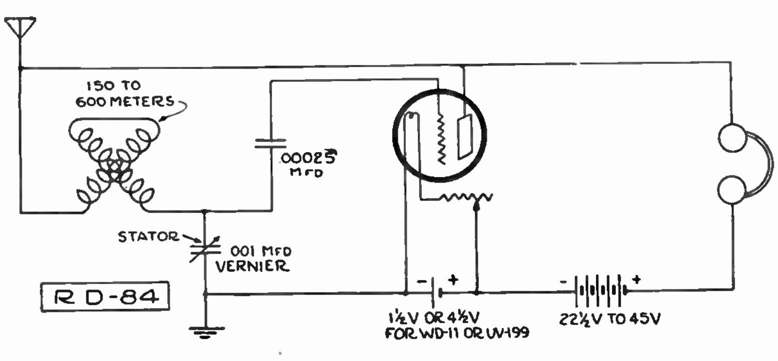
In tuning the set as a transmitter, rotate the dial in conjunction with the switch levers until a slight "hollow" sound is heard in the receiver. This sound cannot be explained very well in writing but can be best described as "hollow." Switch on the "Mike" and say what you wish, providing you have a piece of paper from Uncle Sam saying you can.

Note the exact points on the dial and switches where this takes place, and always turn to this when about to transmit. The receiving end will take care of itself. The signals received will be strong and sharp tuned, and in all, it is an excellent receiver, which will not bother your neighbors, yet it re-radiates energy but not squeals or whistles. Queer isn't it? But it is

Compact Regenerative Portable Outfit

FOR the fan who contemplates building a very compact portable set the hook-up shown is recommended. Any of the tubes with low current consumption can be used. Naturally the proper rheostat to be used will depend on the tube and the source of filament current.

The antenna circuit includes a variometer and a .001 mfd. vernier variable condenser in series. These two controls of wave length will permit extreme selectivity. The regenerative feature of the circuit guarantees plenty of volume in reception. The circuit is an adaption of the Colpitts transmitting circuit named the "Gibbons."



If desired, audio frequency amplification can be added in the usual manner. The plate voltage need not be more than 45 and in fact 22½ volts will do in most cases. This depends on the tube.

Since maximum results are expected, good apparatus should be used and care taken in assembly and wiring. Soldered joints should be properly made. Spaghetti insulation should be used in all compact sets, thus reducing the possibility of short circuits to a minimum.

As a portable set, UV-199 or WD-11 tubes are convenient. The latter can be lighted by a single dry cell and the former needs only a large, tubular flashlight unit (yielding 4½ volts). The tube sockets should be mounted on sponge rubber or heavy felt batting to eliminate vibrations that break the filament, and microphonic tube noise when the set is in use. Short flexible leads to the socket and thence to the regular bus bar wiring will also aid in stopping these shocks.

List of Parts

1	Variometer	$ 6.00
1	Variable condenser .001 vernier	5.50
1	Tube socket	1.00
1	Rheostat 30 or 6 ohm	1.00
1	Fixed mica condenser .00025 mfd.	.35
1	Panel 7 x 10	1.25
1	Cabinet	2.50
	Binding posts, bus bar, etc.	1.00
	Total cost	$18.60

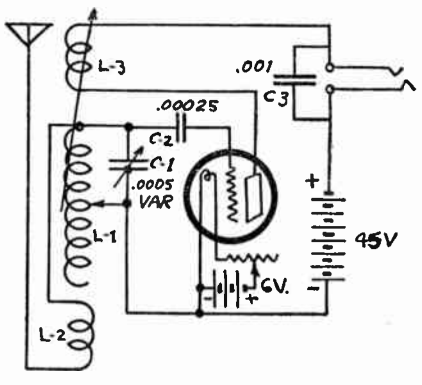
Lock on Tube Lighting

Two good ways to prevent children from lighting the tubes of a set are as follows: Procure a key switch (such as used in houses as flush switches) and insert it in the panel, or in the end of the cabinet, and attach the negative side of an A battery or positive side of the A and negative side of the B battery. Then it cannot be lighted unless the key is used.

An ordinary drawer lock can be used also, making the tumbler bear on a strip of spring brass. By using the positive of the A battery and the negative of the B battery together this cuts out both batteries.

A Groundless Set

THE circuit shown in the illustration is that of a portable set which has given remarkable results. At first glance it looks like a three-circuit set with an untuned primary. However, the extra connection from the grid lead to the dead end of the primary allows the primary to be tuned sharply. As shown, no ground is used. In fact, signals are about twice as loud as when one is used.



The main inductance **L 1** is wound on a bakelite tube, 3½ by 4½ inches, using number 24 scc. wire. First tap to the grid, and then at 5, 10, 15, 30, 45 and 60 turns. A space ½ inch wide is left at turn 15 for the tickler shaft.

On the same tube and ½ inch below, L 2, the primary is wound. This consists of from 5 to 10 turns (space wound) of litz wire made as follows: Open up an old Ford coil and remove a good secondary section. This is about 36 to 38 scc. Drive two nails about 20 feet apart and string the wire from one nail to the other, making three strands of 20 wires each, or 60 in all, which will be about right for the primary. Make a small hook of a piece of bus wire and insert this in your hand drill and the other end in the loop of the wire, then turn the drill to twist the wire. This makes a litz wire at almost no cost.

The tickler, L 3, is a standard wood rotor, wound with 40 turns of number 24 scc. The whole is mounted on a 6 by 8-inch bakelite panel so that it is really portable.

List of Parts

1	Variable condenser .0005 mfd. vernier	$ 5.50
1	Tube socket	1.00
1	Rheostat 25 ohms	1.00
	Materials for winding coils	1.75
1	Fixed mica condenser .00025 mfd.	.35
1	Fixed mica condenser .001 mfd.	.40
1	Panel 7 x 10	1.25
1	Cabinet	2.50
1	Phone jack open circuit type	.70
	Binding posts, bus bar, screws, etc.	1.00
	Total cost	$15.45

Using an old A-and-P detector tube which had already been burned 2,000 hours and with 40 volts on the plate, no ground and 275 feet of wire hund around the room, I can receive Radiocasts from Chicago, 550 miles distant, and at times I can pick up Kansas City. 900 miles. This is with one tube and aerial, but no ground.

With the winding as shown, a range of from 75 to 600 meters is covered, and thus the new 100-meter range is within easy reach. The selectivity is wonderful, and I can tune out 400-meter stations 60 miles away and bring in others at a distance of 1,300 miles.

Using a UV-201 with 145 volts on the plate, our local station KDKA, 50 miles distant, is plainly audible on a loud speaker. My aerial is one wire 400 feet in length, average height 100 feet.

Lettering Panel with White Ink

To letter a bakelite panel, clean the surface with wood alcohol to remove any film of grease, and then print on the panel with a steel pen and draftsmen's white ink.

When the writing is dry, cover it with a protective coat of transparent varnish, using a fine camel's-hair brush. If at any future time the lettering is to be removed, it may be done with a rag dampened in wood alcohol.

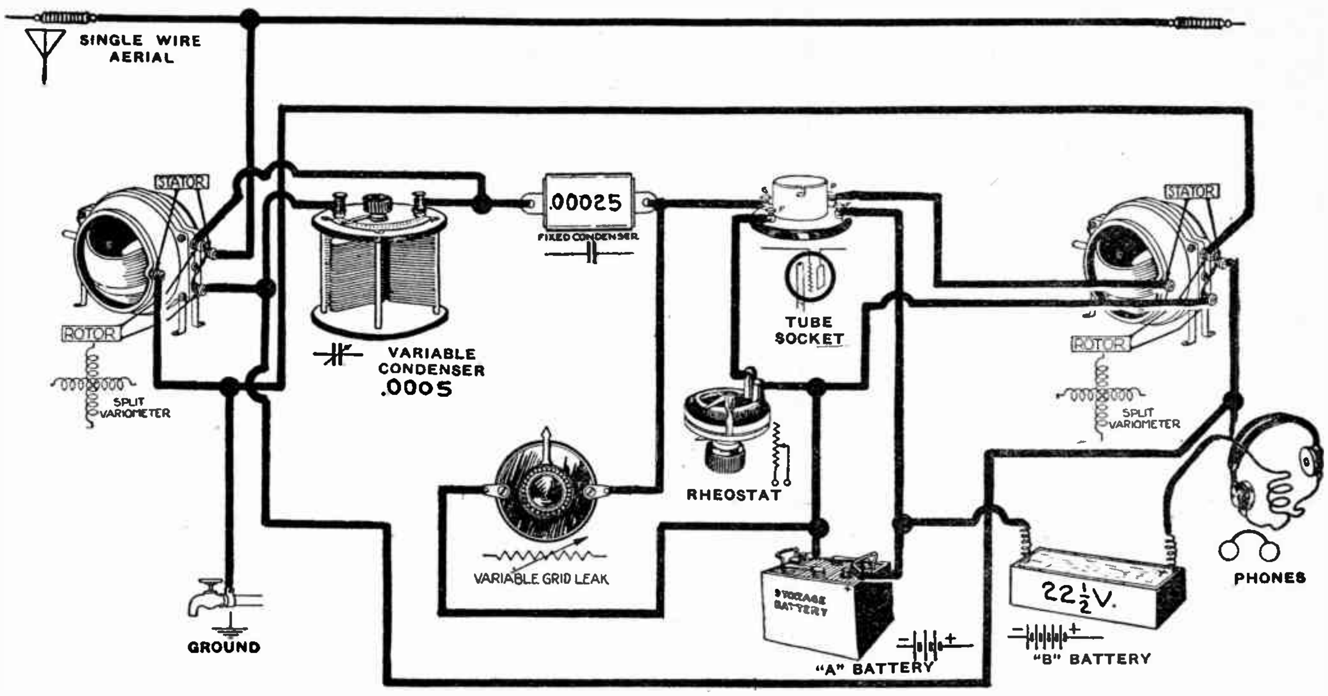
A small insulating bushing set in the metal end plates of a variable condenser causes a concentration of the electrostatic field, resulting in large losses. As a consequence such condensers work very poorly compared with those having a larger area of insulation.

Radio equipment should be thoroughly cleaned from time to time. If dust collects it will short the set and the receiving range will be cut down considerably. In order to prevent breaking of wires when working inside the set, it is a good idea to use a rubber tube for blowing out the dust.

Spacing Wires

The set builder should always remember that space is the best insulator for the high frequency currents used in Radio. Especially in a multitube reflex set the wires must be kept as far apart as possible. The success of a reflex set depends very largely on well-spaced wiring, for the balance between the circuits is very delicate and interference from one part may completely upset another.

Long Distance Reception on Single Tube



SPLIT variometers have a habit of getting mixed up with long distance work. Do you know why? Well, inductance tuning means dead end losses, while capacity tuning, when good variable condensers are used, undoubtedly gives real satisfaction for long distance results. Do you know that the neutrodyne is a capacity tuned circuit? Hence the results. Think it over.

This circuit uses two split variometers and a good .0005 variable condenser (not the 75-cent kind). Yes, and a good variable grid leak will help things a lot. The rest of the parts are the usual collection of necessities. Get a good aerial, 100 feet, including lead-in; a good ground connection, plus a good detector tube, and give it a fair chance. Then watch it give you some real results.

But get used to the tuning, before you try to get 2LO; you know so many want to get long distance work before they are acquainted with their sets.

Now as to building the set, draw a horizontal line across the back of the panel about 4½ inches from the bottom and drill the condenser shaft hole in the center of this line. Place a variometer near each end of the line, but far enough in from the edges so they will not interfere with sliding the panel into the cabinet. The rheostat and variable grid leak holes should be on a line about 2 inches from the bottom, the rheostat between the variable condenser and left hand variometer; the grid leak between the variable condenser and right hand variometer.

This arrangement should permit a neat job of wiring as the instruments are placed for short, direct leads with few cross-overs. The lead from the grid binding post on the tube socket should be split, one wire going to the grid leak on the panel, the other to the fixed condenser and the variable condenser. Binding posts, for both appearance and convenience, should go on a small bakelite strip at rear of baseboard.

List of Parts

2 Variometers split type	$12.00
1 Variable condenser, .0005 mfd	4.50
1 Variable grid leak without condenser	1.50
1 Fixed mica condenser, .00025 mfd	.35
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
1 Panel 7x12	1.75
1 Cabinet	3.00
Binding posts, bus bar, etc	1.00
Total Cost	$26.10

The tube goes on the 5x11 baseboard behind the variable grid leak. It is good practice to set all parts on the panel in the positions given above, before drilling. to see that none of the panel-mounted instruments touch. This is an interesting combination of the "three-circuit" and ultraudion hook-ups which should be both sensitive and selective.

Two stages of audio frequency can be added by substituting the outer springs of a four-spring jack for the phones and connecting the inner springs to the primary of an audio frequency transformer.

Triple Honeycomb Coil Regenerative

THE dyed-in-the-wool amateurs used to, and half of them still do, swear by the honeycomb coil as an inductance. It is extremely low in losses, compact in size and readily interchangeable to cover various wave length ranges, so for many years a triple coil mounting was the standard tuning unit on amateur sets. With the coming of Radio frequency amplification it was but natural that someone would figure out a way of combining two aids to distance, so Radio frequency amplification has been here combined with regeneration.

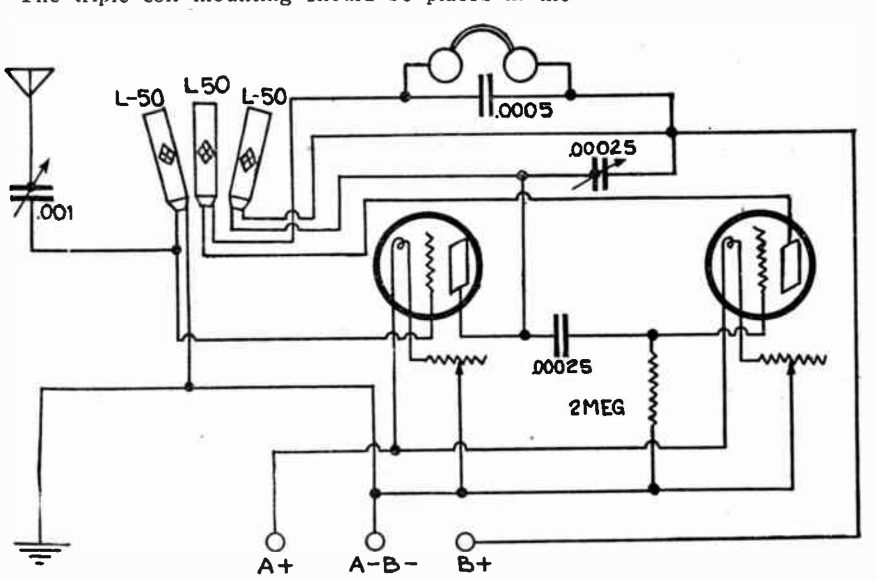
In operation, this set will be found delicate of adjustment but well worth while after one has gotten the "feel" of tuning it. The controls, as will be seen by careful study of the diagram, are the two condensers and the coil coupling. Tubes of either the A class or '99 class may be used, but the plate voltage should not be increased above 45 to 67 or stability will be lost.

The triple coil mounting should be placed in the center of the panel lengthwise and near the top; the two rheostats can be placed side by side below it and near the bottom. The .001 mfd. antenna tuning condenser should go midway vertically of the panel near the left edge; the .00025 mfd. variable condenser is opposite on the right hand side of the panel. If the combination of a 50-turn coil with a .00025 mfd. condenser is found to cover only the lower Radiocasting wave lengths, two solutions are possible. A 75-turn coil can be inserted to cover the upper range, or, a .0005 variable condenser is substituted and, used with the 50-turn coil, will be found to cover the entire range.

It would be wise to try various leaks in the grid leak mounting to get the one best suited to the tube used as a detector. In all probability, the builder will find that the coils have to be kept rather widely separated to prevent uncontrollable oscillation as both tubes are regenerative in this hook-up.

List of Parts

1 Triple coil mounting	$5.50
3 50-turn honeycomb coils (mounted)	4 80
1 Variable condenser .001 mfd	5.25
1 Variable condenser .00025 mfd	3.50
1 Grid leak and mounting	1.00
1 Fixed mica condenser .00025 mfd	.35
1 Fixed mica condenser .0005 mfd	.40
2 Tube sockets	2.00
2 Rheostats 25 ohm	2.00
1 Panel 7x14	2.25
1 Cabinet	3.50
Binding posts, bus bar, etc	1.00
Total Cost	$31.55



Winding and Tapping Inductance

A few suggestions as to the winding and tapping of single layer inductances are not out of place. As an aid in designing the windings, the following table which gives the number of turns per linear inch, will be valuable.

With this table one can readily determine the size and other details necessary to wind any given inductance.

Turns Per Linear Inch

Size B. & S. Gauge	Enameled	Single Cotton	Double Cotton	Single Silk	Double Silk
20	29	25	23	27	26
22	36	31	28	34	32
24	45	37	33	42	39
26	56	45	39	52	46
28	71	54	45	63	56
30	88	64	57	77	67
32	112	75	60	93	78
34	140	87	68	112	91
36	173	101	78	130	104
38	225	115	89	151	117
40	288	130	102	178	129

It is a rare thing indeed to see a properly tapped coil; the usual practice of dividing a coil into taps having an equal number of turns results in large jumps in wave length for each tap at the beginning of the winding and smaller jumps at the end. This is due to the fact that the wave length does not vary directly as the number of turns but is equal to a constant multiplied by the square root of the product of the inductance and capacity. In order that the wave length of a circuit may increase regularly with the number of taps, the tapping of the coil should be done in the following manner:

First we must determine some desirable percentage of increase. Then, from the following table select the proper constant for that particular increase.

Percent	Factor
4	1,057
6	1,087
8	1,116
10	1,147
12	1,178
15	1,226
20	1,308
25	1,394
30	1,483

The first tap is selected roughly, say ¼ inch from the beginning of the winding. Then, say, a 20 per cent increase of wave length is wanted with each tap. The distance, ¼ inch, is multiplied by the constant 1,308, and the product will be the distance of the second tap from the beginning of the winding. For the third tap the process is repeated. Multiply the distance to tap 2 by the constant, and the product will be the distance of the third tap from the beginning of the winding. The process is repeated until all the taps are obtained. By referring to the table giving turns per inch, the turns between each tap for the size wire can be readily determined. It should be remembered that the product in each case is the distance from the beginning of the winding.

Testing Crystals

The more ambitious of experimenters will find it an interesting and instructive pastime to test out crystals of different kinds for sensitiveness. While thousands of crystals and combinations of crystals have been tried out, a new combination may accidentally be discovered that will bring results well worth the trouble.

The scraping of dials on the panel of a Radio set can be corrected by placing a thin piece of felt on the back of the dials. They will then work smoothly, without noise.

It is a good thing to have a small pair of pliers handy with which to pick up the minerals, because the oil on the hands will cause a coating of insulating material to form, thus destroying part of the sensitivity. Never allow hot solder to come in contact with a mineral of this kind.

Most of the squealing heard in the receiving set is due to over-regeneration. If a tube is oscillating it is impossible to get intelligible signals over the Radiophone.

Copper wire not larger than Number 26 gauge is ideal for catwhiskers on crystal detectors. Phosphor bronze, silver and gold wire make good contact points. Brass and copper wire will be found well suited for contact with silicon, galena and iron pyrites.

Selective Split Variometer Circuit

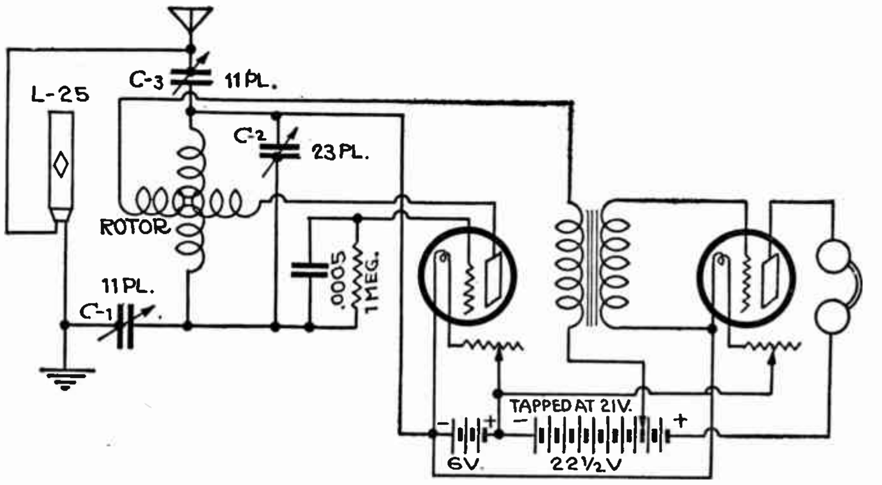
IN THE accompanying diagram I show a split variometer with a combination coil, that will make wave traps sit up and wink at its sharp tuning capability. Besides doing all the stunts without ground and aerial, I recently brought in PWX, Havana, Cuba, 2500 miles distant from here.

Let the fan who hasn't had good results with a split variometer start by building this hook-up with condenser C 1 only, leaving out the other two variable condensers and honeycomb coil. Now just a word in regard to the variometer. It takes a little time and patience to master the rotor. I would like to impress upon you that when you are adjusting your variometer take for granted you are adjusting the rheostat, because their action on the set is much the same. Please remember this.

List of Parts

1	Split variometer	$ 6.00
2	Variable condensers .00025 @ $3.75	7.50
1	Variable condenser .0005	4.50
1	25-turn honeycomb coil	.50
1	Grid leak with mounting and .0005 grid condenser	1.50
1	Audio frequency transformer	4.50
1	Rheostat 25 ohm	1.00
1	Rheostat 6 ohm	1.00
2	Tube sockets @ $1.00	2.00
	Binding posts, bus bar, etc.	1.00
1	Panel 10 x 12	2.85
1	Cabinet	5.00
	Total cost	$37.35

The rotor should be set at right angles from stator, that means cross-wise. From this position it should be moved only slowly and slightly, not more than 10 or 15 degrees, just enough to increase the signal. If it squeals, back up a little; if a louder signal is required try advancing it a little. After you get thoroughly acquainted with the working of your set, don't get in a hurry; spend a few more nights on the spot that brings in the loudest signals and its relation to the rheostat.



You are now ready to add condenser C 2. This will give you increased wave lengths and sharper tuning. The rotor plates of this should be kept all the way out most of the time; otherwise you have too long a wave length and you will get nothing. Verniers should, by all means be employed on these two condensers. Do not delude yourself with the idea that you can replace these condensers with a 3 and 43-plate. A 3-plate is nothing more and nothing less than a vernier on a condenser. And a 43-plate with too long an aerial is so often the trouble when you can't get down below 400 meters. Use size of condensers as specified.

After you get your bearings with this condenser, as with the addition of each you reset your dials, add condenser C 3 and honeycomb coil. This will now give you such sharp tuning with condenser C 2 that I had to hunt for my local station; 5 to 10 degrees will tune it out completely with proper adjustment of your other dials. Yes, you can tune out the other fellow, not only one Radiocasting station—two or three if required, if they are not too close wave lengths; yes, and leave that music clear and without cutting down your possible stations that are within your reach.

The rotors of the condensers should be connected as indicated. If properly hooked up there is absolutely no body capacity; you can sit on top of it without any part of it being grounded or shielded, and there will be no effects. Tap your transformer on 21 volts on the B battery. If you wish to run this on 22½ volts, you simply can't bring out the volume.

Although I show this hook-up with ground and aerial, you can get good reception up to 25 miles without ground or aerial; 200 miles without aerial, and from 500 to 1,000 with aerial only. If you are a "doubting Thomas," just give her a trial.

Place one condenser at left of panel, variometer in the center and second condenser at right of panel. Rheostats are placed close to bottom edge between dials.

Care of Storage Battery

Proper care of the battery will double the usual reception of the set. Always remove the acid or water from the tops of the battery, as the moisture will sometimes cause unnecessary noises. Never place the battery near window curtains, as the fumes will ruin them. Do not set the battery on or next to a rug as the acid might leak and ruin it. If battery is in good condition it will not freeze. The care of the Radio battery is more important in the summer time than in the winter, because many people are not inclined to use their sets in summer. If the battery is not used for a long time and is left in a discharged condition, sulphation will result. This condition can sometimes be remedied by a prolonged charge. Many times it is necessary to dismantle and repair.

Those who have charging rectifiers should be careful not to use too high a charge rate, as it may cause buckling, shedding and overheated plates. Occasionally a complete cycle of charge and discharge will increase the capacity of your battery. Sometimes it is advisable to take it to a battery station and have it given the water cure.

One way of removing the greenish substance that collects around the positive pole of a storage battery is to pour the contents of a teakettle of warm water slowly over the surface of the battery. The vent caps or battery corks should be left in place so that the water cannot get into the interior of the cell. After the terminals are cleaned they should be filed or made bright with some heavy sandpaper. Coat the terminals and other exposed metal parts, except the contact points, with vaseline to prevent further corrosion.

To prevent a hum in the set, keep the electric wires away from apparatus. A droplight on the table where set is located is sometimes responsible for a hum.

Never fasten an aerial permanently to the bough of a tree. Fasten it by means of a pulley, with a heavy weight at the end, which will keep it taut, yet will allow the tree to sway without breaking the wire.

A Radio set will not work satisfactorily when the storage battery or B batteries are nearly run down. Have the storage battery charged and get new B batteries. B batteries should last at least six months, and in many instances several years.

For Wide Wave Length Range

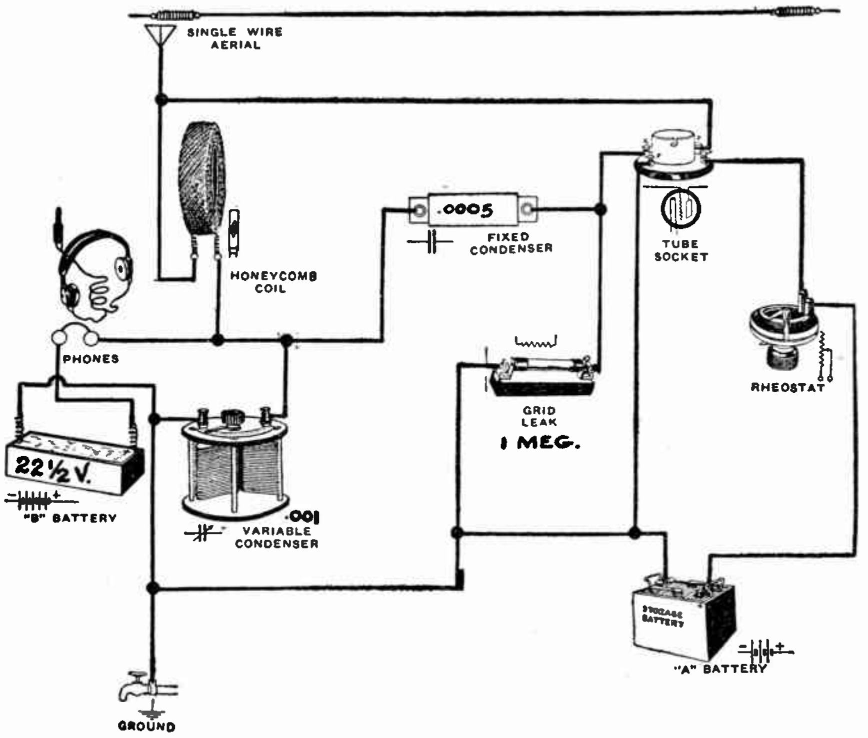
THIS simplex diagram presents an extremely efficient circuit; it is not only simple to construct, but covers a wide range of wave lengths. The cost of necessary apparatus is low; an assortment of honeycomb coils, including 35, 50, 75 and 100, will supply even the unusual demands of the ordinary fan. The device resembles somewhat the well-known ultra-audion; its operation is very similar. Tuning is confined to the variable condenser, which should be of the vernier adjustment type.

A detector tube can be used with 22½ volts on the plate, but if an amplifier tube is used it probably would be advisable to increase the plate voltage.

The rheostat used depends on the type of tube, likewise the voltage of the A battery.

List of Parts

1	Variable condenser, .001 mfd. vernier	$6.50
1	Honeycomb coil mount, single	.50
1	35-turn honeycomb, mounted	1.50
1	50-turn honeycomb, mounted	1.60
1	75-turn honeycomb, mounted	1.60
1	100-turn honeycomb, mounted	1.60
1	Grid leak, 1 megohm, without condenser	1.25
1	Fixed mica condenser, .0005 mfd.	.40
1	Tube socket	1.00
1	Rheostat, 6 ohms	1.00
1	Panel 7x10	1.25
1	Cabinet	2.50
	Binding posts, bus bar, screws, etc.	1.00
		$21.70



Mount the variable condenser 3½ inches from the bottom toward the left edge of panel. Rheostat and coil mounting are placed on a vertical line to the right with the rheostat below the mounting. It would be advisable to shield this panel with foil or thin metal sheet and connect the shield to the wire connecting the A with the ground.

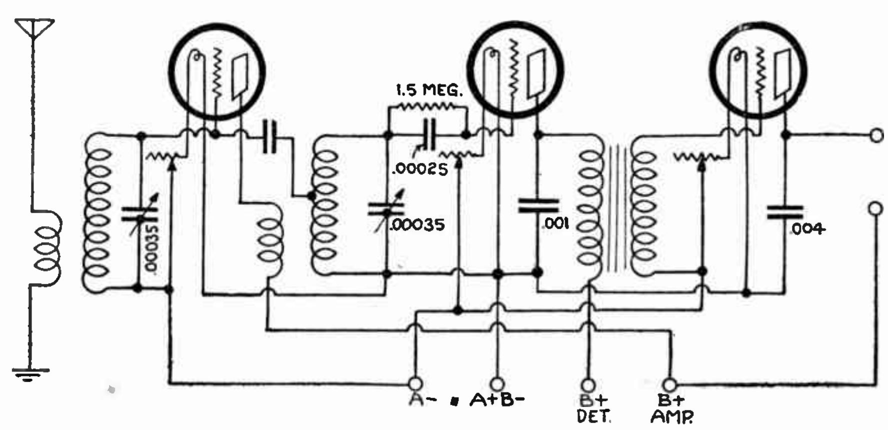
If a 199-299 tube is used the cartridge in the grid leak will have to be of a higher value—3 to 5 megohms—and the plate battery should be 45 volts. The rheostat should then be 40 ohms instead of 6 as listed. The 35-turn coil will permit reception of amateur reception while the 35 and 50-turn coils should cover the Radiocasting range of wave lengths.

The sharpness of tuning with this hook-up is remarkable, especially if the condenser is of the low-loss type.

One Stage R. F. Neutrodyne

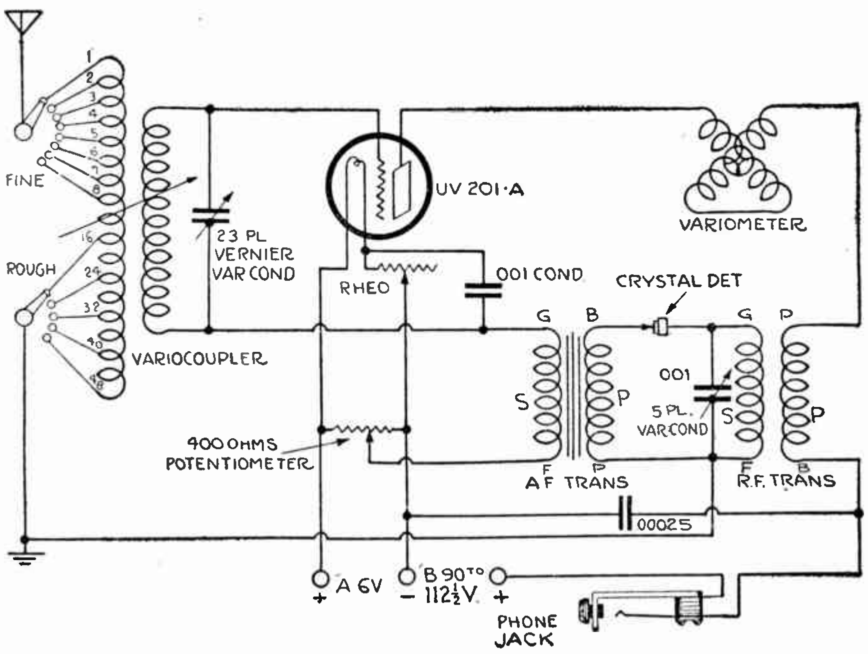
A SIMPLE form Neutrodyne circuit in which the number of parts required has been reduced as much as possible is shown in the illustration above. This circuit has one stage of tuned, transformer coupled Radio frequency, the detector and one stage of audio frequency. It has only two tuning controls and is indeed a simple set that any person can operate. The stage of Radio frequency gives the long distant range while the audio frequency builds up the volume. A soft or detector tube is recommended for the detector stage. Hard or amplifier tubes should be used for the two amplifier stages. With the detector tube a plate voltage from 18 to 22½ is sufficient. The amplifier plate voltage should be about 67½. As may be guessed by the maker, the standard form of neutroformer is requirde. This circuit will require a panel size of about 7 to 21 inches. The expense of constructing the entire set should not be over $50.

To assure loud speaker volume on distant stations, a second stage of audio frequency amplification may readily be added. A two-circuit jack would be inserted where the two output binding posts now are, the filament leads are carried across.



Regenerative Reflex Is Powerful Receiver

THE first matter of importance is that all apparatus must be of very best quality; second, the values indicated in the diagram must not be altered, since a small change will, in most cases, cause the two frequencies to become unbalanced, and result in a jumble of sounds, instead of voice and music; third, a little patience is necessary before one becomes acquainted with its peculiarities in tuning, and when this is accomplished, the circuit is no more difficult to tune than any other. It should be realized that this circuit is very critical and sensitive; therefore care should be used in tuning.



List of Parts

1	Radio frequency transformer	$ 5.00
1	Audio frequency transformer	5.00
1	Tube socket	1.00
1	25-ohm rheostat	1.75
1	400-ohm potentiometer	2.00
1	Phone jack, single circuit	.70
1	Fixed mica condenser .001	.40
1	Fixed mica condenser .00025	.50
1	Variable condenser .0005 mfd., vernier	4.50
1	Variable condenser .0001 mfd. plain	1.50
1	Variometer	4.50
1	Variocoupler 90-degree	4.50
1	Crystal detector	1.50
1	Panel 7 x 14	1.75
	Binding posts, bus bar, etc.	1.00
	Total cost	$35.60

Important Parts of Set

The following are data of importance in this hookup: Beginning with the aerial, it is 100 feet long and of average height; 90° variocoupler is used, loosely coupled. The stator is wound with 48 turns of number 22 scc. wire, having 8 single twin taps to the aerial, and 5 taps of 8 turns each to the ground. The rotor has 50 turns of number 24 scc. wire. Forty-eight turns on the coupler stator are sufficient for all Radio cast wave lengths; all over this number tend to decrease signal strength through dead end loss in the coil.

The variometer should have not more than 60 turns on the rotor and the same number of turns on the stator, and the wire should be not smaller than number 20. The rotor winding is usually set in such a position that its field opposes that of the stator.

Transformers Used

Much care should be taken in selecting transformers. The audio should be well shielded, and of good construction. The 9-to-1 ratio may seem a bit high, but with proper tuning, and if the transformer is correctly constructed, little or no distortion will be noticed. The Radio frequency transformers should be of the reflex type, of one-tube design, and lateral-wound. Care should be taken to connect the transformers correctly as indicated in diagram. Be sure the Radio frequency transformer has at least a 4-inch clearance from all other inductance. This is very important and the downfall of many good reflex sets.

Changes in Hook-Up

Note, some changes have been made which add to the efficiency of the hook-up, in that more volume is obtained. Note the change in the crystal detector circuit. Formerly the method was to merely "throw" a crystal detector between the two transformers. The variable condenser proves to be a big advantage in the crystal circuit. The crystal detector may be of the cat whisker type, or a fixed one; the latter is my choice. It is a fact, that a crystal which gives excellent results in a straight crystal set will sometimes prove valueless in the reflex. Therefore many should be tried in order to find a good one.

The following layout is suggested for this receiver. Place the secondary tuning condenser in the center of the panel lengthwise with the vario-coupler on a line with it to the left and the variometer on a line to the right. Symmetry can be approximated by placing one of the coupler switches in the upper and one in the lower left corner; the rheostat in the upper and the potentiometer in the lower right corner. The phone jack can then go below and between the condenser and variometer dials.

Actual Wiring of Set

In wiring the set, prevent leads from coming in inductive relation to each other. It is important that grid lead is separated as far as possible from ground leads.

For the benefit of the beginner the following suggestions for tuning the set are given: If a fixed crystal is used, turn up filament about one-half of rheostat resistance; set all variable instruments at one-half their maximum value; then cut in primary of coupler, beginning with a few turns and increasing one turn at a time, until a signal is heard, or when the tube starts to oscillate. In the later case adjust variometer till signal clears up; then proceed tuning more sharply by adjusting rotor of coupler and secondary condenser. At this stage, if the signal is not clear, adjust potentiometer and then build up volume by means of variometer and condenser, which is across secondary of Radio frequency transformer.

If volume is built too high a point will be reached at which the tube will burst into oscillations. If this occurs, touch grid lead with your finger and at the same time turn rotor of variometer back a bit to compensate for the excess regeneration.

It is well to know that the temperature of the filament is rather critical, there being three different positions upon the rheostat at which points signals are clearest, while each succeeding point renders the signals louder. Any change in the filament temperature will also necessitate a change in grid potential, by means of the potentiometer.

Tuning Hints

If a cat whisker type crystal is used, first remove cat whisker from crystal and turn in almost all resistance of rheostat, which causes filament to burn at a very low temperature; then proceed tuning primary of coupler till signal is heard. The signal, in this case, is very weak, since the tube is acting as detector instead of the crystal. Next turn up filament to one-half of resistance of rheostat, which will cause the tubé to oscillate; then, by adjusting crystal properly, oscillation will cease and the signal will again be audible and of greater volume. Then proceed as clear.

It is advisable in tuning to utilize as few turns on the coupler as necessary. If a signal does not come in clearly, the station is not tuned in properly, and you will nearly always find the trouble in the primary of the coupler. It is evident that stations varying by more than 200 meters in wave length may be tuned in by means of secondary circuit only, but unless the primary of coupler is also varied, the signal will not be perfectly audible.

Loud Speaker May Be Used

Many letters were received inquiring whether this hook-up will operate a loud speaker. In reply the writer will state that stations within 50 miles are very satisfactory on a Magnavox, and with one added stage of audio frequency, stations at 1,000 miles can be headr on thes peaker with plenty of volume. Voice and music are also exceptionally clear from the speaker.

Additional stages of audio frequency amplification may be added in the usual way, being sure to shunt first audio primary with a fixed condenser.

Real DX Reception on Two Tube Circuit

YES, sir; here's a long distance circuit with two tubes. This gives you a chance to make use of that loud speaker once in a while.

Two variometers—no, they are not split this time—one good variable condenser, a variable grid leak, a good audio transformer, some fixed condensers and the usual assortment of necessities.

One of our fan friends sent it in to us; now he passes it on to you and frankly states it's an improvement on a diagram given in the Radio Digest.

Not only does he get coast to coast stations, but finds it easy to tune and very selective, with plenty of volume. UV-199 and C-299 tubes can be used, but then 45 volts will be necessary on the detector stage instead of the 22½ shown in the illustration.

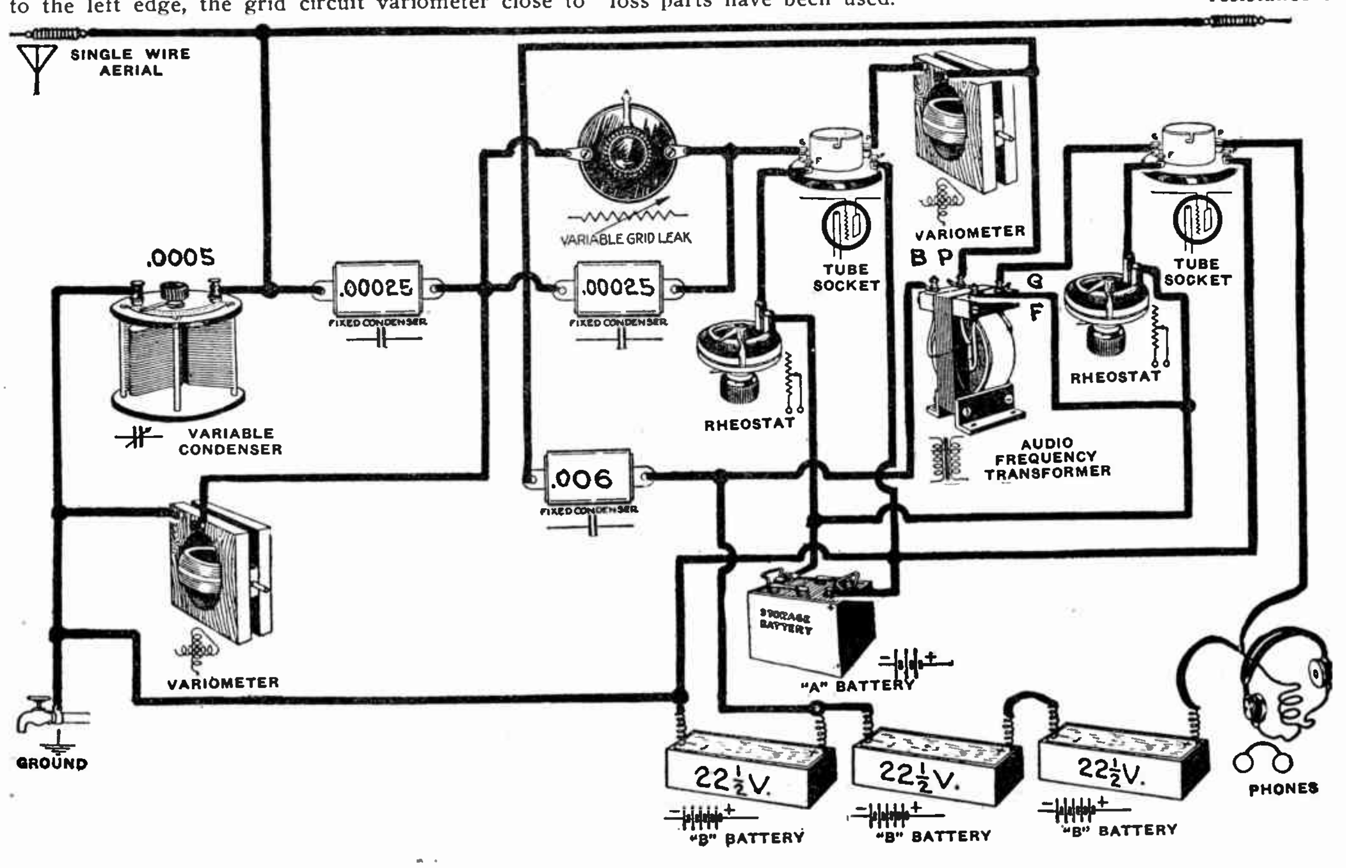
The circuit does not resemble any of our standard circuits, so it will give you something new to play with.

It would be extremely difficult to get symmetry in the arrangement of parts on the panel when designing this set, and one would take considerable chance of losing efficiency if symmetrical arrangement is too much considered. It is suggested that a horizontal center line be drawn lengthwise of the panel on the back; the .0005 mfd. variable condenser is placed close to the left edge, the grid circuit variometer close to it, then the grid leak and rheostat on a vertical line, the rheostat near the bottom of the panel. Next would come the plate circuit variometer and last the rheostat of the amplifier tube.

The detector tube may be placed close up behind its rheostat, but the amplifier tube should be placed further back on the baseboard with the audio frequency transformer between it and its rheostat. Unusual volume, with a selectivity not usually found in a "single circuit" receiver, will be had if efficient, low loss parts have been used.

List of Parts

1	Variable condenser, .0005 mfd. vernier	$ 5.50
2	Variometers	12.00
2	Tube sockets	2.00
1	Rheostat, 6 ohms	1.00
1	Rheostat, 25 ohms	1.00
1	Audio frequency transformer, 4 or 5 to 1	4.50
2	Fixed mica condensers, .00025 mfd.	.70
1	Fixed mica condenser, .006 mfd.	.75
1	Variable grid leak	1.25
1	Panel 7x18	1.75
1	Cabinet	3.00
	Binding posts, bus bar, screws, etc.	1.00
		$34.45



Spider Web Regenerative Hook-Up

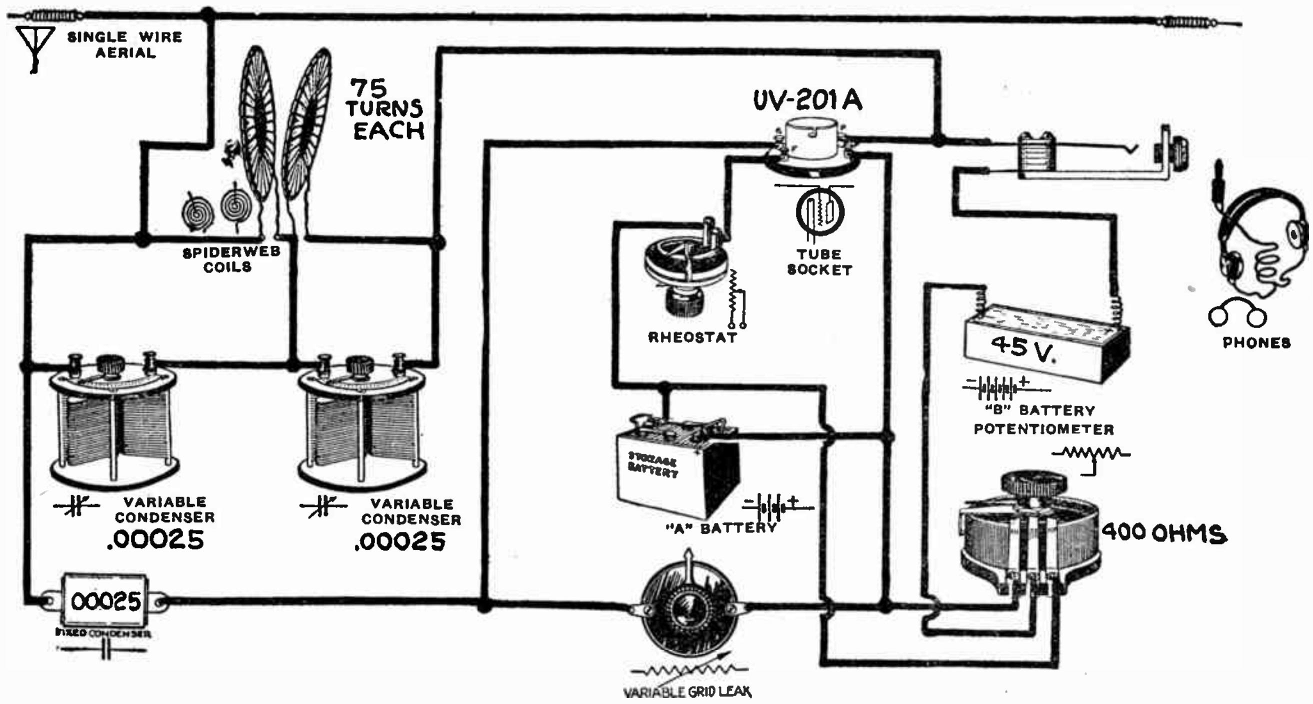
SOME experimental work in the laboratory developed the circuit illustrated. Try it and have your fun with it.

Two spider web coils are both wound with 75 turns of wire. The frame should be the same size in each case, and the two variable condensers must be of the same capacity. A slight variation from the circuit presented is to substitute a variable grid condenser of the same capacity in conjunction with the variable grid leak. A UV-201A tube is used with a 45-volt plate battery and the potentiometer has a resistance of 400 ohms. The coupling adjustment between the two spider web coils is apt to be very critical and therefore some form of vernier control is recommended. Vernier plates on the variable condenser are not necessary, although some form of vernier control of the dial will be found of decided value in tuning.

The two variable condensers should be mounted side by side, their shaft holes about 4½ inches apart, near the left edge of the panel and close to the bottom.

The mounting for the spider web coils is placed above and between them. The potentiometer is placed to the right of the condensers and near the bottom, while the variable grid leak and rheostat are mounted side by side above it and on a line with the coil mountings. The tube socket is then placed near the right hand edge of the 5x13 baseboard directly behind the potentiometer.

This hook-up, which will interest the experimenter, is a combination of the popular Miloplex and the ultra-audion with the addition of an "absorption circuit" that also aids in tuning. Audio frequency amplification may be added as usual by connecting the primary of the first audio frequency transformer in place of the phones.



List of Parts

2 Variable condensers, .00025 mfd.	$8.00
1 Potentiometer, 400 ohms	2.00
1 Variable grid leak	1.50
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
1 Phone jack, open circuit type	.70
Materials for two spider web coils	1.00
1 Fixed mica condenser, .00025 mfd.	.35
1 Panel 7x14	1.75
1 Cabinet	3.00
Binding posts, bus bar, screws, etc.	1.00
Total Cost	$21.30

For a simple test which will at least detect a complete break in a coil or transformer, one can employ a standard flashlight bulb and its battery. Connections to the bulb should be made to the conductor under examination, with the bulb in series with the circuit. The bulb will light if the connection is not broken. Bulbs of large current capacity must not be used for test purposes, as excessive flow of current through the delicate wires of a transformer is apt to overload them.

Snap switches of any sort may be placed on the panel of your set and it will not be necessary to disconnect the batteries each time you listen in. Always have the current turned off the B batteries when the A battery current is turned on. Let it have time enough to warm up the inside of the tube before turning on the B battery current.

Do not use annunciator (bell) wire in winding inductances for receiving sets. The wax coating on the wire reduces the efficiency of the coil by increasing the distributed capacity. If Number 16 or 18 wire is necessary use dcc. It will prove entirely satisfactory.

In connecting up the loose coupler, bear in mind there is no electrical connection between the primary and secondary coils.

A potentiometer is not a variable resistance. It is a voltage supply device arranged to vary the voltage supplied to some auxiliary circuit.

By placing a .001-mfd. fixed condenser between the grid lead on the secondary of the second audio-frequency transformer and the negative side of the filament circuit, clearer and sometimes louder reception will be obtained.

Look out for the blue glow in a detector tube. This is a sure sign that the B battery voltage is too high, and it is apt to paralyze the tube.

•A potentiometer is not a variable resistance. It is a voltage supply device arranged to vary the voltage supplied to some auxiliary circuit.

Rosin core solder is excellent for use in soldering Radio sets, but great care must be taken to see that the wires are held by the solder and not the rosin.

When forming loops for taps two or three tight turns are sufficient. Too much twisting may cause a break at the twist, which will be scarcely noticeable until the coil is wired into the circuit.

With one-tube receiving sets designed for minimum size and weight, a flashlight battery may be used to light the filament. This battery will supply one hour's service a day for about one month.

Ultra-Selective Long Distance Receiver

THE circuit shown is another of the selected receivers, and is presented because of its unusual efficiency and moderate cost of construction. While the circuit is a little advanced for the beginner, it will appeal to the fan that has already become somewhat acquainted with Radio receiving sets and who is looking for a good three-tube receiving set for use at home.

The apparatus required is two variometers, one honeycomb coil and single coil mount, one variable condenser with vernier .0005 mfd., one grid condenser and variable grid leak, one .00025 mfd. fixed condenser, one .005 mfd. fixed condenser, three tube sockets, three rheostats, two amplifier tubes, one detector tube, two audio frequency transformers (ratio about 5 to 1), two double circuit jacks, one single open circuit jack, one panel 9 by 14 by 3/16, one baseboard 9 by 8 by ½, and nine binding posts.

The circuit is of the regenerative type, and has unusual selectivity. A single wire aerial, 60 to 80 feet long, will give very good results for both local and long distance reception.

Either dry or storage cell tubes can be used. The tube filaments is controlled by the individual rheostats.

The honeycomb coil consists of a 75 turn coil from which 15 turns have been unwound. The variometers are of the flat disc type, with a figure 8 winding. This type is very selective, efficient and of low internal capacity.

List of Parts

2 Variometers @ $5.00	$10.00
1 Variable condenser .0005 mfd. vernier	5.00
1 Honeycomb coil 75 turns mounted	1.60
1 Single coil mount	.50
1 Variable grid leak with .00025 condenser	2.00
1 Fixed mica condenser .005 mfd.	.75
3 Tube sockets @ $1.00	3.00
3 Rheostats 25 ohms @ $1.00	3.00
2 Audio frequency transformers 4 or 5 to 1 @ $4.50	9.00
2 Jacks double circuit type @ $1.00	2.00
1 Jack single circuit type	.70
1 Panel 9 x 14	1.30
1 Cab'net	5.00
Binding posts, bus bar, screws, etc.	1.50
Total cost	$45.35

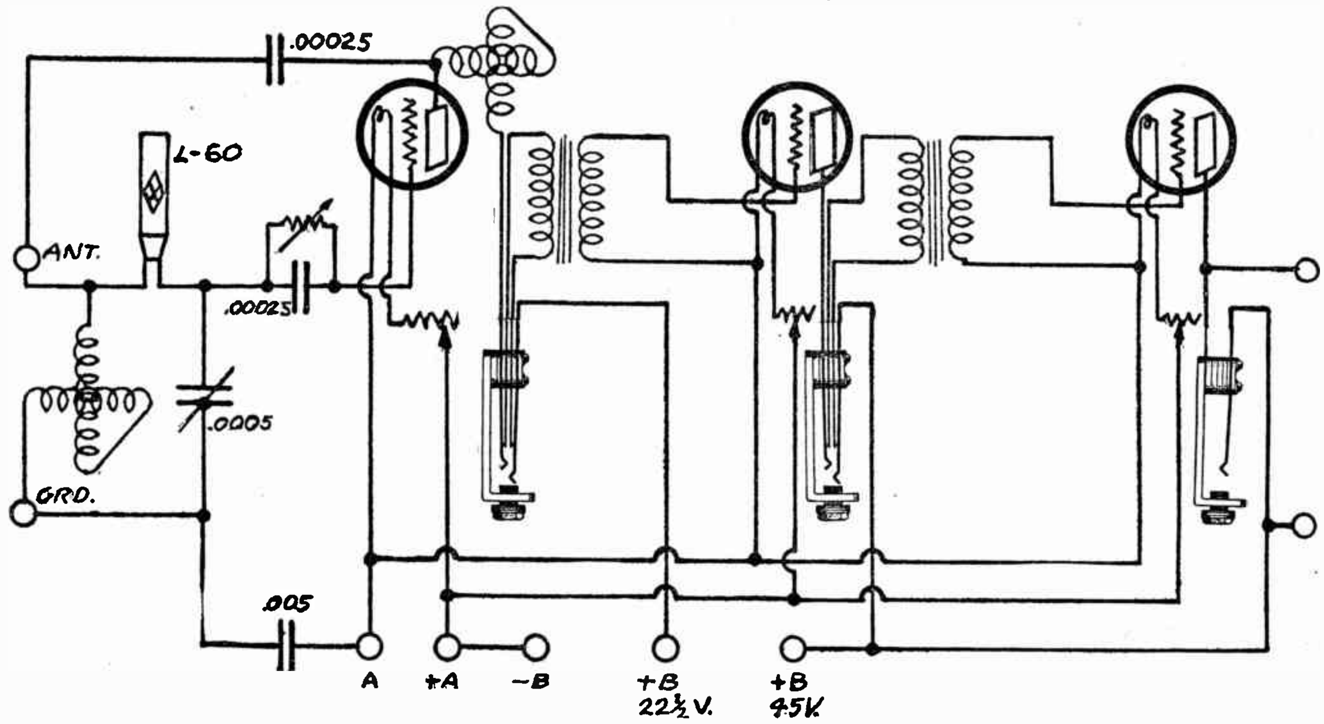


plate battery voltages can be varied by experimentation for clearest reception and maximum volume.

The use of jacks permits two stages of audio frequency amplification as desired. The lighting of the

The variable grid leak adjustment is not very critical, but varies slightly with different tubes. The combination of variometer and condenser permits very selective tuning control over a wide wave length range.

"Kilocycle" Defined

In Radio, "kilo" means a thousand, and "cycle" means one complete alternation. The number of kilocycles indicates the number of thousands of times that the rapidly alternating current repeats its flow in either direction in the aerial in one second. The smaller the wave length in meters, the larger the frequency in kilocycles.

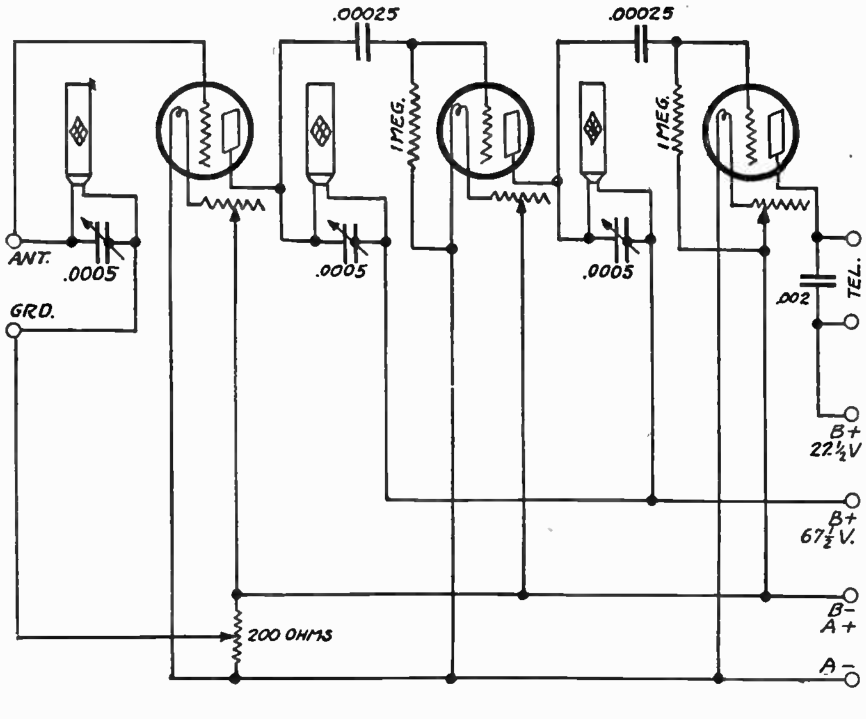
Avoid Oscillation

The main difficulty with homemade Radio frequency amplifiers is that the tubes go into oscillation, and in such condition the only thing received will be howls and squeaks. The same applies to a neutrodyne set, unless the neutralizing condensers are properly adjusted. In this lattter type of set the squeals and whistles are supposed to be neutralized out.

Three Stage Tuned Radio Frequency Unit

THERE have been many inquiries for a good tuned impedance coupled Radio frequency receiver. The selectivity of this type of circuit is unusually good and the circuit is recommended for fans who plan long distance receiving for the Fall. A two stage audio frequency amplifier can be added in cases where loud speaker volume is desired.

Three sets of three different coils can be kept on hand for all the usual Radiocasting wave lengths. These three are 35, 50 and 75 turns. When tuned with the .0005 condensers the required wave length range is well covered. Naturally the coils as used will be the same in the three stages; that is, either all 50 turn coils or all of 35 or 75 turns. This means nine coils to be kept on hand.



List of Parts

3 Variable condensers .0005 mfd @ $4.50	$13.50
3 Single coil mounts @ 50c	1.50
3 Honeycomb coils 35 turns @ $1.50	4.50
3 Honeycomb coils 50 turns @ $1.60	4.80
3 Honeycomb coils 75 turns @ $1.60	4.80
1 Potentiometer 400 ohms	2.00
2 Fixed mica condensers .00025 mfd @ 35c	.70
1 Fixed mica condenser .002 mfd	.40
3 Tube sockets @ $1.00	3.00
2 Rheostats 25 ohms @ $1.00	2.00
1 Rheostat 6 ohms	1.00
2 Grid leak mounts and 1 megohm resistances @ $1.25	2.50
1 Panel 7 x 14	1.75
1 Cabinet	3.00
Binding posts, bus bar, screws, etc.	1.50
Total cost	$46.95

The fan must remember, however, that each stage must be tuned to the proper wave length in order to get satisfactory reception.

If dry cell tubes are used, the potentiometer should be of the high resistance type. The resistance of the rheostat is determined by the type of tubes used. The first two tubes are Radio frequency amplifiers, the last tube is a detector. Three fixed condensers are required, two of .00025 mfd. capacity and one .002 mfd. phone condenser. Two 1 megohm grid leaks are used.

The detector tube requires 22½ volts on the plate but the two amplifier tubes should have 67½ volts. The honeycomb coils should not be placed in inductive relation to one another. Three single coil mounts should be used. A single wire aerial 80 to 100 feet long and as high as possible is recommended for distance receiving.

Tapped Coil in Simplex Circuit

MANY of the Radio apparatus manufacturers are putting out tapped inductance units. Some are in the form of single layer coils wound on tubing; some are spider web windings; others have a lattice wound honey comb coil. These coils take the place of the old single slide tuners.

The taps need not be more than four or five, since the finer tuning can be taken care of by means of a .001 mfd. variable condenser in series in the aerial circuit, as shown in the simplex diagram. For close tuning it will be found advantageous to have some vernier control on this condenser, since it will help clear up the reception through very accurate adjustment.

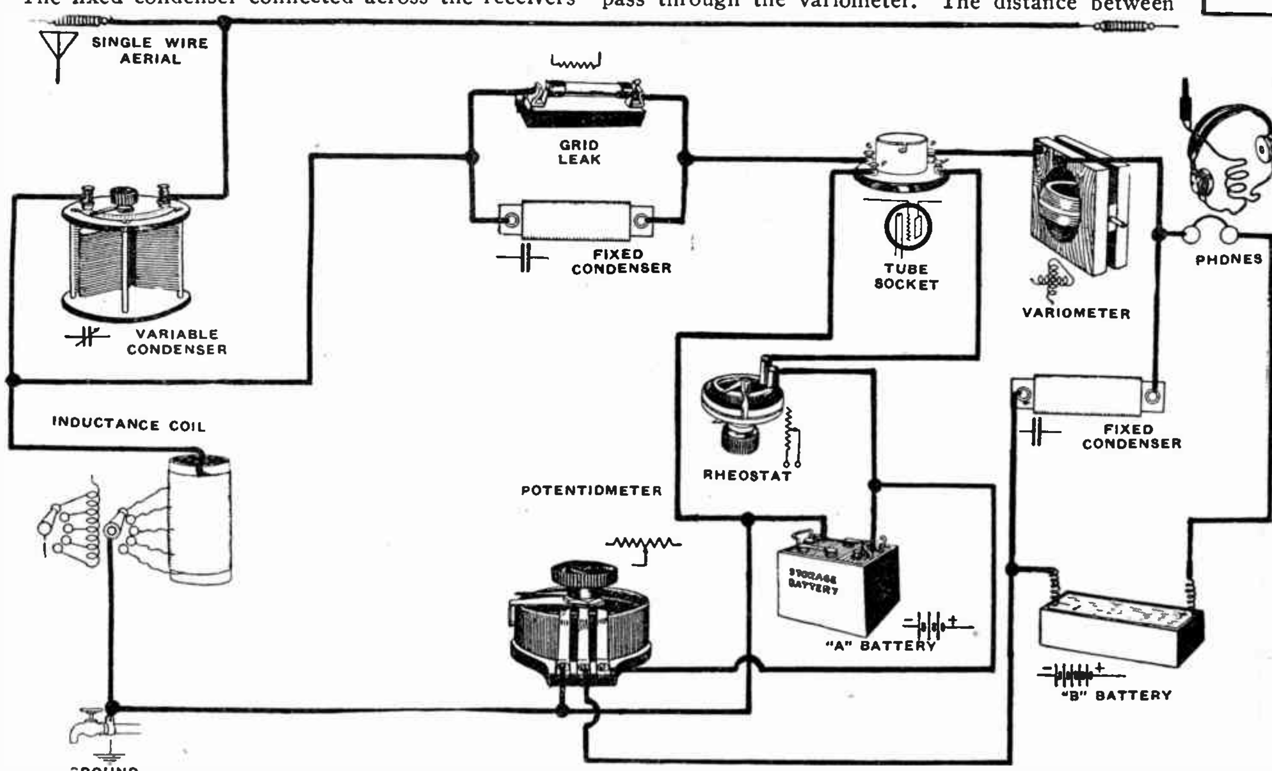
If a 400 ohm potentiometer is connected across the A battery as shown, very close adjustment of plate potential is possible; this is important with the variety of detector tubes at present available. The plate or B battery should consist of one 22½-volt unit.

The fixed condenser connected across the receivers should be .002 mfd. capacity; the grid condenser .00025 mfd., and the grid leak should have a resistance of about 1½ megohms. The plate circuit is controlled by means of the variometer. This variometer can be inductively coupled to the inductance coil if desired; that is, the center line of the inductance unit may pass through the variometer. The distance between them depends entirely on the apparatus used and is best determined by experimentation.

Audio frequency amplification can be added in the usual manner if more volume is desired.

List of Parts

1 Variable condenser .001 mfd. vernier	$ 6.00
1 Tapped inductance 4 or 5 taps sufficient	2.00
1 Variometer	5.00
1 Rheostat 6 ohms	1.00
1 Tube socket	1.00
1 Grid leak either cartridge or rotary variable	1.25
1 Fixed mica condenser .00025 mfd	.35
1 Fixed mica condenser .002 mfd	.40
1 Potentiometer 400 ohms	2.00
1 Panel 7 x 10	1.25
1 Cabinet	2.50
Binding posts, bus bar, screws, etc.	1.00
Total cost	$23.75



Two Element Tube Set

EVERYONE who builds their own Radio outfit desires to receive over a maximum distance with a minimum expenditure. A receiver may be constructed which is far more sensitive than a crystal outfit but is more economical and reliable in its operation.

Now-a-days everyone wants a vacuum tube set and yet everyone cannot afford to invest in the necessary storage battery, B battery and other accessories that go to make up receivers of this type. A Fleming valve type vacuum tube may be purchased complete with all accessories for $2.50. This is a two-element tube operating from dry cells. With the receiver circuit outlined in the diagram, station that were picked up, and the quality of the reception, is every bit as good as that obtainable with a good crystal set, and there is an entire absence of circuit noises and howling. In fact, one cannot make the two-element tube howl, no matter how one tries.

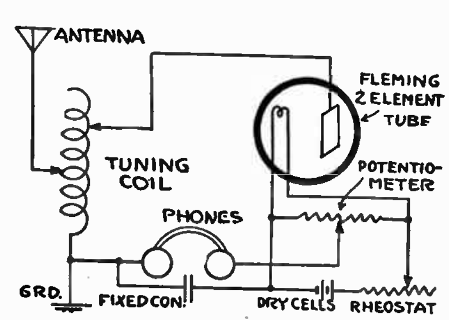
List of Parts

1 Tuning coil, 2-sliders	$3.00
1 2-element tube and accessories	2.50
1 200-ohm potentiometer	2.00
1 Fixed mica condenser, .002 mfd	.40
1 Pair of head receivers	6.00
2 Dry cells at 45c	.90
Total cost	$14.80

To operate, the rheostat is turned until the signals are the loudest. When the rheostat is placed at the proper point, it is not necessary to adjust it further and the tube retains its same degree of sensitivity for several hours. It is evident that it would not be advisable to operate these tubes without a rheostat as that would allow too much current to pass through the filament from the battery.

The advantage of permanent adjustment of this arrangement will appeal strongly to those who have been troubled with crystal detectors. Crystal detectors are fine, but they do get out of adjustment and here is something that gives just as good quality, greater distance and no trouble in adjustments.

In the way of experimenting, a second circuit was set up, using a 200-ohm potentiometer. By the use of this arrangement the results were found to be a little better, but those who cannot afford the addition of the potentiometer can be assured that they will get good results well worth the trouble by using the other circuit.



Testing for Right Connections

To make sure that the B battery current has not been routed through the filament in any way, connect your A battery to the binding posts intended for the B battery and turn on the current. To make the test complete, short the regular A battery binding posts with a small piece of wire and then turn the rheostat to the full "on" position. If the filament does not light up, the wiring is correct and you are ready to hook up the B battery with safety. If any signs of life are seen in the filament you had better track your hook up. In using this method you are only putting the normal voltage through the fialment.

Efficient Variocoupler

A good variocoupler should not have a big surplus of wire. It should be constructed to efficiently receive a limited band of wave lengths, such as 200 to 600 meters.

It is not advisable to have one instrument cover a broad range such as from 200 to 3,000 meters, for in such a tuner losses occur, due to "dead" ends.

A variocoupler, in order to cover the Radiocasting stations' wave lengths, should have about 60 turns of Number 24 wire on a primary, or stator, 3½ inches in diameter. The rotor should have about 50 turns of Number 26 wire.

Compact Three Tube Portable Receiver

Suitable for Home or Field Use

THE portable set is undoubtedly gaining widespread favor among Radio enthusiasts, and a considerable number of these sets are being built. The satisfaction and added pleasure in owning a portable Radio receiving set is only known to those who are fortunate enough to own one.

The convenience with which the entire outfit can be carried about from place to place is another feature well worth considering. You say to one of your friends, "You ought to hear my set work." Why not carry it over to his house and demonstrate the remarkabe ability of the set to pick up concerts from the powerful distant Radiocasting stations. That is only possible with the portable set.

List of Parts

1	Variocoupler	$ 5.00
1	Variable condenser .0005 mfd	4.00
1	Variable vernier condenser, 3-plate	1.50
1	15-point switch	1.75
2	Audio frequency transformers @ $4.50	9.00
1	Variable grid leak with .00025 cond	2.00
1	Fixed mica condenser .002 mfd	.40
2	Phone jacks, double circuit @ $1.00	2.00
1	Phone jack, single circuit	.70
2	Plain rheostats, 25-ohm @ $1.00	2.00
1	Rheostat, vernier, 25-ohm	1.75
3	Tube sockets @ $1.00	3.00
1	Vernier dial	1.00
3	Vacuum tubes dry cell	12.00
3	Medium 22½ volt "B" batteries	5.25
3	Dry cells	1.50
1	Panel 7⅛x15⅛x¼	3.00
1	Cabinet	10.00
	Binding posts, bus bar, etc	1.00
	Total cost	$66.85

To appreciate that feeling which only comes to the owners of such types of receiving equipment, it is necessary to build one yourself. No matter where you carry it, you can look on it proudly and say, "I built it," and that means a lot; especially when you have succeeded in building a portable like the one shown in the photograph.

This set was built by one of the happiest Radio men in the city of New Orleans, Mr. W. J. Geary. Although new in the Radio field, Mr. Geary is gifted with the knack of wielding tools in a very artistic fashion, as you will note from the perfect workmanship throughout. Not only that, but he also carries the stuff required to push planes through pine knots—note the right and left hookers.

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $67.00

Cabinet Dimensions Arrangement of Parts

The cabinet in which the instruments are installed measures 16 inches long, 8 inches wide by 14 inches high. Three-eighths-inch oak is used throughout. The cabinet and cover are in natural color and finished dull by applying wax to the wood. Complete, with batteries, tubes, etc., the entire outfit weighs 32 pounds.

The set consists of a single-circuit receiver with detector and two stages of audio frequency amplification, jacks being provided in order to permit plugging in on the detector, one stage or two stages of amplification.

For those interested in reproducing the set described, the diagram, Figure 1, and the list of parts used will prove of value.

The arrangement of the apparatus in the cabinet is clearly shown in the photograph. The tops of the detector and amplifier tubes are seen protruding just a trifle out of the bakelite panel. Three holes have been cut in the panel to allow the tubes to be inserted in the respective sockets, which are installed at the right distance below the panel. The three jacks are mounted to the right of the first tube.

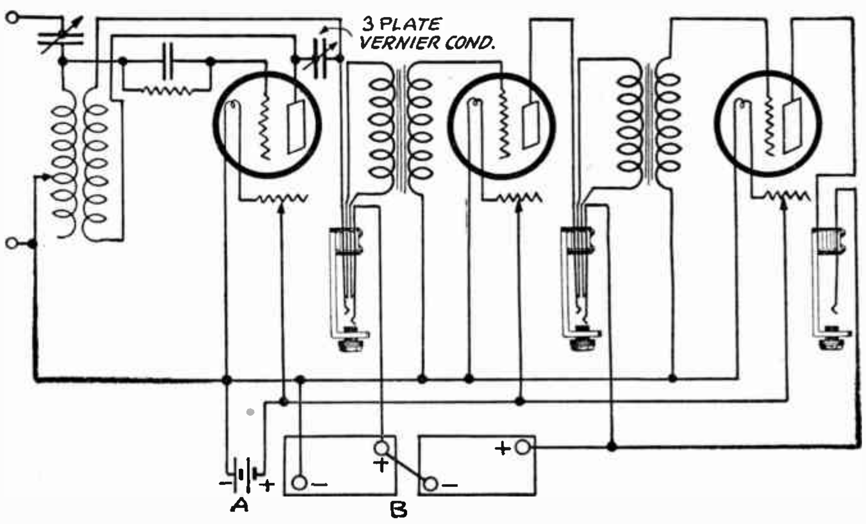
Rheostat Installation

The vernier rheostat, employed for delicate adjustment of the detector filament, is mounted in front of two plain rheostats which control the filaments of the amplifier tubes. To the right of the rheostats in the back is the 23-plate variable condenser, while in front of it can be seen the 15-point inductance switch. Next to the 23-plate condenser dial is the dial which controls the tickler coil of the variocoupler. The large dial is the latest development in vernier attachments and is employed in adjusting the 3-plate condenser, which is shunted across the tickler coil to a very fine degree of selectivity. This makes it possible to obtain maximum response from distant Radiocasting stations without distortion.

The two binding posts at the extreme right of the panel are for the antenna and ground connections.

With a one-wire aerial 90 feet long and 30 feet high at both ends, the following Radiocasting stations were intercepted and their concerts enjoyed on many occasions: WEAF, KSD, WBAP, WOAW, WMC, WSY, WTK, KDYW, WSB, WDAJ, KYW, WQX, KDKA, WOC, WJAM, WOS, WDAX, WAAP, WHAS, WCAG, WGV, WDAT, WDAN, WWJ, WDAF, WGAT, WJK, WEAM, WGY, WJAX, WCX, WHAB, WFAA, WGM, PWX, WJAD, WKAF, WLAK, WGAM, WFAL, WBL, WLAG, WLW, WEAO.

Mr. Geary uses the headphones most of the time, as it is not very practical to carry about a loud speaker of any type. If a loud speaker is desired, provision should be made for it in the cabinet.



One Tube Super

In the ordinary single-tube super-regenerative circuit, the tube has to perform three functions—i. e., those of oscillating at the signal frequency, and oscillating at the quenching frequency, as well as of rectifying. Such circuits give best results on comparatively strong signals, and therefore if the tube could be relieved of one of its three duties, better results might be obtained when receiving comparatively weak signals.

List of Parts

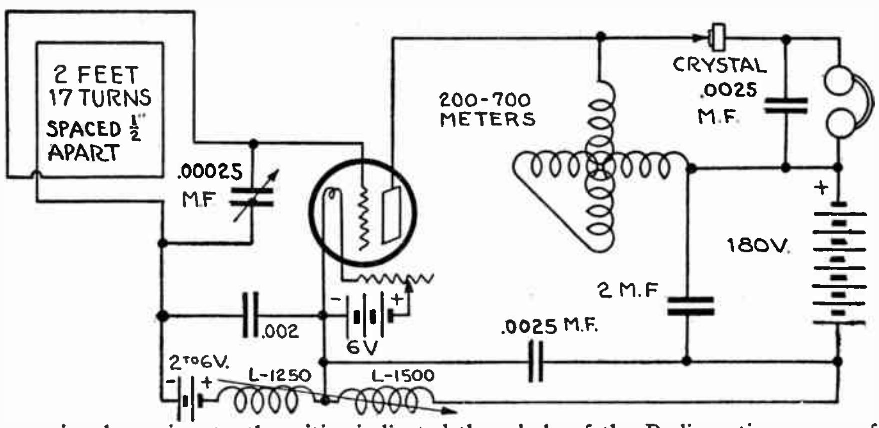
1	Variometer	$ 6.00
1	1250-turn honeycomb coil	2.50
1	1500-turn honeycomb coil	3.00
1	Double coil mounting	3.00
	Materials for loop antenna	2.50
1	Variable condenser .00025 mfd	3.25
1	Crystal detector	1.00
1	Fixed condenser 2 mfd	1.50
2	Fixed mica condensers .0025 @ .50	1.00
1	Fixed mica condenser .002	.40
1	Tube socket	1.00
1	Rheostat 25-Ohm	1.00
1	Panel 7x12	1.50
1	Cabinet	2.75
	Binding posts, bus bar, ets	1.00
	Total cost	$31.40

This has been borne out in practice as exemplified in the circuit in which the tube acts as an oscillator at signal and quenching frequencies in the guise of a high-frequency amplifier, while retification is obtained by means of a crystal shunted across an inductance in the plate circuit of the tube. As might be expected. the circuit is not suitable for receiving extremely strong signals, owing to the current carrying limitations of the crystal, but with weak signals it is remarkably efficient.

The operation of the set is quite simple. First, the correct coupling between the honeycomb coils should be found—it will usually be fairly loose, and once found little readjustment is necessary. The high-pitched whistle common to all super-regenerative circuits will then be heard, but it will not prove nearly so bothersome as with most other circuits, owing to the filtering action of the tuned plate circuit.

Capacity Effects Reduced

With a fixed and variable condenser of the capacities indicated the whole of the Radiocasting range of wave lengths can be covered—the only tuning adjustments being those of the condenser and variometer.



Instead of a variometer, a suitable coil shunted by a vernier condenser can be used. It is to be noted that the only regenerative coupling between the grid and plate circuits is that provided by the inherent electrostatic capacity existing between grid and plate, owing to their construction and proximity.

The circuit may be found rather puzzling to operate at first, but the particular knack is very soon acquired and excellent results are obtained.

How to Make a Harkness Reflex Receiver

A Simple and Efficient Radio Set

AMONG that vast multitude of Radiophans there is an ever increasing number who are seeking a hook-up that with the minimum number of parts, will give them good, loud speaker reception for local broadcasting and that at the same time will have the ability to bring in long distance stations although not necessarily with loud speaker volume in every case. The ideal set is one that can be assembled by the fan without the usual complications characteristic of the numerous multitude of hook-ups now available. The parts required should be standard and easily assembled by the constructor. The finished set should be as compact as possible so that it can be made portable or will not take up an unnecessary amount of room when hooked up for operation.

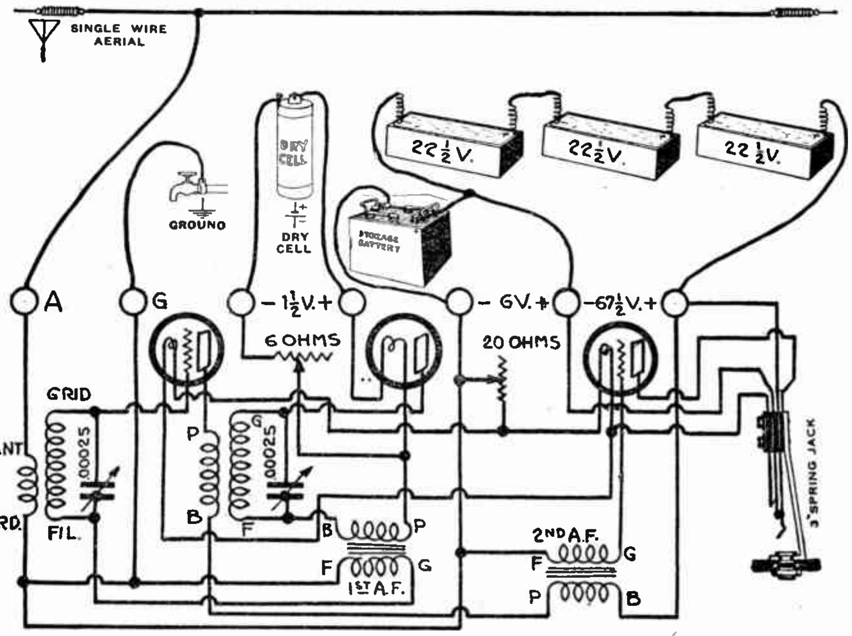


Figure 1

Discussion of Circuits

There is no question relative to the efficiency of neutrodyne circuits, likewise no one doubts the economy of reflex circuits. So provided the final circuit doesn't have the numerous tubes of the neutrodyne and avoids the complex difficulties of the reflex type, then we can anticipate some form of combination of the two ideas. Inasmuch as the neutrodyne is nothing but a development on efficient tuned Radio frequency coupling, this later form was employed. But the question of balancing or neutralizing has been eliminated not only because of the difficulties that fans have found in the compensation of the plate to grid capacities but also because of the rather doubtful value of this feature.

Reflex action is utilized in a more or less simplified form with the total elimination of fixed condensers making use of the internal capacity of the transformer windings acting as by-passes where required. The crystal detectors both fixed and adjustable are not always what they should be whereas the average detector tube would only increase the necessary parts required and complicate the hook-up. So, in their stead a two element tube is used. This eliminates the uncertainty of the action of the crystal detector and at the same time doesn't increase the drain on the batteries to any marked extent.

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $30.00

Two three element amplifier tubes are used and in addition one two element tube is required. The circuit is equivalent to two stages of tuned Radio frequency, detector and two stages of audio frequency amplification. Only one jack is used for phone and loud speaker connections. This jack at the same time acts as filament control inasmuch as it shuts off the filament current to the amplifier tubes when not plugged in. One rheostat is used for the two amplifier tubes and another for the two element tube. This tube has a separate single dry cell battery which is

List of Parts

2	Variable condensers .00025 mfd. @ $3.25	$ 6.50
2	Tube sockets @ $1.00	2.00
1	Socket for 2-element tube	1.00
2	Audio frequency transformers @ $4.50	9.00
1	Rheostat 25 ohms	1.00
1	Rheostat 6 ohms	1.00
	Parts for air-core transformers	2.00
1	Three spring jack	.75
1	Panel 7x12	1.50
1	Cabinet	2.75
1	Sub panel 7x8	1.00
	Binding posts, bus bar, etc.	1.50
	Total cost	$30.00

not connected in to the series of voltage for the amplifier tubes, since it was found that this materially cuts down the volume. So the fan may anticipate, if he attempts to use the same battery for lighting the two element tube as for the amplifiers, that the circuit will notdeliver the volume that can be expected as when the directions are followed.

So many letters are received stating that directions were followed, "with exceptions." You can anticipate that the response to all "with the exception" letters can only be answered in one respect—follow directions. The circuit was assembled and tested as shown, and all the changing over that was tried would not give the results that the one illustrated did.

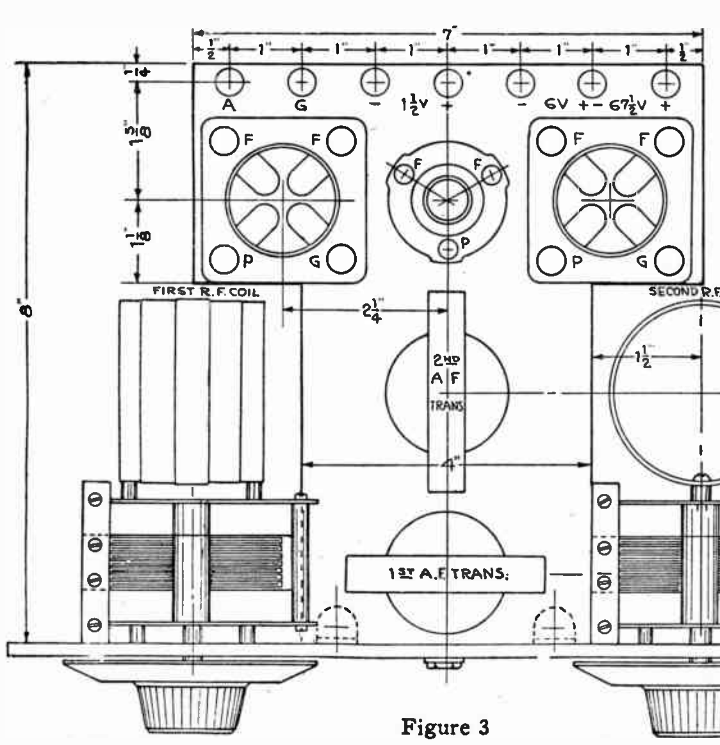


Figure 3

Installation Details and Description of Parts

In order to make the illustration as complete as possible and to assist those new fans who are somewhat in doubt as to how to connect the set after it is finished, the illustration in Figure 1 presents not only the circuit diagram but also the aerial, ground and battery connections. It will be noted as stated above that a single dry cell is used for lighting the two element tube. A six-volt storage battery is connected for the filament circuit of the two amplifier tubes. The plate batteries consist of three 22½-volt units connected in series, or one 45 and one 22½-volt units, as the case may be. The antenna should consist of a single wire aerial anywhere from 50 to 100 feet in length. A good ground connection is essential.

The table of parts required is given. In the original set the amplifier tubes were of the A type. UV-199's or C-299's can be substituted, if desired. Two audio frequency transformers are necessary but should not have a higher ratio than 5 to 1. The two variable condensers .00025 mfd. capacity should be of the highly efficient type. A single 20 ohm rheostat is used for the two amplifier tubes while the two element tube necessitates a 6-ohm resistance. The jack is the

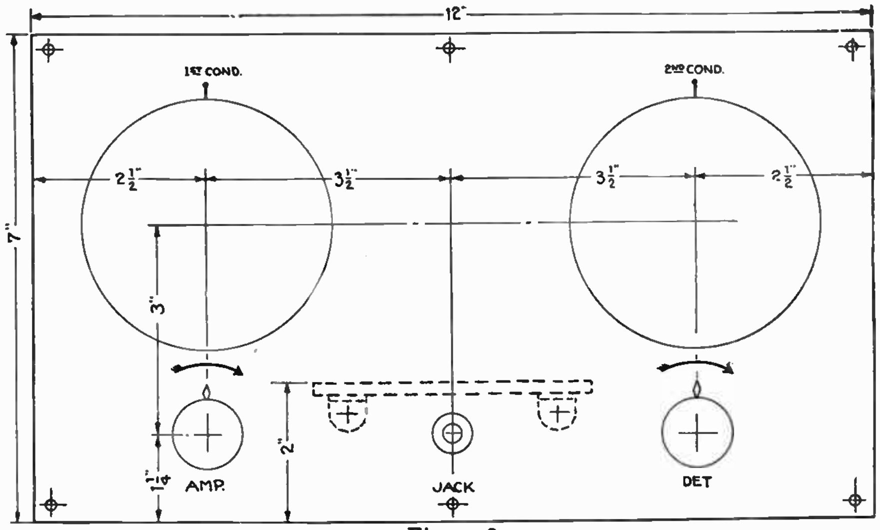


Figure 2

three-spring type with a make contact for connecting in the filament circuit when the phones or loud speaker are plugged in. The panel used is 7 by 12 inches. The sub-panel 7 by 8 inches. The standard size panel is 7 by 9 inches so this will have to be used for the sub-panel and 1 inch cut off from the long end. Two small brass angles are necessary for mounting the sub-panel onto the main panel.

The air core transformers can be purchased or constructed as desired. They require two pieces of mica or hard rubber tubing as desired, 2½ inches in diameter and 2 inches long, and ¼-pound spool of number 24 ssc. wire is necessary for the windings.

The cabinet should conform to the main panel size and should be slightly over 8 inches deep in order to permit proper clearance for the sub-panel.

The layout of the panel is shown in Figure 2. The location of the two condensers are shown by center line only. The mounting holes can be laid out and drilled according to the apparatus used. This also holds true of the two rheostats, the panel mounting angles, jack and holes used for fastening the panel into the cabinet.

The amplifier rheostat is on the left side under the first condenser, whereas the detector or two element tube rheostat is on the right side under the second condenser. The jack is in the center in line with the two rheostats to make neater appearance.

Sub-panel Layout

The layout of the sub-panel is shown in Figure 3. Here again only center line locations are given since the dimensions of the mounting holes depend entirely upon the parts used. The clearance of the sub-panel

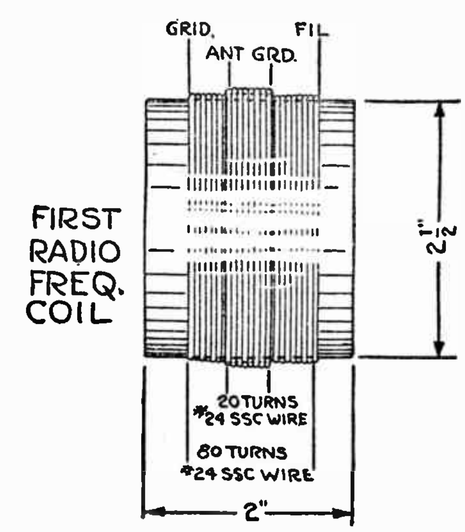


Figure 4

from the two condensers and the coils is sufficient to take care of almost any type of variable condenser. Ample room is provided for the location of the two audio frequency transformers.

Dimensions of standard tube sockets are fairly uni-

(Continued on next page)

(Continued from preceding page)

form so that their location will fit in well regardless of the type used. All binding posts are kept in the rear of the sub-panel and it should be noticed that the arrangement in Figure 3 corresponds to the layout of these binding posts as shown in Figure 1. The socket for the two element tube is located centrally between the two amplifier tubes. All filament terminals on these sockets should face toward the rear and the binding posts so as to shorten all filament leads as much as possible and keep the plate and grid leads close to the Radio and audio frequency transformers located in the front. This will permit shortest possible wiring with minimum amount of interference.

Construction of Radio Frequency Coils

Figure 4 shows the first Radio frequency coil and consists of two windings. The first or lower layer has 80 turns of number 24 ssc. wire, over this a strip of paper is then wound in a single layer. On this paper is wound 20 turns of the same wire running in the same direction which makes up the primary winding. The use of adhesive coatings is not recommended. If possible it is suggested that the primary winding be spaced in order to reduce capacity. This is not absolutely essential.

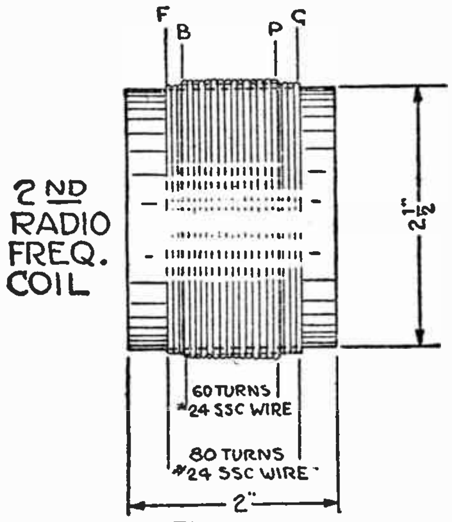


Figure 5

The second coil, which varies slightly from the first, is shown in Figure 5. In this coil the secondary winding again consists of 80 turns as above, but the primary winding has 60 turns. In both coils all windings should run in the same direction.

These coils are mounted on the ends of the condensers. It will be noticed that the first coil is mounted with the core in a horizontal position whereas the second coil has the core in a vertical position. The mountings shown in Figures 4 and 5 conform to the markings shown in Figure 1.

Instructions for Tuning

In tuning this receiver it will be found that the settings of the two condenser dials will be fairly close to one another inasmuch as both secondaries have the same number of turns and are only slightly affected by the inductively coupled primaries. Neither one of the two rheostats has a critical setting. On tuning in, both condensers should be turned together until the approximate relative ratio is determined. The B battery voltage should not be increased inasmuch as little or no gain of volume is anticipated. It can be decreased as desired since often tubes used for Radio frequency amplification require definite potentials in the plate circuit for best results.

How to Erect a Good Aerial

WHAT kind of aerial do you use? This is a highly important question and should be given careful consideration by every Radiophan.

The lead-in, even though it is insulated, still acts as a part of the aerial, and if you happen to live near the ground floor of an apartment house and find that it is necessary to use an extremely long lead-in to reach the aerial on the roof, you might better forget the aerial altogether and simply use the lead-in.

The ground wire also acts as an aerial, or rather counterpoise in this case, and if you have an extremely long one, just try disconnecting it from the cold water pipe and see if you do not get practically the same results.

A single straight wire is the best for all around receiving. There is no question about that, but there are different ways of taking off the lead-in. If you take this from the middle it means that you are really erecting a two wire aerial, one-half the total length of the wire, halving the inductance and doubling the capacity.

It is possible to have the aerial and lead-in all in one length, if you can get a single piece of wire long enough. By running the aerial wire through the eye of the insulator, at the 'near end," it is possible to keep right on with this wire and drop it down to the outside of your window, where an insulated wire will have to be attached. By doing it this way, rather than attaching a separate piece of wire to the aerial, you will save one joint and make things just that much easier, for both yourself and the Radiocasting.

Every joint in both aerial and ground lead should be carefully soldered.

A long aerial, clear of everything, will pick up more energy, but almost any kind of outdoor aerial will bring in nearby signals.

One Tube Weagant Receiving Set

A Fool Proof Regenerative Outfit

THE FOLLOWING is neither an excerpt from the Arabian Nights nor the brilliant discovery of a new-fangled receiver that will bring in signals when none exist. On the contrary it is the account of a simple regenerative set that is almost fool-proof, and which has given uniformly excellent results on arc, spark, phone and amateur waves since it was first published in 1918.

Five years ago, when E. E. Bucher published his book on "Vacuum Tubes in Wireless Communication," he described a circuit devised by Roy A. Weagant, then chief engineer of the Marconi company, which on account of its extreme simplicity was particularly recommended.

Rumor had it that Mr. Weagant had evolved the circuit as a means of circumnavigating the famous Armstrong patent. But while he legally failed to do so, he nevertheless gave to the Radio world a substitute that for simplicity, universality and performance can hardly be "beat."

A glance at Figure 1 will acquaint the Radio enthusiast with the circuit. A little energy will suffice to provide the broadcast or amateur listener with a set of which he can justly be proud.

Parts of the Circuit

Getting down to a description of the parts of the circuit, the primary circuit, composed of L_1 and C_1, is the same as any standard regenerative set. It consists of a 50-turn coil in series with a .001 mfd. variable condenser. The secondary circuit is the typical inductance with capacity in parallel. The inductance value is a 50-turn coil and the condenser in shunt is of the order of .0005 mfd. The tertiary, or tickler circuit as it is commonly known, consists of an inductance of 50 or 75 turns with a .0005 condenser in series, the whole placed in parallel with the plate and filament circuits. Any Armstrong circuit, by the addition of a variable condenser, may be revamped into a Weagant without the slightest hesitation on the score of efficiency.

On account of the great variation in phone wave lengths, the desire of many fans for the arc and spark wave lengths, together with the experimenters who desire going down to 100 meters, a honeycomb coil mounting with three plugs is recommended to give the greatest versatility to this receiver.

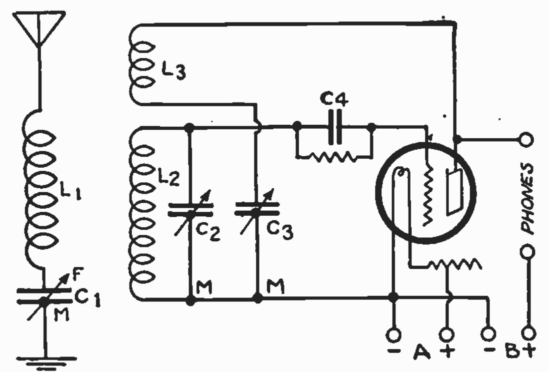


Figure 1

Inductance Values

As a rule in the Weagant circuit the inductance value of L_3 is a trifle greater than that of L_2. For example, if the secondary coil is of 50 turns, then best results will probably be found with a tickler coil of about 75 turns, although many sets have given excellent results with a coil the same size as that of the secondary. The reason, apparently, is on account of the series capacity in the tickler circuit contrasted with the parallel capacity in the secondary.

For Radiocast waves the reader should use a 50-turn coil for the primary, a 50-turn for the secondary and either a 50 or a 75-turn for the tickler. For 100-meter work it is necessary to wind single layer coils of the dimensions given later in this article.

After hooking up your apparatus, as shown in Figure 1, if the set fails to oscillate, reverse the two leads going to the back of the coil mounting on the tickler side so as to reverse the polarity of the winding. Sometimes, with a given value of tickler inductance a set will oscillate on high waves when the tickler is in one direction, and will oscillate on short waves when it is in the opposite direction. It will take only a moment to find the proper direction of winding. Also make sure that the series capacity C_3 is not shorted. This will discharge your B batteries as this circuit is in parallel from the plate to the filament.

Tuning Instructions

Tuning is accomplished by means of the secondary and tickler condenser, the primary, secondary and tickler inductances being set in one position. In the ordinary regenerative sets, regeneration is obtained by altering the inductive relationship of the coils, whereas in the Weagant circuit regeneration is brought about by changing the capacities of the secondary and tickler circuits, a method that is smoother and less troublesome. The tickler coil can as a rule be left close coupled to the secondary and all oscillation and regeneration changes effected by means of the series condenser C_3.

For long waves, take the coils you have been accustomed to using and you will find they work as well as on your old set.

For short waves, 100 to 250 meters, the author uses a 35-turn coil; a secondary of 17 turns of number 23 dcc., wound on a 2½-inch coil fitted with honeycomb plug, and a tickler of 25 turns wound on a 2¼-inch tube (same size of wire). The tickler is placed inside

List of Parts

LIST OF PARTS

3 Variable condensers .0005 mfd.	@ 5.50	$16.50
1 Triple coil mounting		5.00
2 Honeycomb coils of 50 turns	@ 1.60	3.20
1 Honeycomb coil of 75 turns		1.70
1 Tube socket		1.00
1 Rheostat, 6 ohms		1.00
1 Grid leak with .00025 mfd. condenser		1.75
1 Panel 7x14		1.75
1 Cabinet		3.00
Binding posts, bus bar, screws, etc.		1.00
Total cost		$36.10

the secondary, and its relationship fixed and forgotten. The same precaution of getting the proper polarity on the tickler coil should be observed. A honeycomb plug with about 6 inches of wire can connect from the tickler receptacle on the coil mounting. The panel layout is shown in Figure 2.

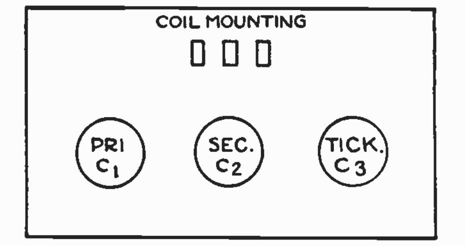


Figure 2

In shifting from 100 meters to higher waves, simply pull out your two homemade coils and plug in the larger-sized coils.

As to the types of tubes, with the Navy VT-1 and 2, or almost any oxide coated filament tube, the grid leak will not be extraordinarily critical, and the set will oscillate with almost any B battery potential, giving good signals; with the gas content tube, such as the UV-200, the grid leak is a bit more critical and should be of a variable type. The UV-200, on account of its great sensitivity, gives the most volume on phone wave lengths, while for continuous wave work the Navy tubes (J's) are fine.

Unlike the Reinartz (a single circuit Weagant, after all) the Weagant is not an excessive radiator. The coupling between the primary and secondary prevents this to a marked degree. Selectivity gained with a Weagant receiver cannot be approached by any other receiver, even the three-circuit Armstrong, so far as the writer has been able to ascertain.

Another advantage of the Weagant over the Armstrong is the fact that the telephone cords (in the case of a single tube set) are not directly in the oscillating circuit and therefore will not be productive of body capacity.

It would be well for the Radio enthusiast, regardless of the type of circuit which he intends using, to arrange all his connections on the variable condensers so there will be no potential in the shafts. This also obviates body capacity. In Figure 1 the condensers show a marking of M for movable plate which should go to low potential part, while the marking F should go to point of high potential.

Summing up the Weagant, the outstanding advantages it possesses are: selectivity, universality, simplicity of control and lack of body capacity. Despite the abundance of trick circuits with which the Radio fraternity has been deluged in the past two years, it is refreshing to contemplate the Weagant as peer of them all, despite its five years age. Radiocast listeners and amateur operators, who have used the Weagant after trying all others, are in accord with the opinion ventured above.

Keep Lead-in Free from Metal

Even though the lead-in wire is insulated, never let it touch against any metal. This means the cornice around the edge of the roof, the metal window screens or weather strip, or any other metal. In spite of the insulation, there will be leakage here, and trouble will surely result. Leakage will be greater during storms or damp weather and considerable difficulty may be encountered tuning in. It usually manifests itself by constant whistling and inability to clear up a station altogether.

Amplification

A vacuum tube regenerative set, using only one tube, will bring in signals from nearly the same distance as a set having an audio frequency amplifier. The amplifier only serves to increase the strength of signals brought in by the detector tube, for the purpose of operating a loud speaker or making the signals louder in the phones.

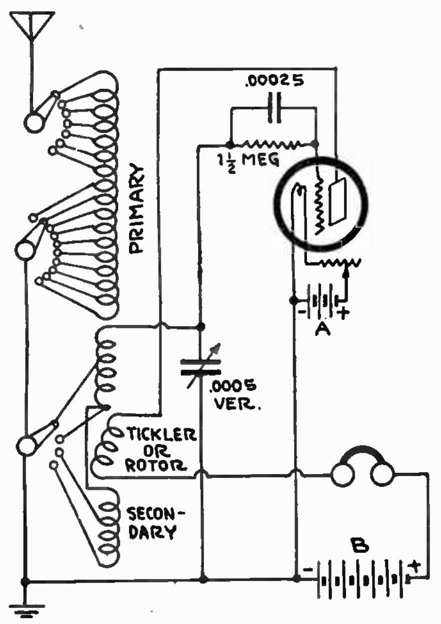
Any six-volt automobile storage battery can be used for an A battery.

Unusually Selective Three Tube Set

Entire Tuner Wound in One Unit

In the endeavor to find the best hook-up we forget some things that are facts about Radio. There are very few known circuits, and many hook-ups are really one or the other of the well-known circuits differently arranged. If we would give the hook-ups a little careful study before plunging into them, we perhaps would know much about them from the circuit they originated from and know what to expect. Almost all circuits in use at present are based on the three fundamental principles for regeneration, Radio frequency and super-heterodyne. At present one of the popular circuits is tuned Radio frequency.

In keeping abreast of the advance of Radio we are forgetting the proved reliable regenerative circuit that in itself possesses Radio frequency and regeneration and has fewer controls to operate as well as parts in the construction. The writer is a neutrodyne and heterodyne fan, but from the view point of the advantages mentioned, a regenerative circuit with a special tuner is described herein that has tapped secondary as a special means of increasing the signal

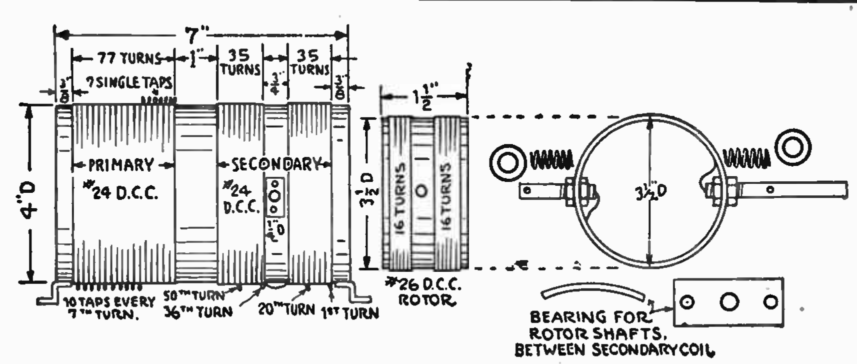


strength and selectivity, and a tickler coil in the plate circuit inductively related to the secondary. Much has been said about doing away with taps and tuning with a condenser. This is all right for a limited wave length, but for extreme variations of wave lengths considerable signal strength as well as selectivity is sacrificed; therefore we will still use taps to balance the inductance. The regenerative circuit, with the tuner herein described, is equal to any two-stage Radio frequency receiver that I have tried for both selectivity and range. It brings in KHJ of Los Angeles on the loud speaker; so, let your own judgment be your guide. The absence of the additional tubes and transformers for Radio frequency and the less number of controls are the appealing features, and for those desiring to construct such a tuner and receiver the hook-up is herewith given with a description of the tuner.

Construction of Coils

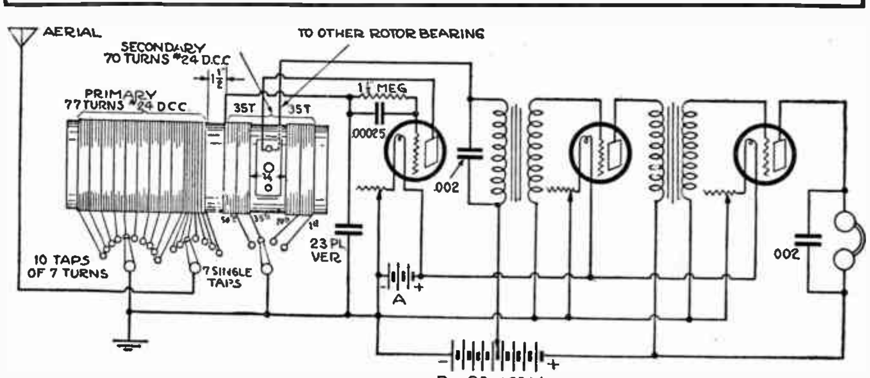
Obtain a 4-inch diameter tube, 7 inches long, of bakelite or formica and wind both primary and secondary on it, using number 24 dcc. wire. Wind the secondary first by starting ⅜-inch from one end of the tube. This allows space for bolting a base or support for the tuner. Tap this first turn for a lead to the switch. Wind 20 turns and take off another tap, then 15 more turns and leave a ¾-inch space on the tube, and start winding in the same direction. Take off another tap at the beginning of the winding, then wind 15 more turns and take off another tap; then continue and wind 20 more turns, completing the secondary, which now has 70 turns of wire, or 35 turns on each side of the ¾-inch space, and is tapped at the first 20th, 36th, 50th and 70th turns.

HOW TO WIND AND ASSEMBLE COILS



In leaving space on a tube it is advisable to cut the wire, pass it through a small hole in the tube and solder it on the inside where it crosses the space to the beginning or continuing of the winding. Next, start winding the primary spaced one inch from the secondary just completed. Wind 7 turns, tapping each turn, then wind 70 more turns, tapping each seventh turn. Drill a ¾-inch hole through the tube in the center of the ¾-inch space between the secondary windings and bolt a thin plate over each hole. The plate is to be drilled for the rotor shaft. Drill a ¼-inch hole through the exact center of a pice of tube that is 3½ inches in diameter and 1½ inches long. Wind 16 turns of number 26 dcc. wire on each side of the holes (connected across the space), beginning as close to the outside edge as possible. You will have 32 turns on the rotor. This rotor is placed inside of the tube where it revolves. For shafts use ¼-inch brass rod or tubing, one short piece and one long for the dial. Thread these shafts on one end pass them through the plates on the outside of the 4-inch tube and lock into the rotor with two nuts and washers. Drill a small hole in each rotor shaft for a retaining pin and use a washer and compression coil spring between these pins and the bearing plates on the tube. Solder the outside or end wires of the rotor on the shafts. This may look like a big job, but if description is followed it will not take long to finish it and you will find it worth while. A better tuner cannot be made. The controls should all have vernier adjustments.

HOOK-UP IN WHICH COIL IS USED



Addition of Audio Frequency

The audio frequency for this circuit is standard. It can be made in a separate cabinet. Those who have built the tuner and hooked up with a detector tube alone want to know how to add amplification. The diagram herewith gives details of the tuner and how to place it in the circuit with two stages of audio frequency amplification. A UV-200 tube is used for the detector and UV-201A's for the amplifier. There is no question but what the small dry cell tubes can be used with equal success.

Radiophans building their own sets desire a more selective tuner and the one illustrated comes pretty near to being perfection in that respect. While this tuner works especially well in the circuit shown, it can also be used as a standard variocoupler by using the secondary windings as a primary and the rotor as a secondary, or it may be used as an inductive variometer tuner similar to the Paragon circuit. The author is using one in a super-heterodyne with regeneration, and will say that it is so selective and the tuning so sharp that stations are difficult to find.

In making the tuner, the primary and secondary windings are all wound in the same direction. A formica or bakelite tube is preferable for both stator and rotor windings. If you cannot obtain tubes of either of these materials and must use a cardboard tube, handle it very carefully so that it will not get out of shape. Coat it with collodion or paraffin before winding on the wire. This keeps the moisture out. The windings may be coated also with the same material, but this is not necessary. Never use shellac.

The rotor tube must be as large in diameter as possible, provided it will rotate inside the rotor windings and is the secret to Radio frequency with this tuner.

The rotor end of the tube should be toward the detector tube in order to have short leads. The wires for the plate of the detector tube and the first transformer, or phones, are fastened to the plates or rotor shaft bearings between the secondary windings on the outside of the 4-inch tube. The taps on the primary and secondary are taken off the top, bottom or side of the coil where it will be most convenient in the make-up of the set. Follow the diagram closely and you will be surprised at its action. There is nothing secret or extraordinary about this tuner; correct design is behind its success.

List of Parts

1	Variable condenser .0005 mfd. vernier	$ 6.00
1	Rheostat	1.00
1	Tube socket	1.00
	Material for winding coils	2.75
1	Grid leak 1½ megohms with .00025 mfd. condenser	1.75
1	Panel 7 x 12	1.50
1	Cabinet	2.75
3	Switches and points @ 75c	2.25
	Binding posts, bus bar, screws, etc.	1.00
	Total cost	**$20.00**

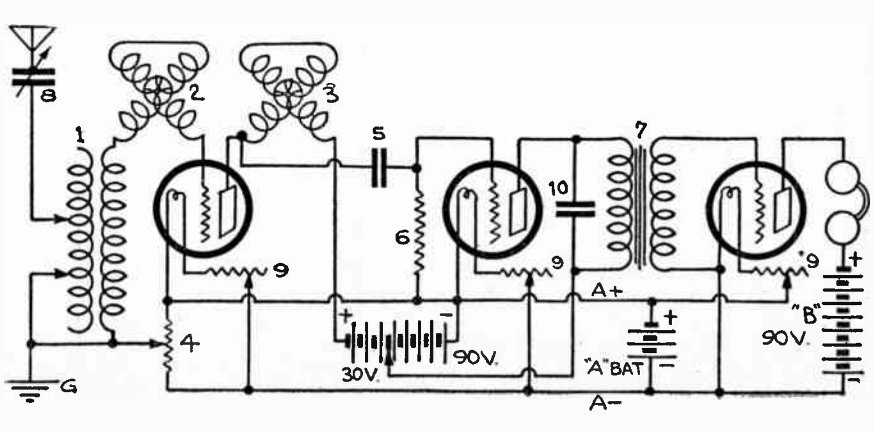
Changing 3-Circuit to R. F. Amplifier

I wish to mention for the benefit of those who build this set that all connections must be soldered, aerial well insulated and the instruments set well apart, especially variometers. Also keep the grid and plate circuits separated well or at right angles if it is necessary to wire closely. I contribute the good volume to a well insulated aerial and lead-in, and, last but not least, an excellent ground. The ground is made to a water pipe and an 8-foot pipe driven into the ground in a damp place in the soil, with all wires soldered.

The best working condition was found with 30 or 31 volts on the detector plate. I might say that one set would not work well with .00025 grid condenser but found that .000025 was the proper capacity. The grid leak can be set at the proper point and allowed to remain at that setting.

In regard to tuning, I wish to say that with a little experience both variometers and the rotor of the coupler can be left at the best receiving point and most of the tuning done with the primary condenser, potentiometer and Radio frequency tube vernier rheostat.

Another stage of audio frequency can be added in the usual way by inserting a two circuit jack in place of the head receivers with the two center leads connected to primary of the next transformer.



List of Parts

1	Variable condenser .0005 mfd. plain	$ 4.50
1	Variocoupler	5.00
2	Variometers @ $4.00	8.00
3	Tube sockets @ $1.00	3.00
3	Rheostats @ $1.00	3.00
1	400-ohm potentiometer	1.75
1	Variable grid leak with .000025 condenser	2.00
1	Fixed mica condenser .002	.50
1	Audio frequency transformer, 4-1	4.50
1	Panel 7 x 18	2.25
1	Cabinet	3.50
	Binding posts, bus bar, etc.	1.00
	Total cost	**$39.00**

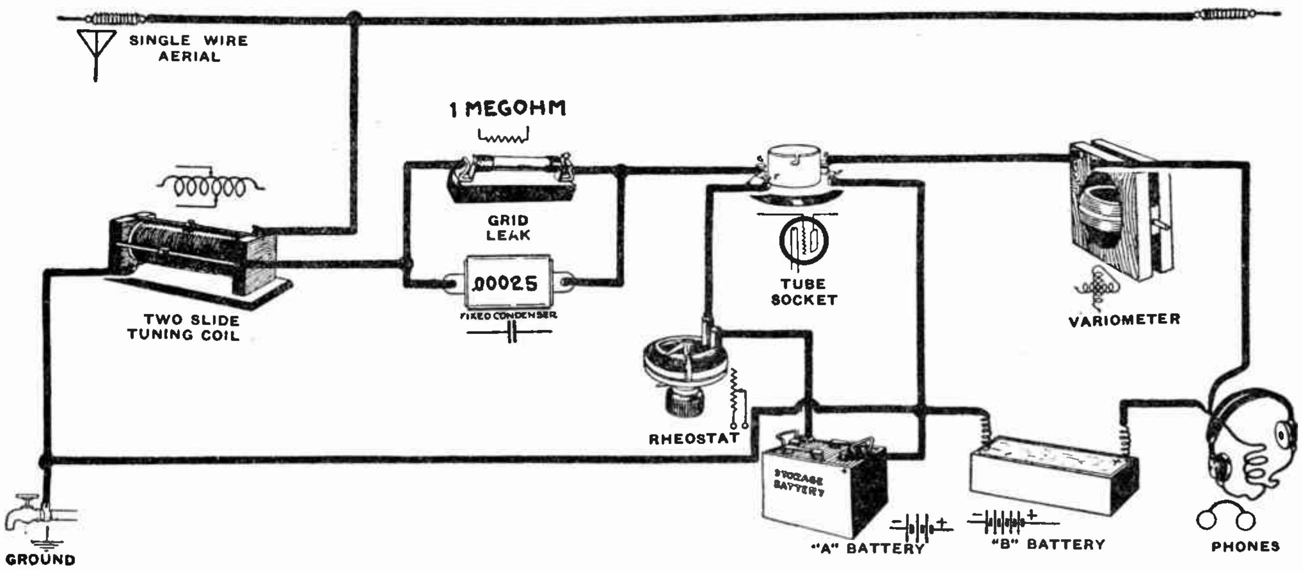
Simplex Hook-Up With a Two Slide Tuner

BACK in the early days of amateur Radio, before federal laws regulating the art, before vacuum tubes and Radiocasting, the two slide tuning coil was the accepted form of tuner. Variable condensers of the multiple plate type had not even been invented. The two or three-slide tuning coil was connected to an antenna of from four to eight wires, a ground, a carborundum crystal and a pair of phones and the very best form of known receiver was the result. The tuning coil has given place to the variometer and the variable condenser in popularity, but for economy and simplicity, with a fairly high percentage of efficiency when well made, it is unequalled.

List of Parts

1 Two slide tuning coil	$2.00
1 Variometer	4.00
1 Tube socket	1.00
1 Rheostat, 6 ohms	1.00
1 Grid leak of 1 meg. with .00025 mica condenser	1.25
1 Panel 7x10	1.25
1 Cabinet	2.50
Binding posts, crews, bus bar, etc.	1.00
	$14.00

Here's a real simple Simplex hook-up with which the beginner can, at low cost, get better acquainted with regeneration and the fine art of tuning. Just a two-slide tuning coil and a variometer with the usual accessories for a detector tube; that is, a 1-megohm grid leak, a .00025 mfd. grid condenser, socket, rheostat, battery and phones, make up your outfit. An 80-foot single wire aerial, a good ground connection to the water pipe or well, and you're all set to listen in with good results. No pretense is made for long distance work and the builder should not expect to get everything from 2LO, London, to KPO, 'Frisco, the first night. The selectivity, if the tuner is well made, will be found to be most satisfactory.



Crystal and Tube Set

There is a decided tendency on the part of economical fans to arrange an efficient galena detector circuit in such a way that by throwing a single switch the receiving set may be changed from the tube to the crystal detector circuit. For reaching out after distant stations the tube is unexcelled, but for programs Radiocast from a nearby station, a good crystal brings in the entertainments loud enough to enjoy them. In the meantime, the tubes are not drawing on the battery.

If you have some wire from an old coil of some sort and want to make a tuning coil, but think the wire is too small for this work as it will have too much resistance, two wires may be used if the coil is wound neatly. By winding one wire on one layer and the other on the next, and tapping in on exactly the same lengths of wire, excellent results can be obtained.

Regeneration Control by Absorption

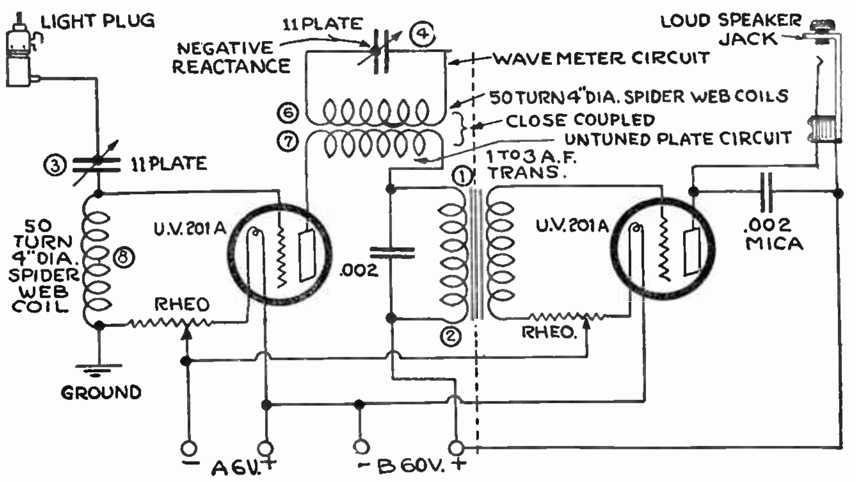
A SIMPLE one or two-tube circuit which will operate a loud speaker with good volume is shown in the illustration.

An untuned plate circuit is used, employing a hard tube, such as UV-201A, and amplification is obtained in a wavemeter circuit employing the principle of negative reactance.

The diagram shows the circuit with a one-step audio amplifier added in place of phones at terminals 1 and 2. The set is easy to wire and inexpensive. It uses three 50-turn spider coils, 4 inches in diameter and wound with number 24 ssc. wire, and two 11-plate condensers. No grid leak condenser is required. The set operates well on an indoor lighting socket plug, with input to loud speaker of Magnavox type. The aerial condenser and coil should be located at least 12 inches away from the wavemeter circuit, as coupling between these two parts of the circuit is detrimental. The two other spider coils are coupled closely. In use, 60-volt plate current is employed, and tuning is accomplished with antenna condenser 3 as usual, leaving condenser 4 of the wavemeter circuit at zero or other quiet position. The wavemeter circuit condenser, 4, is then turned up slowly until maximum amplification without squeal is obtained. It is also possible to use both dials for very sharp tuning to avoid local Radiocasting. This is an economical set to build and operate, where loud speaker results are desired. The circuit is protected by patent rights and is distinguished from others in principle and performance.

List of Parts

2 Variable condensers .00025 mfd. vernier @ $4.00	$ 8.00
Material for spider webs	1.50
1 Audio frequency transformer 3 or 4 to 1	4.50
2 Fixed mica condensers, .002 mfd. @ 40c	.80
1 Phone jack open circuit type	.70
2 Tube sockets @ $1.00	2.00
2 Rheostats 25 ohms @ $1.00	2.00
1 Panel 7 x 14	1.75
1 Cabinet	3.00
Binding posts, screws, bus bar, etc.	1.00
Total cost	$25.25



One Tube Reflex

Reflex circuits offer the true experimenter, the man who does not mind a change or two—an adjustment here and there—after the set is finished, a wonderful field. The circuit shown here is but a "single-tuber," but it is the proper set to begin with when one begins doubling-up on tubes and is, in addition, a remarkable set for both volume and distance. Some will balk at the crystal detector, but it should be remembered that, with a step of Radio frequency amplification in front of it, the limited range of a crystal alone no longer exists.

List of Parts

1 Variable condenser .0005 mfd. vernier	$4.50
1 Two-circuit jack	1.00
1 400-ohm potentiometer	2.00
1 Rheostat, 25-ohm	1.00
Materials for Radio frequency transformer	1.50
1 Audio frequency transformer	5.00
2 Fixed mica condensers, .0025 mfd.	1.00
1 Fixed mica condenser, .001 mfd.	.40
1 Crystal detector	1.25
Materials for fixed coupler	1.00
1 Panel 7x12	1.60
1 Cabinet	2.75
Binding posts, bus bar, etc.	1.00
	$24.00

For those who wish to construct their own Radio frequency transformers, the data is as follows: The core is detailed in the illustration, in one slot 175 turns of number 36 sc. or enameled wire is wound to form the primary, and the same amount of wire in the other slot forms the secondary. The wire from a Ford spark coil may be used for this purpose.

The audio frequency transformer is of no special type, but higher ratios than five to one are not recommended. The tuning unit consists of a fixed coupler with an 8-turn primary and 48-turn secondary, number 22 or 20 dcc. wire wound on a four-inch tube. Fixed couplers which closely approximate these figures are readily obtainable on the market. The plate voltage should be varied between 45 and 90 volts until best results are secured. That a loop antenna may be plugged in when desired, a four-spring jack is added to the secondary circuit.

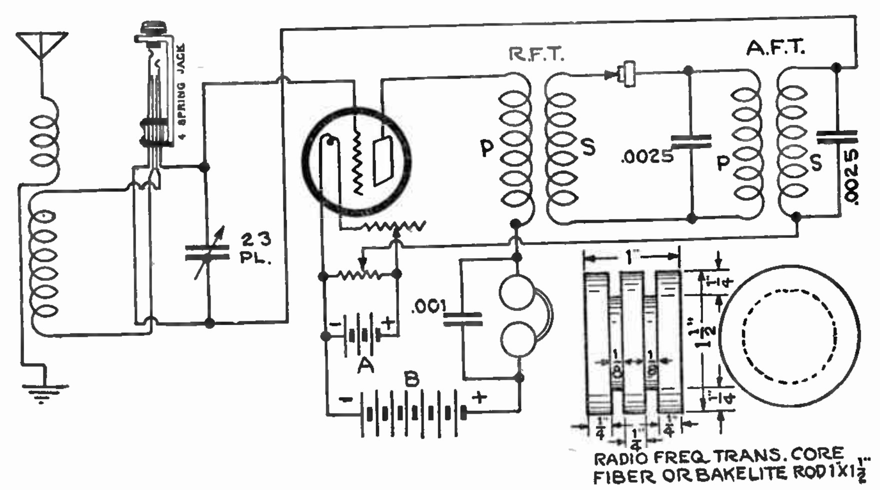
In laying out the set, it would be a good idea to lay the parts out on the panel according to the following suggestions before drilling to be sure that no parts touch when mounted. Place the variable condenser near the left hand edge near the bottom and the potentiometer at the right with its shaft on line with the condenser.

Panel Hole Filler

Good hole filler for black panels may be made in the following manner: Melt some sealing wax compound and mix tar or liquid shoe blacking with it until you have obtained the desired blackness.

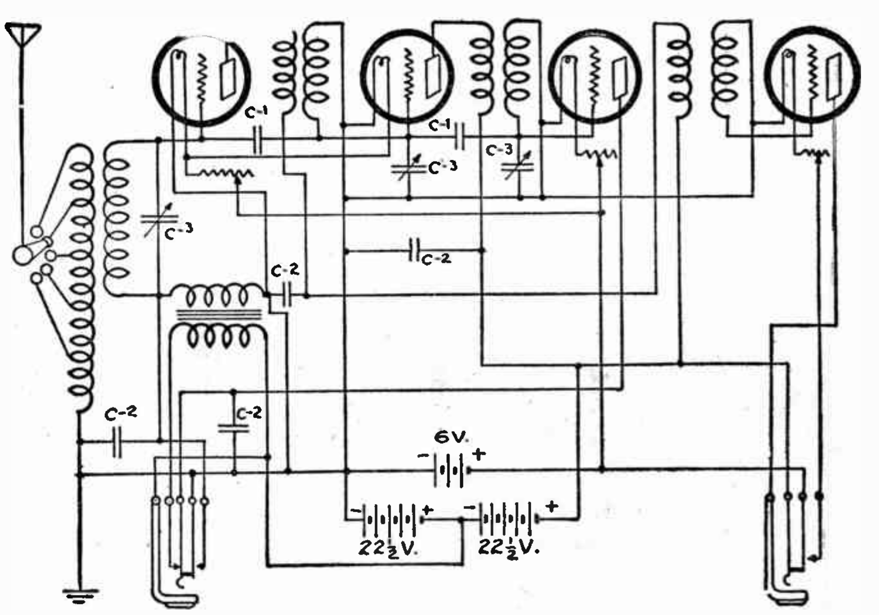
Place a piece of metal over the hole on the front side of the panel and pour the compound in the hole from the back with a spoon. Keep the metal in place until the compound becomes hard, which will only take a few minutes.

Shield the back of the panel with a thin sheet of tinfoil or metal, soldering a connection with it to the ground. Every joint in the wiring should be soldered. Make sure that the switch points and arms are not loose. Much unnecessary noise may be eliminated in this manner. Radio sets may sometimes be kept from howling by placing the plate and grid leak wires as far apart as possible. It is also advisable to plan the wiring so as to be sure that the smallest amount of wire is used in connecting the parts.



Theory and Operation of Neutrodyne Circuits

Their Advantages and Difficulties



THE latest development in Radio is the popular craze for new circuits. The rankest amateur plays with the apparatus, hooks it up in a slightly different way, hears a station and promptly advertises that he is the inventor of a new circuit. The Radio publications, hard pressed by a clamoring rank of fans for new stuff, promptly fall and announce that they are going to feature another new wonder circuit.

The question of the practicability of these new circuits can only be decided through an actual set-up of the apparatus and a test of operation. Considering the number of these new wonder circuits, the reader can readily conceive the fact that it is not an inexpensive proposition. In doing this, though, the real worth of the circuit is soon disclosed. The simplicity or difficulty of the hook-up becomes apparent.

There are many circuits that are unusually good and efficient, but perhaps are much too complicated for the average fan to construct; then, too, they are difficult to operate. Sometimes the difficulty may not necessarily be one of construction but rather a question of theoretical balance of the circuits. This last factor is one that the greatest percentage of fans will find it extremely difficult to overcome.

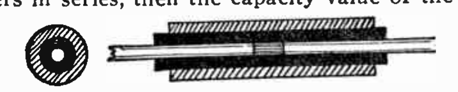
One of the circuits that is affected by this last factor is the Hazeltine Neutrodyne. The word "circuits" is used but actually it is a misnomer. The Hazeltine Neutrodyne is not a circuit but rather a method of overcoming, through neutralization, the coupling between the grid and plate circuits of any Radio frequency amplifying tube.

Theory of Neutralization

Every amateur knows that the internal capacity, due to the condenser action between turns in the windings of any tuning unit, should be kept as low as possible. Because of this, the peculiar method of winding honeycomb coils was developed and in like manner lattice and spider web coils were placed on the market. This same condition holds true of transformers and even in vacuum tubes, between the three elements, because of the dielectric value of the vacuum in the bulb. Even the wiring of the set creates capacity reactions if closely spaced. The actual microfarad value of this capacity effect may be small, but the ultimate effect on the operative efficiency of a receiving circuit is very important.

Professor Hazeltine discovered a method of fighting fire with fire—namely, of applying an external capacity to the circuit from tube to tube which offsets or neutralizes the tube's internal capacity coupling. The values of these neutralizing capacities are so small that they are expressed in units of micro-microfarads. And one million micro-microfarads make one microfarad. Expressed in microfarads the value of the neutralizing capacity runs from .000001 to .00001 microfarad.

The best method of obtaining such low capacity values is by connecting two or more very small condensers in series, then the capacity value of the series



becomes— (according to a well known formula)

$$C=\frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}}$$ (depending on the number in series)

Because of the low value necessary the adjustment becomes exceptionally difficult unless the proper equipment, methods and facilities are available.

The method used in manufacturing the Neutrodyne condensers is illustrated in the small insert. There is a small composition or glass tubing of good dielectric value into which there is inserted a piece of copper wire at each end; the thickness will be about Number 8 gauge. Over the tube is slipped a copper sleeve. There is then a condenser capacity between the tube and the wire at each end, but since the wires are not touching or connected, the whole is equivalent to two condensers in series. By pushing the wires in or pulling them farther out, a very minute control of a low capacity value is obtained. After the proper value has been reached the wires are held in position and the whole unit sealed. In other words, a permanent variable is not necessary.

A Neutrodyne Hook-Up

In the hook-up is given a circuit in which the neutrodyne system has been incorporated. The two condensers marked C-1 are the neutrodons, the adjustment of which will be detailed later. The circuit consists of two stages of Radio frequency amplification, tube detector and two stages of audio frequency amplification, one of which is reflexed to the first Radio frequency tube. The second stage of audio uses a separate tube, making four tubes in all.

Condensers C-2 should have a capacity of .001 to .002 mfd. Condensers C-3 are variable, with a capacity of .0005 mfd. One rheostat is used for the two Radio frequency tubes, one for the detector and one for the separate audio frequency tube. Depending on the type of tubes used, the plate voltage may require changing.

Adjusting the Neutralizing Capacity

The set is completely set up and tuned in for reception. In adjusting the first neutralizing condenser the wire to the filament terminal of the socket of the second tube is disconnected. This shuts out the filament current of that tube without removing it from the socket. There will still be sufficient capacity coupling to pass signals through and reception will be heard in the headphones. The first condenser is then adjusted until this reception of the signals is completely shut off. In this way the capacity coupling has been completely neutralized. The filament wire is connected and the same way is followed for the second condenser and the third tube. After the adjustments are completed these condensers are sealed and should not be further adjusted; but any alteration in the coupling apparatus nullifies the action of the neutralizing condensers. The internal capacity of vacuum tubes of the same type does not vary to any great extent and does not necessarily require new adjustment of the neutrodyne when a tube is changed. A change in the type of tube will, however.

Three Tube Neutrodyne

MANY fans felt that the five-tube neutrodyne was too large a proposition to start in with, or they possessed an audio frequency amplifier unit which could be used with any detector outfit and therefore did not require the additional audio frequency stages. To meet the requirements of these fans and also to illustrate the use of the compensating condenser method of neutralization, the three-tube circuit shown in the illustration is presented.

The standard neutroformer is used in the initial tuning unit, but is hooked up in a manner slightly varying from the usual procedure. The primary winding of the air core transformer, the .0005 variable condenser and the secondary winding are all connected in series as shown. In this way all of them make up the primary circuit which is tuned by the variable condenser between the windings, while the secondary consists merely of the secondary winding of the transformer or neutroformer with its .00035 condenser shunted across it. This method of hooking up the tuning unit was found slightly more efficient than the old method.

The neutroformers consist of the standard neutrodyne air core transformers with the single tap secondary used in conjunction with the regular .00035 condenser. The special compensating condenser consists of the two separate fixed plates and one rotating plate. A 400-ohm potentiometer is used for the grid potential control on the first tube, and a variable grid leak is used for proper adjustment of the grid of the detector tube. If desired, audio frequency amplification can be added as in standard practice. About 22½ volts are required on the plate circuit of the detector tube if the UV-200 or C-300 type are used; with A tubes about 45 volts are necessary. The amplifier plate voltage should be about 90. Only two rheostats are necessary, one for the two audio frequency tubes and one for the detector stage.

"Open" circuits (incomplete connections) may be due to broken wires, wrong connections, or poor contacts. "Short" circuits (where an undesired path for the current is provided in addition to the desired one) may be due to touching of bare connecting wires, wrong connections, touching condenser plates or some metallic object having fallen among the wiring.

How to Take Care of the Radio A Battery

See that the connections are clean and tight and scrape off the wire or terminal connections going out of the battery so that they are bright and will form a good contact.

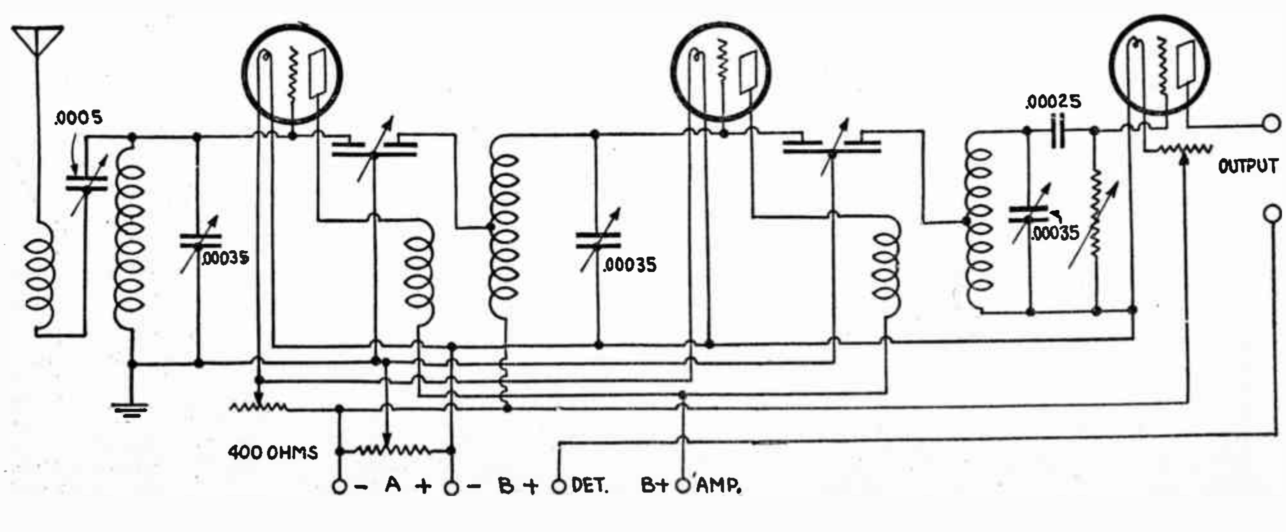
See that there is no acid or water spilled upon the top of the battery which would cause voltage leakage between the cells. Keep the top of the battery dry.

Keep the plates covered with water at all times. The solution should come at least ¼ inch over the top of the plates. Use only distilled water.

Do not permit the battery to stand completely discharged for any length of time. It should be recharged when hydrometer reading shows under 1,200. When full charged hydrometer reading is between 1,280 and 1,300.

In using the hydrometer, see that the float does not cling to the side of the glass tube. When taking reading also see that the rubber bulb is fully expanded and not indented, as otherwise suction would permit incorrect reading.

Remember that all new batteries are somewhat like a new automobile. They do not reach their full efficiency until they have been in service for a little while. A new battery will therefore, not give as long service on a single charge as it will after it has been recharged a few times.



Get Advice Before Purchasing

Anyone having little technical knowledge on the subject of Radio should take some experienced friend's advice before buying any piece of apparatus. If this is not possible, he should purchase articles made by companies having a recognized standing in the field and whose engineers are capable of giving the best in design.

Where There Is Smoke

When insulators on outdoor aerial systems in localities where there is much smoke become coated with soot, which often happens, there is loss of energy by leakage on the surface of the insulators, requiring the renewal of the defective insulators. This condition is particularly annoying during wet weather when the soot absorbs moisture.

How to Make Five Tube "Traveler"

Simple but Efficient R.F. Set

The list prices of the apparatus used are given below. You will find these reasonable considering the tone quality and the results you will obtain

IN DESIGNING this receiver the writer has not attempted to accomplish anything revolutionary nor to present civilization with anything that will "upset all our ideas of Radio communication." Rather, this receiver is presented as an easily constructed combination of sound Radio design, attractive appearance and some of the refinements in parts construction that have made their appearance in recent months. There are five tube receivers on the market that can be purchased at a price below the total cost of the parts for Traveler, but in from two to a dozen particulars, such a set will be lacking when compared with this set.

Considering now the refinements which, when all is considered, are really what distinguish this receiver from others. In any part of the country where one is within 20 to 25 miles of a superstation or 10 to 12 miles of a standard class B broadcaster, the ordinary type of coil will pick up signals, and the possibility of entirely eliminating that station at will, is out of the question. Whether the coils are wound on solid tubes or are self supporting, whether they are set at the magical angle of 57 degrees or are vertical, does not matter. This seems to have been pretty well proven in Chicago, which is one of the finest testing grounds in the world. One of the summer's developments is the doughnut type of coil, also known as the toroid. The writer does not say that it will not pick up signals—it probably will to a slight extent—but it does this to a lesser degree than any other type of commercially practical inductance. The Thorola doughnut coils used are an excellent example of this type of inductance and the method of keeping down distributed capacity by crimping the wire, is especially to be noted. They can be placed in practically any relation to each other and, used with good condensers, give sharp tuning.

It was but natural that straight line frequency condensers be used. The department of commerce allocates the stations into wave channels on the frequency basis, all channels being an equal distance apart in kilocycles. If we want our channels, and therefore the stations, to come in at regular intervals on the dials, what is more natural than to use a condenser which will tune a coil so that the dial readings, when plotted, will give a straight line. There are those who will claim that coil and condenser should be designed to work together if the plotted line is to be absolutely straight and the stations exactly spaced around the dial. That is true and the curve resulting from the use of Thorola coils and Karas condensers is not absolutely straight, but—it is very close to it. Karas condensers were chosen because it is evident that much care went into their design, and precision care seems to be used in manufacture.

Many readers are going to get a shock at seeing vernier dials on a tuned radio frequency set. This is not general practice, of course, but the writer's experience with a really selective five tube job, properly and efficiently operated, indicates that such dials are most desirable. You can get squarely on the peak of a sharply tuned DX station which increases the volume surprisingly and helps to break through locals. Dialogs are chosen because they are just as smooth to operate as any other, show no backlash and have little to get out of order. Their price is also a very pleasant surprise.

Walbert sockets have two distinct advantages to recommend them. The springs in the bottom are integral with the terminals and provide both bottom-of-pin contact and side wiping. There is a metal ring around the tops of the cylindrical wall to prevent breaking the top edge when inserting or removing a tube. Certain engineers might criticize the construction, but that is true of any socket. These sockets have their good points, as mentioned, which is also true of any others.

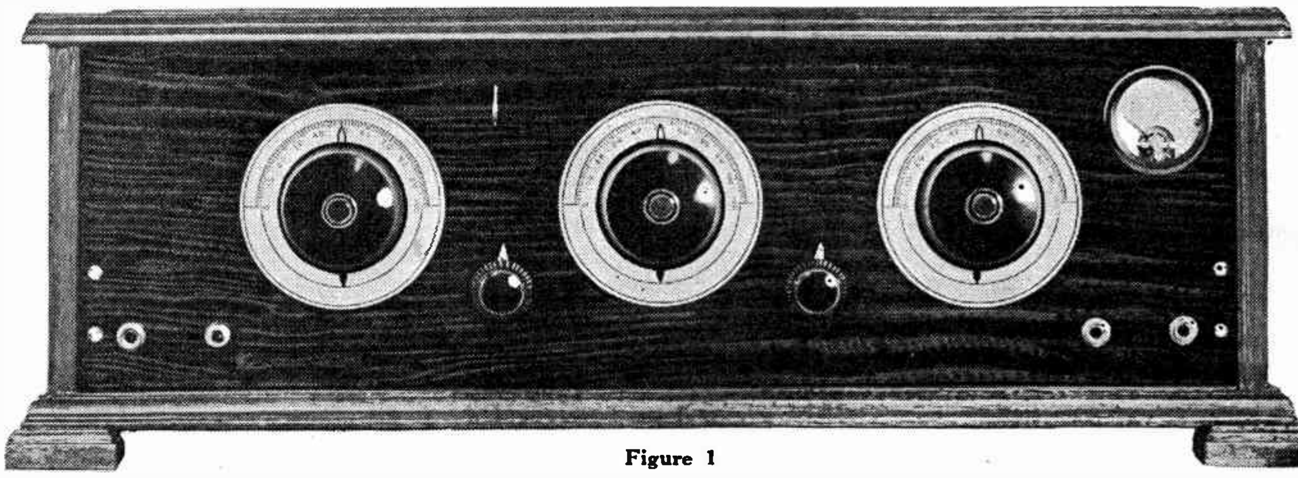


Figure 1

The audio frequency transformers were chosen largely on past performance in other sets and the fact that Thordarson transformers are the choice of many leading set manufacturers. The ratio between primary and secondary turns is a good one for two stages in a set of this kind where the input and output energy of the detector will be comparatively high.

Cutler-Hammer rheostats are favored by the writer for a set to be constructed at home because the fan does not have to dismantle them to mount them on the panel. All spring tensions are adjusted by the builders before shipment and there is not much chance of the home builder upsetting these when putting C-H rheostats in place. The one hole mounting also appeals, as it eliminates the chance of not getting three holes correctly drilled. The Frost Pantab jacks have long had an enviable reputation for consistently reliable operation and the spaced soldering tabs are easy to get at. While their advantage of providing a bracket for sub panels has not been utilized in this receiver, it is a most convenient feature when designing sets where space does not permit the use of brackets.

There is no peer to the Bradleyleak for quiet, smooth variation of resistance in the biasing of the detector grid, and tuned radio frequency circuits certainly require a unit of this kind for very best results. Once the rheostat on the radio frequency tubes has been set, it will surprise many to note the difference in range and volume possible by adjustment of the grid leak. A condenser is made by Allen-Bradley for this unit which just fits across the terminals and this is specified in the list of parts. The switch used is also made by Allen-Bradley and provides a sharp, clean break of the circuit and compactness. There is little mechanism and nothing to get out of order.

Not much can be said about the Amperites except that they do what is required of them and do it well. On tubes used as audio frequency amplifiers, which are not critical, they enable one to get rid of another control on the panel and keep the applied voltage at about 5; this will vary slightly, depending on the charge in the battery, but is close enough. Erla fixed condensers are the writer's choice because their construction would seem to keep the capacity close to rating.

Meter Is Desirable

If you've ever sat gazing at a receiver that refused to "get out of town" and wondered whether the tubes were getting enough filament voltage, you can appreciate that voltmeter. The Jewell meter specified is, at the same time, both accurate and compact, which is an unusual combination in meters suitable for panel mounting on receivers. You do not keep it connected all the time, but, by means of a flexible lead, clip the negative terminal to either of the points designated as X1 and X2 to learn if the first three tubes are getting a potential of 5 volts or better. If they are, it can be taken for granted that the last two are, through the Amperites.

If you have not as yet tried Walnart's binding posts, you have yet to see the cleverest bit of mechanical designing yet applied to this item in set construction.

As to the panels there is not much choice between the various bakelite types put out, but Formica has been chosen for a long time by the writer on the assumption that if many of our leading manufacturers of sets use it, it must run consistently good. It can be had in black mahogany or walnut to suit the fancy of the individual builder.

In one set, therefore, you can now have doughnut coils, straight line frequency condensers, vernier dials, exact knowledge of tube voltage and filament control on the last tube. When the speaker or phone plug is in the first jack, only four tubes are lighted and drawing current; if it is then moved to the second jack, the last tube automatically is lighted and comes into use. Drilling dimensions for front panel and base panel will be exact for the parts specified, and, if directions are followed precisely, the finished set will work extraordinarily well.

As to performance, Traveler will do what any other well designed, carefully built outfit will do, but for all around efficiency it surpasses others which the writer has seen. It is doubtful if it could be placed within a couple of blocks of a 1,000-watt station and still bring in DX on wave lengths but 10 or 15 meters away. It will, however, cut through in any but the most extremely congested locality, it has a splendid range and the tone is all that anyone could ask.

If the parts are all at hand we are now ready to drill the front and sub base panels and mount the various pieces of apparatus on them. The reader has two alternatives at this stage of construction; the directions and diagrams given below can be followed to lay out three full size drilling templates, or, he can write in to Department 5, Radio Digest, 510 N. Dearborn street, Chicago, Ill., and enclose 25c for full size blue print

LIST OF PARTS

1 Kit of 3 Thorola Coils	Reichmann Co., Chicago	$12.00
3 Karas .0005 mfd. Condensers	Karas Electric Co., Chicago	21.00
3 Dialog Vernier Dials	Walnart Electric Mfg. Co., Chicago	3.75
2 Pantab Jacks, No. 231	Herbert H. Frost, Inc., Chicago	1.80
1 Pantab Jack, No. 235	Herbert H. Frost, Inc., Chicago	.95
1 C-H Rheostat, 15-Ohm	Cutler-Hammer Mfg. Co., Milwaukee	.75
1 C-H Rheostat, 30-Ohm	Cutler-Hammer Mfg. Co., Milwaukee	.75
1 Voltmeter, Pattern 135, 0-8	Jewell Elect'l Instr. Co., Chicago	7.00
2 Formica Panels, 7 x 24	Formica Insul. Co., Cincinnati	6.72
2 Audio Transformers, 3½ to 1	Thordarson Elec. Mfg. Co., Chicago	8.00
1 Bradleyswitch	Allen-Bradley Co., Milwaukee	.60
1 Bradleyleak, with condenser	Allen-Bradley Co., Milwaukee	2.20
5 Walbert Sockets, 201A size	Walbert Mfg. Co., Chicago	3.75
9 Engraved Binding Posts	Walnart Elec. Mfg. Co., Chicago	.99
2 Amperite Units, No. 1-4	Radiall Co., New York City	2.20
1 Erla Fixed Condenser, .005 mfd.	Electrical Research Lab., Chicago	.65
1 Erla Fixed Condenser, .001 mfd.	Electrical Research Lab., Chicago	.35
1 Can Kester Solder	Chicago Solder Co., Chicago	.25
1 Cabinet, 7 x 24 x 10		10.00
Miscellaneous, such as brackets, bus bar, screws, etc.		2.00
	Total Cost	$85.71

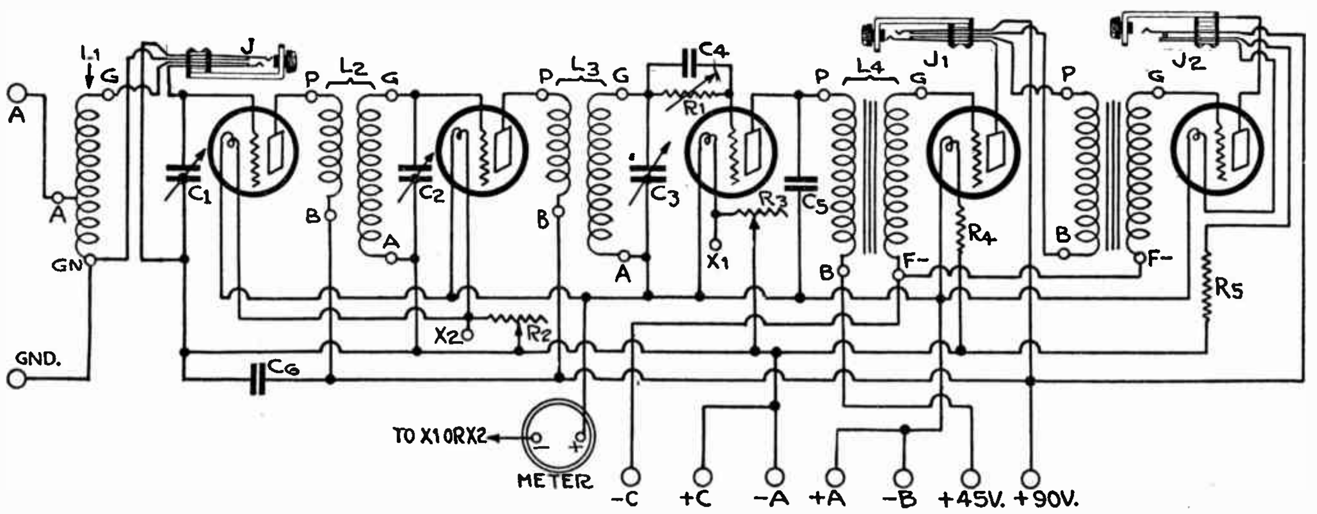


Figure 2

templates. They will be sent promptly on receipt of this amount in stamps, silver or money order.

If the former course is chosen, figure 3 shows the exact location of all holes necessary on the front panel. To get these holes marked on the panel, first cut a sheet of paper to 24 by 7 inches for a template and then, with ruler and pencil, make a small cross where each hole is to go, following figure 3.

Bracket Holes

Bracket holes have not been shown in this illustration as these will vary depending on the brackets used. To get them just right, lay the front panel face down on the table; on it set the panel which is to be the sub base, with one long edge down and so that one surface of the sub base is 7/16 inch from the edge of the front panel that will later be the bottom. The

Since first building and testing this set, and making the template drawing figure 6, the writer found a way of simplifying the wiring at the right end of the sub base which makes necessary three holes not shown in figure 6. To get their locations, mount the two audio frequency transformers and the socket which goes between them. The Fil. and Grid terminals of each transformer go toward the rear while the P and G terminals on the socket also go to the rear. It will be noted that mounting holes for the right hand transformer have been drilled only for the holes in the transformer in the rear right and front left corners. With the pencil, mark through the hole in the rear left corner onto the sub base. Now mark a small cross on the sub base 1/4 inch to the left of the rear left mounting hole of the left hand transformer. An-

Wiring the Sub Base

1. Put in a long wire from front left terminal of socket 1 to front left on socket 5 beneath the sub base with short wires branching off to front left terminals on sockets 2 and 3 and the front right on socket 4.

2. Connect front right terminals of sockets 1 and 2 with wire beneath sub base.

3. Connect right end terminal of rear Amperite to left front terminal socket 4 below sub base.

4. Connect G terminal of Thorola T-2 to front terminal of Bradleyleak (above sub base).

5. Rear terminal of Bradleyleak to be connected to rear left terminal of socket 3.

6. Above sub base, connect rear right post on socket 3 to front right post on transformer 1 (the transformer at the left).

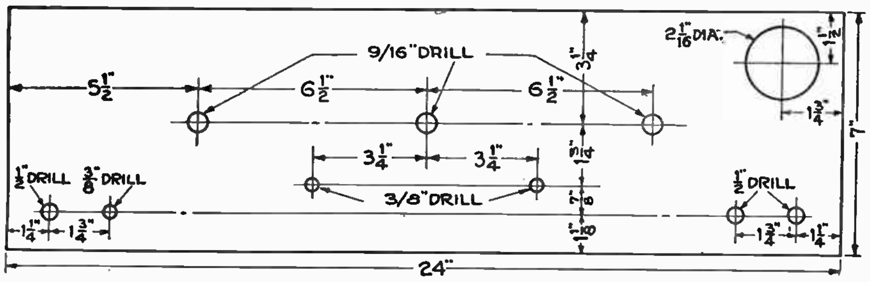


Figure 3

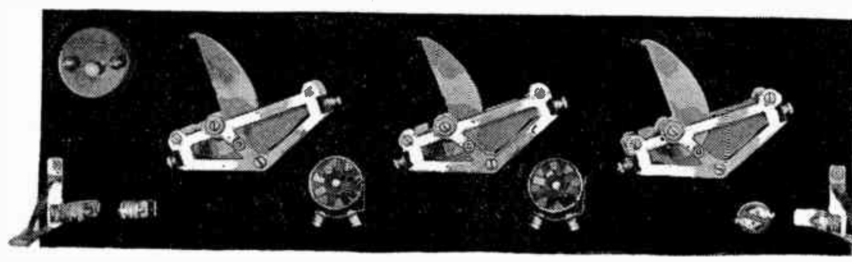


Figure 4

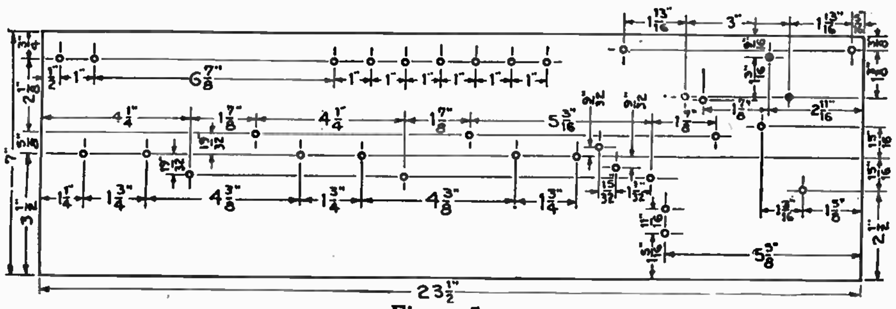


Figure 5

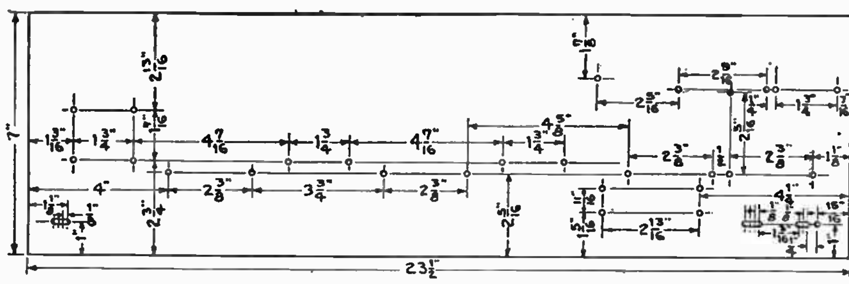


Figure 6

upper surface of the sub base will then be 5/8 inch from the bottom as the panel is 3/16 inch thick. Now place the brackets in the angle just formed. The outer edge of each should be 1/4 inch in from the ends of the front panel, as we are later going to take half an inch off the sub base which amounts to 1/4 inch at each end. Now, with the pencil, mark through onto the back of the panel. Measure the distances these marks are from bottom and ends and put crosses corresponding to them on the 24 by 7 template.

Now paste the template to the front of the front panel with four little drops on the corners, or use clamps if you have them. Lay the front panel on a flat surface back down, and with hammer and center punch, prick each hole through into the panel. This should require but one moderate tap of the hammer. When this is done for each hole, lift off the template and wash the corners of the panel. Now drill according to figure 3, starting the large holes with a small drill, about 3/32-inch or No. 27. Then use the large drill. If your collection of drills does not contain one large enough for the condenser mounting holes, a reamer is necessary to bring them up to size.

Mounting the Meter

The meter hole may present some difficulty if you have never installed a meter on a panel before. There are two ways of doing this. You can either use the fly cutter made for the purpose by the Jewell company, which is perhaps the easiest way, or you can draw a circle 2 1/16 inches in diameter and drill about twenty small holes just inside this line. They are to be drilled so that just a paper thin wall separates each hole. This is the method used by the writer. Then, with a sharp screw driver and hammer, cut through the thin walls all the way round and the disk should drop out. Now with a half round file, smooth down the edges of the hole to the line. Figure 4 shows where each of the parts go; the condensers should be mounted at an angle with the short edge of each horizontal. The jack in the lower right corner of figure 4 is a four-spring two-circuit jack; that in the lower left corner is the filament control jack. The one next to it is the second two-circuit jack. It will be noted that the writer hung his baseboard on the underside of the brackets.

The sub base panel should now be cut to 23½ inches long by taking ½ inch off one end, so it will slide into the cabinet. Two diagrams are necessary to show the holes to be drilled in the sub base. You can either combine them on one template or make two templates to avoid confusion. The holes necessary for mounting parts are shown in figure 5, while those through which wires pass are indicated in figure 6. The writer would suggest making a template per figure 5, passing it on, center punching, and drilling the holes required as one operation. All holes shown there are for 6-32 screws and a No. 27 drill is correct. Then make the template as per figure 6, paste it on, center punch and drill with as small a drill as will pass the bus wire you have purchased. This will be about 1/16 inch. To determine the positions of the bracket holes, and presuming you have the brackets on the front panel, place the sub base under the brackets so that the rear edge is 9 inches from the front surface of the front panel. Now mark with a pencil through the bracket holes and drill for 6-32 screws. The positions of the parts on the sub base are shown in the photograph figure 7.

other cross is to be marked just to the right and slightly in front of the P terminal of the socket between transformers. Take off these three pieces of apparatus and drill holes at the spots just marked.

Now with the sub base in front of you and the front edge nearest you, mount the Thorola C on the two holes at the left end with G and GN to the right; the first radio frequency amplifier socket comes next with P and G at the rear; then Thorola T-1 with G and A to the right; then another socket with P and G to the rear; next comes Thorola T-2 with G and A to the right; then the detector socket with P and G at the rear; then the second audio frequency amplifier socket with P and G to the right. These units are all in a straight line across the panel. The three instruments previously mounted and taken off can now be put on again. The Bradleyleak is mounted between Thorola T-2 and the socket to its right; the Bradleyleak terminals and condenser go to the right. It will be necessary to use two 4-36 machine screws one inch long for this. The Amperite units are mounted, each with a single flat head 6-32 machine screw, in the two holes in front of the detector socket.

The antenna and ground binding posts go in the two holes at the rear left corner of the sub base, while the other seven go in the seven holes about midway the length of the panel near the rear edge. Insert them, from left to right, plus 90, plus 45, minus B, plus A, minus A, plus C and minus C.

It will be noted from careful examination of figure 7 that the two sockets between the Thorola coils, and the one to the right of Thorola T-2, are raised above the sub base about 1/4 inch. The reader can do this or not as he pleases. The writer slipped binding post nuts over the mounting screws on those sockets, between the sockets and the sub base to raise them and reduce any dielectric absorption of energy by the sub base from the socket springs, and reduce the tendency of dielectric placed close to them to cause

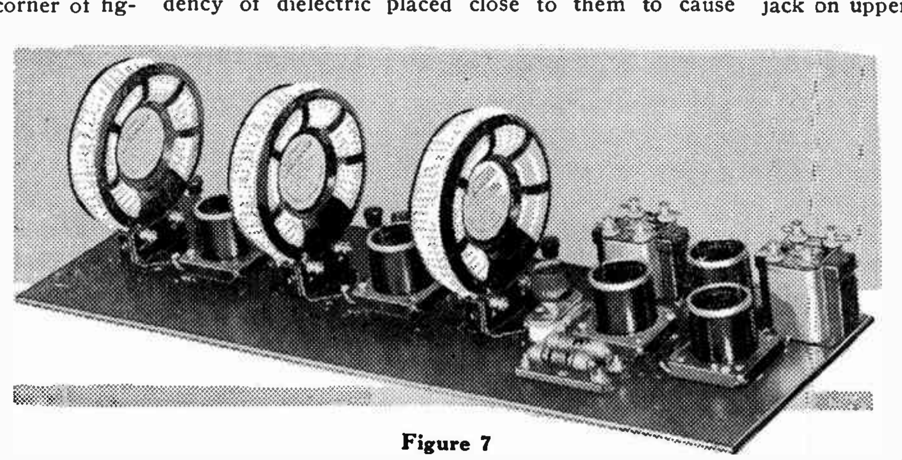


Figure 7

greater capacity between the plate and grid springs.

Wiring this set is remarkably easy. The reader should have no difficulty at this stage of the construction. Only two points could be called even moderately hard to get at, and the builder will have smooth sailing with the set finished surprisingly soon.

Each operation which consists of putting in a wire, is given a number which applies, after that, to the wire inserted. The first seventeen wires are put on the sub base before it is attached to the front panel. These will be described first.

7. Above the sub base, connect rear right post on transformer 1 to rear left post on socket 4.

8. Rear right post on transformer 2 connects to rear right post of socket 5 (above sub base).

9. Connect rear left posts on transformers 1 and 2 by wire passing under sub base.

10. Connect rear left post on transformer 1 to minus C binding post, passing under sub base.

11. Connect A terminal on Thorola T-2 with wire 1, through sub base.

12. A short lead is put in connecting rear right post on socket 1 with P on Thorola T-1.

13. Now a wire from G on Thorola T-1 to rear left post on socket 2.

14. This series of above sub base wires is completed by connecting rear right post on socket 2 with P terminal on Thorola T-2.

15. Bend a wire so that it passes through sub base from B terminal on Thorola T-2 under the hole beneath terminal B on Thorola T-1, and then back to plus 90 binding post.

16. Put a wire through sub base from B terminal on Thorola T-1 to wire 15 just inserted.

17. Put a wire through sub base from B post on transformer 1 (front left corner) and over to plus 45 binding post.

These are all the wires that can be connected without combining panel and sub base, so with the brackets, carefully bolt these two assemblies together, taking care not to injure or bump any of the pieces of apparatus while doing so. With the two fastened together we can proceed with the wiring.

Connecting Panel to Sub Base

18. Considering now the jack in lower left corner of panel, connect the shorter of the two long springs to stator terminal of first variable condenser and to rear left post on socket 1. This wire is to pass above sub base. The stator terminal is almost directly above jack on upper end of condenser.

19. The spring next to that just connected is to be wired to G terminal on Thorola C by a wire passing below sub base.

20. Now bend a wire to pass from the remaining short straight spring, under the hole beneath GN on Thorola C, back to GND (ground) binding post. A short wire is dropped from terminal GN through sub base to this wire just inserted.

21. A comparatively long wire is now bent to connect long spring on jack, through sub base and across to the left end of the front Amperite.

22. Put a wire through sub base from A terminal on Thorola T-1 to wire 21.

23. Bend a wire to pass from rotor terminal of center variable condenser, in front of sub base and back under it to wire 21.

24. Another wire is bent the same shape to connect rotor of left hand variable condenser to wire 21.

25. There are two rheostats; that to the left being R-2, the other being R-3. Connect the right terminal of R-2 to wire 21.

26. Connect left terminal of R-3 to wire 21.

27. Insert a wire connecting the left terminal on R-2 with wire 2, that which connects the front right terminals of sockets 1 and 2.

28. Run a wire straight back from wire 21 to the minus A binding post.

29. Connect plus C binding post with short one-inch wire to minus A binding post.

30. Now connect the right hand terminal on the filament switch to the nearest point of wire 1, the first one put in.

31. A wire is now inserted diagonally from left terminal on switch to plus A binding post.

32. Going now to the jack in lower right corner of panel and presuming it has been put on with frame to the right, the filament control springs are the two to the left. Connect the inner of these two springs to the rear left terminal on socket 5.

33. Connect the outer filament spring to the right end of the front Amperite.

34. A wire is to be bent to pass down in front of sub base, then under it, from right terminal of rheostat R-3 to front right terminal of socket 3.

35. Going back to the jack mentioned in operation 32, drop a wire through and under sub base from the remaining spring on jack to the front right post on socket 5.

36. The second jack from the right has, so far, been untouched. Connect the longer of the two long springs to the rear right post of socket 4.

37. Connect the front right terminal on transformer 2 through and under sub base to the short straight spring next to that just connected by operation 36.

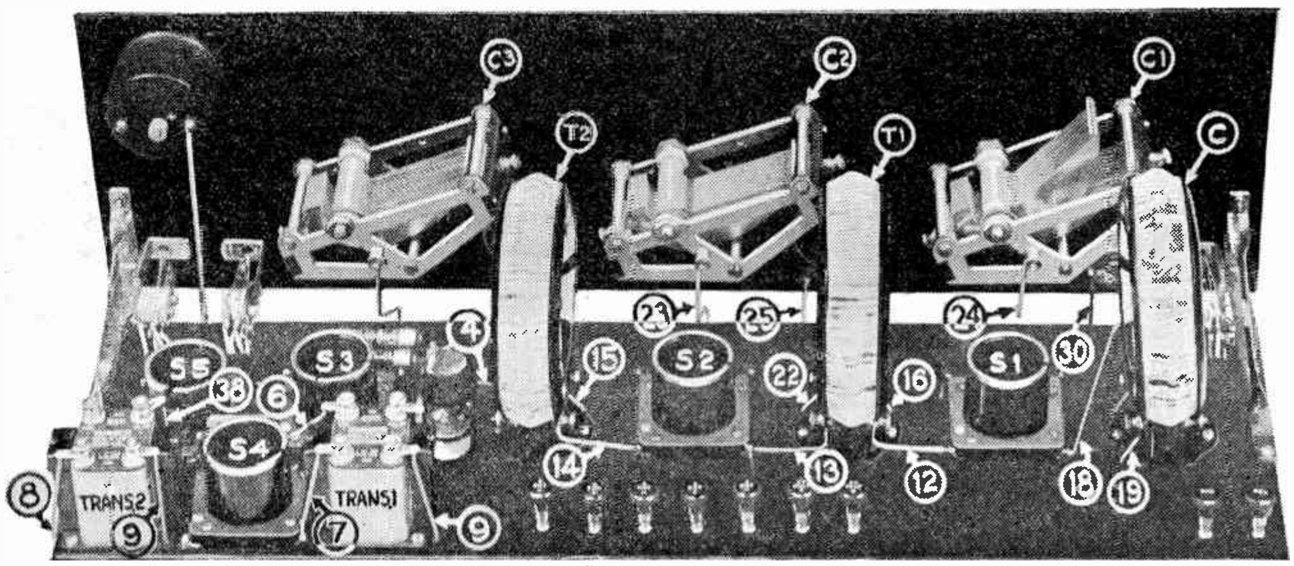


Figure 8

38. The front left terminal on transformer 2 is to be connected by a wire running through and under sub base to the remaining short straight spring.

39. Considering now, these two jacks in the lower right portion of panel, bend a wire to pass from the frame terminal of the end jack beneath the remaining spring terminal of the other jack, then across sub base and close to wire 1, until opposite plus 90 binding post, then straight back to that post.

40. From the shorter of the two long springs in left hand jack (referred to as "the remaining spring terminal" in operation 39) put a wire through sub base to wire 39.

41. Drop a wire through sub base from left terminal on rear Amperite to wire 21.

42. Run a wire down and straight back, above sub base, from the stator of right variable condenser to the wire connecting G of Thorola T-2 with the front end of the Bradleyleak (wire 4).

43. The next wire, from the stator of center variable condenser, drops straight down and then back, either above or below sub base to rear left terminal of socket 2. If run below it will be necessary to drill small hole beside rear left terminal of socket 2.

44. Bend and insert a wire to reach from rotor of right hand variable condenser (C-3), in front of, then back under sub base, to wire 1.

45. On underside of sub base, connect minus B binding post to plus A post with a short wire.

46. On underside of sub base it will be found that wires 1 and 15 are separated by a distance approximately the length of the Erla .005 mfd. fixed condenser which is to be connected across from one to the other.

47. The Erla .001 mfd. fixed condenser is placed on the front of socket 4, with one long side down resting on the base part of socket. In this position it will be found that the left terminal touches wire 6 while the right end is directly above the front right post on socket 4. Solder to wire 6 and drop a short wire connecting right terminal to front right terminal on socket 4.

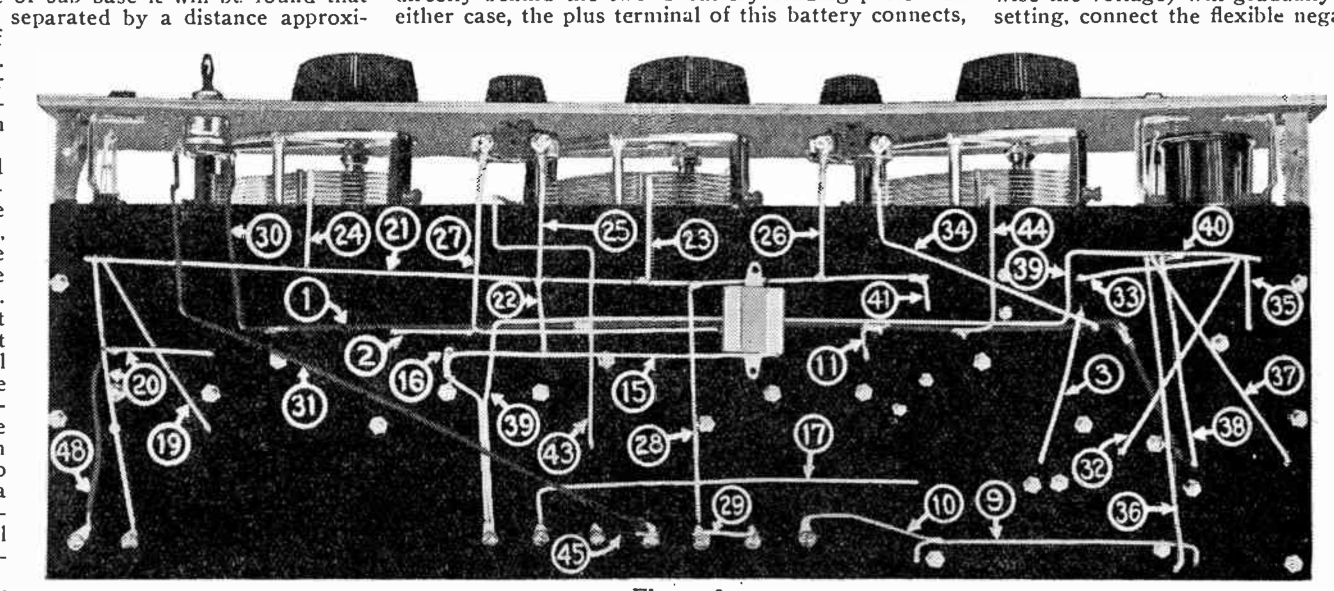


Figure 9

48. A piece of flexible wire is now connected to the Antenna binding post, beneath sub base, cut to the proper length that it can be brought up through the holes beneath terminals A-1 and A-2 on the left side of Thorola C and reach either of them.

The first of the wires used in connecting the meter is fastened from the left terminal of the meter, labelled plus, and dropped straight down below the sub base and back to the long wire which was number 1. To the other terminal, a flexible lead is attached terminating in either a spade connector or small clip. Presuming that these have been put in, we are ready to set up the Traveler.

Batteries Necessary

Three power units are needed, a six-volt storage battery of any ampere hour capacity between 60 and 120, two large 45-volt B batteries such as the Eveready number 770, and a small 4½-volt C battery.

Two small holes should be drilled either in the bottom of the cabinet near the rear edge or in the back close to the bottom, for the antenna and ground wires. The set can be slipped into the cabinet temporarily to get these opposite their proper binding posts. The leads from the storage battery and B batteries can well be brought in on a Belden cable, consisting of five wires each insulated from the others and all encased in a heavy protecting braid. This will make it necessary to drill but one hole ⅜" in diameter opposite the B minus binding post on figure 8.

Connecting Batteries

The plus 45 terminal on one of the Eveready units is connected to one of the wires in the Belden cable and the other end of that wire, identified by its color scheme, is slipped into the left binding post of the group of seven, labelled plus 90. The negative terminal of that same B battery unit is attached to the plus 45 of the other B unit by a short length of wire and also to another of the wires in the five-wire cable. The other end of this wire is put on the plus 45 binding post in the set, which is second from the left. The negative terminal on this second B unit is then attached to another wire in the cable, the opposite end of which is to be put under the third binding post in the set identified as negative B.

The plus terminal of the storage battery is usually identified either by being painted red or with POS. or + stamped into the case close to it. This terminal should be connected to one of the two remaining wires in the cable, the opposite end of which connects to the fourth binding post in the set, lettered plus A. The other terminal of the storage battery is the negative, and the remaining wire of the five in the cable should be connected to it. The opposite end of this wire, in the set, connects to the next binding post which is negative A.

The C battery can either be placed within the set on the rear edge of the sub base leaning against the back of the cabinet or can be placed just behind the cabinet with leads brought in through two small holes drilled directly behind the two C battery binding posts. In either case, the plus terminal of this battery connects, by a short wire, to the sixth binding post identified as plus C, and the negative 4½-volt terminal of the battery connects to the seventh and last binding post.

Aerial, Ground and Tubes

The antenna lead-in, which the writer sincerely hopes has been kept well insulated all the way down from the antenna and where it comes through the wall, is then slipped through the small hole in the cabinet opposite the binding post in the rear left corner and is slipped into that binding post. The ground lead, from water pipe, well or a buried mass of metal, is slipped through the next hole and connected to the other binding post of the two in the left corner.

Five tubes of the amplifier type known as "A" tubes, are used in this set and they should now be inserted by pushing down slowly and firmly and then turned to the right. A loud speaker can be inserted now in the jack at the right end of the set or a pair of phones in the jack next to it. The filament switch should be pulled out, whereupon the two tubes at the right should light if speaker jack is used or only number 4 if the phone jack is used.

Operation of Receiver

The right rheostat should be turned clockwise until the arrow points horizontally to the left. This is presuming that both pointers were adjusted to be vertical when rheostat is turned to left as far as will go and in the off position. The left rheostat is also turned clockwise until the indicator points horizontally to the left.

Reading from right to left, the three large tuning dials will be considered as numbers 1, 2 and 3. Now when tuning, it will be found that maximum sensitivity in the first two tubes is obtained, on the lower dial numbers, with the left hand rheostat slightly below horizontal while, on the higher numbers, the rheostat is to be turned until almost vertical.

This left rheostat acts as a control over regeneration and, with it, regeneration and the consequent gain in sensitivity, can be secured at any wave length. In other words, the set can be made to squeal or go into oscillation at any wave length—a condition to be avoided by all means. This rheostat should be brought up toward maximum, at any setting of the dials only until the hissing is heard or the crackling of static. One quickly learns the approximate position of the rheostat pointer, over its effective arc of about one inch, for any setting of the dials.

Tuning Dials 1, 2 and 3

In this connection, one is guided by the settings of dials 2 and 3 which run together and rarely, if ever, should be more than a degree apart when adjusted for maximum strength on a station. Dial 1 is affected by the close coupling of the antenna system and will be found to run from 5 to 10 degrees below the other two.

With an out-of-town station tuned in, one can adjust the variable grid leak (to the right of the third Thorola coil) for maximum sensitivity and then leave it alone. Turning this Bradleyleak to the left increases the resistance and increases the sensitivity on distant stations until a point is reached where everything suddenly "plops" out and the grid leak must be turned back until the station again comes in. The right rheostat which controls the detector tube can likewise be set. This should be done by strength and clearness of program and not by voltmeter.

The voltmeter is employed as follows: The detector rheostat has, presumably, been set with the storage battery fully charged. This charge (and likewise the voltage) will gradually go down. With best setting, connect the flexible negative wire of the voltmeter to point X-1 of figure 2. This point on the set is either end of wire 34, preferably the end which attaches to the right terminal of the right rheostat. The voltmeter reading should be carefully observed and jotted down. Each evening, before beginning operations, it is an excellent idea to clip this wire to the point mentioned and adjust rheostat until voltmeter again gives the recorded reading.

However, in the initial tryout period, after determining the correct detector voltage, switch the flexible wire to point X-2 of figure 2 to get the voltmeter readings on several different wave lengths. This point is either end of wire 27, the writer using that end which connects to the left terminal of the left rheostat. As described before, this rheostat is varied as one uses the upper or lower end of the scale on the tuning dials. The flexible lead can very well be left on this point and control of the radio frequency amplifier tubes' voltage varied by the voltmeter readings. For example, one quickly learns that at 10 on the dials 2 and 3, the meter may show 4½, at 40 on the dials the pointer may be a fraction under 5, while at 80 on the dials, the voltmeter may read around 6.

(Continued on page 54)

How to Make DX-Seven Super-Het

Full Construction and Assembly Details

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $104.00

WHEN any of us plan to build a new receiver, especially a super, we usually have in mind two chief points, namely, range and clearness of reproduction. If the builder of the contemplated set happens to live far out in the country miles away from class B and super-power stations, he is not quite so concerned with selectivity and is willing to sacrifice something of this quality for range. However, the builder living in large cities where there is at least one powerful broadcaster, and possibly fourteen, must rank selectivity of equal importance in his plans, with range and clearness. As a rule, metropolitan and most home builders east of the Mississippi, have finally chosen a compromise that was about 75 per cent efficient in each of these particlars, as compared with the ideal.

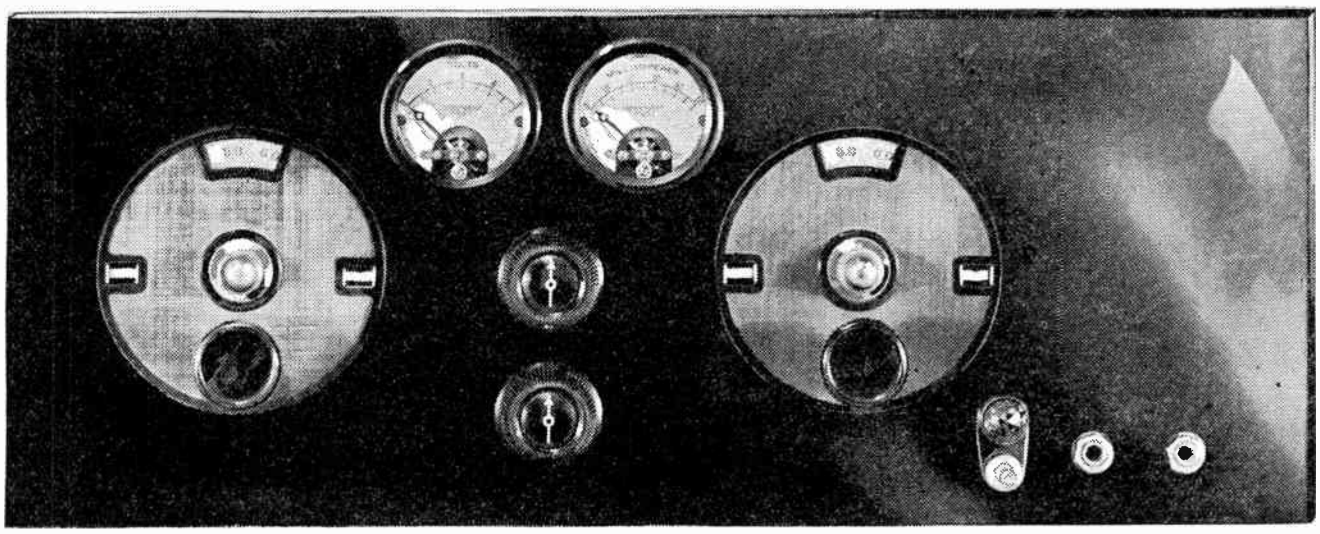


Figure 1

The Problem Overcome

The writer lives in Chicago where eight wave channels are divided up among about fifteen stations and form a barrier to distance that is a vertible wall, against which one bangs his receiver at setting after setting only to find a local station spread strongly over several points. Some may offer the advice of getting or constructing a "good" set, but when one lives within the 100 per cent strength zone of five powerful nationally-heard stations, that is not so easy. After trying combination of apparatus without number, the set to be described was evolved, and is a most satisfactory solution of the problem. Sensitivity is not sacrificed for selectivity, nor has either quality been cut to get clearness. It is called by the writer "DX-Seven" because it will do DX anywhere, and is a seven-tube set instead of a straight eight.

The sensitivity of a super-heterodyne is governed largely by the efficiency possible in the intermediate stages. If, due to feedbacks within these stages, the amplification per stage, within the tubes, has to be cut down with the potentiometer, the range is at once seriously impaired. Which brings us to the choice of intermediate frequency transformers. The Celco transformers, finally chosen by the writer, are constructed on the principal of two D's, each facing the other edgewise, and resulting in a closed magnetic field which cannot be affected by currents other than those put into each transformer by the preceding tube via the primary winding. An undesired current striking one of these transformers sets up a current in each D of the secondary winding and, as these windings are in reverse relation to each other, the currents set up in the D's oppose and balance each other, with the net result that no current flows in the secondary and there is no difference of potential between the ends of the secondary.

Only the desired current or signal picked up by the loop can flow in the transformer.

These transformers can be assembled in a receiver so closely that the edges touch, or in any relation to each other as regards angles, without fear of having to lower the efficiency with the potentiometer. High grid bias can be put on the grids of the intermediate stages without tendency to oscillate, giving extremely great amplification and low B battery drain. Result, range and economy. There is, however, another benefit from the use of Celco transformers, in the matter of quietness. Due to the D construction, the secondary circuits cannot pick up stray noises such as static, power hum or long wave signals which originate outside the set. Thus they cannot be amplified and reach the second detector and the set is surprisingly quiet. A pleasant surprise. Since each transformer is air core and tuned, the grid circuits are very sharp, which eliminates much of the undesirable noise that comes in on the loop, and interefering signals. The sharpness of these circuits augments the selectivity of the heterodyning or frequency changing. The writer is satisfied that they are responsible for the greater part of the success in the building of this set.

LIST OF PARTS

1 Celco Super Kit	Central Engineering Lab., Chicago	$27.50
2 Benjamin .0005, type 8662 Cond.	Benjamin Elec. Mfg. Co., Chicago	10.00
2 Mar-co Vernier Dials, Nickel	Martin-Copeland Co., Providence, R. I.	5.00
1 Benjamin 7-tube Gang Shelf	Benjamin Elec. Mfg. Co., Chicago	9.50
1 Pair Benjamin Brackets	Benjamin Elec. Mfg. Co., Chicago	.75
1 Gleason Midget 14-plate Cond.	The Gleason Corp., Chicago	1.50
2 Amperite Resistors, 201A	Radiall Company, New York City	2.20
1 Carter Imp Rheostat, 6 ohms	Carter Radio Co., Chicago	1.00
1 Carter Imp Rheostat, 10 ohms	Carter Radio Co., Chicago	1.00
1 Carter Imp Potentiom., 200 ohms	Carter Radio Co., Chicago	1.25
1 Celco Indicating Switch	Central Engineering Lab., Chicago	1.35
1 Yaxley 4 spring Jack, No. 4	Yaxley Mfg. Co., Chicago	.80
1 Yaxley Open Circuit Jack, No. 1	Yaxley Mfg. Co., Chicago	.50
1 Erla Concert Grand Transformer	Electrical Research Lab., Chicago	10.00
1 C Battery, 7½ volts	Burgess or Diamond	.85
1 Dubilier .002 mfd. fixed Cond.	Dubilier Radio & Cond. Corp., N.Y.C.	.40
1 Dubilier 601G .00025 with clips	Dubilier Radio & Cond. Corp., N.Y.C.	.45
1 Dubilier 1.0 mfd. bypass Cond.	Dubilier Radio & Cond. Corp., N.Y.C.	1.25
1 Daven Leakandenser, 5 megohms	Daven Radio Corp., Newark, N. J.	1.00
1 Daven .05 megohm resistor	Daven Radio Corp., Newark, N. J.	.75
8 Walnart Binding Posts	Walnart Electric Mfg. Co., Chicago	.88
3 loop, 1 neg. A, 1 plus A, 1 neg. B, 1 det. B, 1 amp. B.		
1 Bakelite Panel, 18x7x3/16	Formica Insul. Co., Cincinnati	3.00
1 Jewell Panel Voltmeter, 0-8	Jewell Elect'l Instr. Co., Chicago	7.00
1 Jewell Panel Millameter, 0-25	Jewell Elect'l Instr. Co., Chicago	7.00
1 Set Crowe Cable Markers	Crowe Name Plate Mfg. Co., Chicago	.25
1 Strip Bakelite 17x1⅞x3/16	Formica Insul. Co., Cincinnati	.75
1 Cabinet, 18x7x8	Make carried by local dealer	3.00
4 Small Right Angle Brackets ⅜ x ⅜ x ⅜	At 5 and 10 cent store	.10
	Total cost	$104.03

The Benjamin condensers you have heard of before. Their first appeal for this set was their compactness or small size. The era of huge, unwieldy receivers is about over, and small, better designed layouts have taken their places. DX-Seven, as you will note, is but 18 inches long and 7 inches high. If apparatus of high quality can be obtained in small size it suits our purpose admirably. As to technical characteristics, Benjamin condensers are straight line wave length which seems to give plenty of separation on the lower wave lengths and leave good spacing on those in the upper half of the broadcast range. They are finished in unpolished silver which has long been known as a good idea, not for looks alone, but also for results. A rather cleverly designed friction adjuster in the form of a disc is supplied and but one strip of dielectric is used to hold rotor and stator plates in their proper positions. The more you study these units the better you'll like them.

Mar-co Dials

The problem of the dial manufacturer has always been, to the writer, an interesting one. There must be a satisfactory ratio between the movement of the control knob and that of the condenser plates. There must be no "backlash," or what the automobile owner calls "play" in his steering wheel. Backlash is present if, when you stop turning a dial, let us say, to the right, and you turn it to the left, there is a slight movement possible of the control knob before the condenser plates begin to revolve to the left. Such a condition makes accurate, on-the-peak tuning very difficult. Then, too, the dial must be attractive in appearance; it should provide not only readings on a scale, but also space for putting down the letters of preferred stations.

All these points have been covered to perfection by the Martin-Copeland company in their Mar-co dial. It is, to put it mildly, handsome in appearance. There is not a trace of backlash in any of the half-dozen the writer has. The ratio is such that it does not take too many turns of the knob to go from end to end of the scale, yet one can split a degree on the scale in setting the condenser. Station call letters can be logged right on the dial, and the smoothness of turning is a pleasure to use.

In choosing the Benjamin gang socket for this set, the writer saved himself and incidentally, you, a lot of work. The seven sockets come all mounted, each on springs, assembled in a line on a 17¼" by 4⅛" shelf. Connections can be readily made either above or below this shelf without drilling holes; the non-microphonic qualities of the socket are unaffected by the use of stiff bus bar. The nonmicrophonic qualties mentioned is obtained by supporting the barrel of the socket on four springs which also provide contact to the pins of the tube. Any jar or vibration which may reach the tube bases is taken up by these springs and does not reach the tube to cause vibration of the filament and loud growls in the speaker. So convenient to use is this gang arrangement that future sets presented by the writer will, many of them, have this feature.

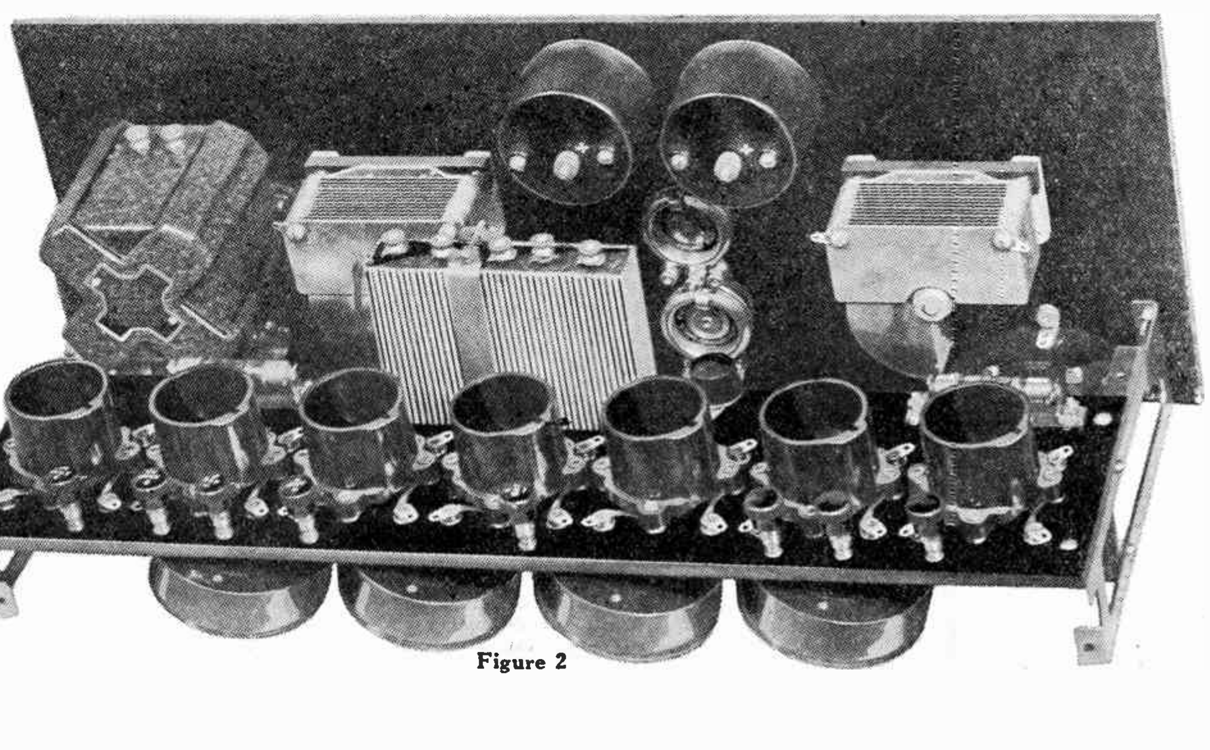


Figure 2

Since this set was expected to be sharp, and a comparatively large sum of money had to go into parts, it was decided to even go so far as to get a low loss midget condenser. Many designers wouldn't, for these midgets all look pretty much alike. After examining several, the James. Jr., made by the Gleason corporation, was chosen. Its skeleton frame looked free from losses and there is a very small area of contact where end plates meet dielectric. Construction is rugged though the unit is very small, and the contact spring giving connection to the rotor plates has ample bearing surface on the shaft. In capacity it is rated at .000045 mfd.

Erla's Concert Grand

When many of you see the price of the audio frequency transformer you will sit aghast and remark that the writer must think you're a mint. It isn't as bad as all that and might have been worse. Remember, this set was built with tone quality as one of the three principle features to be kept in mind. Few will deny that each stage of audio frequency amplification added, brings with it some distortion. Therefore, if we can put off one of the usual two stages and make the remaining one extremely efficient, not only in quality but in amplifying power, we are going to get living room volume of remarkably purity. In the writer's opinion, two stages of audio amplification in a super are unnecessary. The signal strength after the second detector should be sufficient, if the front part of the set is correct, to operate a speaker on anything within range.

The Erla Concert Grand transformer is a very unusually constructed unit. The average core in an audio transformer provides two diametrically opposite paths for the magnetic lines of force to travel in, from end to end of the winding. Erla have added two more by what they term "cruciform" construction and provided a large central leg on which primary and secondary are wound. The net result is less distortion by the D. C. current from the B battery on the pulsating voice currents, more even amplifications of the voice frequencies between 32 and 8,000, and greater amplification over the entire range. Thus we eliminate the distortion that would creep in from a second stage yet get all the amplification of the audio frequencies required a superheterodyne and a purity of reproduction not usually obtained from a single stage. You won't need any more tubes if you build this set carefully and this last stage gets all the strength it should.

You will find that Carter rheostat and potentiometer perfect examples of compact but dependable construction. Their makers claim them the smallest units made for their respective purposes; I do not doubt it. In spite of their diameter of but 1¼ inch and projection behind panel of but ⅜ inch, nothing has been skimped or cut down. There is plenty of bearing, the shaft is husky enough for a much larger unit. The contact arm makes firm contact with the resistance wire and operation is smooth. The one hole mounting feature saves worry and work.

Small Parts

Care was used by the writer in selecting the miscellaneous small parts that make up this set. In the matter of a battery switch, Celco again was the choice. This little unit, in addition to being provided with a heavy duty wiping contact, also provides a small indicating light, which, at a glance, tells one whether the tubes are burning. The experience of finding the battery run down because the set was not turned off the night before a football game at the writer's alma mater, recently convinced that such a device was most useful. The small bulb adds but little to the battery load. Yaxley jacks went into the set because the writer paid a visit to the factory not so long ago and watched the care with which they are assembled and the seeming disregard for expenses with which the defective parts or assemblies are thrown out. You'll get a strong positive contact between springs and no weakening through use.

The Daven Leakandenser is a comparatively new unit on the market and a unique one. There is no grid condenser, as we usually expect to find it. The "condenser effect" is obtained, however, by the use of two wires. One is connected to the cap at one end of the cartridge, the other is connected to the other cap. The two are wound parallel to, but insulated from each other, each forming the plate of a condenser. Such a winding can be made to give the exact capacity specified. Within the bakelite tube on which this wire is placed, there is a resistor unit of the usual type which, on test, will be found to be surprisingly exact. Laboratory tests by the writer showed these to run so exact they might be called perfect. The other Daven product, the .05 megohm resistor, is made with equal care and this constructor long since found he could with confidence stick to Daven in this matter of fixed cartridge units.

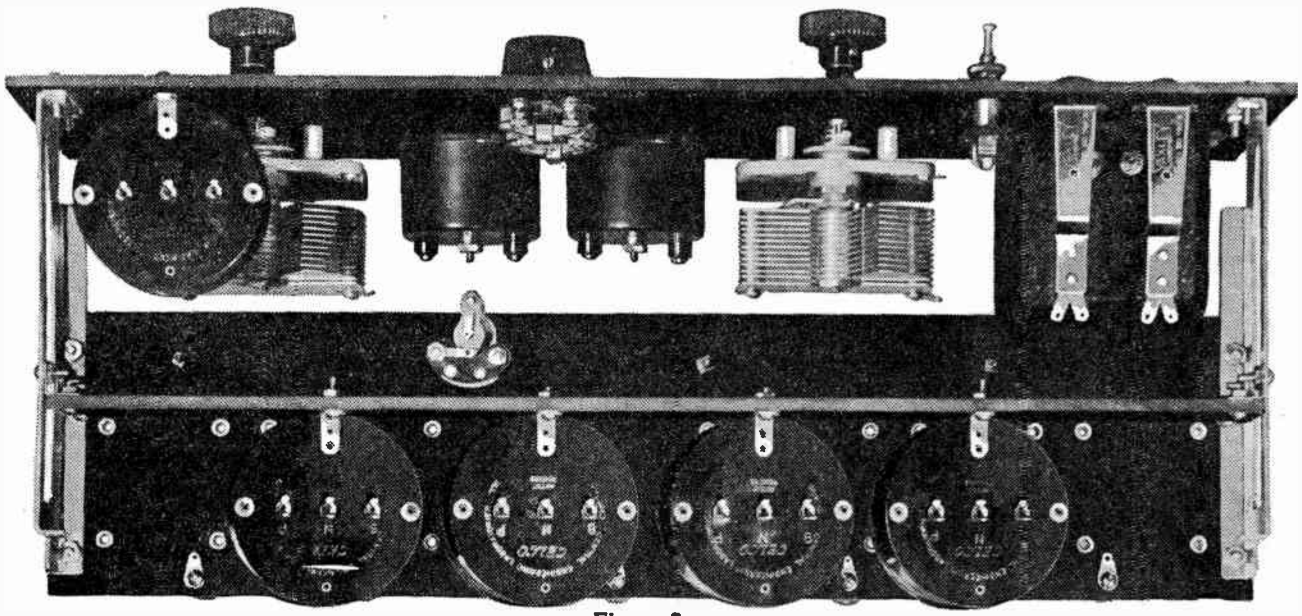


Figure 3

Jewell Meters

Why more designers do not specify and more builders use meters, this writer cannot see. To have them, gives a feeling of confidence in the operation of a set that is most pleasant. You know exactly what voltage the tubes are getting and, to some extent, the condition of the battery. One knows at all times what current is being drawn from a B battery. Very soon, from practice, you set controls and turn dials, largely from meter readings with more consistent satisfactory results. Jewell has turned out, in the units chosen, two units that are not one bit less efficient in construction or use than their bigger brothers, yet are only 2" in diameter across the containing case. The voltmeter is of the high resistance type and far more accurate than any of the cheaper low resistance types could possibly be. They not only are attractive in appearance, but add to the looks of the panel as well as add to the efficiency in the results of the set.

The writer is quite sure that you will agree that this is one of the trimmest and most compact supers yet presented the Radio public for home construction. It is only 7 by 18 on the panel remember, and the depth is but 7⅜ inches. Possibly there have been complete full-fledged supers that small, but every one the writer has seen were for 199 or 299 tubes. It is a rare occurrence for the old-timer, with experience dating back to '80, to get much of a thrill out of a receiver but this is a delight in so many ways that it would be an exceptionally hard-shelled "op" that wouldn't enthuse over it.

The whole thing is easily held on one hand; if one of the new cabinets with 12-inch depth is used, a Philco glass case storage battery and the B units go inside also. When it is put into operation on a good loop, it goes through locals with a precision and snap not found in previous assemblies used by this writer.

Full-size template is furnished with this book. Having either template trimmed to the size of the panel, either paste it to the front of the panel or secure it with small C clamps. At each cross, tap with center punch and hammer and, when you have checked this work over to be sure none are missed, remove template.

All holes are first drilled with the 9/64" drill, then those indicated for a larger size are put through with the proper drill. Should you not have in your collection all the larger sizes shown, drill with the next smaller size diameter which you have and enlarge to the correct diameter with a reamer. The meter holes may cause some trouble if you have never put them in sets before. However, this can be overcome either by purchasing a fly-cutter marketed by Jewell for the purpose or by drawing the 2-inch circle on the panel and drilling a number of 9/64" or 11/64" holes clean around and just inside the circle. These should be so drilled that the outer edges of each drill hole just touch the line drawn and are separated from each other by a very thin wall. With a sharp screwdriver and hammer, these walls can be cut through and the jagged circle broken out. The edges of the holes are then filed down to the line with a half-round file.

Hole Identification

Considering the front panel template the first two holes are for one of the Benjamin brackets. The next two mount the oscillator coupler of the Celco kit. All four should be countersunk, as indicated by the double circle around them. Above these holes, and slightly to the right, is a group of holes consisting of a large hole surrounded by four smaller ones. These mount a Benjamin condenser and a Mar-co dial. The smaller hole below the large shaft hole is the pin for the dial and is not countersunk. The two ⅜-inch holes below and between the meters are for the Carter Imp rheostat and potentiometer.

To the right of them is another group for the second Benjamin condenser and Mar-co dial, while to the very right edge of the panel are two more countersunk holes, on a horizontal line, for the Erla transformer. Below them, reading from left to right are two holes for the Celco light and switch, hole for the Carter four spring, jack hole for the open circuit jack, and two countersunk holes for the second Benjamin bracket.

Panel Assembly

When assembling these units on the panel, some suggestions may be apropos. The voltmeter goes in the left hand meter hole; the potentiometer goes in the upper of the two Imp unit holes. The variable condensers are mounted so that the rotor plates swing downward when going out of mesh with the stators. The Erla transformer is put in so that the B and F terminals are toward the top. When putting in the Celco switch, the light goes through the upper hole while the switch itself projects through the smaller hole at the bottom. Both Yaxley jacks are rotated, and secured, in such a position that the frames are toward the bottom of the panel. Each Benjamin bracket is arranged so the flange is toward the center of the set; the straight side is outward.

The sub panel template is for the shelf and intermediate transformer strip. The Benjamin gang shelf is sold complete, with all sockets in place and all but three of the holes shown, already drilled. There are a number of other holes also, but they may be disregarded. The upper drawing of figure 3 is the gang shelf and the three holes referred to are on a line of 11/16 inch from the top. This drawing, in addition to giving the locations of these holes, also shows you which of those found already in the shelf are to be used. Should the home builder care to dismount seven standard Benjamin sockets from their bases and make up his own shelf, this drawing will enable him to place all parts correctly. The sockets are mounted as shown in the photograph, figure 2, with P and G terminals to the rear.

The two holes at each end, and 5/16 inch in from the edge, are for the Benjamin brackets but, before putting on these brackets, four holes must be drilled in them for mounting the intermediate transformer strip. Each bracket has two long strips, one of which contains the flange to hold the shelf. At the front end of each bracket is a right angle bend flange which attaches to the panel. With the ruler against the inside of this front flange, a point is to be marked on both the upper and lower strip of each bracket, 3¾ inches back. A 9/64-inch hole is drilled at each of these points and a small right angle ⅜ by ⅜ by ⅜ bracket attached. This work will be made clearer from examination of the photograph, figure 3.

Going back to the gang socket shelf template the three loop posts are mounted in the three holes ¼ inch in from the rear edge and toward the right, in the sub panel template. The next hole toward the left, in that line, is for minus A, the fifth hole is for plus A, the sixth for minus B, the seventh for plus 90 and the last for plus 45. The three holes 11/16 inch from the top edge of the illustration are used as follows: that toward the left is for an Amperite mounting, that near the center holds a piece of strip brass bent to hold the C battery, that at the right secures the second Amperite mounting.

The strip on which the Celco intermediate transformers are mounted comes in next for attention, and the template for its drilling is shown on the attached sheet. The two holes at each end are for attaching to the small brackets mentioned previously that were attached to the larger Benjamin brackets. The other four pairs of holes are for the mounting of the coils themselves. In attaching these coils, the side with B, N and P terminals is to be downward. When on the subject of mounting apparatus on the front panel, the writer forgot to mention that the oscillator coupler is to go in with B, C and P downward and F, L and G above.

The midget condenser has purposely been left to the last so there would be no chance of its getting damaged during this assembly work. It is to be mounted on the gang shelf in the hole, shown in figure 3, as ⅜ inch from the top edge and to the right of center. Your set is now complete and ready for the wiring.

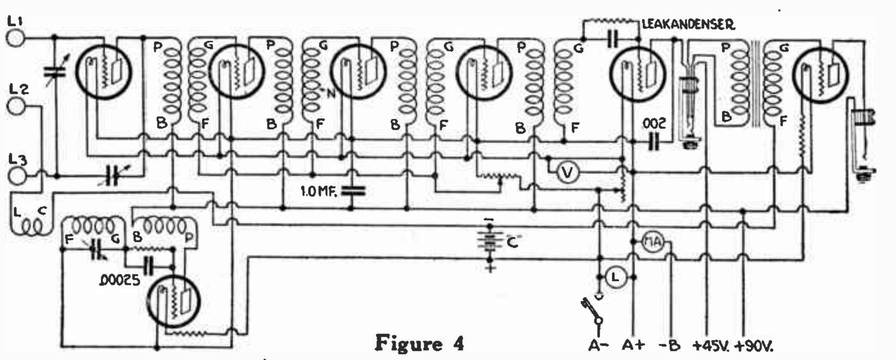
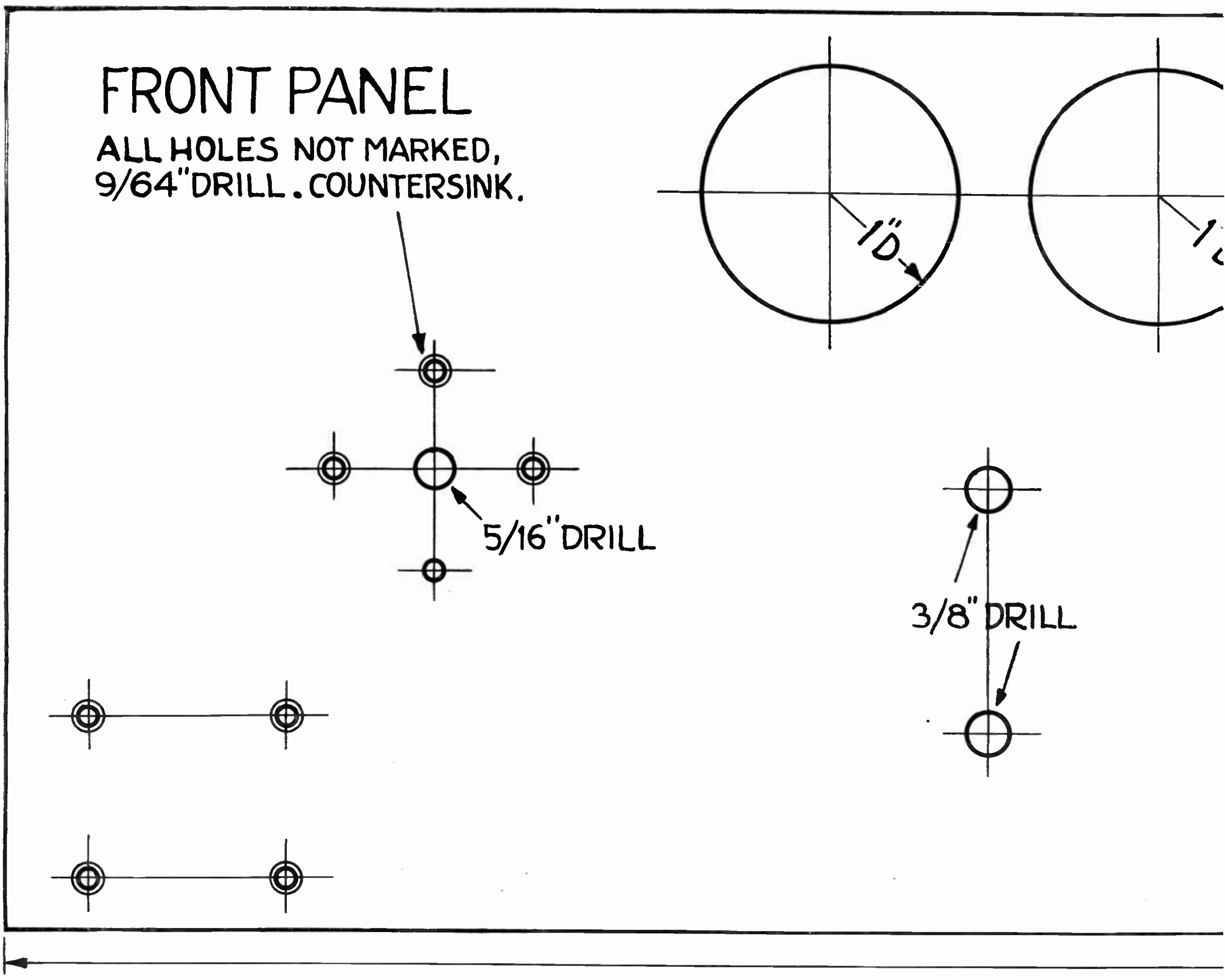
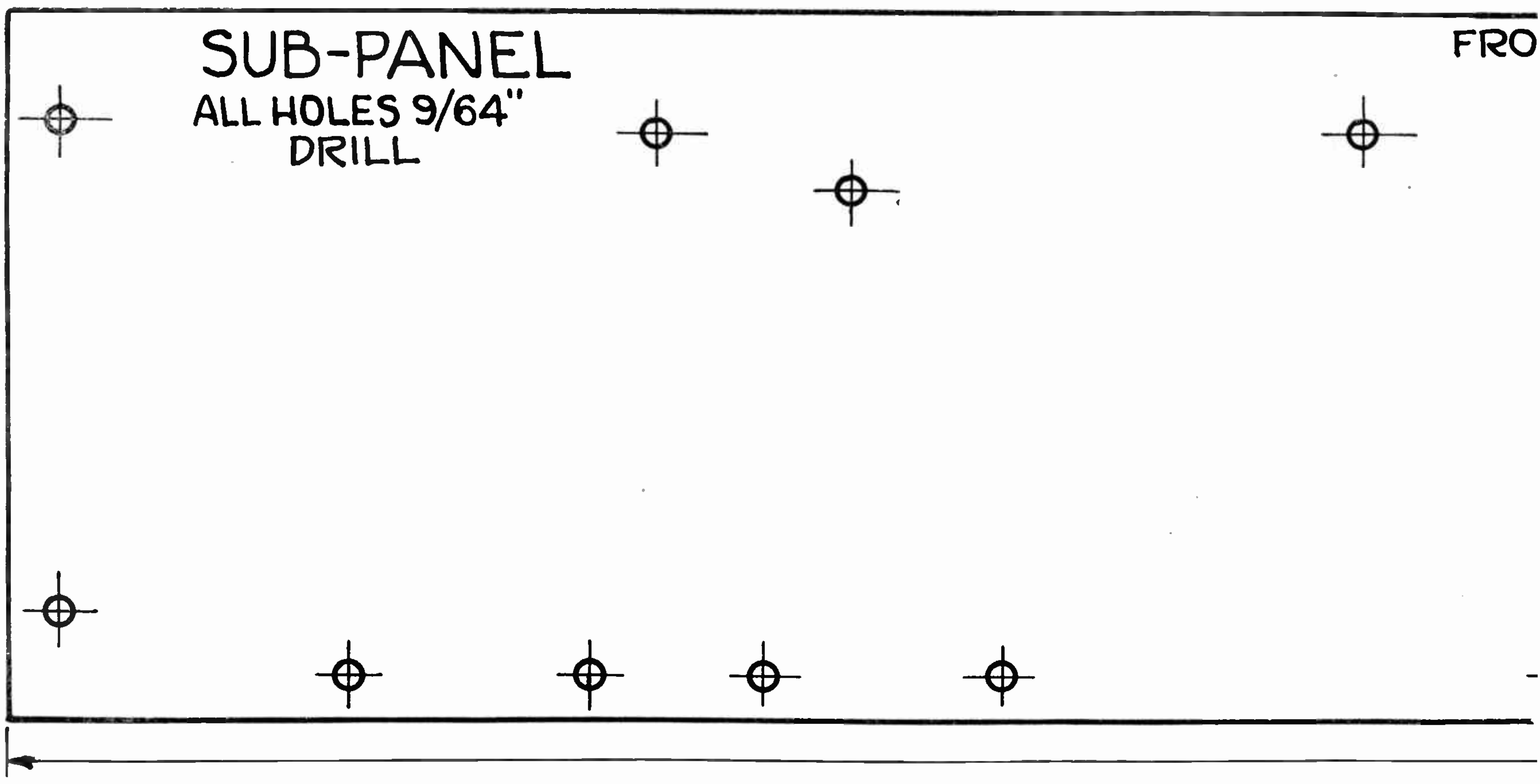
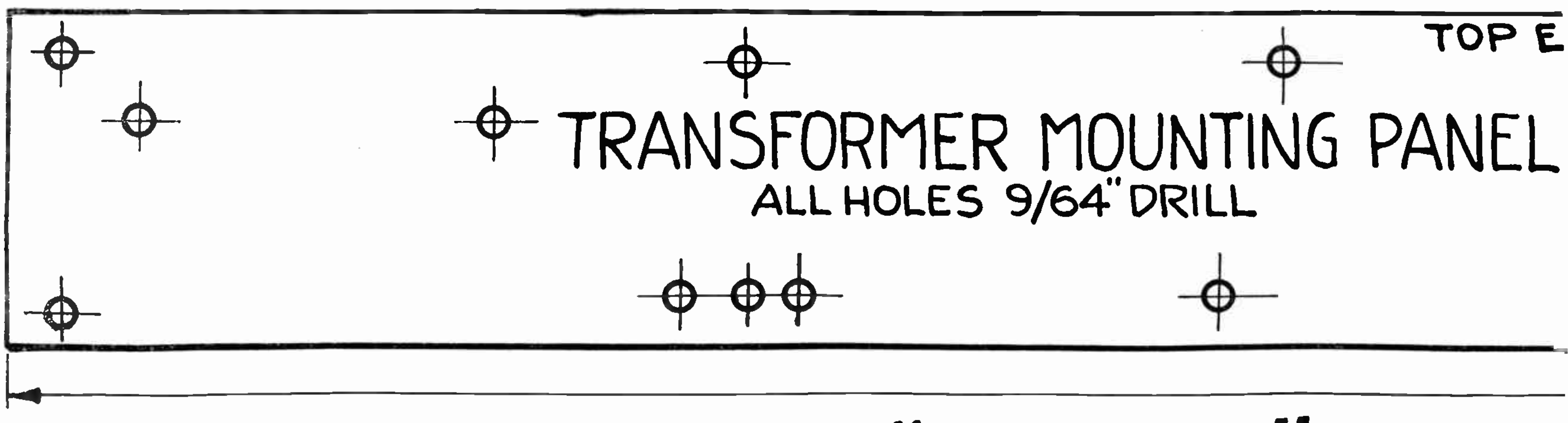


Figure 4

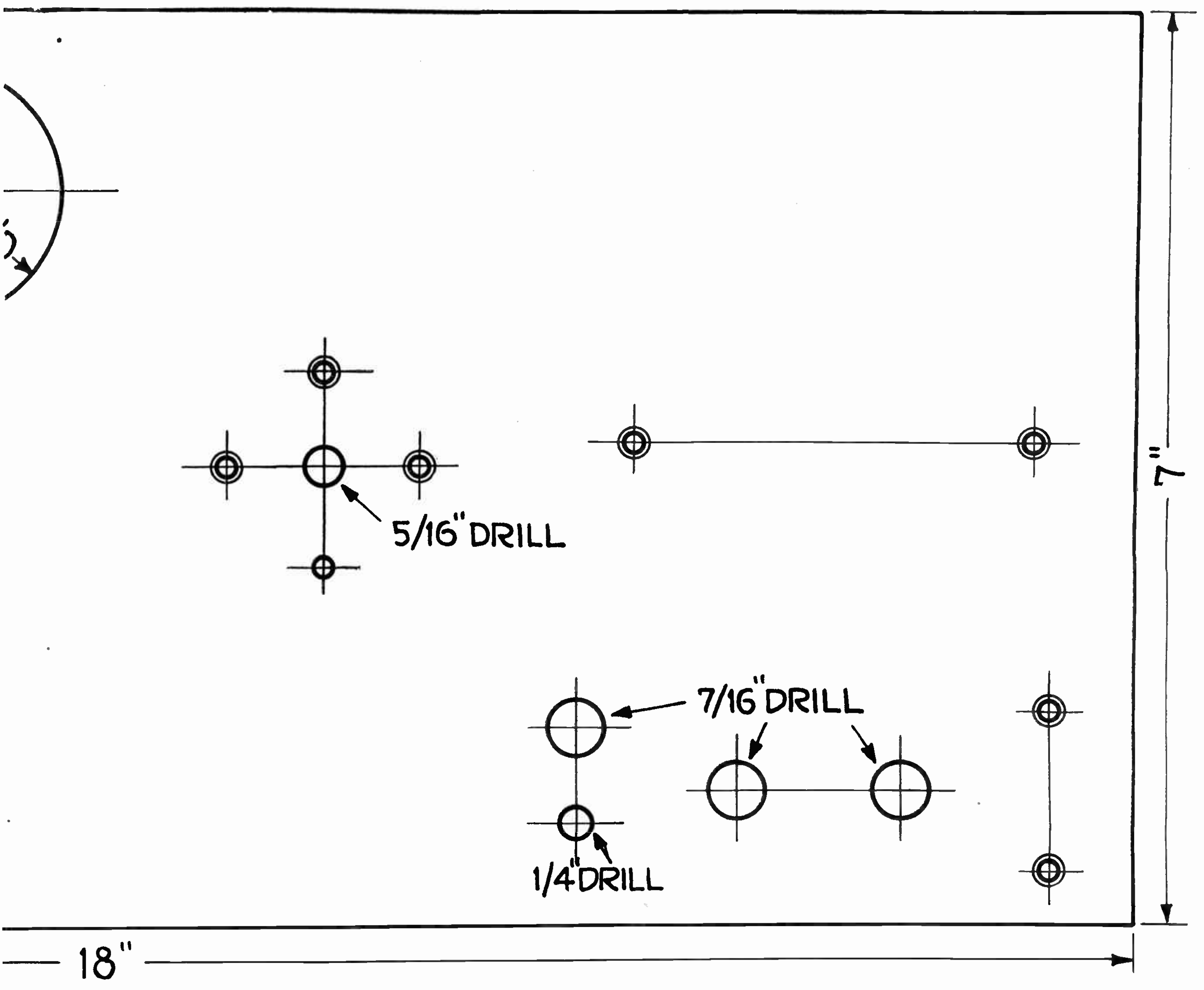


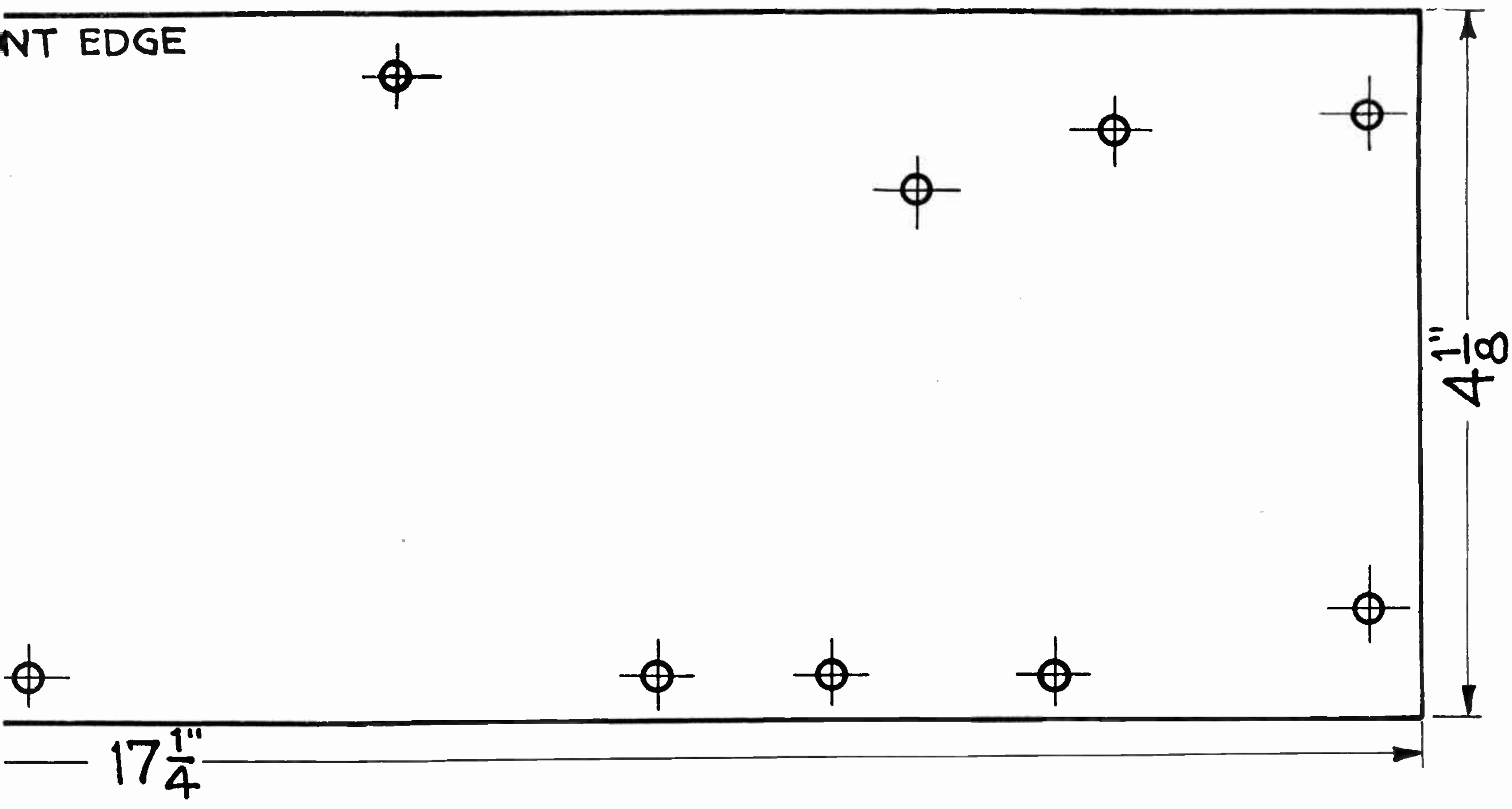


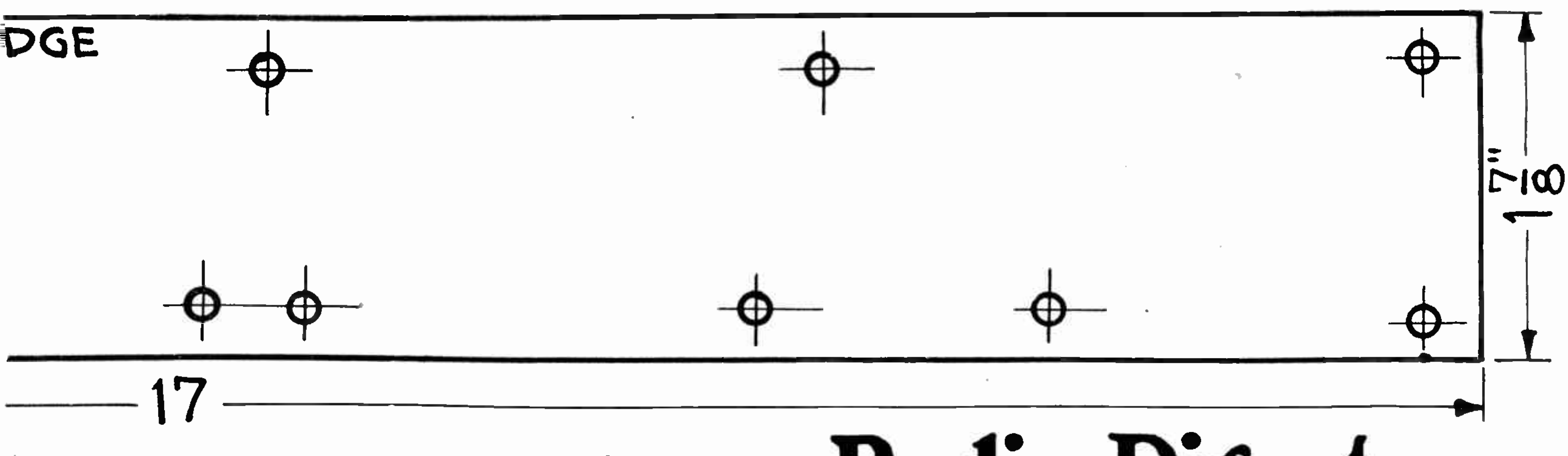


DRILLING TEMPLATES "DX-7" RECE

— DESIGNED BY JOHN G. RYAN —







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Enlarged From **Radio Digest Illustrated** Nov. 28-1925

Drilling the Sub Panel

In studying over the template, the writer noticed two dimensions on the lower part of that drawing were omitted, which are essential to the placing of the transformers. The lower part of that illustration shows the small, vertically placed panel on which the Celco intermediate transformers are mounted and, across the top are four holes 3-1/16 inches apart. No dimension was given as to how far from the top edge they are to be. This distance is 5/16 inch. The four holes near the bottom edge are also 5/16 inch from that edge.

With this lower line drawn on your template, put four more holes on it, in addition to those shown, for the wiring. Working across from the left, the first is to be 4-3/16 inches from the left end, the second is to be 5/16 inch from the first hole. The third goes 6 inches further to the right, while the fourth goes 4⅛ inches from the third. These will, when wiring, pass plate and grid leads. The fifth hole is to be in the upper left corner and ¾ inch from the left edge and ⅝ inch from the top edge. The sixth hole is also ⅝ inch down and is 2 inches to right of the fifth.

Referring now to figure 5, you will note in the lower right corner, quite a vacant space to the right of the last intermediate transformer. The Daven Leakandenser is to be mounted on the back of the transformer strip so that it projects back into that space. The fifth and sixth holes mentioned in the preceding paragraph are used for mounting the two clips with the Leakandenser. The Dubilier 1.0 mfd. bypass condenser is mounted on the front side of the strip, flat against it. Referring to figure 5, the terminals are to the left and one of the mounting lugs is slipped under the nut holding the third intermediate transformer from the left. The Dubilier grid condenser with clips is mounted on the under side of the tube shelf behind the oscillator coupler by loosening the nut on the machine screw which holds the Amperite on the upper side. This Amperite is just in front of the first tube socket from the left, looking at the set from the top with panel toward you. This will put the grid condenser squarely behind the oscillator coupler.

1. The first wire to put in is in the negative filament circuit. With the rear of the set toward you, a wire is put in on under side of shelf from the fourth binding post from the right, going forward between under side of shelf and the transformer strip, then to left until opposite filament switch, forward and down to lower terminal on the switch.

2. From upper terminal of switch proper, next wire parallels the first along under side of shelf but continues straight across to the Amperite at right end. Remember, all directions as to right and left are with rear of set toward you. This wire we are putting in goes up through hole at left end of Amperite.

3. Where wire number 2 passes under right end of the other Amperite, that behind the audio transformer, run a short extension up through hole to the Amperite.

4. On upper side of shelf, run short wire back from left end of left hand Amperite to negative terminal on Benjamin socket nearest to left end.

5. Run short wire back from right end of right hand Amperite to negative terminal on the socket nearest right end of shelf.

6. Where wire number 2 passes back of the rheostat, run a lead from that wire toward panel and down to left terminal of rheostat (still looking at set from rear).

7. From negative terminal of second socket from right end, drop wire through the eyelet and across on under side of shelf to negative terminal of sixth socket. Wire goes up through eyelet.

8. Where this wire passes under the negative terminals of third, fourth and fifth sockets from right, run short wire from it up through eyelet to those terminals.

9. The right terminal of rheostat is to be connected to wire 7 by wire paralleling wire 6 part of the way.

10. Where wires 2 and 6 come together run a wire up through shelf to right end of the C battery (the plus binding post).

11. From left terminal of rheostat run wire straight up to left terminal of potentiometer.

12. From plus terminal of socket at left end of shelf, run wire across in front of transformer strip to plus terminal of socket at right end of shelf.

13. Where wire 12 passes under the plus terminals of the five intervening sockets run a short lead up through each eyelet to the plus terminals of those sockets.

14. On the front end plate of the variable condenser at right end of set just above oscillator coupler, there are two soldering terminals. From the one at left side of plate run wire straight down and back to wire 12.

15. From wire 12 run a wire forward and up to the right hand (plus) terminal of the right hand meter. Run wire across to right hand terminal of the left meter. Run wire down from this last named terminal to the right hand terminal on the potentiometer. From left hand terminal on right hand meter run wire to wire 7.

16. From left terminal on left hand meter run wire down, beneath shelf and back to transformer strip, to left, and back to negative B binding post, fourth from right at rear edge of shelf. (Passes between upper edge of transformer strip and shelf).

17. At top of the combination filament switch and lamp there is a third terminal. Run wire straight back from this to wire 12.

18. The Dubilier fixed .002 mfd. condenser is placed against front surface of transformer strip with terminals vertical so that upper terminal is soldered to the joint of wires 17 and 12. At the same time run short wire to upper terminal of the 1.0 mfd. bypass condenser. From the upper terminal of the 1.0 bypass condenser drop a wire to the hole just to right of the transformer mounting screw, through it and back to the F terminal on the under side of the first Celco transformer to left.

19. Going back to the condenser mentioned in operation 14, put in a wire from the end plate terminal at right down to the F terminal on upper side of oscillator coupler.

20. From the L terminal next to it, put in wire going back under shelf to the center of the three loop binding posts, the second from the right at rear edge of shelf.

21. From the soldering terminal on back stator plate of the condenser at right end of set (still looking at it from rear) drop a wire to G post on upper side of oscillator coupler and continue it back under shelf to left end of the Dubilier grid condenser with clips, which has been secured to under side of shelf.

22. On under side of oscillator coupler is a C terminal. Wire is to be put in from this post, across to left close to front edge of shelf and then up in front of shelf to the F terminal of the Erla audio frequency transformer. Where this wire passes under the left end of the C battery, connect a wire from it, up through hole in shelf to the binding post at left end of C battery.

23. The next wire is to go from the right end of the Dubilier grid condenser, referred to in operation 21, toward the rear on under side of shelf and up through eyelet to the G terminal of the first socket at right.

24. From the P terminal of this same socket, drop wire through eyelet, then forward and down to P terminal on the under side of the oscillator coupler.

25. This next wire is to be a long one starting at the B terminal, also on the under side of the oscillator coupler, straight back through hole provided in transformer strip, then to left about ½ inch behind strip to the B terminal on the last Celco transformer to left.

26. Where wire 25 passes the B terminals on the under sides of the other three transformers connect wire 25 with those terminals by short 1-inch connectors.

27. Plate of the second tube from right is to be connected to the rotor (lower) terminal of the Gleason midget condenser.

28. Where wire 27 comes down through eyelet, and on under side of shelf, put in a short wire to the left to the P terminal on upper side of first Celco unit.

29. Also on the upper side of that Celco unit is a G terminal. Connect with G terminal on third socket by short wire running up through eyelet.

30. Connect P terminal of second Celco to P terminal of third socket. Connect G terminal of second Celco to G post on fourth socket. Connect P terminal on third Celco to P terminal on fourth socket. The G terminal of this third Celco goes to G post on fifth socket. The P post on fourth Celco goes to P post on fifth socket.

31. The G terminal of the fourth Celco is handled differently. From it a wire goes straight forward to the transformer shelf, then to left to the left terminal of the Leakandenser.

32. From the right terminal of the Leakandenser pass a wire to the right and up through the eyelet of the G terminal of the sixth socket.

33. There are three loop binding posts on rear right corner of shelf. From the one nearest to right end run a wire to left about ¾ inch and forward so it passes under G terminal of second socket, then to the left until under a point midway between the fourth and fifth sockets. Then bent forward passing between top of strip and under side of shelf until in front of shelf, then up to the right hand terminal on the back plate of the left hand variable condenser. Put in a short wire connecting this last wire with G of second socket.

34. The third of the three loop binding posts is to be connected, by a wire running to the left and forward, to the upper terminal of the Gleason midget and the wire is continued forward and then to the left to the right hand terminal on the front plate (the heavy plate close to panel) of the condenser mentioned in operation 33.

35. We go now to the jack with four springs and four terminals which is the one next to the switch. The upper terminal is connected to the P terminal of the sixth socket.

36. The next spring connects to the P terminal on the Erla transformer.

37. Third spring is to be connected to the B post on the Erla unit.

38. The fourth or bottom spring goes to the next to the last binding post from the left end of the row in back. In the beginning of this article, when discussing the assembly, the copy read to put plus 90 binding post in this position and plus 45 at the end.

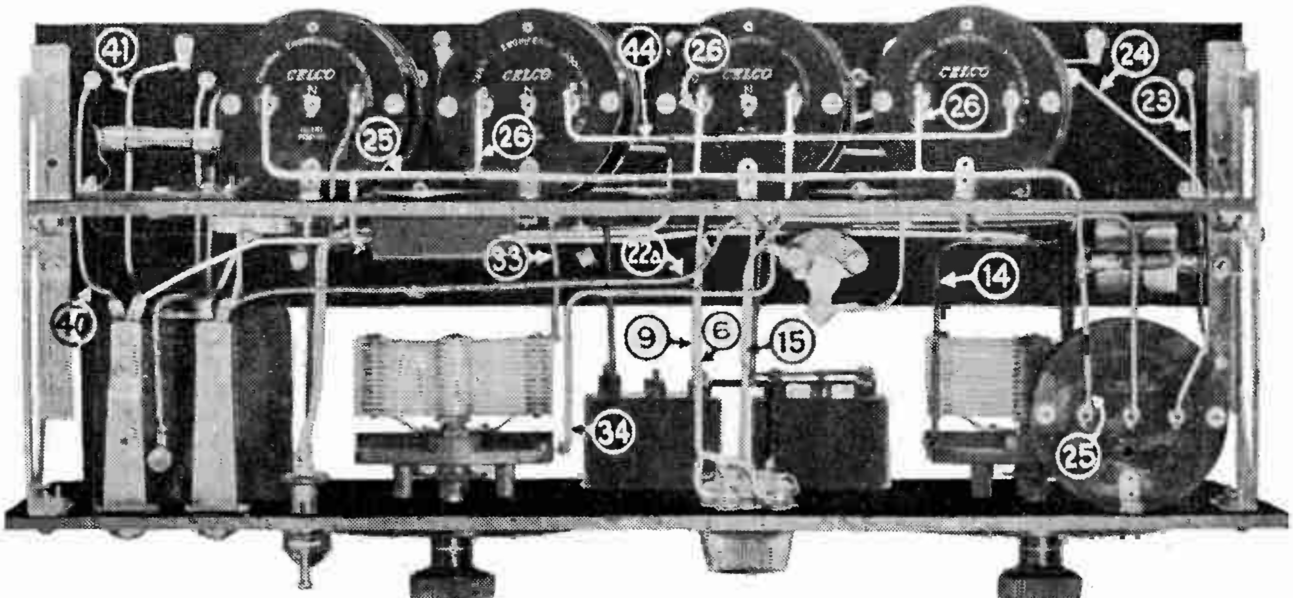

Figure 5

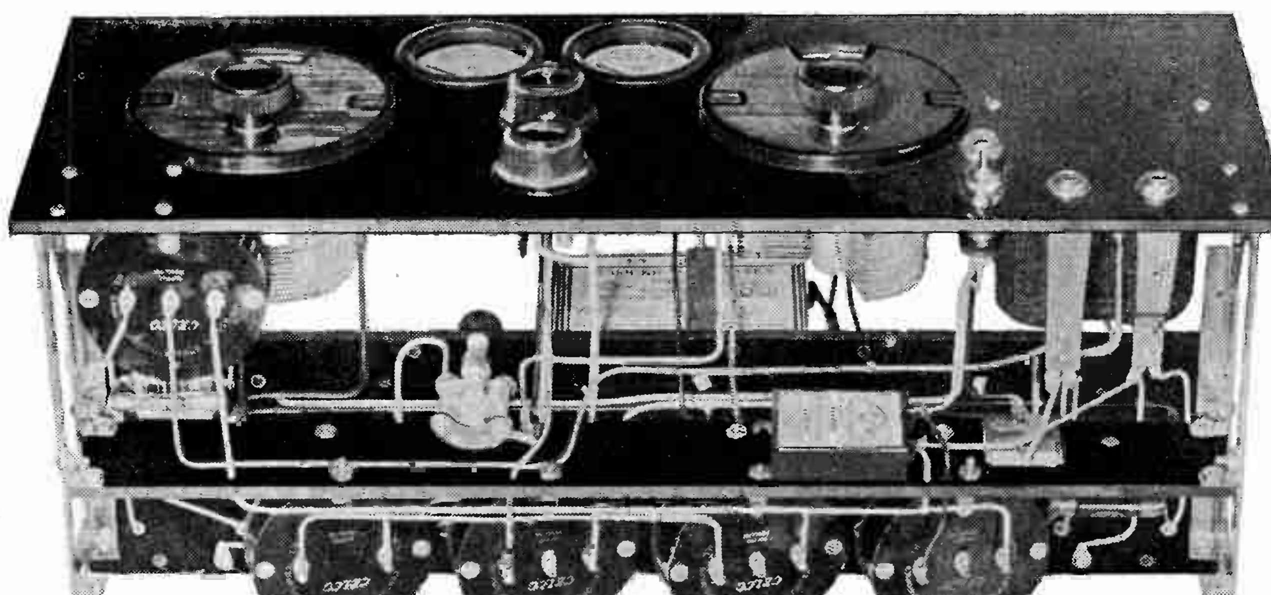

Figure 6

This was a typographical error which can easily be rectified by switching posts if they are engraved, putting + 90 at end.

39. Going back to the upper terminal of this jack mentioned in operation 35, drop a wire to the lower terminal of the .002 mfd. fixed condenser.

40. The upper terminal of the two terminal jack at the left end is to be connected with the P terminal of the last socket at the left.

41. The lower jack terminal connects to the last binding post at the left, plus 90.

42. A short wire is to go straight back from the lower terminal of the 1.0 mfd. bypass condenser, through the strip to wire 25.

43. From that same lower bypass condenser terminal run a wire to the left to the lower terminal of the end jack.

44. On the under sides of the first three intermediate transformers to the right is an F terminal. Connect the F terminals on the first and third.

45. Now run a wire forward from the F post on the second one, through the strip until almost at the front panel, then up to the center post on the potentiometer. Where it crosses the wire connecting the F posts on transformers 1 and 3, solder it to that wire.

46. Connect G terminal of last socket to left with G post on Erla transformer.

Presuming that the reader has assembled the DX-Seven as described, and wired it carefully following the instructions, we are now ready to connect the accessories to this set and adjust it for best operation.

Any good make of loop antenna may be used, the only special requirement being that it have a center tap, although any loop can be altered to provide this arrangement if the user will count the number of turns, find the center turn, and solder on a lead at that point. The Aero and the Lincoln loops, both of which are advertised in Radio Digest, will work very well on this set, and the writer can also personally recommend Ajax and Volumax loops

Connecting Accessories

The storage battery, also known as the A battery, is provided with two terminals—the negative and the positive. The positive terminal may be identified either by the letters "POS" stamped into the case close to the terminal, or with a + sign, or by a touch of red paint on the terminal itself.

Looking at the receiver from the rear, the fourth binding post from the right is to be connected to the positive terminal, and the fifth binding post is to be connected with the negative terminal of the storage battery.

The B batteries for use with this set may be either the storage battery or the multiple dry cell types. In either case two units of 45 volts each are required, and each unit will have a positive and a negative terminal. The negative terminal of one is to be connected to the sixth binding post, and the plus terminal of that same unit is to be connected to the seventh binding post and also to the negative terminal of the second 45-volt unit. This leaves only a positive terminal unconnected on the second B unit, and this goes to the eighth binding post at the rear of the set.

The two end terminals of the loop aerial are connected to the first and third binding posts near the right end of the set, while the center tap goes to the second binding post.

The loud speaker is provided with a long cord, at the end of which are two nickeled terminals known as phone tips. These are to be inserted in what is called a phone plug, by which the speaker can be connected to the set by inserting the phone plug in either of the two jacks at the lower right corner of the front panel. For this initial tryout we will insert it in the second jack, which is that closest to the right edge.

Seven hard tubes of the A type are used on this set, and these should now be inserted in the sockets, which is accomplished by pushing straight down and then giving a slight twist to the right. The filament switch is now pulled out, and the small lamp which is part of this set should light up. The rheostat, which is the lower of the two small knobs below the meters, should now be turned to the right as far as it will go and then slightly back so the tubes will be lit nearly but not quite to maximum brilliancy.

Preliminary Operations

The potentiometer, which is the upper of the two knobs just below the meters, should now be turned pretty well over to the left, although the best position for this instrument cannot be determined until we have tuned in a station.

Tuning is accomplished by means of the two Mar-co dials attached to the variable condensers. That at the left controls the frequency of the oscillations developed by the oscillator tube, while the dial at the right controls the condenser across the loop antenna and permits variation of the tuning of the loop antenna circuit, so that the loop circuit will be adjusted for the reception of any wave length between 200 meters and 550 meters.

Tuning the DX-Seven

As a starter try setting the right hand dial at 40 and swing the left hand dial slowly back and forth between 20 and 60. After you have done this once or twice and no signals are heard, shift the position of the potentiometer knob slightly either to the left or right and again revolve the left dial. This may have to be tried three or four times before a signal will be brought in.

The voice or music will be heard faintly at first, and the volume can be increased on slight readjustment of the right dial, and also careful adjustment of the potentiometer. After the program has been brought to maximum strength by these refinements, try adjusting the rheostat and the potentiometer together. A combination of their settings will be found which gives maximum volume and quality.

The potentiometer can be turned too far to the left, in which case there will be distortion, and it will have to be brought back slightly. Once the correct combination has been found, further adjustment of these two knobs should not be necessary.

Perfecting Resistor Values

While a resistor of .05 megohm was specified for use in the grid circuit of the oscillator tube, this value was presented as the correct average value after a long series of tests with different tubes. It may be that your particular oscillator tube would work better with a cartridge having a value of .1 or .025 megohm resistance.

In no case was it found possible to use a resistor having a value of .25 megohm, and the use of this cartridge caused all signals to stop at once.

You can either shift your tubes around in the sockets in an endeavor to find one that works best with the .05 cartridge, or you can purchase the other two values mentioned, namely, the .1 and the .025 megohm resistors, and try them with the same tube.

The only other unit about which there might be any question is the 5-megohm leakandenser. This was specified by the writer after a great deal of super-heterodyne experience as the most used value for a grid leak in that position. Here again you have the option of shifting tubes to find the one which will work best as a detector with that particular leakandenser, or purchasing additional cartridges of 4-megohm and 7-megohm values. It is highly probable, however, that you will secure most excellent results with the value specified.

C Battery Voltage

The writer has not as yet seen a model of this set nor a combination of tubes used in one of these sets where there was any advantage in using other than the full 7 ½ volts supplied by the C battery. The use of a lower voltage merely increased the current draw from the B batteries, as indicated on the milliameter, and cut down the volume. The use of any more voltage gave no increase in either range or signal strength, and gave only a very slight decrease in B battery current consumption.

After you have chosen the best tube of those which you have for use as second detector and as oscillator, the remaining five tubes should be shifted around a bit in their sockets to determine the three which are the most closely alike in their characteristics for use in the third, fourth and fifth sockets, in which case they are known as the intermediate frequency amplifiers. After that has been determined by carefully observing the range and volume with different combinations, you should determine which of the two remaining tubes makes the best first detector or mixer in the second socket.

In this matter of socket position the writer is considering the set as viewed from the front. The remaining or seventh tube is, of course, used in the seventh socket as the audio frequency amplifier.

Logging Stations Received

For each position of the right dial or loop dial at which a signal is brought in with maximum strength there will be found two corresponding positions on the left or oscillator dial. This is always the case with super-heterodynes, as the generated frequency heterodynes the incoming signal at a predetermined frequency difference either above or below the frequency of the incoming signal. If, for example, intermediate transformers are adjusted to pass a frequency of 40,000 cycles, and the incoming signal has a frequency of 1,000,000, signals will be heard when the oscillator system is adjusted to give either 960,000 cycles or 1,040,000 cycles.

It would be a good idea, after about five stations have been tuned in and the dial settings noted, to obtain a piece of graph paper and plot the wave lengths indicated across the bottom line of the sheet and condenser settings on the left edge of the sheet, with zero at the bottom.

Making Curves of Dial Settings

Thus, when you have a station you can determine the wave length used by that station from the directory in Radio Digest, and locate this wave length on the bottom line of your graph paper. Since you have determined the condenser settings at which you receive that station, move your pencil up from the bottom edge on the correct wave length line until you reach the horizontal line corresponding to the dial settings.

You will thus have three intersection points for each station, and after about five stations have been brought in you will find that three long lines can be drawn through your triplets of dots, one of which will give you the loop setting for any wave length, while the other will give you the upper and lower oscillator dial setting for any wave length. These lines are known to Radio men as curves, and from them the tuning up of other stations is easy.

On local stations it may be found desirable to insert the phone plug attached to the speaker in the first jack, as the volume may be too great when used in the second. You may also prefer to tune for distant stations with a pair of head receivers, which it will be found better to use in the first jack.

Do not forget that the loop antenna is directional, and that the plane of the loop must be parallel to the direction of the station from the point where you are located for maximum energy pickup from that station. The loop will not pick up energy from a station located in a direction at right angles to its plane. City dwellers will find that steel buildings will deflect the path of the energy, so that while a station may in reality be northwest of you, the loop may have to be pointed east and west for best reception of that station.

One might even be so surrounded by steel buildings that all stations come in with the loop in but one plane. In other words, it may be perfectly audible from all directions with the loop pointing northeast and southwest.

The writer regrets that he cannot give you a definite value for the two resistor cartridges mentioned, but until the happy time when all tubes are exactly alike in their characteristics, such direction would be impossible. On all other points, however, the directions given are best, and if you have followed them carefully you cannot go wrong.

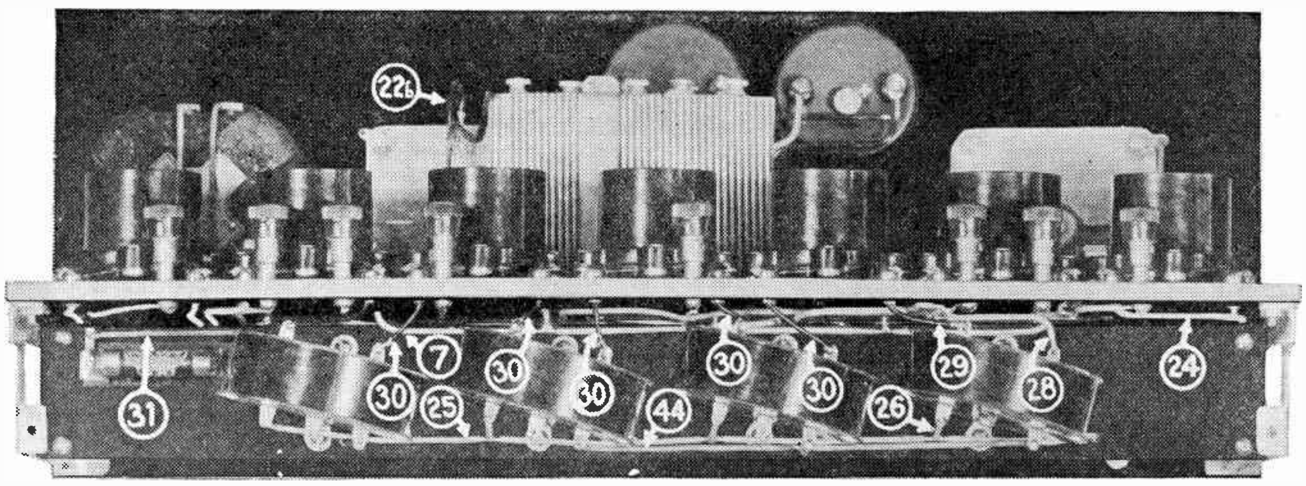

Figure 7

Construction, Traveler Five Tube

(Continued from page 50)

These figures will depend, of course, on the tubes, the battery lighting them and the B batteries.

Increasing Selectivity; Tone Quality

If one has trouble with selectivity and either cannot separate two locals completely or cannot break through them to get out of town, shift the flexible aerial lead to the other A point.

If one still has trouble in securing selectivity even on the better of the two, the antenna length must be cut down about 10 feet and, if originally over 110 feet including lead-in, may have to have two or three 10-foot pieces chopped off.

Another alternative is to take the flexible lead from the antenna binding post and solder it to a .00025 mfd. fixed condenser, the other terminal of which is to be soldered to the antenna binding post.

There should be no trouble with clarity of programs. The writer had none and the builder should have none either. However, it is possible that a slight blurring on strong signals may be noticed. In this case, try connecting a fixed condenser of a size between .00025 mfd. and .001 mfd. across either audio frequency secondary or the second audio primary. If a fixed grid leak cartridge and its clips are around, results can sometimes be improved by connecting it across any of the pairs of terminals just mentioned.

Surprise—Using a Loop

No mention has as yet been made of the use of the left jack, which, in the circuit, is placed between the first Thorola and the first variable condenser. It was saved as a surprise feature.

A loop antenna can be used on this tuned radio frequency set, due to the fieldless coils. This has been impossible on neutrodynes and most tuned radio frequency sets because of interaction between the loop and the coils. The first question is, "Can you get out of town on the loop?" to which the answer is that you certainly can, in any location but a steel building or a house badly shielded by a large steel apartment building or factory next to it.

When the air is comparatively static-free and DX good, use the outside aerial. When the conditions are good for long range but there is considerable static, use the loop. If there is a particularly wonderful musical number on some nearby station and you wish it absolutely clear of all interference and static, use the loop.

Construction Simplest Possible Super-Het

Efficient Inexpensive Seven Tube Receiver

THERE have been many articles published in Radio Digest and other Radio magazines on super-heterodynes—long sets, short ones, high panels, deep baseboards, many controls, two controls, one stage of audio, two stages and push pull, preceded by straight R.F., and even reflexed. Fans have built them, some with success and some with nothing to show except a lot of parts and a feeling of disgust. The general reaction has been a demand for something simpler—for a set that the average man, not an engineer or even an advanced experimenter, could construct and operate successfully. To which one might well reply, "Well, don't build a super. Construct something with less tubes and less necessity for accuracy." Which is all very well but the fact remains that everyone seemingly wants a super-heterodyne this year and nothing else will do.

With all this in mind, Radio Digest began looking around for a super that would fill the bill, one that would combine good looks and efficiency with low first cost and ease of assembly, with the emphasis on the last point. With the "simplest possible" thought in mind let us consider what is essential to a super-heterodyne. This type of receiver was developed to get around certain inherent disadvantages of vacuum tubes as they are now generally constructed. Tubes do not efficiently amplify or build up incoming Radio waves at the comparatively low wave lengths used by Radiocasting stations. We therefore, with another tube, create a new stream of energy at a wave length closely approximating that of the incoming program. The two are mixed together and create a new wave length which is much longer and far more efficiently handled by the tubes.

Essentials of a Super-Heterodyne

This is the principle involved; now for the essentials. First of all, there must be a means of tuning the loop aerial, which is all the antenna necessary with a super. This means of tuning is a variable condenser, the usual size being a .0005 mfd., often known as a "twenty-three plate." It is mentioned above that one of the tubes creates a stream of energy. This tube is known as the "oscillator" and some means of varying the frequency of the energy developed must be provided, so that this frequency will always have a certain predetermined relationship to any incoming signals, no matter what their wave length. For this purpose, too, we use a variable condenser, also of .0005 mfd., capacity. With this oscillator condenser is also used an oscillator coupler. This circuit must contain inductance, so this coupler provides grid circuit inductance, a plate circuit "feedback" coil and a small coil to be hooked into the grid circuit of the "mixer" tube and so combine the frequencies.

Having mixed the frequencies, we are now ready to amplify them and the question immediately comes up of how many amplifier tubes to use. It has been found good practice to use three; more than this brings the signals up to a volume too great for the average detector to handle while less than this would be not taking advantage of all the strengthening possible. Some means of coupling tubes together is always necessary and transformer coupling has been found both simple and satisfactory. So, we couple the tube in which the waves were mixed to the first amplifier with a transformer, which is known as a "filter coupler," because, since one winding of this transformer is tuned with a fixed condenser, the transformer has the property of filtering the wanted from the unwanted and passing only the former.

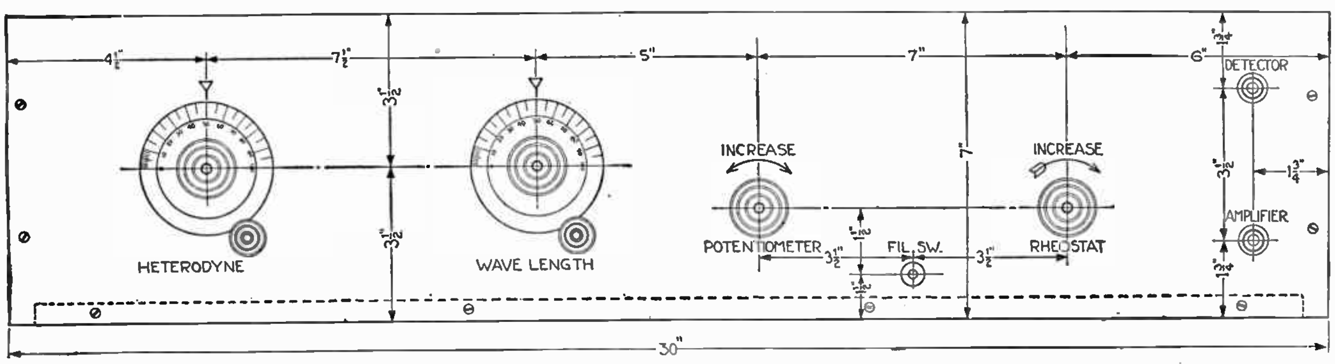

Figure 1

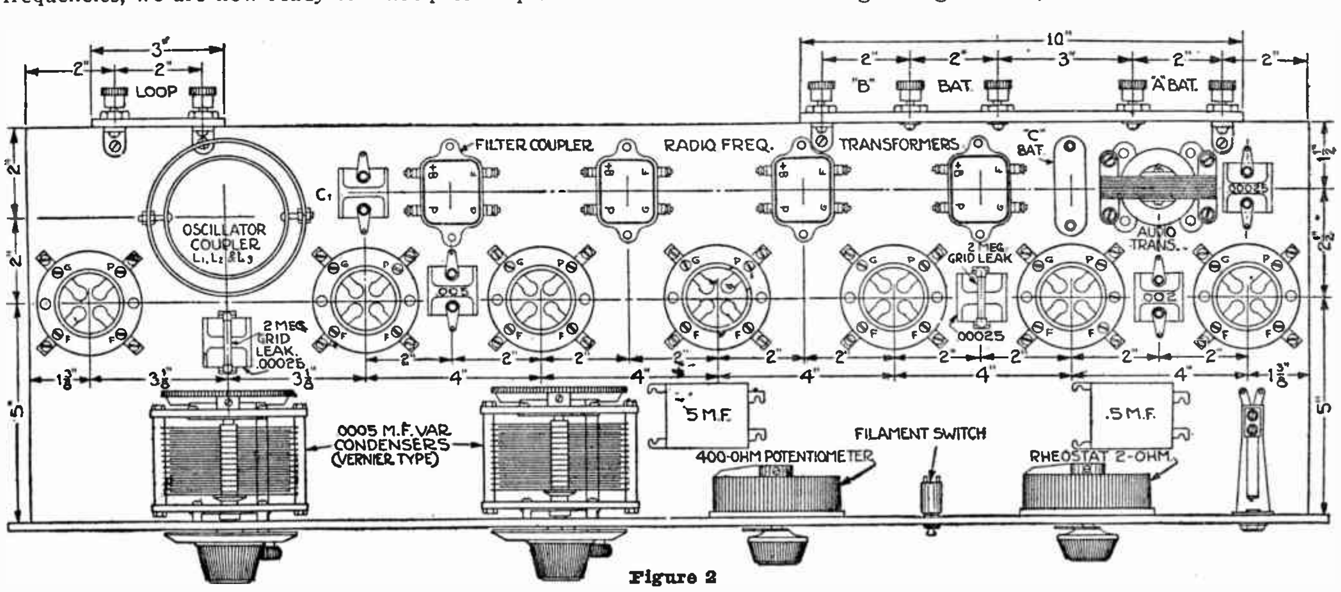

Figure 2

The list prices and names of the manufacturers of the apparatus used are given in the list of parts. The cost of the parts required will approximate $80.00

Transformers Used

The transformers used to couple the first amplifier to the second and the second to the third and the third to the detector, are not tuned in either winding and are therefore known just as long wave transformers. One thing is important with regard to them, however; their "peak efficiency" must be fairly closely matched and must exactly coincide with the single narrow wave band that is passed by the filter circuit. Every untuned transformer amplifies one particular frequency, or narrow band of frequencies, much better than it does the others over the range of wave lengths it will pass. For example, while our long wave transformers will pass frequencies included in the wave length range 5,000 to 9,000 meters, the voltage amplification at 7,000 meters is much greater than that at any other wave length, and falls off rapidly on each side of this point. This point is known as the "peak efficiency," and since we naturally want all the strengthening possible, our filter coupler is designed to pass this wave length and we mix the incoming with the oscillator frequency to produce it.

In order to separate the audio frequency component of our energy from the radio frequency current, a detector is necessary, so the signals are passed from the last radio frequency amplifier stage through one of the long wave transformers into a vacuum tube equipped with grid leak and grid condenser and operated to rectify and detect instead of amplify. Since the Radiocast energy has been so tremendously increased by our three long wave radio frequency amplifiers, it enters and leaves the detector so strong that only one stage of amplification at audible frequencies is necessary. This single tube is coupled to the detector by an audio frequency transformer in the usual way now familiar to most fans.

List of Parts

2 Benjamin .0005 Variable Cond.	Benjamin Elec. Mfg. Co., Chicago	$10.00
2 Mar-co Vernier Dials, nickel	Martin-Copeland Co., Providence, R. I.	5.00
1 General Radio 2-ohm Rheostat	General Radio Co., Cambridge, Mass.	2.25
1 General Radio 400-ohm Potentiom.	General Radio Co., Cambridge, Mass.	3.00
1 C-H Filament Switch	Cutler-Hammer Mfg. Co., Milwaukee	.60
1 Yaxley double circuit Jack	Yaxley Mfg. Co., Chicago	.80
1 Yaxley open circuit Jack	Yaxley Mfg. Co., Chicago	.50
7 Benjamin "A" type Sockets	Benjamin Elec. Mfg. Co., Chicago	7.00
1 Qualitone Super Kit	Home Radio Co., Chicago	22.50
1 Karas Audio Transformer	Karas Elec. Co., Chicago	7.00
2 Daven Leakandensers, 2 megohms	Daven Radio Corp., Newark, N. J.	2.00
2 Sangamo .5 mfd. Bypass Cond.	Sangamo Elec. Co., Springfield, Ill.	1.80
1 Sangamo .0005 Fixed Cond.	Sangamo Elec. Co., Springfield, Ill.	.35
1 Sangamo .005 Fixed Cond.	Sangamo Elec. Co., Springfield, Ill.	.60
1 Sangamo .002 Fixed Cond.	Sangamo Elec. Co., Springfield, Ill.	.40
1 Sangamo .00025 Fixed Cond.	Sangamo Elec. Co., Springfield, Ill.	.40
1 Formica Panel 7 by 30 by 3/16	Formica Insulation Co., Cincinnati	4.20
1 Wood Baseboard 9 by 29 by ½		1.00
7 Binding Posts		.70
Miscellaneous, such as bus bar, screws, spaghetti, etc.		2.00
1 Cabinet 7 by 30 by 10		10.00
	Total Cost	$82.10
1 Storage Battery, 6 volt, 100 A. H.	The Prest-O-Lite Co., Cincinnati	
2 B Batteries 45 volt, large size	National Carbon Co., N. Y. C.	
1 C Battery, 4.5 volt	National Carbon Co., N. Y. C.	
7 Vacuum Tubes, amplifier type		
1 Loop Antenna	Ajax, Lincoln, Aero, Volumax	

Two Tuning Controls

On the panel then, we require only two tuning controls, the variable condensers and two subsidiary controls, but seldom touched, the potentiometer and rheostat. Considerably better selectivity will result if variable condensers of the low-loss type are used, with metal end plates and small strips of insulating material supporting the stator. Within the set we need seven tubes, namely, the first detector or "mixer," the oscillator, three amplifying at radio frequencies, a second detector and one amplifier at audio frequencies. Due to the necessity of matching, certain parts of super-heterodynes are sold as a kit, which usually includes an oscillator coupler, a filter coupler and three long wave transformers. There may be other incidentals included such as large capacity condensers; if so, they need not be purchased separately. These kits may be designed to pass a wave length of 2,300 meters, 3,500 meters, 4,600 meters, 6,100 meters, 8,300 meters and even 10,000 meters. Qualitone kit parts are shown in the illustrations. The oscillator coupler may not look like that in the drawing but this point makes no difference as many very excellent couplers are entirely enclosed and do not have a variable rotor as did this one. Too much stress cannot be laid on the use of highest quality, mica dielectric fixed condensers, as the writer has found that these condensers are second only to the matching of transformers in importance.

Panel and Baseboard Layout

Laying out the apparatus on panel and baseboard is the first thing to be done. It is most advisable to lay out everything on paper first and use the paper layouts as templates for center punching and drilling. The panel layout shown in Figure 1, should be made full size with the center holes indicated. Condensers and potentiometers and rheostats are usually provided with templates for the mounting holes, so these smaller templates are pasted on the sheet of paper with shaft center holes carefully placed over the centers indicated in Figure 1. Shielding has not been found necessary in this set, so there are no shield holes to worry the constructor. A similar procedure is followed with the baseboard; only center holes are shown in the baseboard layout. The builder can easily place the parts on the paper layout and determine the exact points for mounting screws. It will be well worth while to exercise some care in choosing a baseboard; pick one that is absolutely flat to begin with and made of a wood that you know is not so likely to warp. Half-inch veneer, made of thin laminations, can be obtained at any lumber yard, and while harder to put screws into will always look well and stay flat.

Some slight shifting of parts may be necessary due to the difference in sizes of different makes of apparatus. For example, the transformers may be considerably larger than those used in the set built by the writer, and the tube sockets may all have to be moved forward half an inch or so. Similarly, if a large C battery is to be used, it may suit the builder to move the audio frequency transformer and the .00025 mfd. condenser slightly to the right, which may be done without affecting the working of the set in any way. However, the fan will find a full size drawing in the back cover with center holes marked, a decided help as a starting point, and will probably be able to follow is exactly.

Wiring Instructions

In wiring this receiver, the first leads to put in are the filament connections. Looking at the layout, Figure 2, the binding post furthest to the right at the rear of the baseboard is the minus A; a soldering lug is slipped under the head of the screw holding it in place. A piece of bus bar wire is now bent so that it will go around to the right of the last tube socket and then to the left to the filament switch. Slip a piece of spaghetti tubing over this lead and solder one end to the lug on the binding post and the other to one of the switch terminals.

Now lay a piece of bus bar along the front edge of the tube sockets; if it will not reach from socket 1 at the left to socket 7, solder on another short piece so that it will. Put a soldering lug on each right front binding post on each socket and bend them down at an angle. Solder one end of the long piece of wire to the lug on the first socket to the left, then cut a piece of spaghetti just long enough to reach from that point to the corresponding post on socket 2. Solder the long piece to that lug and slip on a second piece of spaghetti to cover the wire to the front right post on socket 3. Proceed across the board until each socket has the corresponding filament binding post soldered to the long lead with spaghetti between. A short wire is now bent and soldered to the long lead where it is attached to socket 5; the other end is soldered to the second filament switch terminal. That completes the negative A circuit.

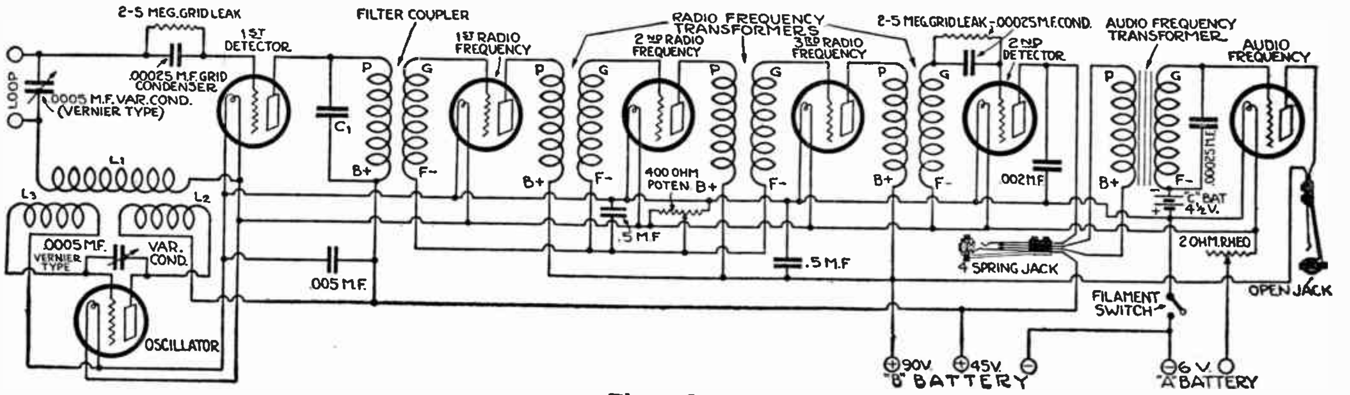

Figure 3

The Positive Circuit

The binding post at the back of the set and second from the right is the positive A. A wire is bent to pass between the audio frequency transformer and the C battery, then to the right of socket 6, over the .5 mfd. fixed condenser, to the rheostat. Slip spaghetti over this wire and, using soldering lugs, attach to the plus A binding post and to the rheostat. A long piece of bus bar is now connected to all sockets to the front left hand binding posts exactly as was the other except that the soldering lugs on the sockets are bent up. This will place the second long filament wire directly above the first.

Now run a short spaghetti-covered lead from the remaining rheostat terminal to this upper filament bus at the point where it connects to the left front post on socket 6 (counting from the left). The filament circuit is now complete and may be tested. Connect the 6-volt storage battery to the terminals marked "A Bat." Put all tubes in the sockets, turn the filament switch to "On" position and turn up the rheostat slowly. The tubes will glow dimly at first and, finally, with some brightness. If all tubes light, remove them and disconnect battery.

The potentiometer is now connected by running a short lead from its left binding post to the lower filament bus where it is attached to socket 4, and another

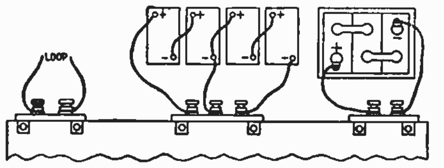

Figure 4

from its right terminal to the upper bus where it is soldered to the front left binding post on socket 5. Each wire should be bent, covered with spaghetti and attached to a soldering lug. This leaves the center terminal to be connected later.

The Oscillator

We will now take up the oscillator tube, coupler and condenser. It is usual for the manufacturers of super kits to enclose a diagram showing the proper connections for the oscillator coupler, and every builder will probably have such a diagram. The coupler shown was made from a 180 degree variocoupler on which the outer tube is 3½ inches in diameter, wound with two separate coils of number 24 silk covered wire. One winding contains 18 turns and the end nearest the edge is connected to grid (G) binding post of tube socket 1 and the stator (fixed) plates of the variable condenser at the left end of panel. This is inductance L-3 in the wiring diagram Figure 3. The end in the middle of the tube is connected to the right front binding post of socket 1 (the lower filament bus). The 8-turn coil is wound beside the 18-turn coil. Since all couplers are not provided with a 3½-inch stator, the following deviations may be necessary: On a 4-inch stator wind the coils with 16 and 7 turns, on a 3-inch stator wind them with 21 and 9 turns.

The end of the 8-turn coil (L-1) nearest the second edge of the tube is now connected to the movable or rotor plates of the second variable condenser and to the right binding post of the two marked "Loop" at the rear edge of the baseboard. The inner end of this 8-turn coil is connected to the plus filament circuit at the point where the upper filament bus connects to the left front post on socket 2. The rotor of this oscillator coupler is 3 inches in diameter with 22 turns of number 24 silk covered wire. One end of this winding is connected, using a short piece of flexible and a piece of spaghetti-covered bus wire, to the rotor plates of the left hand variable condenser and to the terminal on socket 1 marked P. Here again your rotor may differ from the rotor on the writer's coupler. On a 2½-inch rotor use 24 turns, on a 3½-inch rotor use but 20.

A long piece of wire should now be bent so that, when one end is connected to the second terminal of this inner coil, the wire will lie close to and in back of the filter coupler and about 1 inch behind the radio frequency transformers along the rear edge of the baseboard. A short piece of flexible covered wire will, of course, have to connect this wire to the rotor so that the rotor can be turned. A soldering lug is slipped on the terminal of the filter coupler marked B plus and this long wire is soldered to it. Spaghetti is slipped over this long lead and the free end is soldered to a lug on the center post of the three marked "B Bat." Another wire is bent so that it passes from this last-named binding post, between the third radio frequency transformer and the C battery, behind socket 6, then diagonally forward and to the right over the .002 condenser to the longest spring on the upper jack. Slip spaghetti on this lead and solder to the center B battery post and the long spring on the jack.

It will be noted in Figure 2 that a fixed mica condenser of .005 mfd. capacity is placed between sockets 2 and 3. The rear terminal of this condenser is now connected to the B plus binding post on the filter coupler. At the same time it would be well to connect the rear terminal of condenser C-1 to the B plus terminal of the filter coupler. The front terminal of the .005 condenser is connected to the lower (negative) filament bus wire where it is soldered to socket 2.

The Intermediate Amplifiers

A long lead is now bent from bus bar so that, when one end is at the B plus terminal of the first radio frequency transformer, it lies in back of the radio frequency transformers, but close up against them and ends at the first or left hand post of the three marked "B Bat." A soldering lug is slipped on each of the B plus terminal on the radio frequency transformers and the long wire just placed is then soldered to these lugs and to the B battery post, with spaghetti between joints.

Slip a lug on the P binding post on the filter coupler and also on the P binding post of tube socket 2. A short wire can now be bent that can be soldered to these two lugs and to the front terminal on condenser C-1. Now connect G of the filter coupler to G on socket 3, P on socket 3 to P on the first radio frequency transformer, G of this transformer to G on socket 4, P of socket 4 to P on second transformer, terminal G of second transformer to G on socket 5 and, finally, P on socket 5 to P on the third transformer.

Between sockets 5 and 6 is a grid condenser and leak. A short lead is now run from the G post on the last radio frequency transformer to the rear terminal of this condenser; another wire should connect G on socket 6 to the front terminal of the grid condenser and its leak. Now bend a wire so that it will connect the F binding post of this last radio frequency transformer with the left front post of socket 6 by going over the right edge of the grid condenser and leak. To complete the radio frequency circuits, the F binding posts on filter coupler and the first two transformers must be connected to the center terminal of the potentiometer. Bend a wire so that it will go up from F on the filter coupler, to the right and over the first and second transformers and down to F on the second one. Where this wire passes over F on the first transformer solder a short lead that will connect to that post; also, another wire that goes straight toward the panel, down to the front terminal of the .5 mfd. fixed condenser and on to the center terminal of the potentiometer. Spaghetti is, as usual, placed on this lead between joints. The rear terminal of this condenser is then connected to the lower filament bus where it joins the front right post on socket 4.

The Finishing Touches

Now to complete the amplifier B battery circuit. A wire is bent to connect at one end to the left binding post of the three marked "B Bat," and pass between the C battery and audio transformer, over the .002 mfd. fixed condenser to the long spring on the lower jack. While soldering this lead to the jack, put in another wire that goes to the front terminal of the .5 mfd. fixed condenser behind the rheostat. The rear terminal of this condenser is connected to the lower filament bus where it is soldered to the front right terminal of socket 6. The short spring of the lower jack is now connected to P on socket 7, the wire being covered with spaghetti. If the lower jack is of the type that has but one spring, the frame acts as would a long spring.

Examination of the upper jack will show two short springs that, when no plug is inserted, make contact with the longer ones. Note which one touches the long spring and connect it to the terminal of the audio frequency transformer marked B plus. The other short spring is then connected to the P terminal on the audio transformer. This leaves the shorter of the two long springs, so it is now connected to the rear terminal of the .002 mfd. fixed condenser between sockets 6 and 7 and to P on socket 6. The front terminal of this condenser connects to the front right post on socket 6.

Bend and solder a wire to connect G on the audio transformer with one terminal of the .00025 mfd. condenser beside it and continue the wire to G on socket 7. The second terminal of this condenser should be connected to F minus on the audio transformer and to the negative post on the C battery. The C battery should be placed so that its negative terminal is toward the front. Its positive terminal can now be easily connected to the negative A binding post at the rear edge of the set (the right end post). While working in this part of the set, the minus A binding post should be connected to the right hand post of the three marked "B Bat."

Going now to the other end of the set, we are ready to finish up. Run a wire from the stator (fixed) plates of the second variable condenser (from the left) to the front terminal of the grid leak and condenser between sockets 1 and 2, and continue it around the oscillator coil to the remaining loop binding post. A second wire is used to connect the rear terminal of the grid condenser and leak with the G post on socket 2.

Testing and Operating

Many of those who have built this receiver will prefer to connect it to the batteries, a loop and loud speaker and try it at once without testing. There is no reason why this should not be done if instructions for building and wiring have been carefully followed.

The average set builder, including the writer, is always very anxious to try out the set after so many hours of laborious work have been put into it and there is quite a thrill in hearing station after station come in on the loud speaker as the dials are turned.

The method of connecting the batteries is clearly shown in figure 4. There can be no confusion in the connecting of the loop antenna as there are only two leads from the loop and two binding posts to which they may be connected. Either side of the loop may go to either of the two binding posts and, if a box type of loop is used no difference will be noticed if the leads are reversed. If the flat spiral type of loop is used it will be well to try reversing the leads as it is usually found that the outer end of the loop will give better results when connected to the loop binding post which leads to the grid leak and grid condenser of the first detector.

Connecting Batteries

Either four 22½-volt B battery units may be used or two 45-volt units. A large 45-volt unit is in reality just two of the 22½-volt blocks in series. In figure 4 we show four of the 22½-volt units properly connected to the three binding posts in the center of the rear edge of the set. It will be noted that the negative binding post on the first battery to the right connects to the right hand binding post of these three B battery connections. The positive terminal of this first battery connects to the negative on the second battery, the positive of this second battery connects to the negative on the third and to the center binding post of the three posts on the set. The positive of this third battery connects to the negative of the fourth and the positive of the fourth battery connects to the left hand binding post of the three provided for B battery connections on the receiver.

The two binding posts at the right hand end of the receiver are for the A battery which should be a storage battery of 6 volts and any number of ampere hours from 60 to 120. On the battery one of the binding posts will either be marked with the large letter P or the three letters Pos. or the lead terminal will be painted red. This terminal should be connected to the inner of the two A battery posts on the set. The other terminal of the battery which may be marked Neg. connects to the end binding post of the receiver. The above connections should all be made with no tubes in the sockets and the filament switch in the "Off" position.

Now insert one tube in any socket, turn the filament switch to the "On" position and turn the rheostat slowly to the right. If the tube lights up dimly it indicates that the A battery circuit is complete and that the B battery circuit is not connected in any way that it will blow out the tubes. Now turn the filament switch off, insert the remaining six tubes and again turn the rheostat to the right. All this was done previously of course, but this second preliminary test is desirable to be sure that connections made since the first test have not been made so that the B battery will blow tubes.

How to Tune

Now plug in the loud speaker in the lower jack and we are ready to tune in a station. Looking at the set from the front, the condenser to the left will hereafter be referred to as the oscillator condenser, while the other one will be referred to as the loop condenser. Set the loop condenser at 50 and slowly revolve the oscillator condenser through its scale. If no signals are heard and no series of whistles is heard, turn the potentiometer about 20 degrees to the right of where you had it during this try out. Again revolve the oscillator condenser through its scale and either signals or whistles should certainly be heard. If signals, adjust the potentiometer until signals are at maximum strength without blurring; if whistles are heard, turn potentiometer to the left with the right hand and swing the oscillator condenser back and forth with the left hand until the point is reached in the turning of the potentiometer where the whistles cease. Set the loop condenser at 70 and swing the oscillator condenser slowly through its scale. Signals should be heard, but if they are not, set the loop condenser at 30 and swing the oscillator. Practice will familiarize the builder with the tuning of this set and it will be found that once the potentiometer has been set for maximum signal strength on any one station it can be left in that position, as can the rheostat, and all tuning will be done with the two condensers. The loop tuning condenser will be found to be rather broad, the sharpness of a super-heterodyne being almost entirely in the oscillator condenser. If for any reason the receiver does not work at first, or refuses to work later, the following tests will quickly determine where the error has been made in the wiring or the location of a defective piece of apparatus.

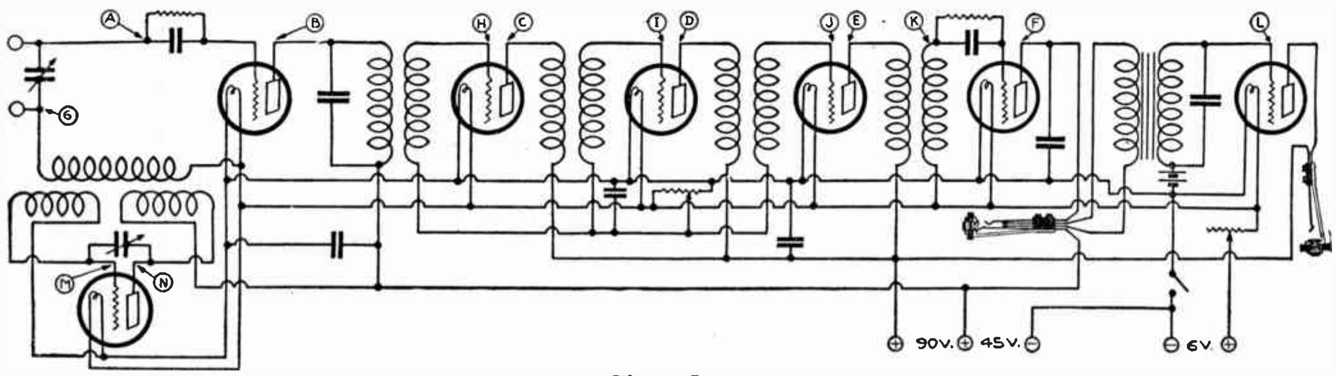

Figure 5

Testing the Circuits

Referring to figure 5 it will be noted that the circuit diagram has again been drawn, but this time certain points have been lettered as points to which to connect when testing. Tests can be made with a single dry cell and a pair of headphones. The batteries should be disconnected from the receiver when making tests. Connect one of the phone terminals to one side of the dry cell and attach a piece of wire to the remaining dry cell terminal so that it will reach to any part of the set. Touch the end of this long wire to the unconnected phone cord terminal two or three times so that you are accustomed to the click which results.

To determine whether the pick-up coil of the oscillator coupler is O.K. touch the wire from the battery to the point G and the phone cord terminal to the plus A battery binding post. This should be done with the rheostat turned clear to the right to maximum. To test the loop connect the battery and phones to the points A and G. To test the grid coil of the oscillator coupler connect test terminals to point M and the negative A battery terminal with the filament switch in the "On" position. To test the plate coil of the oscillator coupler, connect these terminals to the point N and the center B battery binding post. The primaries of the intermediate transformers may be tested by connecting one terminal of our test outfit to the plus 90 B battery binding post and the other to point C, D or E. To test the secondaries of the first two long wave transformers and the secondary of the filter coupler, connect our test terminals to the plus A battery binding post and points H, I or J. These tests on the secondaries should be made with the potentiometer turned toward the end of the potentiometer to which the plus A battery bus was connected. To test the upper jack and the primary of the audio frequency transformer connect the test terminals to point F and the plus 45 B battery binding post. The secondary of the audio frequency transformer may be tested by connecting to point L and the negative side of the C battery.

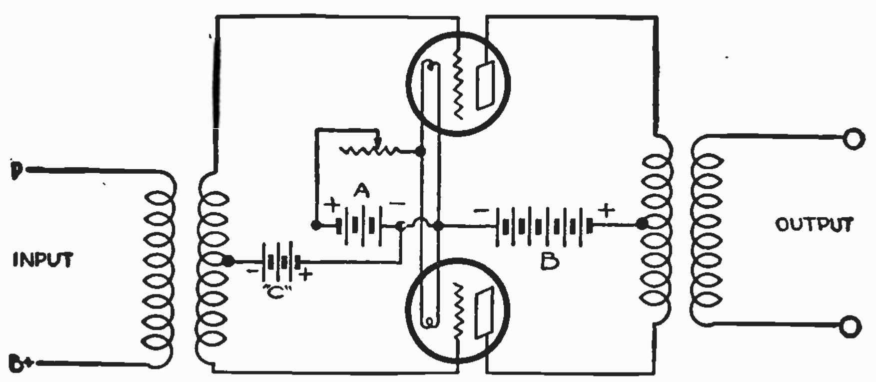

Figure 6

It will be noted by reference to figure 5, that when any of the pairs of points mentioned in the foregoing test are touched, a complete circuit should result and a click in the phones should be heard. If, on touching any of the pairs of points mentioned, the click is not heard it indicates either a defective connection to the instrument or a defective piece of apparatus.

Possible Improvements

Even though the set works and works exceedingly well at first, this should not be taken as the best that can be secured from it. The condenser across the primary of the filter coupler which is of .0005 mfd. capacity is very important and it has been found that even when carefully tested by the fixed condenser manufacturers there is likely to be considerable variation in condensers. If two or three fixed condensers rated at .0005 mfd. are available it would be well to try inserting each of these, one after the other, to determine whether there is any difference in the results considering both volume and clearness.

While UV-201A tubes are not, as a rule, critical as to the amount of grid leak to be inserted in the grid lead when they are used as detectors, it would be well to try other values than that specified, in the grid leak mountings. The tubes will function and function very well with two megohms in use but since there is variation in tubes it might be well to try values as low as one megohm and as high as four.

The third and final possible change that might be made is the C battery. C batteries are usually constructed with a tap at three volts as well as at the 4½-volt point. Try the 3-volt point and see whether any difference is noted in the clearness of signals. If a friend has a C battery that you can borrow try connecting it in series with the one which you already have, as occasionally a tube is found which requires 6, 7½ or 9 volts grid bias.

As a last injunction do not be too impatient to get the 3,000-mile stations. This super-heterodyne will positively work well, even though the wiring is but mediocre and the apparatus is but average quality. It is efficient because it's simple and there is no shielding or other material put in this set, which while they may cause a theoretical improvement, may also broaden the tuning and decrease the efficiency. The writer does not say that shielding is a bad thing, but as a rule it will be found that shielding is unnecessary and likely to lower the efficiency. The chief point that attracted the attention of Radio Digest was the sharpness and the way it would pull in DX stations through the nine or ten locals in and around Chicago. This was not the case on but one model, but proved true with six models which were constructed. Different makes of apparatus were used in these sets, but the general layout and the wiring diagram were the same in all the models.

Questions and Answers

No matter how carefully one watches the details when writing a series of articles there seem to be several small things that always get by and which the ever watchful fans note immediately and write in about. Many letters have come in regarding the simplest possible super-heterodyne and, in some of these, Radio Digest readers have brought up points that the writer missed.

S. L. T. of Allentown, Pa., writes as follows:

"In the super-heterodyne which you are describing in Radio Digest beginning with the issue of November 15, the oscillator coupler contains a rotor which is variable in its relation to the stator. I note in many of the kits now on the market that the oscillator couplers are not variable and I want to know if there is any advantage in the variable feature."

A. It is often desirable in super-heterodynes to be able to vary the strength of the oscillations imposed on the grid circuit of the first detector tube by the oscillator tube and its accessories. If the energy thus mixed with the incoming signal is too strong it will cause distortion on weak signals from distant stations; if it is too weak it will cause distortion on the strong signals from locals and unsatisfactory reception will result. If the conections for the oscillator circuit supplied by each manufacturer are followed carefully, fixed coupling will prove perfectly satisfactory. This will necessitate slight changes from the hook-up given for the simplest possible super-heterodyne, but this should not affect the operation. One advantage of variable coupling which was noticed in the "simplest possible" set was that adjustment of the oscillator coupler made it possible to bring the readings of the two variable condensers almost exactly the same. Adjustment of the oscillator coupler affected the tuning of the oscillator condenser in this way, although variable coupling was not incorporated with that end in view. Fans need have no doubts about using a kit incorporating a fixed coupler, as it will work with perfect satisfaction in this set.

J. C. B. of Des Moines, Iowa, wishes to know if it is possible to use this receiver on an outside antenna. Our reply was as follows:

An outside aerial may be used with this super-heterodyne if some means of coupling it to an aerial and ground is provided. This can best be done with a fixed coupler utilizing six to ten turns on the primary and fifty-six turns on the secondary if on a 3-inch tube, or eighty turns if on a 2-inch tube. The primary should be placed about 1 inch from the secondary so that loose coupling will result. If the builder does not object to another control which need be varied only occasionally, a coupler of the usual type may be used with a primary that is variable in its relation to the secondary. This might very well take the form of the low loss unit described by Mr. Fournier in the Digest of November 22, with the tickler rotor omitted.

Whether a fixed or variable coupler is used it should be placed in another cabinet from the super-heterodyne and preferably should be placed in a cabinet which is lined with thin copper or aluminum. The leads from the primary and secondary should go to two binding posts at the rear to the left for connection to antenna and ground, the leads from the secondary should go to two binding posts at the rear to the right for ready connection to the binding posts ordinarily used for the loop. The reason for shielding the coupler cabinet is that the secondary is liable to pick up the signals from stations itself instead of absorbing them from the primary connected to the antenna and ground.

We have a letter from W. B. R. of Baltimore, Md., who, while he is very well satisfied with the range of his receiver complains that he cannot put the Pacific coast stations on the loud speaker and wishes to know if he can add a stage of push-pull amplification to this set.

This can be done, but as in the case of the antenna coupler, we strongly believe that this should be placed in a separate cabinet and shielded. The energy in a push-pull amplifier pulsating at audio frequencies is quite strong and care must be taken that this energy does not get back into the receiver itself and cause undesirable noises and possibly unwelcome whistles. A small cabinet similar in design to that used in the receiver itself and made for a panel 7x10 inches can readily be obtained and lined with either thin copper or aluminum which should be grounded. A rheostat is all that need appear on the face of this smaller panel and it will be found that the tube sockets and transformers and possibly the C battery also will go into a cabinet of this size. The fan can either place two binding posts at the rear and to the left for connection to the receiver and two more binding posts to the right for connection to the loud speaker or two jacks can be placed on the panel, one to the left and one to the right.

A short length of double conductor can now be attached to two plugs, one of which is to be inserted in the left hand jack on the push-pull panel. If it is not desirable to use the push-pull, the loud speaker plug can be inserted in the set; if the push-pull is desired the remaining plug on the short length of the double conductor is inserted in the amplifier jack of the receiver and the loud speaker plug is inserted in the output jack near the right end of the push-pull panel.

P. L. M. of Fond du Lac, Wis., noticed that we did not provide vernier control of the condensers. It was taken for granted that the average builder would either purchase condensers in which vernier adjustment was provided or would use a plain type of condenser with a vernier knob.

Dust in Set Causes Loss

Dust in Radio sets is often the cause of a large loss in efficiency. This is especially true in wet weather, when the dust becomes damp, and allows the feeble currents to leak.

The worst places for dust to be allowed to collect is about binding posts and terminals and between the plates of rotary variable condensers. It may be removed from between wires and around terminals with a small brush, about two inches wide. Many Radio engineers use pipe cleaners, the same as are used for cleaning the stems of ordinary smoking pipes, for removing dust from between condenser plates and from otherwise inaccessible places.

How to Construct a Super-Triplex Receiver

Very Selective Three Tube Regenerative Set

HAVE you ever listened in on a long distance station and waited patiently for the call letters only to have one of the local stations suddenly open up with its introduction and drown out the other fellow? Exasperation but weakly expresses your feelings. Unfortunately it requires an unusual receiver to avoid this very common difficulty. In addition, in the attempt to overcome this, most often the volume of reception, in a simple form of circuit, is lost.

In building up the super-triplex, the four circuit tuner idea was first tried out and then discarded. The unusual success of the Miloplex circuits was due to the fact that a circuit commonly known as an absorption circuit was employed. It will be found that a circuit of this type always exists in any form of real selective hook-up. As in the Miloplex III, it may be a separate circuit with no connection to the remainder of the hook-up, or as in the Wizard Miloplex, the first circuit published, it may be concealed in the form of an integral part of the circuit. Regardless of its form of location in the circuit, the fact remains that selectivity is increased.

Loop Aerial Kink

Only a short time ago the writer was operating with a loop aerial circuit. Naturally, as all tuning is centered in the loop condenser, selectivity is not entirely what it might be otherwise. The interference of one local station was so great as to entirely destroy the beauty of opera Radiocasting from another station. As another loop aerial was on hand, the following experiment was tried out: A 23-plate variable condenser (.0005 mfd.) was shunted across the terminals of this second loop. No attempt was made to connect the second loop with the receiving circuit. It was set parallel to the loop on the set and as close as possible. As the interfering station was of a shorter wave length, the condenser across the second loop was set at maximum capacity and the set returned for the station desired. This entirely cut out interference.

Another procedure is to tune the set close to the interfering station before the second loop is placed into position; then the second loop is put in and all the tuning is done with this condenser, leaving set tuning alone. This means of improvement of selectivity will be found very convenient in loop aerial reception. But where a tuning unit with an outdoor aerial is employed, we must go back to the first method.

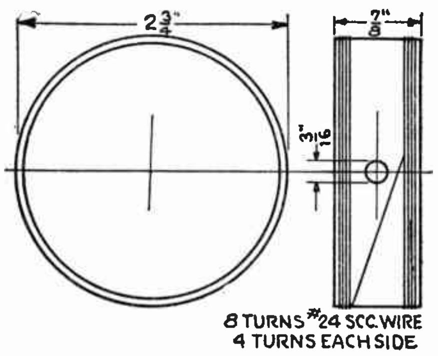

Figure 2

The Triple Circuit Coupler

There was need, consequently, for the development of a tuning unit a little more advanced than at present available, and the conclusion was reached that if a few more turns were added to the one turn primary, and these turns could be variably coupled to the secondary and plate circuits, a decided improvement would be noticed. This led to the development of the three-circuit variocoupler in which conditions are reversed, the rotor becoming the primary and both secondary and plate windings being in fixed relation to each other.

The Super-Triplex

It was found that if the fourth or absorption circuit, consisting of a fixed winding and a variable condenser,

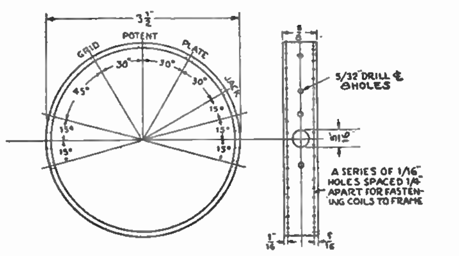

Figure 3

was kept isolated, a loss in strength of reception was quite noticeable. Further experimentation indicated that this absorption circuit, or better still, oscillation control could be made an integral part of the plate

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $74.00

circuit with no detrimental but decidedly desirable reactions. Despite the fact that the controls are many, the selectivity and volume are very unusual, and one night's reception of local Radiocasting will give the constructor sufficient experience to handle any long-distance work.

Parts Required

All parts with the exception of the variocoupler being of standard design, no construction details are necessary, but as it may require some time before manufacturers will be able to furnish this special unit complete instructions on how to make it will follow.

The parts required are: one piece of cardboard or composition tubing, 2¾ inches in outside diameter and ⅞ inch long; another piece of tubing, 3½ inches in outside diameter and ⅝ inch long; one brass mounting strap of 1/16 inch stock, ½ inch wide and 5 inches long; one set of rotor bearings, that can be purchased for 75 cents; two small copper terminals, for binding posts, sufficient number 24 scc. copper wire, and a winding form consisting of a wooden block, 3⅛ inches in diameter and 1½ inches wide, with seventy-two 1/16 inch brads 1¼ inches long.

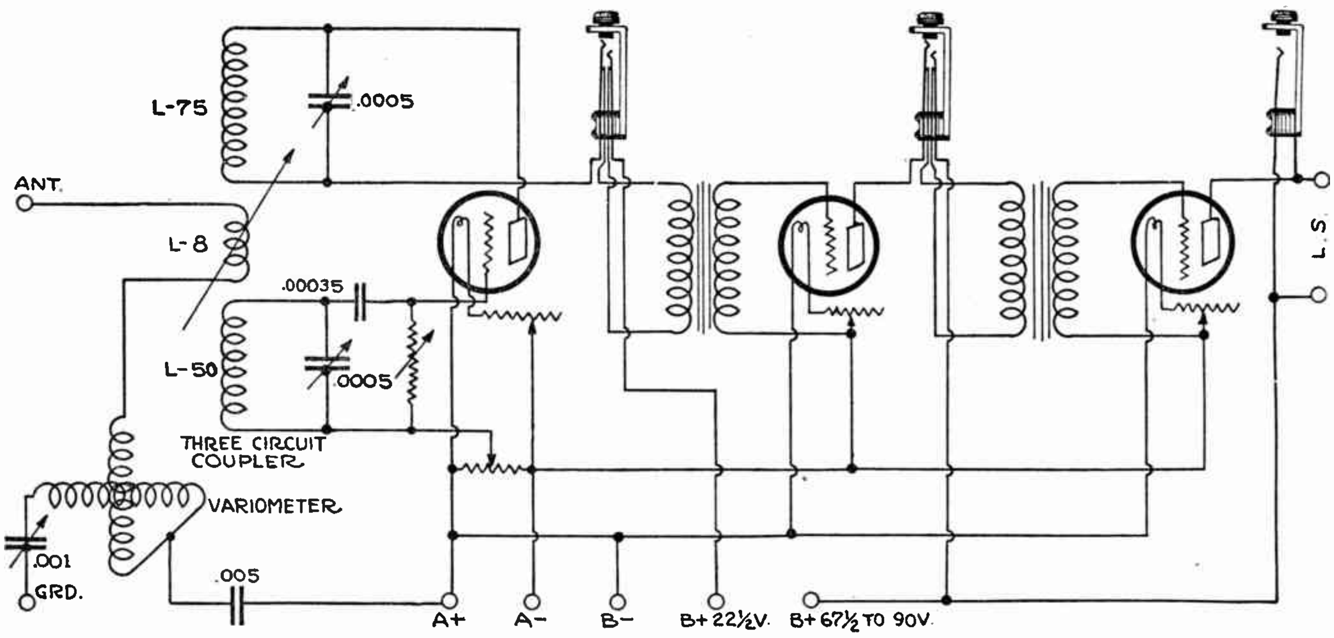

Figure 1—Hook-up Diagram

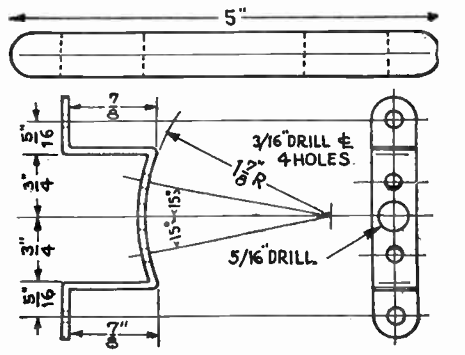

Figure 4

Framework Details

Figure 2 shows the details of the rotor. Two 3/16 inch holes are drilled for the shafts. Eight turns of the 24 gauge wire are wound on this rotor, four on each side of the shaft. Each end is locked under the nut fastening one shaft. In other words, the shafts providing for the electrical connections to the rotor winding and connections are taken care of by the rotor terminal shown in Figure 8.

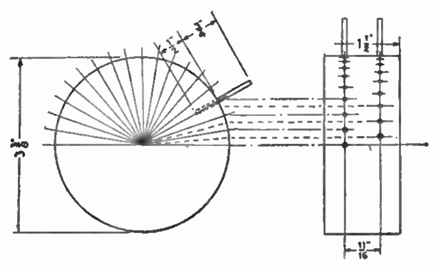
Figure 5

The frame of the fixed windings is shown in Figure 3. Two 5/16 inch holes are drilled on the bearings of the rotor shafts, and four 5/32 inch holes adjacent to the bearing holes are drilled for mounting the bearing. The remaining four holes, also 5/32 inch, are used for binding posts for the ends of the fixed secondary and plate coils. This identification of the holes will be clearly understood by reference to Figure 8.

A series of 1/16 inch holes spaced ¼ inch apart are drilled along both edges of the mounting frame and are used to hold the fixed coils in position against the framework.

Winding the Coils

Details of the coil winding form are shown in Figure 5. Seventy-two brads are used but they should not be too firmly fastened in the wooden form, as it is necessary to pull them out after the coil has been completely wound. Thirty-six of these brads are put in on each side and spaced at a radial angle of 10°. Both sides are not alike, however, but are staggered. This is necessary to properly advance the winding one peg every time a complete revolution of turns is made.

The winding is started by making a few turns about one nail. The wire is then brought around the outside of the next nail on the same side; then it crosses diagonally over and around the outside of the fifth and sixth nail on the other side. This is shown in Figure 6.

The secondary coil has 50 turns and the primary has 75 turns. The ends should be left about 3 inches long for connections after the winding has been completed. The last turn is wound around the brad to temporarily secure it and prevent its unwinding. The whole form should then be given a very light coat of high-grade thin shellac, or better still, a cellulose solution made by dissolving celluloid in either acetone, ether or alcohol. When this is dry, strap or bind the turns

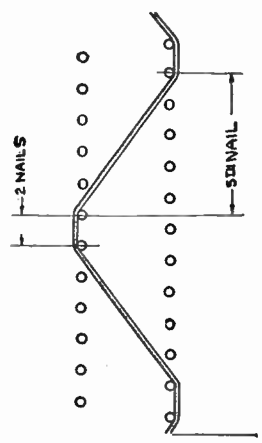

Figure 6

together with some thread between the interstices of the windings on both sides, if possible. In this way, if the adhesive quality of the coating is not sufficient to hold the windings together, the threads will prevent the unwinding of the wire. The brads should now be pulled out, taking care that the windings are not displaced. When all of the brads are removed, the coil should be slid from the form and a few more threads may be applied around the borders to hold it together more firmly.

The next step after the bearings and binding posts have been assembled on the frame, is to sew the two coils onto the frame for which purpose the series of small holes were drilled around the edges. The rotor

(Continued on next page)

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can then be assembled inside of the frame and the ends of the secondary and plate coils can be secured under the proper binding posts, as indicated. Both coils should be wound in the same direction and the outside ends should be used for the grid and plate terminals. If deemed advisable, a final coating of the previously mentioned celluloid solution can be used over the entire unit, but care should be taken not to make it too heavy as this would destroy the advantage of low capacity value in the windings.

The fans will find this type of tuning unit exceptionally efficient because of the unusually good qualities of this form of winding. It will, of course, take more time to make, but the finished piece of apparatus is well worth the effort.

This coupler is a special tuning unit combining a number of features developed for this circuit. The absorption coil, plate tuning coil or oscillating coil—call it what you want—is part of the plate circuit and has a .0005 mfd. variable condenser across it; this is the 75-turn fixed winding on the coupler. The sec-

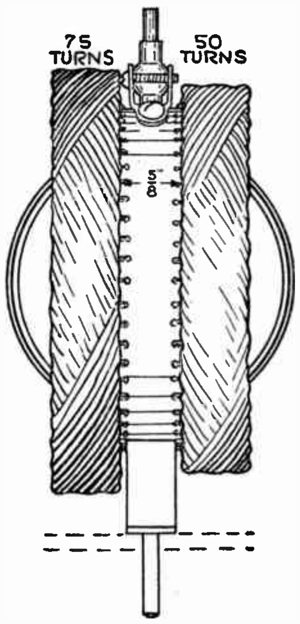

Figure 7

ondary consists of the 50-turn fixed coil and also has a .0005 mfd. variable condenser across it.

The Primary Circuit

The primary circuit consists of three pieces of apparatus. The first is a .001 mfd. variable condenser on the ground side of a variometer followed by the 8-turn rotor of the three circuit coupler in series. The primary circuit is tuned by means of the variometer and the variable condenser, neither of which are unusually critical. The rotor of the special coupler permits a

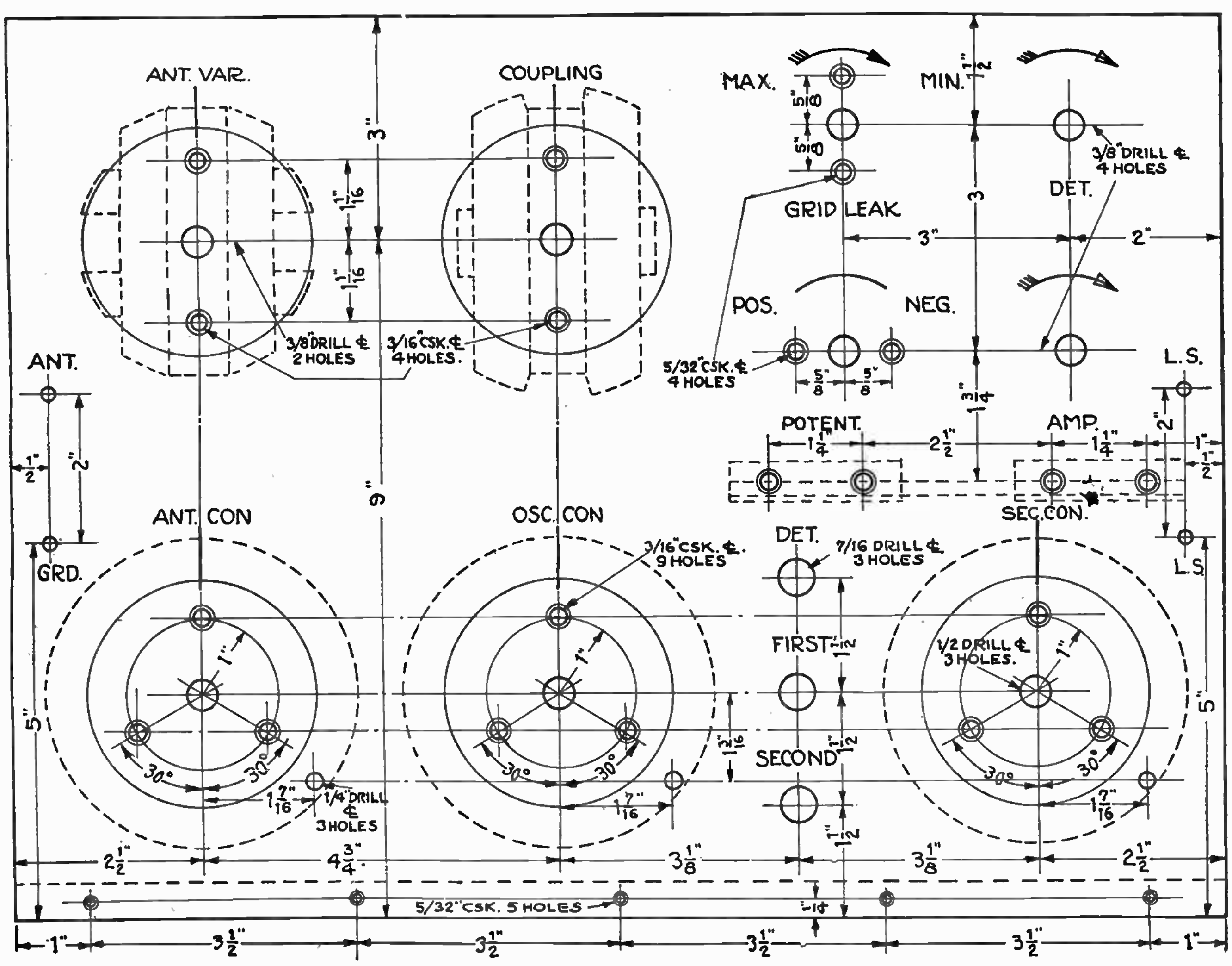

Figure 9—Panel Layout

variable coupling between the aerial and balance of the circuits. This coupling is the means whereby unusual selectivity is made possible. Real efficient tuning, however, is entirely dependent on how well the operator becomes acquainted with handling this

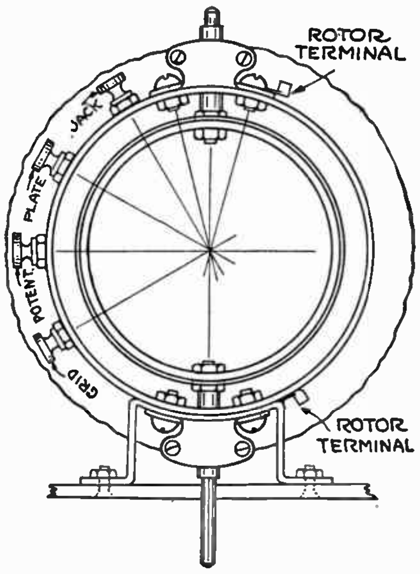

Figure 8

coupling control. He must learn to discriminate between stations and signals that require close coupling, and those where a loose coupling is of most advantage. That this coupling is effective is amply proved by the fact that even a strong local station can be cut out just rotating the coupling dial, although the remainder of the circuit may be very closely tuned to it.

Type of Apparatus Required

There are no set rules of restrictions on the type of apparatus required except that quality is essential. Occasionally we hear of a fan who gets Hawaiian Islands on a set constructed of 10-cent store apparatus, but don't take a chance that you are going to be one of the lucky fellows. If you're determined to make a receiving set of this type and want to feel positive that it will operate as efficiently as the original does, then save yourself a lot of trouble by purchasing and using only good apparatus. There are plenty of them on the market, and it requires no instructions as to what manufacturer's part you should use. Fans have now reached that degree of experience that they can readily discriminate between good and bad.

Inasmuch as the three-circuit coupler was constructed of such type of winding as to give the lowest value of internal capacity, likewise it is recommended that the fan consider this in purchasing his variometer

List of Parts

1	Three circuit variocoupler	$ 7.50
1	Variometer	6.00
1	Variable condenser, .001 mfd	6.50
2	Variable condensers, .0005 mfd	10.00
5	Dials, 3 inches	3.75
1	Fixed condenser, .005 mfd	.75
1	Fixed condenser, .00035 mfd	.40
1	Variable grid leak	1.85
1	Potentiometer	3.00
1	Vernier rheostat	3.00
1	Double rheostat	3.00
3	Sockets	3.00
2	Audio transformers	14.00
9	Binding posts	1.35
2	Double circuit jacks	2.00
1	Single open circuit jack	.70
1	Panel 3/16 by 12 by 16 inches	3.25
1	Sub panel, 3/16 by 6 by 6¾ inches	1.15
1	Baseboard, ½ by 7½ by 16 inches	1.00
	Wire and spaghetti	1.50
	Total cost	$73.70

The variable condensers should be of good quality, but vernier control is only required for the secondary. The vernier control rheostat is used on the detector tube. For the two amplifier tubes a double rheostat was used, consisting of two windings and two levers with a large and small knob in front for operating this receiver. This saved space and permitted a uniform layout.

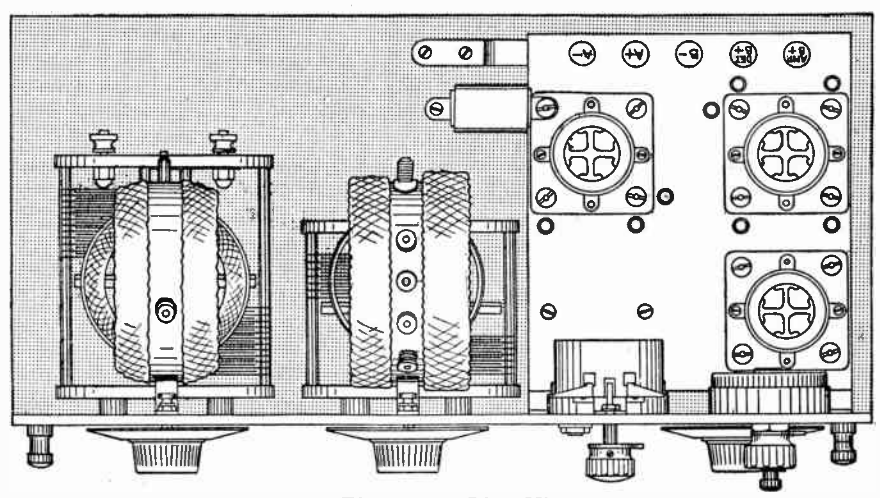

Figure 10—Plan View

The potentionmeter was a high resistance type, 1850 ohms. This however, is not essential except where dry cells are used for filament lighting.

A good quality variable grid leak is necessary. In glancing over the circuit the impression may be made that either the variable grid leak or the potentiometer is superfluous. Experimentation, however, did not indicate that it was wise to eliminate either.

The problem of proper panel layout is of much more importance than the average fan thinks. There are three facts which must be kept in mind:

1. The necessity of compactness;
2. The proper symmetrical arrangement; and
3. Efficient spacing and arrangement of apparatus.

Long, narrow panels are by no means handsome in appearance. Besides, they necessitate exceptionally long leads, thus increasing the effects of interference, capacity reactions and the possibility of short circuits or easily broken connections.

Proper Procedure

In the panel layout, naturally the first consideration is what parts having controls are to be assembled on the panel. In the Super-Triplex there are three variable condensers, one variometer, the three-circuit coupler, variable grid leak, potentiometer and rheostats. Naturally it is most convenient to start out without being limited to size of panel, then the design of the layout can be developed around the apparatus, while otherwise the layout must be confined to the panel size.

In the panel layout shown in the illustration it happened that a panel 12 inches by 16 inches was available, and as the design readily worked itself to these dimensions no change of size was necessary.

Interference

It is quite evident that only two of the controls mentioned have effective fields of force which must be considered. These are the variometer and the

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variocoupler. They were therefore placed in the upper right-hand corner and spaced 4¾ inches apart, which is sufficient to avoid any serious coupling tendency from the one to the other.

The three condensers, as was immediately apparent, were best arranged along the bottom, the only alteration made being the addition of three jacks for controlling the various stages.

An examination of the layout shows clearly why the double rheostat was used for controlling the two audio frequency tubes. This eliminated the space requirement for an extra rheostat and permitted a symmetrical arrangement of the four additional controls in the upper right-hand corner.

Advantages

The advantages of this entire arrangement are more or less apparent. The aerial variometer and condenser controls require the least adjustment of all and also are least critical. They are then farthest out of the way, leaving the more important ones at the right side. The coupling and oscillator condenser are next in this reverse order of importance. The most critical adjustments of all is the secondary condenser, placed in the lower right-hand corner, and requires, therefore, no reaching over other controls for adjustment. In accordance with standard practice the aerial and ground binding posts were added at the left side of the panel. To balance the right side, two posts were added for loud speaker connections. The jacks then are only used when tuning the set with head phones. When the plug is pulled the loud speaker is automatically connected and all wiring cords are kept clear of the front of the set. All battery connections are made in the rear.

Sub-Panel Mounting

It was originally intended to assemble all remaining apparatus on the baseboard, which is fastened to the main panel by means of five countersunk screws, as shown at the bottom of the illustration. This, however, necessitated unusually long leads from the rheostat to the sockets. These long leads, especially the A battery leads, are easily bent and thus are likely to cause short-circuit troubles with disastrous results. Sufficient space for using panel mount sockets was not available.

A little thought revealed the fact that when the socket itself was removed from the panel mounting plate an excellent arrangement for supporting a small sub-panel was available. These two original mounting plates were then accounted for, as shown by the dotted lines indicated at the right side of the panel layout. The sub-panel, measuring 6 by 6¾ inches, was then mounted on the plates. Only the three sockets and five binding posts are fastened to this sub-panel, the two audio frequency transformers being mounted on the base. A metal brace helps support the rear end of the sub-panel. With the audio transformers just under the sub-panel, all leads are short.

No doubt a number of fans were at a loss to identify eight of the holes in the sub-panel. These were not added for mounting of apparatus but are used for the leads running from the upper to the lower side of the sub-panel. The rear view shows a number of these wires passing from top to bottom through these openings. Plan view shows the relative position of the apparatus as viewed from above. In reference to the arrangement of the tube sockets, the one shown on the left is the detector tube and the one alongside of it, on the right, is the first audio stage, and the one in front of that is the second audio tube.

In mounting the special three-circuit coupler the 75-turn fixed coil should face to the right of sub-panel side. As previously explained the sub-panel is supported in front by means of the panel supports taken from two panel mount sockets. In the rear, a metal strip is bent up and fastened to the sub-panel and base as shown in the rear view. The locations of the audio frequency transformers are also clearly shown in this view. The identification of the five binding posts is given in the plan view.

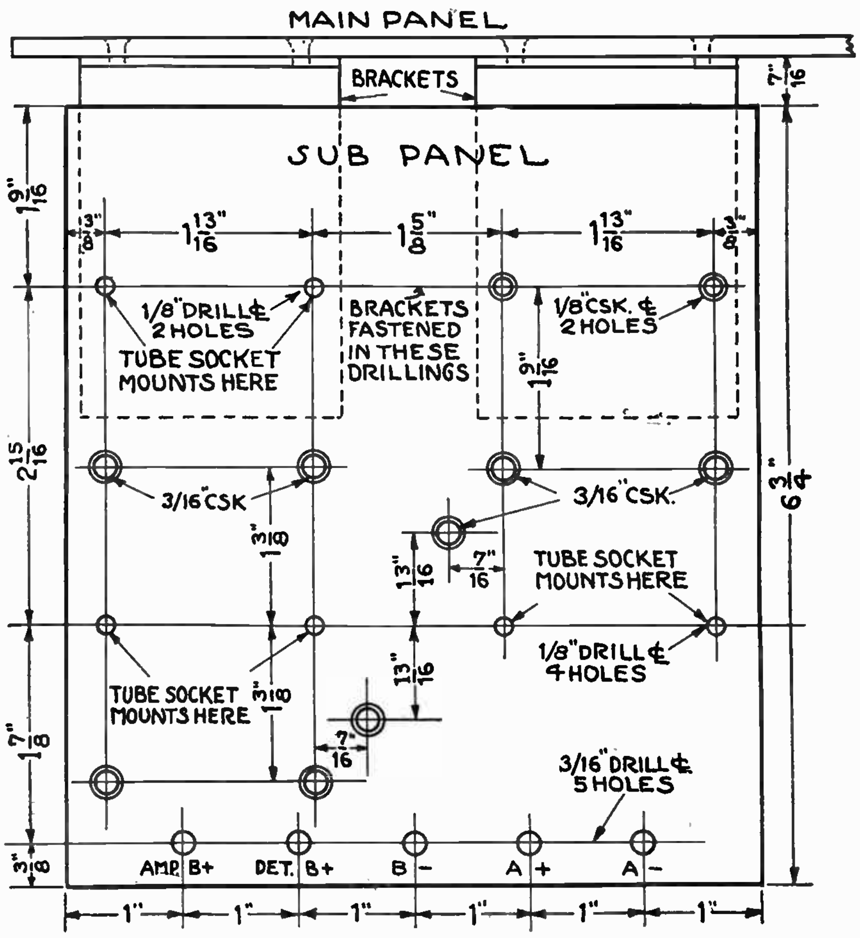


Figure 11—Sub-Panel Layout

Wiring

The same precautions that have been emphasized before hold true in this set also. Naturally the leads should be kept as short and direct as possible. Inasmuch as there is no Radio frequency used, the constructor is not likely to run into interference difficulties. This, however, does not mean that the set can be carelessly wired. Although the writer uses little or no spaghetti, it is recommended that the average fan cover wires wherever they run in close proximity. Careless handling may short the B battery leads to the filament of the tubes with disastrous results. Beware of long leads that have a tendency to sag against other wires below them. The writer has been consistently using 1/16 inch brass bus bar wire, which is quite stiff and not only has no tendency to sag but in itself helps stiffen up the general assembly of parts. In spite of repeated suggestions that close attention be paid to well soldered joints, sets are constantly brought in because of trouble, in which carelessly soldered joints can be pulled apart with no effort at all. Many a receiver has a peculiar throbbing reception owing to a poor connection somewhere in the circuit. A fair percentage of the difficulties encountered are wire troubles, and many of the remainder can be attributed to poor apparatus. Be careful to avoid splash soldering, especially when working around variable condensers. Hot solder when dropped on lattice windings burns through the insulation and often shorts out a considerable number of turns.

Battery Connections

The five binding posts for battery connections are the only terminals in the rear. When the set has been placed in a suitable cabinet, some means can be arranged that connections can be made directly to these binding posts through a small opening or a series of openings in the rear of the cabinet. The A battery voltage should suit the particular type of tubes to be used. Although a soft detector tube was used in the original set with two A tubes, yet three A tubes can be used as well. With the soft detector tube the detector plate voltage should be 22½. With an "A" tube in the detector stage it may be found necessary to increase this to approximately 45 volts, while 67½ volts on the plate of the amplifier tube is sufficient.

Tuning

Because of the number of controls the question of tuning may appear to be rather difficult. This, however, need by no means be the case. After all connections have been completed and the tubes inserted, adjust the rheostats. The potentiometer should be thrown over completely on the negative side. It is understood, of course, that, in wiring, the positive and negative terminals to the potentiometer were made to conform to the marking in front. The grid leak should be placed at about the halfway position.

Set the coupling at halfway, that is, with the rotor at right angles to the fixed windings. The aerial condenser is set at about three-fourths full capacity. The oscillating condenser at about one-fourth full capacity. The secondary condenser dial and aerial variometer dial should both be rotated in conjunction with one another. This rotation, especially of the secondary condenser, should be very slow, as the adjustment may be found somewhat critical. Naturally, when the characteristic carrier wave whistle is heard, readjustments should be made for best reception on all controls.

The primary controls, variometer and condenser, will not be found very critical. The coupling control is a little more critical, but by no means so bad as the secondary condenser. Its position is a factor of the strength of the incoming wave, that is to say, in order to eliminate interference from other stations, it is advisable to keep this adjustment as loose as possible, although with a weak signal, full strength of coupling is sometimes required.

This receiver does not feature an individual setting for a station. Readjustments of the controls for different positions will bring in a station sometimes better and sometimes worse than the original setting. The fan must find out for himself those adjustments which consistently give the best results. The usual tuning experience can best be gained by working with the strong local stations, gradually extending the field of operation until long distance work can be skillfully handled.

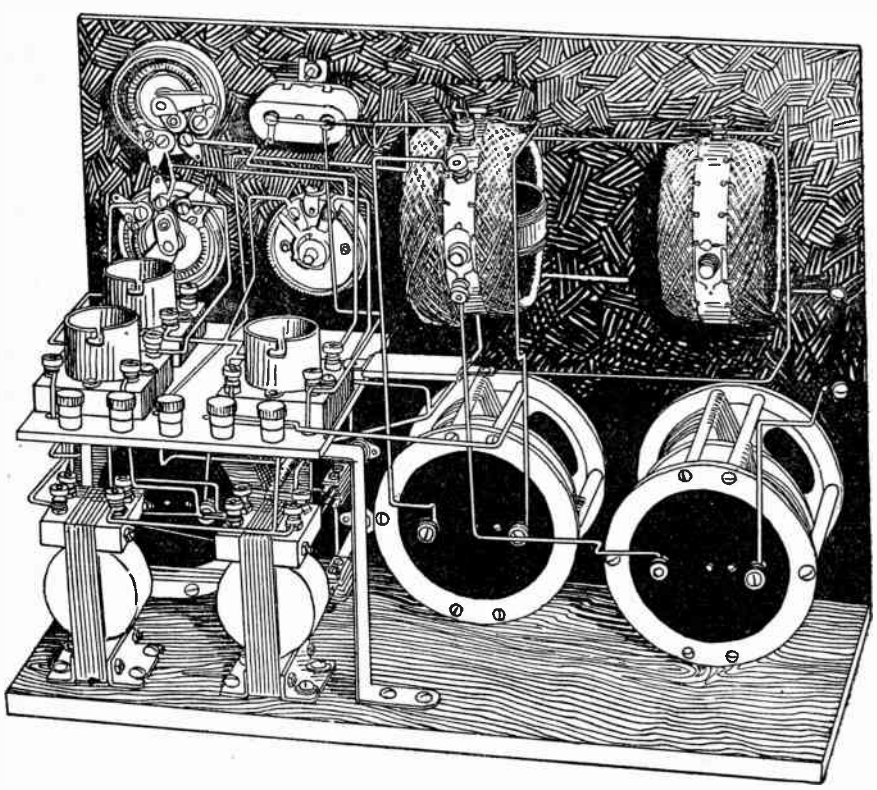


Figure 12—Rear View

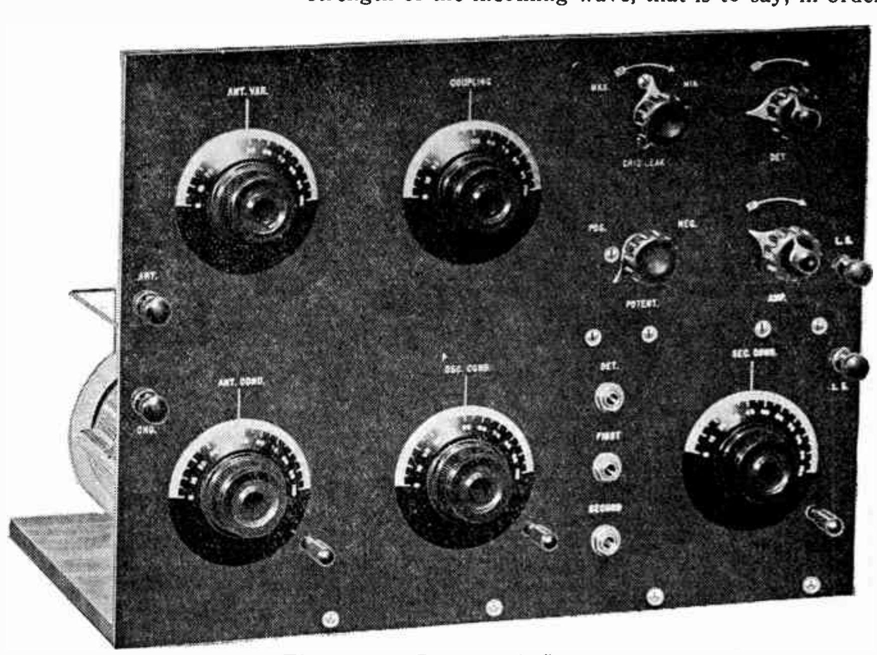


Figure 13—Completed Set

How to Construct a Super-Heterodyne Set

Eight Tube Long Distance Receiver

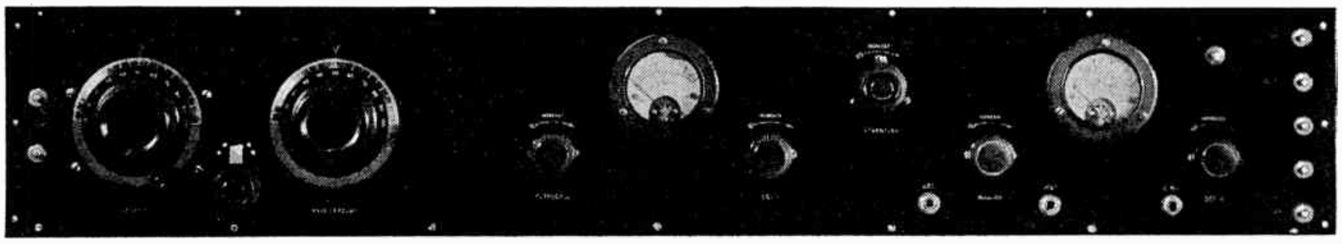
By Allan C. Forbes

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $160.00

IN THESE days of new inventions, some of us do the talking, some the writing and most of us do the listening and reading. We who listen hear the merits, advantages and disadvantages of the latest in Radio discussed from A to Z. Some of it soaks in and some of it goes right on through. Maybe it is best that most of it does pass on through, because if it stayed with us we would have our heads so chock full that we wouldn't be in a position to absorb any more from the next orator.

In this article all the different phases of the construction and operation of the set will be taken up. With the information contained in this article together with the photographs and circuit diagrams, anyone that has already made a set or two should have no difficulty whatsoever in making an "eight-tuber." It is a very simple set to construct, provided, however, that you know what to do and do it.

Before going into the actual layout of the set, let's stop a minute and analyze a few of the various circuits now on the market. But hold on here—we are getting a little ahead of our story. Let's review the subject a little and see just what the super-heterodyne circuit is, why it is, what makes it so good and why is it better than any other circuit. Let's see why everyone says it is so wonderful. All right let's go: Now then, in the first place, along about the year 1913, we had practically discarded the vacuum tube as detectors for two reasons: because they were scarce and very hard to get and they were too expensive, required batteries, etc. We in the commercial service, thought we had better hang on to the good old crystal detector for a while longer. Then along comes the "arc" telegraph stations for use on long waves and greater distances. We couldn't use the ordinary crystal detector for the reception of signals from these stations so we used a "tikker" which was nothing but a small motor driving a commutator to which were connected brushes leading to the head phones.



Front View of Assembled Set

Tikker Form of Reception

This "tikker" form of reception worked all right and then Mr. Reginald Fessenden came along and developed a miniature arc to fit in a receiving set and generate a high frequency oscillation. He called this a heterodyne receiver for use in the reception of signals from arc stations.

This form of reception was better than the tikker, but not so reliable as the operator had a great deal of difficulty in keeping the arc going and making it stable. You can easily see that this is, or was, the first form of the super-heterodyne circuit for the reception of Radio telegraphic signals, wherein a separate circuit, called the oscillating circuit or heterodyne circuit, superimposed another wave on the incoming signal and the resultant frequency was the one that produced an audible signal in the head sets.

It was only a short time after the commercial introduction of the heterodyne receiver in 1914 that the three-element vacuum tube made its appearance in commercial form ready for work and we found that it could be connected up so as to regenerate, oscillate and "howl" and was ideally suited for arc reception. This "kinda" made the heterodyne principle fade away for a while until during the war experiments were made and in 1919 it was given to the world under the name of "A new method of short wave amplification" and since that time various additions and subtractions have been made to the original circuit but the principle remains the same and is readily recognized in all the various circuits claiming to be a super-heterodyne.

Short Wave Over Long Distances

The thing most responsible for the development of the super-heterodyne set is the very thing that we are struggling with now—namely, the reception of short wave Radio telephone over long distances. For this reason, if for no other, it seems very logical that we should finally fall back on it and bring it up to a point where it will do what we want it to. The fellow who has only logged fifty or sixty distant stations and has never heard Havana (Cuba) or Spodunk (Somewhere) feels woefully out of place at a meeting of the fans. Now if he will pay strict attention to this article and use a little common sense and good judgment he can build one of these supers and get in these distant stations.

It has been common knowledge with most of the old time Radio operators that short waves, those waves lying between 200 meters and 1,000 meters, carried very poorly over land or water for distances of over 300 miles. Of course, there has and always will be freak reception so we have always believed that amplification would solve the problem—but the question was what kind of amplification. When we only had crystals to deal with we tried various kinds of crystals in parallel, crystals in series, crystals on the roof and everywhere we could think of, and we tried chemicals. Then we tried relays to amplify the signals from the detector but none of these means proved commercially successful. We just naturally couldn't seem to amplify the signal from the crystal or chemical or magnetic detectors so we were stumped until the advent of the three element vacuum tube.

Employing the Three Element Vacuum Tube

With the vacuum tube came audio amplification, Radio frequency amplification and super Radio frequency or the application of the heterodyne principle to assist amplification.

Now we approach the real meat of the super-heterodyne circuit. Follow closely: The disadvantages of audio frequency amplification are well known, due to the fact that the noise of the tubes themselves rises so rapidly. It has been determined by experiment that more than two stages of amplification using ordinary construction is undesirable. With extra care three and four stages can be used and on some transoceanic work we have used ten stages, but it is not generally satisfactory. Then, too, in using audio frequency amplification we are not increasing the signal strength as applied to the detector. Inasmuch as all detector tubes have a characteristic such that the strength of the audio signal depends upon the strength of the signal impressed upon the detector, by using audio frequency amplification we merely amplify the signal as delivered by the detector and are thereby limited.

Radio Frequency Amplification

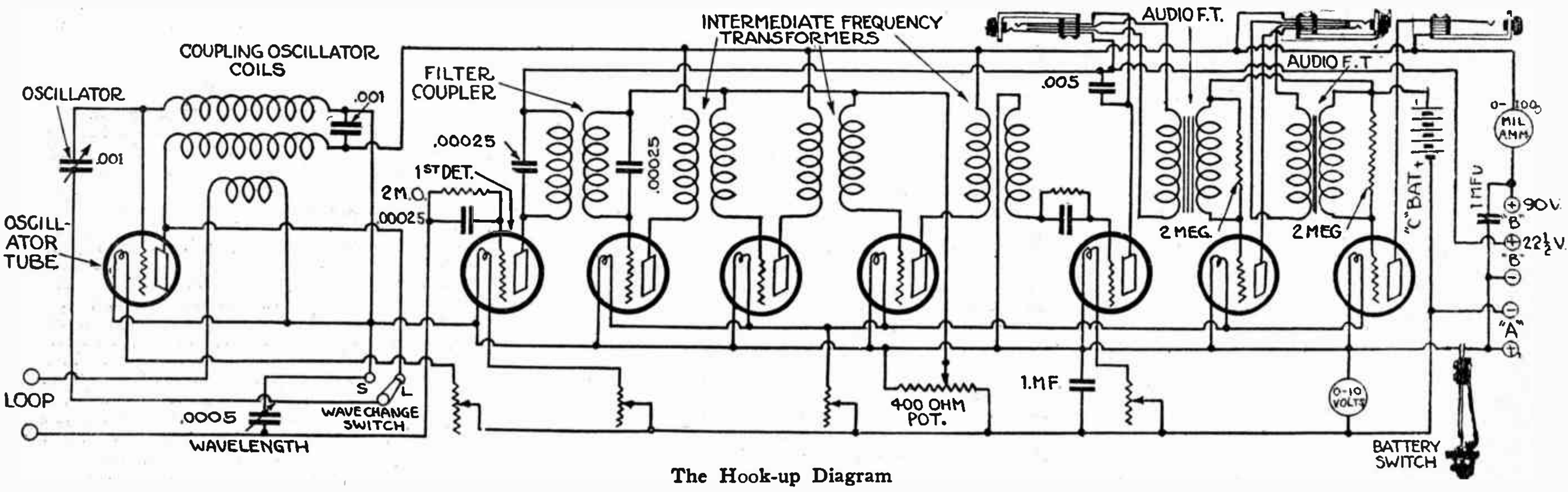
The disadvantages of amplifying the signal before detecting it, (we call this Radio frequency amplification) lies in the construction of present day apparatus. Most manufacturers design their Radio frequency transformers to cover all the wave bands from 200 to 600 meters. In order to do this they sacrifice efficiency, because it is a very hard matter to make a transformer that will perform at maximum efficiency on all the Radiocasting waves. Also because of the low capacity reactance existing between the various elements of the tubes most of the resistance and capacity couplings act as a nice little short circuit and prevents the building up of a potential in the external plate circuit. We can use and there has been introduced lately, a tuned impedence, which overcomes this objective but this has the disadvantage of introducing complications in the form of controls which make the circuit difficult of operation for the average layman.

The heterodyne method is ideal because it enables us to design our amplifying transformers for a particular frequency, thereby securing maximum efficiency. The usual method is to first rectify the incoming signal. We do this by placing a detector tube first in line. The signal then comes in, or rather is picked up by the loop, passes into the detector tube and is rectified. To understand the super-heterodyne principle you must follow this closely: Now the incoming signal passes through the coupling coil and into the oscillator coil, where the frequency of the wave generated by the oscillator tube is super-imposed on it and passes on to the filter.

Filter, Critical Part of Set

The filter is designed to be, and is, one of the most critical parts of the set. It consists of two coils, one in the first detector plate circuit and the other connected to the first intermediate frequency amplifying tubes' grid. Both of these filter coils must be adjusted to exactly the same frequency (wave length). This can be done by the use of fixed, or variable, condensers but be sure if using fixed condensers that the capacity of each matches the coil, exactly, there must be no guess work here, as most of the trouble encountered in the construction of a super-heterodyne set can be attributed to poor coils, unmatched condensers, or condensers that do not match the coils to which they are connected.

The function of the filter is to stop all those frequencies below or above the one it is designed to pass. In other words, if these coils have sufficient inductance and capacity in the form of condensers to pass one hundred kilocycles (3,000 meters wave length) then this frequency is the only one that will pass. It is easily seen then that with the proper filter in our circuit we can't help but have a selective set. On the other hand if the filter is not tuned to the proper wave length that we wish to pass, then we cannot get extreme selectivity.



The Hook-up Diagram

From the filter we pass to the first intermediate frequency amplifier tube then into the first intermediate frequency amplifying transformer. Our problem now is to get a transformer that will give us maximum amplification.

We have three choices of amplification—namely:

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Resistance coupled, air core transformers (fixed or variable), and iron core transformers.

The resistance coupled method is now obsolete and has been discarded for more improved methods because it is non-selective and in the majority of cases noisy.

The air core transformers, while still used, will not give the high ratio of transformation desired and if made variable, introduce additional controls which make for complicated operation.

The iron core transformer, in spite of all objections, seems to be more ideally suited to the amplification of the intermediate frequency because the iron introduces resistance into the circuit and increases the ratio of inductance to capacity. The iron giving a powerful magnetic flux makes for more stable and quiet operation.

From the first intermediate frequency transformer the current passes through the second tube to the second transformer through the third tube to the third transformer, then to the second detector and to the first audio frequency transformer, then to the first audio amplifying tube through to the second audio transformer to the second audio amplifying tube and into the head set or loud speaker.

Parts Divided Into Three Classes

The subject of parts might well be divided into three main classifications—namely good, bad and indifferent. Under the heading of good parts we could classify all those essentials that go to make up any set in the construction of which the manufacturer has kept in mind the fact that the purchaser of his part intends to use the part in the construction of a delicate instrument.

Under the heading of bad parts, we ought to classify all parts that do not come up to the good standard and yet leave room for the third classification indifferent, which should include all those parts that are obviously made only to sell.

You who contemplate the building of the superheterodyne set must keep in mind this one thing if nothing else. If you buy poor parts you must expect poor results. If you get fair parts you will get fair results, but if you get the best parts it is possible to get, then and then only, will you get the best results.

Approximate Cost of Parts

Don't misunderstand me when I speak of "best" parts; I mean the best from an electrical and a mechanical standpoint. It does not always follow that the best parts cost the most. It is possible to get excellent material to use in the super-heterodyne set at a reasonable figure if you just think before purchasing the parts.

The most important parts of the super-heterodyne, given in the order of their importance are as follows: The oscillator coupler and condenser, the filter coils and fixed condensers, the intermediate frequency amplifying transformers, the audio frequency amplifying transformers, the potentiometer, the rheostats, the grid leaks and all various fixed condensers, the tubes, the loop and loop condensers, the loud speaker, the B batteries, the A batteries, the C batteries.

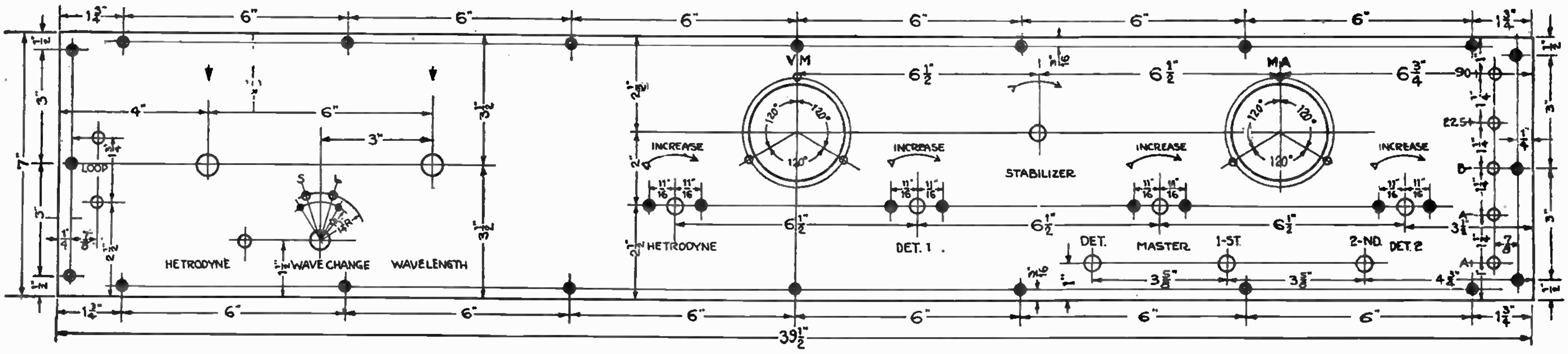
Taking these various parts in the order of their importance in the set let us analyze them and see if we can't determine what we want before we get it, also see why we want it.

First, then, is the oscillator coupler. We know that it must have enough inductance to cover the wave bands we wish to receive, that it must be well insulated otherwise we will have leakage. It is desirable that the coil have low distributed capacity because we want all the capacity in the condenser. Now, knowing these essentials it is easy for us to look over the various makes of oscillator coils and pick out the one that comes nearest to approaching and fulfilling these requirements as to inductance and capacity. Of course, you must not lose sight of the fact that the coils have to be mounted somewhere. Therefore, after satisfying yourself as to its electrical characteristics, make certain that its mechanical construction is such that the coil will stand a reasonable amount of handling and that it will stay put.

The Variable Condenser

Second on the list of importance is the variable condenser that controls the frequency generated in the oscillating circuit. In order to choose this condenser we must consider what it has to do. We know that the oscillator must generate a high frequency current. We also know that this frequency must be varied to suit the incoming oscillation. We also know that in varying this frequency we must "split hairs," that is, we must tune extremely sharp, a difference of a 1/64-inch movement of the condenser in rotating the movable plates being sufficient to eliminate one station and bring in another. We also know that where it is necessary to do such fine tuning we must be able to record the setting and then go back to that setting at any time and be able to pick up the station.

Furthermore, with only the one variable control on the oscillator, if we are going to have a good range on the circuit we must have a condenser with a low minimum capacity range. To make this perfectly clear let us assume that we have an oscillator coil, the inductance of which is such that without any condenser across it it would respond to a wave length of 150 meters. We know then that if we are going to tune in or rather cover all the wave-bands lying between 250 meters and 600 meters, we must get a condenser that has a capacity large enough to load the coil up to 600 meters and low enough to enable us to tune to 250 meters. Loading the oscillator is easy; it simply means the connecting in the circuit of a condenser of the right capacity. If the condenser does not have a low minimum capacity you will be able to tune to 600 meters all right but you will not be able to get below 300 meters. Now you see why it is so essential to have a condenser with a low minimum capacity.



The Panel Layout for Drilling

Micrometer Adjustment

Knowing all the above facts, it is easily seen that we must have a variable condenser capable of micrometer adjustment with low minimum and high maximum capacity. The so-called "fly leaf" variable condenser will operate correctly but, owing to the micrometer adjustment and necessity for being able to go back and "pick up" the station again it is not desirable. This leaves a choice between the "rubber" geared and the "mechanical" geared types. The rubber gets hard and fails to grip, so that eliminates it, leaving only the mechanical geared type which is most desired.

List of Parts

1	Hard rubber panel(3/16"x7"x39½")	$ 6.00
1	Ash baseboard (½x9x38)	1.50
8	Vacuum tube sockets	8.00
4	Rheostats	7.40
3	Intermediate frequency transformers	24.00
2	Audio frequency transformers	15.00
2	Fixed condensers 1.mfd	2.50
1	Oscillator and coupler coil	6.00
1	Filter coil and condensers (2) .00025	7.50
4	Grid leaks with clips, 2 megohms	2.00
2	Grid condensers .00025	1.50
1	Fixed Condenser .001	.40
1	Fixed condenser .005	.75
2	Double circuit jacks	2.00
1	Single circuit jack	.70
1	Battery switch	.60
1	Variable condenser .001 mfd. vernier	7.50
1	Variable condenser .0005 mfd. vernier	6.50
1	Potentiometer, high resistance	2.20
2	Dials, 4"	3.30
7	Binding posts	1.75
1	Milammeter, 0-100 mil-amps	7.50
1	Voltmeter, 0-10 volts	7.50
1	Inductance switch, 2 points	1.00
60	feet bus bar wire	1.50
25	feet spaghetti	2.00
1	Loop aerial	7.50
1	Cabinet	25.00
	Total cost	**$159.10**

The filter coils have been thoroughly discussed in the previous article so that it is not thought necessary to go into detail regarding their function in the circuit except to say that we must be sure they have the necessary mechanical support to hold them in place. Honeycomb or herringbone coils answer the purpose very nicely.

The transformers for amplifying the intermediate frequency should be designed to give maximum amplification on the frequency it is intended to pass. It is preferable to have a transformer that has the ends of both windings coming out at the side or bottom so that the shortest possible lead can be made to them from the grid and plate of the tube sockets.

Audio Frequency Transformers

As the function of the audio frequency transformers is so well known and so many articles have been written on them it is not considered necessary to mention them further except to say that inasmuch as the signal is so highly amplified before it reaches the audio stages, it is not necessary to construct special "push-pull" or "power" amplifiers to further operate the loud speaker. A good high-grade efficient transformer of a four to one ratio for the first stage and a three to one ratio for the second stage should give quite sufficient "power" to operate any of the "good" loud speakers.

The potentiometer is a very important control and should be of not less than 400 ohms' resistance. Its mechanical contsruction should be rugged enough to give a good contact throughout its entire operating scale without giving "scratches." The wire should be heavy and strong enough to stand considerable wear.

Rheostats must be selected with great care. Too often we are apt to slip up on this part of the set and install cheap rheostats that have neither the required resistance nor mechanical strength to do their work properly. The writer has used the carbon compression type with very good results because it gets away from the movable contact arm.

The Grid Leaks

The grid leaks, of course, could be variable so that they can be adjusted for the particular tube used but it is not absolutely necessary. Leeway can be allowed here in the selection of a detector tube as it has been my experience that a hard tube will function just as good as a soft tube as a detector. The condenser is the principal thing to watch and a good high-grade condenser made by a reputable manufacturer can nearly always be depended upon to be what he says it is.

Under no circumstances should the so-called pencil mark grid leak be used as it will give you all sorts of trouble in trying to get the required amount of resistance.

So much has been said about tubes that there is very little more to say. However, the writer recommends either the type 199 or the 201A, both being very good, the latter, 201A, giving the louder signal. The one tube that should be watched is, of course, the oscillator. This should be a tube that will give maximum plate current. The detectors should be sensitive and it follows as a matter of course that the three intermediate frequency and the two audio frequency amplifier tubes should be good so as to give maximum plate flow.

The loop should have sufficient inductance so that when the condenser is connected across it, it will cover the desired wavebands. Sliding contacts on the loop should be examined very carefully and unless so made that a positive contact is assured they should not be permitted, because if the contacts do not "make" you will get noise in the set.

A straight line condenser should be used if possible although any good condenser will answer the purpose. It must, however, have a low minimum capacity and good mechanical construction and insulation. The vernier is not necessary.

Nothing will be said here on loud speakers, A, B or C batteries as they are already so well known that anything the writer might say would only be repetition.

The complete list of all parts necessary for the construction of the eight tube set is given, and the purchase of which should be easy bearing in mind what has been said above.

The A battery will depend upon what kind of tubes are going to be used. The B battery should be 90 volts and preferably storage type as the set with eight tubes uses considerable plate current and, unless the dry batteries are parralleled, you will not get maximum life out of them. The type head set and loud speaker are left for the user to decide as to which of the many is more to his liking. An adjustable loud speaker should be used as this will better enable you to handle the output.

Laying Out the Panel

In laying out the panel have it cut to the correct size then lay it aside and do not touch it until you have made a pattern out of a piece of paper and marked all the holes exactly as laid out for you in the figure. Remember this, panels cut to as large a size as this are expensive and you will save yourself money by laying out the panel on paper first.

When ready to lay out the panel get the rheostats, binding posts and variable condensers and check up the measurements as given on the figure with the actual measurements of the piece of apparatus you intend using. Lay out the rheostats and variable condensers in a straight center line, the jacks and switch in a center line and then the meters and potentiometer in a center line. This makes a straight line job, looks good and is neat. Avoid changing the positions of the various pieces of apparatus to other than a straight line because it makes a complicated looking front and in designing a set of this kind you want and should have a good looking set as well as a good working set.

After laying out all the apparatus on the paper pattern, securely fasten the paper to the panel with six small clamps. Clamp the panel with the paper layout on it to the table or workbench. Then take a sharp center punch and lightly tap the center of hole as marked. Look carefully after you have tapped them to see that you have not missed any. Now remove the clamps and paper pattern and go over all the small light taps with the center punch and punch them in hard.

(Continued on next page)

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The reason for this is that in case you should have made a mistake in some hole you can easily fill in a light tap but if you had started in and made heavy marks, then discovered a mistake, you would have a difficult job trying to fill it in.

Now drill all holes and ream out to size, fitting each piece of apparatus to its own hole as you go along. When you come to the holes for the meters, better take the panel to a shop and have it done because it is a rather difficult job to cut such a large hole correctly. After fitting all apparatus, take it to some shop and have it engraved. It should cost only five or six dollars and the improvement in looks is worth fifty dollars. After it is engraved you can assemble the apparatus on it and tighten up everything. Now you are ready for the base board assembly.

Baseboard Assembly

This heading is very misleading and does not cover what is intended at all. Merely stating that we are now going to show, or rather tell you how to lay out the apparatus on the base, doesn't convince the writer that you realize how important this subject is, so for this reason it's going to take a lot of explaining to put you on the right track.

Let it be distinctly understood right now, before we go any further, that the thing to be borne in mind at all times is that you must get started right. If you get off on a tangent and start varying from the procedure already outlined, you are going to have a hard time trying to get straightened out. Follow the method we lay out for you exactly to the letter and your set will function and it will do just what the set that has already been made has done and is doing. After you have made the set just as we have told you and it works, then and then only should you start changing and experimenting. You can try any one of a dozen different hook-ups. Try anything you like, for that matter, but for goodness sake do not attempt to make the set as the writer has been telling you and at the same time try "Bill Jones" and "Jim Smith's" advice also, because if you do you are in for a peck of trouble.

Build Set as Described

If you can't have confidence in what we are telling you just take it for granted that it must be somewhere near O. K. and go ahead and get all the advice you can. Write the different suggestions in a little notebook under the title of "What I am going to try when my set works," and then make the set exactly as we tell you; then you won't have any trouble and your set will work and you will get some real enjoyment in listening to a real set operate.

You can easily see that it isn't a very hard matter to change a .005 mfd. condenser to a .006 mfd. or to substitute this grid leak for that or to even change a transformer after the set is working correctly, but if you start right in taking the other fellows' advice and changing this or that, how in the name of goodness can you expect it to work? If by any chance it does work it will be nothing but luck, so why take a chance?

It has always seemed queer to the writer as to just why the average person contemplating the building of a set—any kind—should purchase blueprints or booklets, paying out real hard, honest-to-goodness cash for them for the express purpose of learning how to build the set and what parts will be needed and recommended, and then turn right around and ask his neighbor or some casual citizen (the chances are ten to one that they themselves, have never built the set, probably they have never even seen one) how to build it.

There no doubt will be improvements on the circuit from time to time—also as the manufacturers make more money through the sale of present-day apparatus they can employ more research engineers and they in turn can develop more efficient apparatus, but that doesn't change the fundamental principle at all. An ordinary, simple regenerative set is just the same today as it was yesterday, except that it is more efficient through the use of better apparatus.

On the other hand, if we all sit back and wait until the ultimate in perfection is reached, then there will be no Radio because we must use what we have now in order to pave the way to better things later on.

Assembling Parts on Base Board

With these few words of explanation, we are now ready to take up the laying out of the base board. The first thing to do is to put the panel with the apparatus mounted on it up in the attic or down in the basement anywhere away from you so that by no possible chance can you fasten it on to the base board before you are through mounting the apparatus.

The next thing in line is to take the oscillator coil, the filter coils, the intermediate and audio frequency transformer and tube sockets and place them in position on the board. Bear in mind this caution: Be sure and mount all the apparatus so that all leads are as short as possible, the shorter you can get the leads the more efficient a set you will have, and this applies more particularly to this than any other set. More trouble has been caused in supers through long, unnecessary leads than through almost any other cause.

I cannot understand why people will not mount the various pieces of apparatus just as close as possible. As an illustration, take the fellow building a simple set. He buys a couple of transformers for the audio stages and asks which are the best, and the clerk tells him to take those that have shields on them. This he does. Then he asks if there is any special way to mount them, and the clerk informs him that to prevent interference, distortion and other major complications, he should mount one this way and then six or eight inches away he should turn the other one at right angles and mount it. Now if the clerk had only told him to make the leads just as short as possible, the only possible trouble that could occur would be the reaction of the magnetic field of one transformer on the windings of the other transformer, and if this happens there will be distortion.

Distortion Eliminated

With a cheap, poorly designed transformer you might get distortion provided they were placed closer than two inches apart, assuming of course that they were unshielded. With a shielded transformer the probability of distortion due to this cause is very remote. Of course if you set up an oscillatory circuit around the audio transformers so that placing the hand within eight inches of them will cause howling, you have a different problem entirely to deal with. This is not due to the transformer, but to the circuit construction and I venture to say that if you shorten all the leads in the set most of the body capacity effect can be eliminated.

If you are using a high grade transformer you do not need to worry about reaction, just place them so they make a very short lead necessary to connect them.

The general arrangement to be followed in mounting the apparatus on the base board should be one that permits of short leads and no criss-crossing of wires. It's very easy to get the general layout of the parts from the illustrations. Try following this layout exactly and note in placing the apparatus just where the connections go. In this way, by keeping in mind the panel layout and the wiring to follow, you won't go very far wrong in laying out the apparatus on the base board.

Always start placing the various parts of the apparatus on the base board beginning at the rear of the board, the rear of the board, of course, being the side opposite to the side to which the panel is fastened. In this way you can place all the parts; mark the holes with a pencil; remove the part and drill a hole for the screw that holds it in place.

Device for Making Holes

A small gimlet that you can purchase for about ten cents makes an ideal instrument to make the holes

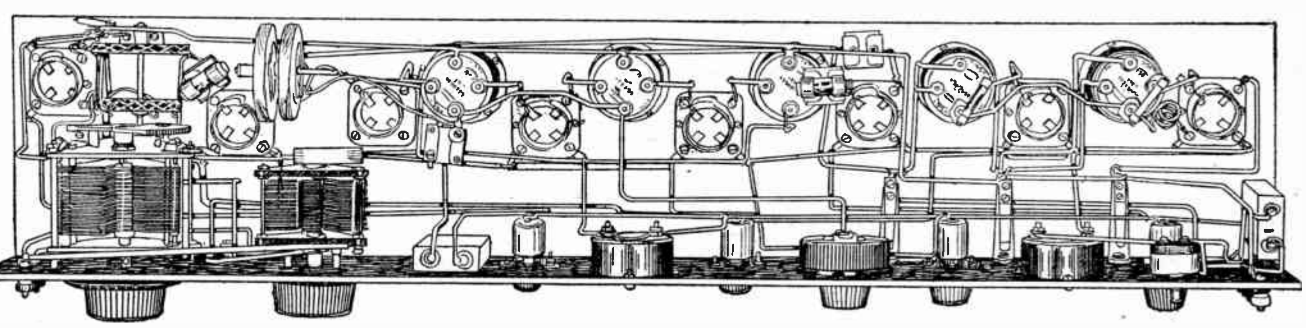
ratus with the circuit diagram, noting mentally how the wires will fit in and where they will go. Now wire up the filaments of the tubes; the rheostats; tackle the oscillator circuit; the intermediate frequency transformers and then the audio frequency to the jacks and the job is done.

The writer always figures out the longest leads first, but then this is no criterion because it is very doubtful if any two men will wire up a set the same way or go about it in the same manner. However, that is not of any great importance. It isn't going to affect the operation of the set a great deal or even in the slightest degree as to which piece of apparatus is wired up first. Experience has shown, however, that by wiring up the filaments first the chances of making a wrong connection to the B battery are greatly reduced. It is also a fact that there are a number of returns to filament and these can be connected at once when working on them if the filament leads are already in.

The question of whether to use square brass, square brass tinned, number 12 round or number 14 round tinned wire, is mostly one of convenience and individual taste. If you think square brass makes a neater job and looks better to you, use it. On the other hand, if you wish a "classy" job as well as one that is of real service, use number 14 round and cover it with genuine varnished cambric tubing. Get five colors; yellow, black, red, brown and green. Put black tubing on all negative and yellow on all positive six-volt leads. Use the red on all plate connections and 90-volt B positive leads—except the two detectors. Use the brown on the plate leads of the two detectors, and wherever the 22½ B positive goes. Use the green on all grid leads for all tubes. This will give you a color code, as we call it in telephone work, that will improve the looks of your set a thousand per cent, as well as enable you to wire it absolutely correct. It will be hard for you to make a mistake in wiring if you stick to the color code, because it acts as a check on your wiring.

Advantages of the Color Code

The writer recommends using the color code for all inexperienced as well as experienced men. It is only slightly more expensive than doing without, and the check that it holds on the making of mistakes is more than worth the extra cost. It is surprising how few of the average laymen there are that will take the little extra time and place "spaghetti" on the



Plan View of Baseboard Showing Apparatus Layout.

for the mounting screws, where you are using a hard wood base board. If you get a gum, boxwood or poplar base board (this is what the writer recommends) you can use the ice pick for a hole puncher.

Try to get the apparatus placed symmetrically. Exercise just as much care in lining up the apparatus as you would in placing the parts on your panel. Remembering this, a set well laid out and securely mounted has more of a chance to get wired up correctly than one that just has the apparatus laid around haphazard, some mounted with one screw, some not even screwed down and some left out of the picture entirely. Then when the wiring is started it is discovered a part is missing and a place has to be made for it.

Care taken in the proper assembly and laying out of the apparatus both on the panel and on the base board will reduce wiring errors eighty per cent.

Always bear in mind that the apparatus cannot think—all it can do is to perform along certain lines. It has one thing to do and usually will do it if given half a chance. You who are constructing the set must do all the thinking and if you fail to reason correctly then failure is the result.

One of the most common causes for failure on the part of the average individual who attempts to construct a set, is lack of confidence in their ability to assemble the parts and then wire them up correctly. Another failure is due to over-confidence. This is made manifest more prominently by the person who has made a set simply by throwing the stuff together and then getting good results with it, which inspires over-confidence as the person is apt to think that if a set can be built so easily a super should not be such an awful job—so he tackles it in the same manner, then he wonders why it doesn't work.

Procedure for Wiring Set

The wiring of the super-heterodyne set can be made simple or hard, depending entirely upon the person making the set. If the apparatus has been laid out as recommended in the previous articles, you can start right in by screwing the panel to the base board. A small angle of brass should be shaped and fastened on the rear of the .001 condenser (if of the mechanical geared type) and resting on the base board. This will assist in supporting the panel and holding it rigid.

Your next step is to commence wiring. First look over the assembled set and compare the placed appa-

leads, using different colors to distinguish the leads and denote what they carry and where they go. The writer doesn't claim originality on the introduction of this method, but just wants to call it back to memory so as to make the wiring of the super just as easy as possible. Try this method once in making your next set, whether it's the super or some other kind. Note with what ease you can trace the wiring and how sure you are of where the correct connections for each lead go.

The great trouble in wiring a set with a lot of connections is liability to connect grids where plates should go, and often the fatal mistake of connecting 90-volt B positive to the negative A somewhere in the set and connecting the positive A and negative B outside the set, so that when it comes time to insert the tubes preparatory to turning on the "juice" eight tubes will be burned out slick as a whistle. Using a color code, this kind of a wrong connection cannot happen, because in making the final trace to see if everything is O. K. you would notice the red to black and would know it was wrong immediately. You wouldn't have to guess. And by the way, let us mention right now: Don't ever guess where a lead goes in a super-heterodyne set, or for that matter, in any other set—know where each lead goes. Guessing has blown more tubes than any other indoor sport.

Use Lugs for Solder Connections

Get yourself a small box of tinned copper or brass flat lugs and insert these lugs under the binding posts on the various pieces of apparatus, then solder all wires to these lugs. The writer never recommends soldering direct to any piece of apparatus if it is at all possible to avoid it. One of the most important reasons for so doing is that unless—and even with extreme care—soldering paste will run down and into the case.

Keep the leads off the base board as much as possible. Run each lead direct and short. Don't try to see how many fancy square corners you can make. The purpose in wiring a set is to furnish a path for the current to flow from and to. It is not placed in the set to see how fancy it can be made to look. First on the program in wiring is efficiency. Second is looks. If a particular lead can be made extremely short, but you don't think it will look good, take my advice and run it short.

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Get all your wires in first, then put in your fixed by-pass condensers. Remember this, do not solder wires direct to the fixed condensers. All of them are fitted with holes. These holes are not there for ornaments, they are placed there so that a 6-32 screw goes in nicely. Just get yourself a 6-32 machine screw, round head, and a nut, then insert it in the hole on the condenser and slip one of the aforementioned tinned lugs under the nut and tighten up on it, then solder the wire to this lug. Better practice would be to solder the lug to the wire before mounting on the condenser. The thing to bear in mind is the avoidance of the paste running into the condenser.

Most of us run in ruts and follow precedent. We make a set with a cabinet and binding posts and square turns only because it is customary to do so. Then someone comes along and tells you to use no wire at all, or something else, and the first thing you think of is that the set won't look good. What are you making? An ornament, or a Radio set that will work better than the ordinary? Make your ornament out of the cabinet, but for goodness sake don't try to make an ornament out of the insides!

Set Ready to Operate

Now that you have the set all wired up according to instructions, it should be ready to operate. The first thing to do is to connect up the loop and the A battery, then insert one (one only) tube in any of the sockets. Pull the switch and see if the voltmeter reads correctly. It should. If it does, then turn the rheostat controlling the current to the tube you have in the socket. The tube should light. If it doesn't, the trouble is probably in the prongs on the tube not making good contact with the prongs in the socket. Fix this, then try the tube in each socket, testing the rheostats and satisfying yourself that the tube makes good contact in the socket.

This completes the testing of the individual tube sockets. Now remove the tube and leave the A battery connected. Get an ordinary 110-volt lamp such as you use for lighting purposes in the house. Connect a short length of wire to the 90-volt binding post on the set, and connect the negative terminal of the B battery to the set at its proper binding post. Now hold the bulb in your right hand with the bottom contact on the 90-volt terminal of the B battery. Then touch the short lead from the set to the side contact on the lamp. If the lamp lights you have a short circuit in the wiring of the set. If you have the set wired correctly the lamp will not light. Assuming that you have it correct, remove the short lead from the binding post and connect the B battery, both the 22½-volt and the 90-volt terminals to their respective binding posts. Now connect the C battery in place but be sure you have the polarity correct.

You can now feel safe in inserting the tubes in the sockets. After putting in the tubes, plug in the loud speaker, set the oscillator condenser on or between 20 and 30 and set the wave length condenser at 20 or 25, place the wave change switch on long, adjust the rheostats on all tubes then vary the potentiometer. If the set is correctly wired you will cause it to howl or stop howling by varying the potentiometer. If the set doesn't howl in this condition readjust the rheostats with one hand, at the same time varying the potentiometer. If this doesn't help, then try pressing down on the tubes in the sockets. It may be that they are not making good contact. Assuming that you have wired the set correctly and get the howl, then swing the potentiometer around until it stops howling and let it stay there. Now go to the oscillator condenser and as you move it one way or the other over the scale you will get a series of whistles. This will tell you plainly that the set is working.

Tuning-in Stations

To tune in a station for the first time requires a great deal of patience, as the tuning of a super is a knack that is acquired with practice only. You must learn it yourself. No one can teach it to you. It's like playing a piano—the instructor can show you how you can get music out of it, but if you don't learn how yourself you will never be able to play. Set the potentiometer at a point where the tubes almost howl, then vary the oscillator slowly with the vernier; start at about 15 on the dial and go up the scale. If you hear the station at all you can hear them on the loud speaker.

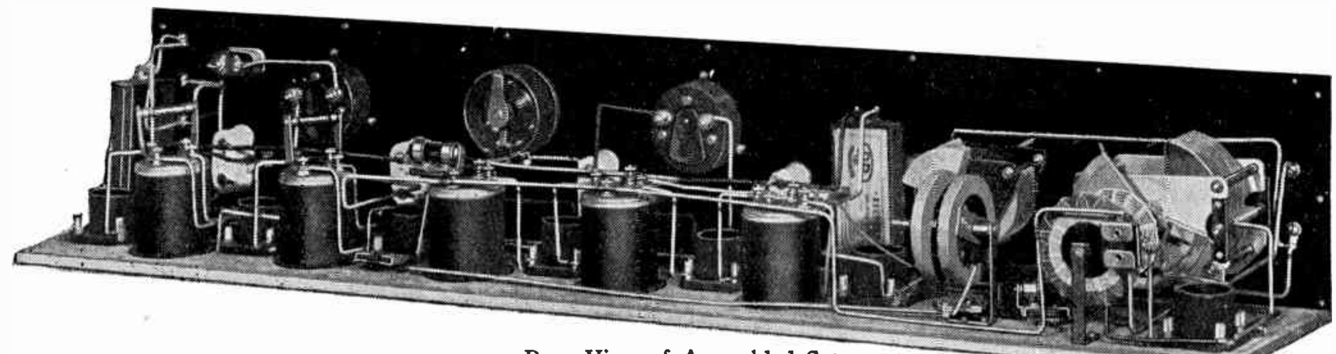
Let the potentiometer alone when you are varying the oscillator condenser. While you are adjusting the oscillator condenser, move the wave length condenser along with it. When you have picked up a station get its best point on the oscillator condenser; vary the wave length condenser to its loudest point; swing the loop so as to bring it in best, and lastly, readjust the potentiometer to its best point.

After you have operated the set for a while you will discover that the loop direction and the wave length condenser are not so critical as you thought they were. You will also find a number of places on the oscillator dial where you can pick up the same station without changing any other control. There is one pair of points where you will get the station loudest, and even one of these is the louder. The rest of the points are due to harmonics and are not discussed here.

You will find in operating that all you have to do is adjust the oscillator condenser, as the setting of the wave length condenser can be approximated closely enough. You will also find that once the rheostat and potentiometer are adjusted you won't have to bother them again.

After the set is going and you have learned how to adjust and bring stations in, you can try changing the tubes around. Sometimes it happens that certain tubes are noisy. If you find any that are, it is best to take them out of the set entirely or use them as detectors, because sometimes the noisy tubes are only noisy on the higher plate voltages, and using them as detector tubes on lower plate voltages cuts out the noise and enables you to use the tubes.

I do not advocate shielding the set, as if it is wired correctly the body capacity effect is negligible. The set made by the writer has absolutely no body capacity at all and is not shielded.



Rear View of Assembled Set

Two Meter Wave Lengths

By Rene Mesny

FOR a long time waves of the order of a meter in length have been realized. It was just this class of waves that were first produced by Hertz in 1887, in order to apply experimental verification to the ideas of Maxwell, but until the present time they have not passed beyond the laboratory stage.

Since the first successes of Marconi, constant search has been made to increase the scale of waves which can be utilized for communication. After having made use of greater and greater lengths in order to assure distant communication, interest has turned to short waves and these have yielded unhoped-for results in the hands of amateurs. The recent success of bilateral communication across the Atlantic Ocean upon a wave length of 100 meters, between M. Deloy of Nice, France, and F. H. Schnell of Hartford, Connecticut, is known to all.

Short Waves Hold Direction Solution

There is interest in descending still lower; it is hoped in fact to solve a capital problem—that of directed waves. We should like to speak of transmissions concentrated in a channel equally narrow to that of a projector, and not of those in favored directions which have been obtained for some time by means of frames.

One of the most available means of obtaining such transmissions is by the use of parabolic mirrors, but the mirrors must have dimensions of from 1½ to 2 times the length of the wave to be reflected, and these considerations lead to the use of wave lengths of only a few meters.

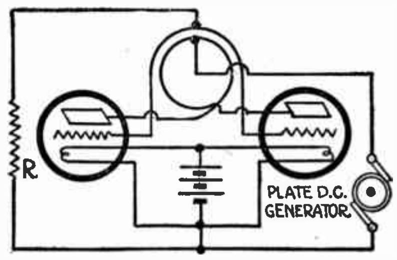


Figure 1

Work of Franklin and Dunmore

It is known that Franklin in England and Dunmore in the United States have studied the question and have obtained transmissions upon wave lengths of 3 to 4 meters and of 10 meters, respectively.

It is proposed to set forth here the principles of the researches which we have carried out with M. David upon the question of very short waves.

One of the difficulties of producing very short waves is the capricious functioning of electronic tubes on the waves and it appears that actually other systems can not be resorted to for the production of sustained short waves.

We have had recourse to a circuit with two symmetrical triodes (audion bulbs) of which the principle is indicated by the diagram of Figure 1. It is a particular case of a more general circuit permitting the obtaining of polyphase oscillations at high frequency, which we conceived in 1921 in insisting upon the particular type of circuit with two triodes and upon its advantages. This assembly with two triodes was also presented by Eccles in 1919.

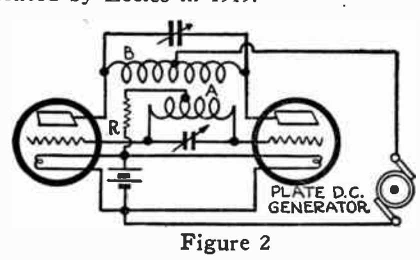


Figure 2

Arrangement for Short Waves

Two inductances A and B, wound inversely, connect in one part the grids, and in the other part the plates of the two triodes. A variable condenser is in parallel with each of these inductances; it is dampened in order to obtain the shortest waves, Figure 2.

The centers of the windings are connected to one of the poles of the filament by means of two wires G and P. The lead from the grids is interposed by a resistance R of several thousand ohms in order to diminish the continuous filament-grid current. In series with the plate lead is placed a potential of a hundred or of several hundred volts. The homologous elements of the two triodes are, therefore, at each instant at equal potentials but of contrary polarity, and the oscillations are cantoned in the inductances of the grids and of the plates and also in the wires connecting the filaments heated in parallel.

No oscillating current passes into the common wires of the grids or of the plates and it is possible to dispose of these at will without taking any precaution. In that lies the advantage of this type of circuit arrangement over the assemblies with a single triode tube in which the oscillations propagate themselves by necessity in traversing the conductors connecting the filament to the grid and to the plate.

With the ordinary receiving triodes used by the French Military Radio Telegraph we have obtained very stable oscillations upon wave lengths of 2 meters; we may also decrease to 1.50 meters, but the operation then becomes irregular and it is impossible to obtain strength.

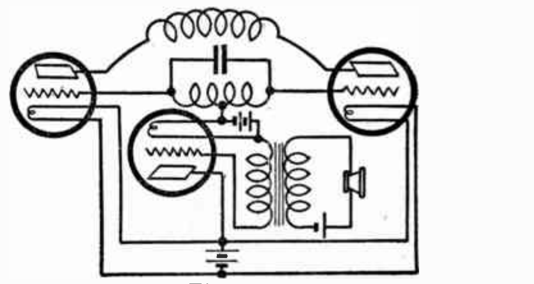


Figure 3

Have Made 1.20-Meter Waves

By modifying slightly the plates of these triodes, we have obtained wave lengths of 1.20 meters and have accomplished very stable operation upon the wave length of 1.50 meters. With two triodes of this type we have sent 0.6 ampere over an antenna whose natural period is one-half the transmitted wave and which is coupled inductively with the inductors of the generator. Thus is obtained what corresponds to a Radiocasting strength of 29 watts.

Whatever the length of the wave, telephony is done just as easily as telegraphy. The arrangement of the modulation for telephony is indicated by Figure 3. It is the application of a principle briefed by M. Bauvais. The resistance (Figure 2) in the grid leak is replaced by the filament-plate interposition of a triode of which the potential of the grid is varied by means of a modulation transformer energized by the microphone circuit. The modulation is excellent and the results obtained in communication are comparable, whatever the wave length used.

Reception may be accomplished by the usual methods, detection is possible by galena or by tube.

Have Been Heard Twenty Miles

The super-regenerative arrangement by Armstrong furnishes excellent results for receiving the short waves.

Tests have been made in the country with short waves (we have obtained good telephonic communication at a distance of 3 miles), but the tests were interrupted by the bad season before we were able to use all of the power that is now at our disposal. Further, our first tests were made without reflectors, for we sought only to verify the functioning of the apparatus for transmission and reception. The experiments will be renewed soon and, according to the results of measurements made in the laboratory, we are now certain to obtain results a little over 20 miles.

Compact Nine Tube Super-Heterodyne Set

Another Long Distance Getter

By Harry Abbott

The list prices of the apparatus used are given in the List of Parts. The cost of the parts required for this receiving set will approximate $155.00

LIKE every other man whose hobby has been Radio for a number of years, I've always wanted a super-heterodyne receiver. I started out with a single-tuber that brought in all the amateurs in the New York city territory and the old De Forest experimental phone station at Highbridge, New York; this was promoted into a three tube affair just about the time WJZ got into action in Newark in 1921. A little later, a step of tuned impedance Radio frequency was put in front of the original set, and early last year a stage of transformer-coupled Radio frequency was also inserted.

Then came the reports of the wonders of reflexing, so, with a new panel, the assembly of parts was revamped into a reflex. This was finally cadjoled into satisfactory operation and functioned well for some months, when Radio Digest began its series on the Neutrodyne. Once again the parts were rearranged and neutroformers took the place of Radio frequency transformers, and incoming signals were neutrodyned into clear music and clean cut speech.

But all the time I wanted a "Rolls-Royce." Theoretically it gave the best amplification and greatest selectivity of any circuit known, and selectivity around New York city is most essential. The fan that can separate WEAF, WJZ and WJY on Manhattan Island has a real receiver. The objections to constructing such an outfit were the number of controls, the size of the panel necessary and the number of tubes, I had five tubes of the 199-299 class; it would be necessary to purchase four more for the set I had in mind.

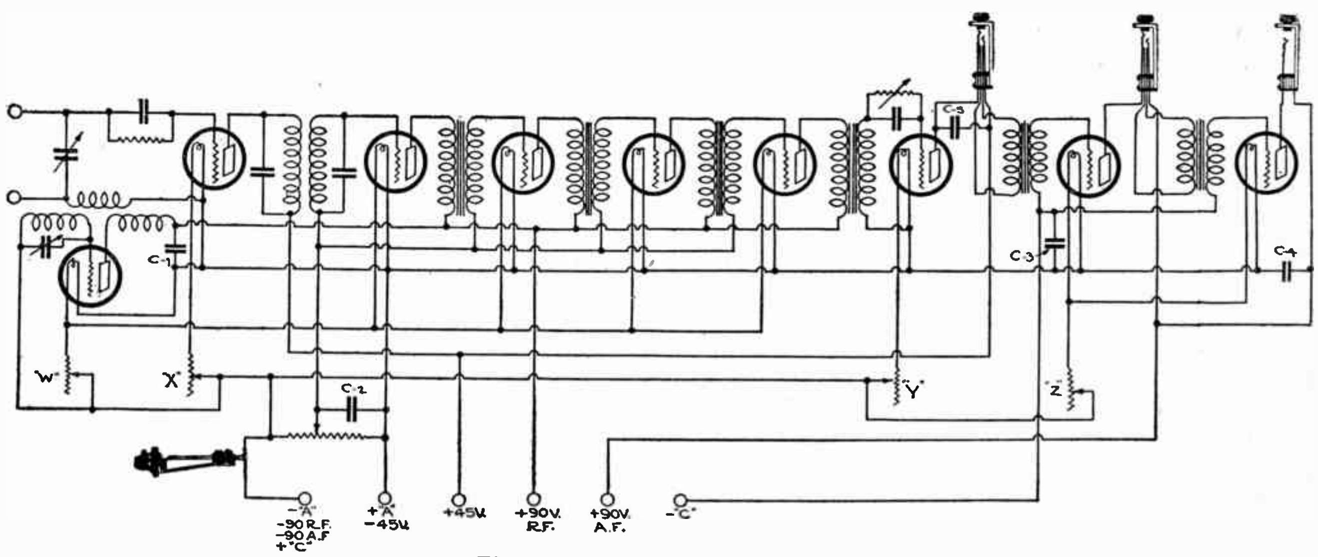


Figure 1—The Hook-up Diagram

Controls Necessary

Careful study of all the available "dope" on super-heterodynes convinced me that the controls could be brought down to two or two-and-a-half. I say "half" because it looked as though the oscillator coupler would require a touch on about one-fourth of the stations and the potentiometer a slight readjustment on a quarter of the stations. This diagnosis was later proved very nearly correct—two-and-a-quarter controls would be more accurate.

The circuit that looked best to me is shown in Figure 1. It called for nine tubes, which could be of either the '99 or 201A class. Personally, I liked the '99s and since each drew but .06 ampere, mine would require only .54 ampere, and six dry cells in series-parallel would furnish that. The matter of panel size was next up for consideration, and, as the circuit shows, I had to put two condensers, two variable grid leaks, one potentiometer, four rheostats and one filament switch on the panel. Much drawing paper was used in making layouts and the dimensions were finally brought down to 24 inches by 8 inches.

Several points which came out during construction and when first putting the set into operation, and which may not at first be clear to our readers, may as well be covered here. Filament control jacks cannot be used, as all nine tubes must be lit whether detector, first or second stage of audio are in use. I had them in at first but found that, after getting signals on the detector, plugging in the audio amplifiers threw off my previously made adjustments. Since I wanted all programs on the loud speaker anyway, and immediately shifted into two steps of audio frequency after getting stations on the detector, I did not mind the elimination of the filament-control feature.

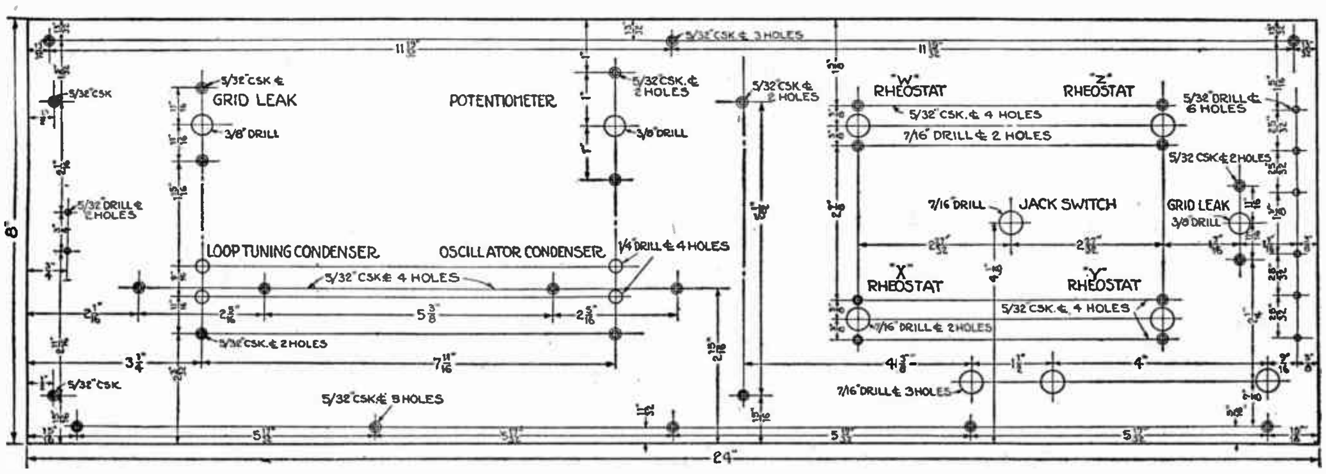


Figure 2—The Panel Layout

Then there is the matter of shielding. To many there will seem to be an excess of shielding in this set; some will feel that such an amount of shielding might cut down volume. Since iron core, shielded, intermediate wave transformers are used my "egg-crate" shields do not noticeably affect the volume but serve merely to keep the oscillator frequency, the intermediate frequency and audio frequency well separated and from interfering with each other.

Batteries Used in Set

Last, but a long way from least, is the matter of B batteries. I found in previous sets that it was much better to operate a detector from one B and the audio amplifiers from another. To get my super-het working I found it advisable to have a third B for the oscillator and intermediate long wave stages. The extra initial investment in B batteries is well worth its cost because none of them are overworked, they wear out evenly and last longer. The small cells of a B battery should not be asked to furnish more than a few milliamperes of current and putting too many tubes on a set of batteries runs them down prematurely. My super, then, used two 90-volt batteries, one 45-volt battery and a 6-volt C battery.

If there is any secret to this circuit I should say it lay in the fixed mica condensers. My super shows seven besides the two grid condensers, and sets constructed along similar lines may require one or two others to clear up stray whistles. It seems to be the usual practice, when writing about one's receiver, to give a long list of stations heard on the loud speaker. I can see no use in doing that.

Getting down to the set itself, there is a panel 24 inches by 8 inches and a baseboard 13 inches by 23 11/16 inches. Variable units go on the panel while those that need no attention are mounted on the baseboard. In all there are 27 units, exclusive or jacks and fixed condensers; on the panel are (from left to right a variable condenser), with grid leak above it, another variable condenser with potentiometer above it, two rheostats, the filament switch, two more rheostats and, finally, the second grid leak. Of these units only the two condensers are used in tuning.

The wiring diagram is given and some consideration of it might be advisable. At the left end, the oscillator coupler will be noted just above the first tube. This may be of any convenient type either purchased, homemade or adapted from a standard instrument. The one in my set resembles two Reinartz coils placed parallel to each other; one is larger than the other and its inner turns are the grid coil while the outer turns are the plate coil. The pick-up coil connected in the grid return of the first detector is the smaller of the two pancakes.

A tuned input transformer will be found in the plate circuit of the first detector and the grid circuit of the first long wave amplifier tube. The values of this unit will depend entirely on the transformer used in the intermediate amplifier. For the transformers incorporated in my outfit, two 1,000 turn coils of the air-cell variety shunted by .00025 fixed mica condensers,passed a frequency corresponding to the peak frequency of the long wave transformers. Some arrangement should be made for the adjustment of these two coils in their proximity to each other as the circuit is accurately tuned by this means.

The four long wave, iron core transformers connecting the long wave amplifiers, and the last of these amplifiers with the detector, may be any of the several makes now on the market, but as mentioned above, be sure the peak efficiency frequency of these units corresponds with the frequency to which your imput transformer is tuned. Only four rheostats are included in my set; that was all I found necessary. On the other hand, among the seventeen articles by supposed authorities which I have saved, I find that many say five should be used, so, I have left panel space for a fifth should any experimenter building this set desire to put it in. In the hook-up shown, the oscillator tube and the four long-wave amplifiers are all on one rheostat. Some may desire to put the oscillator on a separate rheostat, hence a fifth one.

Grid Leaks

Two grid leaks are shown and, no matter what type of tubes are used, they certainly should be variable for best results. The potentiometer may be either 200 or 400 ohms; it apparently makes little difference. The operating point will usually be found a little to one side of center.

The five fixed condensers shown are respectively: C1 is .002 mfd. mica; C2 is 1.0 mfd. mica; C3 is .5 mica; C4 is 1.0 mfd. mica; C5 is .006 mica.

The equipment on the baseboard, as shown in Figure 2, is mounted in four rows and, looking at the diagram, reading from left to right; in the front row; the oscillator coupler, the second audio transformer and the first audio transformer; in the second row, the first detector, the oscillator, the second audio, the first audio and the second detector sockets; in the third row, the tuned coupler and the first, second, third and fourth long wave amplifier tube sockets.

This all sounds like a good deal, and is, but since a super-heterodyne receiver is the only set that will give one long distance loud speaker range on a loop and satisfactory selectivity that is necessary. It is a pleasure to get this apparatus nicely mounted and wired; the cutting, fitting and placing of the shielding is the unpleasant part and there is considerable grief attached to it. It is necessary, though because of the compactness secured.

We now come to actual construction of the set. The panel should be ¼-inch bakelite, formica, condensite or hard rubber and to measure 24 inches by 8 inches. Studying this panel one finds two holes

(Continued on next page)

(Continued from preceding page)
near the center of the left edge ¾-inch apart; these are for the binding posts to which the loop or secondary terminals of a variocoupler are attached. Near this edge, and about 1 inch from top to bottom, are two more holes for the shields. The hole in the upper left corner is for a screw which fastens the panel to the cabinet. The five holes across the bottom are for attaching the panel to the baseboard by means of flat-head wood screws.

The four groups of holes to the left of the center are for condensers, grid leak and potentiometer. If instruments of any other makes than those shown in the illustrations are used, consider only the shaft holes and make the shaft holes of your templates coincide with the shaft holes of my layout. I mentioned earlier that some readers might like to use a fifth rheostat; it can be placed between the grid leak and potentiometer and in line with them. The two holes on a verticle line just to right of the center are for shields.

Holes Necessary in Panel

The groups of holes toward the right hand end of the panel are labeled with the exception of the jack and binding post holes. From left to right the three 7/16-inch holes near the bottom are second stage audio, first stage audio and detector. Along the right edge are six holes on a vertical line to take the six binding posts for battery connections. Reading down from the top, Number 1 is plus 45 for the detector plates; Number 2 is the plus 90 of the Radio frequency amplifiers; Number 3 is the plus A and minus 45; Number 4 is the minus A, plus C, the minus of the B used on the Radio frequency amplifiers; Number 5 is the minus C; Number 6 is the plus 90 of the audio frequecy amplifiers.

The same suggestion applies to this half of the panel as to the left half; if you do not use the instruments I used, take only the shaft holes and center your templates on them. The hole in the upper right corner is for attaching the panel to the cabinet with a flat-head wood screw.

Assembling the Parts

This set may be assembled in two parts; the panel as one assemble, the baseboard as another. If instruments, no matter what the make, are centered as shown in the panel and baseboard layouts, the two assemblies will go together without trouble. At this point the question comes up of shielding the panel. I did not shield mine but while this omission seems to result in no ill effects and I am not bothered with hand capacity, several good reasons have been pointed out by friends why this would be advisable. Among these reasons are the fact that waves from long wave stations can go through the panel and be heard, and that static on longer wave lengths will also affect my set. If the reader desires to make a shield for the panel, the panel layout can be use for centering holes but the holes themselves should be large enough to clear any metal parts of instruments which are "live"; that is, in the circuit. Drawing for all other shields are given.

Passing now to the baseboard layout, which is Figure 2, it will be seen that not only are the locations of instruments given but the placing of shields as well. The baseboard should be made of laminated board containing five thin strips the grain of which alternate in direction. The dimensions are 23 11/16 inches by 13 inches which will make the set somewhat deeper than usual but much shorter than would be the case if all nine tubes were put in a row. In Figure 2, location are given, so that any make apparatus may be used. It will be found that all long wave transformers are pretty much the same in size, which fact applies to the tube sockets.

Since I preferred the 199 and 299 class tubes my drawing shows sockets of that size but there is ample leeway if one prefers to put in the larger tubes and sockets. The front row of sockets is moved forward slightly, the rear row slightly back and storage battery tube sockets will go in nicely. Another difficulty that some might encounter occurred to me so I left plenty of room around the oscillator coupler should any readers be unable to secure one like mine.

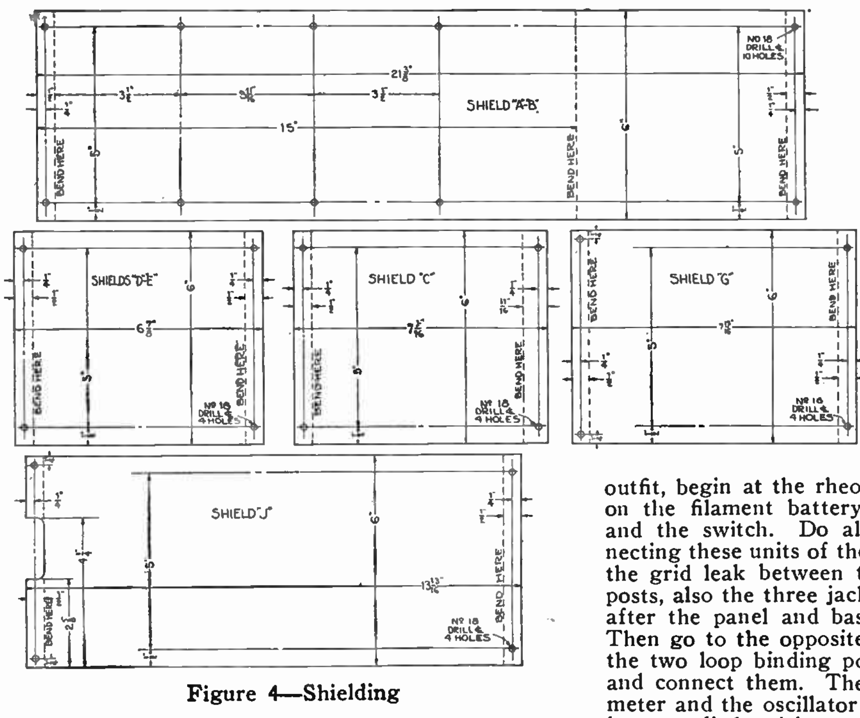


Figure 4—Shielding

Should you be unable to get one of the diamond weave type, use one you have. Either a 90 degree or 180 degree coupler will do, or some makes of variometers can be utilized. Remove turns from the center of the stator until 20 are left at each end. One set of 20 turns is the grid coil, the other set, is the plate coil. Remove all but 15 turns on the rotor as a "pick-up" coil. Three honeycomb or duo-lateral coils mounted on a wooden rod will do as well. A 35-turn coil for the grid curcuit in the middle, a 25-turn on one end for the plate and a 20-turn for "pick-up." The rod on which these slide should be parallel to the panel.

Coils Used

The input transformer is placed at right angles to the coupler toward the rear of the panel. Any of four types of coils—honeycomb, crisscross-wound, curkoidal-wound or straight closely wound coils—seemed to work equally well in my set, with compactness favoring the crisscross no-air-cell type and sharpness favoring the curkoidal-wound variety. Each of the two coils used contains 1,000 turns and each is shunted with a .00025 condenser for most of the iron core long wave transformers available, whose peak efficiencies are 7,000 to 8,200 meters. One type operates on a longer wave and larger condensers must shunt the input transformer. The two coils should be arranged that they may be brought nearer together or farther apart. Once set, they are left alone.

At this time there is no complete data on the manufacture of good wave iron core transformers although I happen to know that one maker puts 1,000 turns in the primary, 2,700 on the secondary and inserts an iron core measuring ⅜-inch by ⅜-inch made up of very thin, varnished laminations The wire is criss-cross wound by machine, the primary is about ⅜-inch wide, the secondary about ⅞-inch wide and they are slipped on the 2½-inch long core. Try making them if you want to but I'd advise buying them. They are set alternately at right angles to another directly in front of the tube sockets.

List of Parts

1	Panel 8x24	$ 3.75
1	Baseboard 13x23 11/16	1.50
4	Long wave RF transformers	35.00
1	Tuned input transformer (2) 1000 turn H. C. coils	5.00
2	Fixed condensers for above .00025	.80
4	Rheostats	7.00
2	Variable grid leak and condensers	4.40
1	Potentiometer	3.00
1	Fixed condenser .002	.50
2	Fixed condensers 1.0	2.50
1	Fixed condenser 0.5	1.00
1	Fixed condenser .006	.75
1	Oscillator coupler	6.00
1	Variable condenser .001 mfd	6.00
1	Variable condenser .0005 mfd	5.00
1	Battery switch (jack type)	1.00
9	Sockets	9.00
2	Double circuit jacks	2.00
1	Single circuit jack	.70
2	Audio frequency transformers	14.00
8	Binding posts	2.00
4½	Square feet aluminum or copper shield 24 gauge	6.00
2	Dials—vernier	2.50
60	Feet bus bar wire	1.50
25	Feet Spaghetti	2.00
1	Loop aerial	7.50
1	Cabinet	25.00
	Total Cost	$155.40

Manner of Construction

In constructing this outfit, begin at the rheostat end of the panel and put on the filament battery binding posts, the rheostats and the switch. Do all the wiring possible in connecting these units of the filament circuit. Then mount the grid leak between the rheostats and the binding posts, also the three jacks, but leave their wiring until after the panel and baseboard are brought together. Then go to the opposite end of the panel and put on the two loop binding posts and the tuning condenser and connect them. The first grid leak, the potentiometer and the oscillator condenser can also be put on. but very little wiring can be done on them as yet.

Proceeding now to the baseboard, first set all the parts on the board without screwing them down. Centering the sockets is easy as one has only to look down through the socket and get the little centering mark in the middle of the opening. Now, move the panel, with its mounted units, against the front edge of the baseboard and see that the units on each do not touch. Mine cleared each other very well but due to differences in construction those you use may require a slight shifting to right or left on the baseboard. The rear row will need no attention and should not be changed from the layout shown as otherwise the shields will not slip into place. When sure the front row is correctly placed, screw down the nine tube sockets and complete as much of the wiring of the filament circuit as may be done on the board. In wiring all parts on this baseboard keep an eye on the layout and keep as low as possible all wires which must pass under shields and put spaghetti tubing on all wires.

Some experimenters bend their bus wire so that the spaghetti rests on the board but a slight clearance of 1/16-inch might be better. After the filament wiring, connect up the four tubes and four transformers comprising the intermediate amplifier at the rear of the baseboard. The long wire connecting the grid return posts of the first three should be in front of the transformers, while the wire connecting the four plus B posts is between transformers and sockets. At the right hand end of the board this plus B wire is extended just beyond the edge of the board, bent at right angles, covered with spaghetti and brought up outside of the shield F to the second binding post from the top on the panel. The panel is not yet attached to the base so at this stage merely allow enough wire and leave it. Now wire the detector and audio frequency tube sockets to the audio frequency transformers and, as before, leave enough wire to attach to the binding posts on the panel.

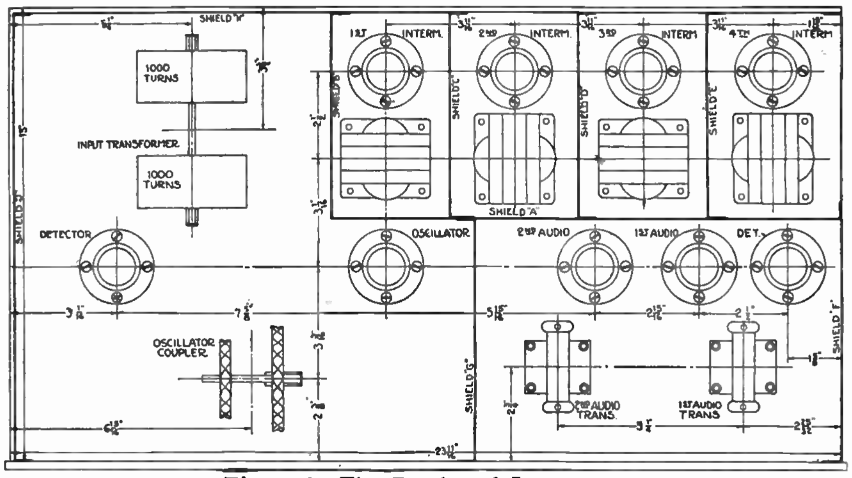


Figure 3—The Baseboard Layout

Going to the other end of the board, connect the tuned transformer consisting of two 1,000-turn coils, to the plus B, grid of first Radio frequency tube and plate of the first detector. The two .00025 mfd. fixed condensers are soldered to the bus wires leading from these coils. Short flexible leads must be attached to these coils so that they can be adjusted. At this time the plate and grid of the oscillator can be connected by bus bar wire and flexible wires to the oscillator coils and the grid coil connected to the minus A wiring.

You are now ready to attach the panel to the baseboard by means of five long, flat-head wood screws through the five holes across the bottom of the panel. This should be done with some care making sure that the board and panel are at right angles to one another as otherwise the panel will not fit well when the two are slipped into the cabinet. Having gotten them together you can now complete the wiring at the right end; the rheostats to the tubes and the plus lead connected to its proper binding post, Number 3 from the top. The jacks and transformer wiring can be completed and the two amplifier grid returns brought to Number 5 binding post, the detector plate circuit to the Number 1 binding post, and the two amplifier plate circuits to the Number 6 binding post at the bottom.

Having completed all the close-to-the-panel work at the right end, you can now move to the left end and connect the first grid leak to the first detector and the tuning condenser to the "pickup" coil of the oscillator coupler. Next take up the oscillator condenser, coupler and tube socket, not forgetting the fixed condenser across the plate and filament of the oscillator tube. The tuned transformer can now be connected to the grid return lead of the intermediate amplifiers and to the potentiometer. In connection with this work it should be mentioned that the outside ends of the coils go to the plate and grid of their respective tubes, the inner end of one being connected to the plus 45 and the inner end of the other to the potentiometer. Reference to the wiring diagram will make this clear.

Shielding

Before proceeding with the shields, go over carefully all the wiring you have done, checking it carefully against the wiring diagram and looking out: First, to see that no B battery wires are liable through jarring or slight pressure to touch the filament circuit; second, to see that no grid and plate wires run parallel if within 2 inches of each other; third, that wires passing under shields A, B, C, D, E, F and G are close to the baseboard and well covered with spaghetti. Now test your filament circuit by inserting the tubes and connecting the A battery to see that all lights are properly controlled by the rheostats. Leaving the tubes in, shift the A battery to the various pair

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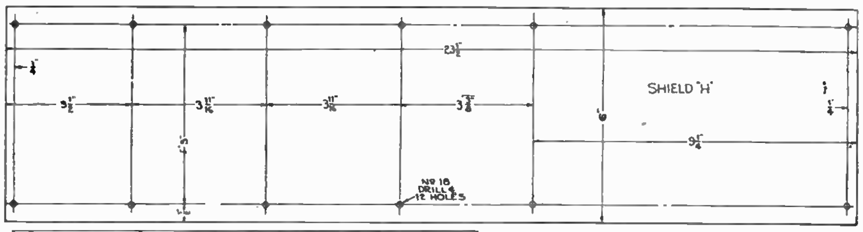
of binding posts intended for the B and C batteries and if the tubes do not light you can be pretty sure that adding the B battery will not blow anything.

The shields can be made of either sheet aluminum of number 24 gauge, obtainable in strips 12 inches



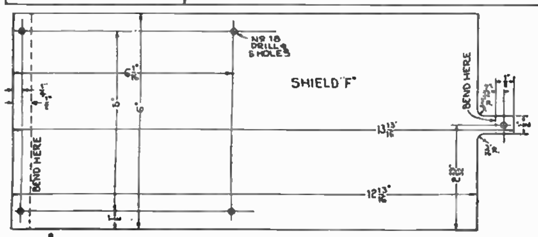


Figure 5—Shielding

wide, or of copper. If the former is used, the holes in the flap of the shields will have to be drilled and small brass, round head machine screws used to bolt the sections together. Copper can be readily soldered so the holes may be omitted if copper is used. All shields with the exception of F and J are regular in shape and no difficulty will be encountered in laying them out directly on the metal itself. Shield J will cause but little trouble, but for F it is advisable to draw a paper pattern for the irregular end and draw around it on the metal. Care should be used in making this, as it is essential that the ½-inch extension holding it to the panel come directly under binding post Number 4, which is the minus of the A battery, and to be fastened by it.

Shields J, G and F can now be bolted to the panel with flat-head brass machine screws; the remaining shields should now be fastened together, either with round-head machine screws or solder, depending on the material of which they were made. The resulting structure should now be lowered gently into place (the batteries all having been previously disconnected) and permitted to rest on the various wires which pass beneath it.

Battery Connections

The plus A battery wire to all tubes in the front row will pass under shields G and F; there will be a wire from rheostat W to the oscillator tube which will follow around under shield A, shield C, shield D and shield E. Under shield G will also pass the wire from rheostat X to the first detector tube, and the wire from Number 1 binding post at the right will go under shield F and under shield G to the tuned transformer. Thus there should be four passing under shield G, and two to five under each of the other shields except J and H.

Using either a pencil or a pointed instrument make a small mark near the bottom edge of shields where wires pass under and when all are so marked, lift off the shields and cut small inverted V's at each mark in the bottom edges. There will be five under shield C and D, the plus A battery wire at the rear, the minus A at the middle, the plus B next to it and forward, the wire from each transformer to the following grid, and near the front will be the grid return lead. Shield E will have but four notches, as the grid return lead from the transformer in front of the fourth intermediate tube goes to the plus filament wire and not to the potentiometer. The wire from the G binding post on that transformer passes under shield A close to its juncture with shield F and up to the grid leak on the panel at the right end.

Reference to the diagram will make clear how certain wires come outside of shield F and up to the binding posts. About 1 inch from the rear, the plus A battery wire comes through from the rear row of tubes and up to Number 3 binding post; 2 inches in front of that the plus B comes out and up to the Number 2 binding post; just in front of the point where shield A joins shield F, the plus A battery wire from the front row of tubes comes out and is soldered to the first A battery wire; about 3 inches back from the panel, the plus B battery from the audio frequency amplifier jacks comes through to go to Number 6 binding post, and the plus B 45 volts comes from the detector jack and the first detector, to be bent up to the Number 1 post. The minus C battery wire comes through to go to Number 5 binding post.

A little adjusting of the shields and slight enlarging here and there of the notches will be found necessary and the shields will rest on the baseboard, not touching any apparatus and clearing all wires by a sixteenth of an inch. Again the tubes should be inserted and the A battery connected first to its own posts when the tubes should light, and then to the B battery posts when the tubes should not light. The set is now ready to try out.

Tuning

Connect the three sets of B batteries, the C battery and the A battery and plug in on the detector jack at

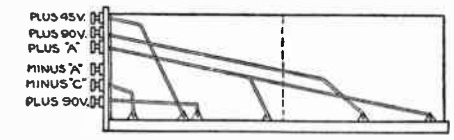


Figure 6

the right end of the panel. The loop should, of course, be connected at the other end, with the outside end of the loop to the grid side of the tuning condenser. The initial tuning of a "super" is quite an adventure. The tuning condenser should be set at 5 and the oscillator condenser should be swung through its scale very slowly. If no signal is heard, move the tuning condenser to 10 and again go slowly through the scale on the oscillator condenser. This process of co-ordinating the dial settings must be done until three or four stations have been heard that a scale may be made.

The potentiometer is an important device on this set. When it is on one side of center, the whistles will be heard as one swings through the scale; on the other side, there is absolute silence. As you turn the potentiometer knob from the whistling side past center a click will be heard which denotes that you have brought the intermediate amplifier out of the oscillating state into the proper condition for reception. It should be set at the point, on the quiet side, just after the click is heard, at which point the benefits of slight regeneration are secured.

With the potentiometer set and a signal tuned in, you can now adjust the tuned transformer by moving one coil nearer to and farther away from the other. This can be done while the set is in operation by using a wooden ruler or other nonconductor about a foot long. Moving this coil changes the peak efficiency of the transformer until it coincides with the peak efficiency of the iron core transformer. The final adjustment is moving the "pick-up" coil in its relation to the plate and grid coils until just the right amount of energy is absorbed from the oscillator to heterodyne both strong and faint signals for best results.

In connection with the audio frequency amplifier, it will be found that with 90 volts on the plates, the correct C battery voltage is 4½. This part of the set should cause no difficulty.

On the drawings for the cabinet it will be noted the greatest dimensions are but 25 3/16 inches by 14 inches by 9 11/16 inches. This is very compact for a "super" although the actual space within this cabinet is probably about the same as though one built the set with an 8 inch by 44 inch panel and a depth of 8 inches. The advantage of my construction is that my set requires only a small table with a 30 inch by 24 inch top, with the batteries on a curtain shelf beneath.

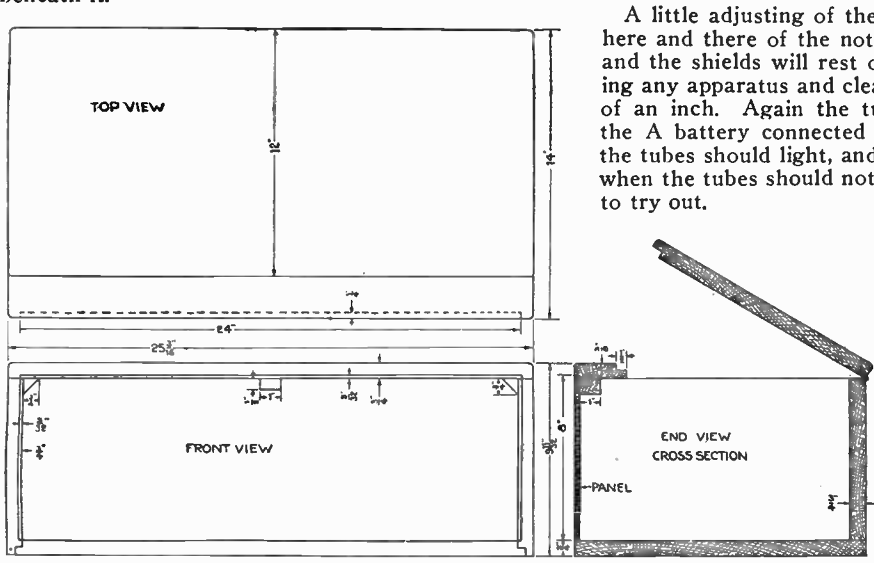


Figure 7—Cabinet

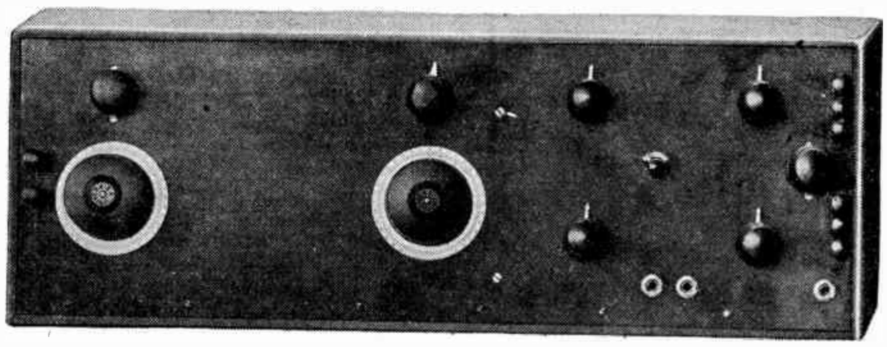


Figure 8—Front View

Practical Remarks for Beginners in Radio

THE ordinary beginner in Radio starts with a "listen in" on some friend's receiving set. If he has happened to hear a good program he decides to join the happy throng and build a set of his own.

His first investigation whether in buying one already assembled or putting it together is confusion, much of it—single circuits, double circuits, three circuits, Radio and audio frequency amplification, regeneration and the like. No wonder he is confused; yet through all this he has a definite idea of what he wants. Generally he wants a set that will give him results as good as are averaged by those in his vicinity, without having to go into technicalities to find the difference in the many kinds of circuits.

Atmosphere and Location

To begin, let me say that atmospheric conditions and location play a very important part in how well or how much you can receive. Night is better than day; winter is better than summer, and there will be a great variation from day to day. Stations will come in better from one direction than another; during the next night conditions may be reversed; yet through all these variations there is a rough average distance that the set may be relied on to cover except under the very worst circumstances. For a crystal set this average will be from 15 to 20 miles, with a single tube set from 75 to 100 miles. Yet under favorable circumstances the crystal set has been known to receive from distances greater than 200 miles, single tube set distances up to and more than 1,000 miles. By this it will be seen that one cannot say off-hand how far a set will receive.

Sets constructed in like manner when located a few miles apart will show vast difference in the distance of reception. This is due to location. As to the set itself Radio frequency represents distance, audio frequency represents volume. Regeneration has, practically speaking, the effect of Radio frequency and audio frequency on the set; that is, it makes the set receive from a greater distance and also makes it louder.

Comparison of Different Circuits

Bearing these facts in mind we will now consider comparison of circuits. The single circuit is to my mind best adapted to general use, regardless of whether one is a beginner or an old hand at the game. After using all kinds of circuits I have come back to the standard single as the most reliable and easy to operate. The difference in the distance between single circuit, double circuit and triple circuit receivers is so slight that it should not be considered. The double and triple circuit tuners will tune a little more sharply than the single. That means they will be a little more impervious to interference by other stations; for that reason the three circuit tuner is preferred by those who find it necessary to work frequently through more or less serious interference.

Begin with Two Stages Only

When Radio frequency amplification is added to the set it is advisable to use not more than two stages; each time a stage of this amplification is added it means that your set will be just that much harder to handle. It will require experience to learn how to tune it. I should not advise any beginner to try it until he has acquired considerable experience with a single tube set.

Audio frequency amplification which will increase the volume of sound is not so difficult to control; for that reason a beginner may easily use one or possibly two stages. More than two stages are not satisfactory because they will distort the music. One stage gives less volume than two but is more desirable because the results are much clearer.

One Stage Audio Frequency

If a powerful Radiocast station is operated within 10 or 15 miles and comes in with good round volume in the receivers, one stage of audio frequency amplification should enable one to use the loud speaker. One should not, however, except he is going to hear the music blare all over the house like a phonograph, although persons sitting in any part of a fairly large room will have no difficulty in enjoying the music.

One or two stages of amplifications are necessary in order to use a loud speaking horn. It cannot be used on a crystal nor single tube set without amplification.

Circuit That Eliminates Interference

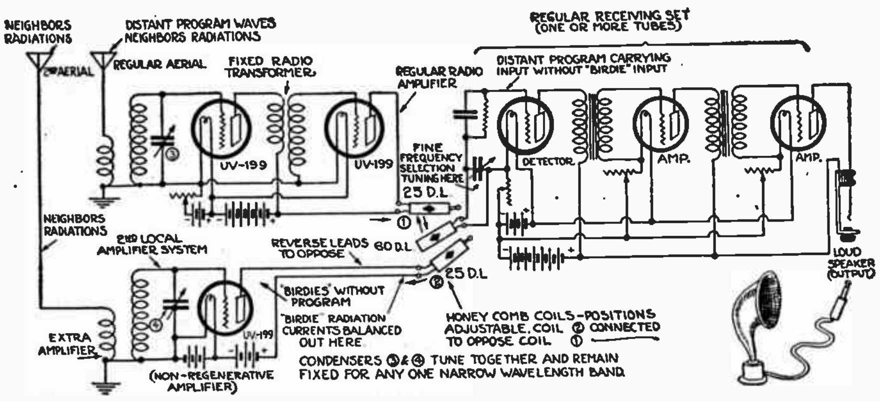
IF SWISHING, whistling sounds from neighbors' radiating receiving sets follow you around like buzzing insects, take heart, there is a remedy other than trying to stop the use of oscillating receivers. Stop some, and new ones start up daily.

A device can be attached to your receiving set that will cut out such interference. It may seem hard at first since the radiations from the neighbor's outfit are of the same character as Radiocast radiations. The problem is simpler than static mitigation as the source and character of the whistling disturbances is known, and the radiations are not powerful.

If you are not satisfied with such partial remedies as the use of less sensitive receiving apparatus or a loop receiver which gets no interference from neighbors located at right angles to the pointing of the loop, the interference mitigator shown in the accompanying diagram will be of interest.

Interference Mitigator

This attachment for any receiving set takes advantage of the differences in neighboring radiations and Radiocast radiation carrying a program. In addition to the regular receiving circuit a second absorbing receiver circuit is used. The regular receiver circuit gets the distant program and the local disturbance radiations. The second receiver is arranged to get substantially only the disturbance radiations coming from the neighbors' outfits. Then a simple balance is obtained opposing the two outputs, so that only the distant program radiations affect the audio amplifier and reproducer of your regular set. This is a phase tuning method supplementing the regular frequency or wave length tuning and directional selection. It can be used with loop or aerial input and accomplished at Radio or audio frequencies, but in the example illustrated, a Radio balance from two aerial inputs is shown. The second aerial may be a short one placed near the regular aerial. This mitigator does not prevent distant reception.



No whistling radiations coming from your neighbors' oscillating receivers can affect your reception of distance Radiocast programs when this attachment is used.

Cause of Whistles

Whistles are caused by beats from the interference of neighboring radiating outfits. Suppose you are receiving a 300-meter Radiocast program, with 1,000,000 cycles frequency adjustment. Then your neighbor can swish his oscillating set within say 60 to 6,000 cycles of this and you will hear the audible beats. But this interference comes from a nearby source. From experience with Radio amplifiers you probably know that they serve to boost weak distant signals to sufficient value to operate a detector but do not proportionately boost strong local signals, because the detector can only handle a fixed amount of Radio frequency current. The "birdie" mitigator utilizes this principle.

As shown, one or two stages of Radio amplification ahead of the detector receiving set are used with the regular aerial input. This input gets the program from the distant station and the local "birdies" radiation. The second aerial input goes to a one-stage Radio amplifier which is non-regenerative and tuned each time to the same wave length as the first aerial input circuit. The second aerial input from a smaller aerial, with the use of the one-stage non-regenerative amplifier affords an output which gives the "birdies" radiation picked by the second aerial, but not the distant program, because the second aerial and amplifier is not sensitive enough to be appreciably affected thereby. Even when the second system gets weak response on the distant program, this does not prevent operation of the mitigator because the program is brought through in much greater amplitude by the regular aerial system.

List of Parts

1	Fixed coupler	$ 6.00
3	Variable condensers .0005 mfd. @ $5.50	16.50
1	Honeycomb coil mount, triple and variable	5.50
2	25-turn honeycomb coils @ $1.50	3.00
1	60-turn honeycomb coil	1.60
1	Fixed Radio frequency transformer	4.00
6	Tube sockets @ $1.00	6.00
4	Rheostats, 25 ohms @ $1.00	4.00
1	Grid leak, variable and with .00025 mfd. condenser	1.75
2	Audio frequency transformers at $4.50	9.00
1	Open circuit phone jack	.70
1	Panel 7x26	4.00
1	Cabinet	5.00
	Binding posts, screws, bus bar, etc.	1.50
	Total cost	$68.55

Two Outputs

The result is that you have two outputs, one with the signals and "birdies" and the other with substantially exclusively the distant program without the "birdies." Standard units can be used for this eliminator and honeycomb coils on a triple mounting are suitable for the coils. This is a real step toward "birdie" elimination as it does the work at the receiving outfit. In a city where there is plenty of re-radiation from oscillating sets, the writer is able to receive Radiocast programs in peace. Further improvements on this mitigator are being made. It is not difficult to set up and use.

Watch Insulation

THE Radio user who desires efficiency, volume, range and selectivity cannot attach too much importance to insulation of the aerial and ground.

As the collector of feeble Radio impulses, the antenna is of supreme importance, and on a par with it, in carrying away the waves after they have been through the receiving apparatus, is the ground connection.

An analysis of Radiocasting will, very probably, explain this most clearly. The wave that is sent out from a Radiocasting station travels over an ever-widening area, gradually becoming weaker and weaker as it goes hundreds or perhaps thousands of miles through more or less absorbing atmosphere and over imperfectly conducting ground.

The receiving antenna may be pictured in the mind as the "fingers of the air." To make use of this feeble impulse, the aerial must be sensitive. Once the wave strikes the wire, it begins a journey to the receiver that may be as weakening as the projection from the distant station.

Main Cause of Weakening

The main cause of this weakening is poor insulation. A point of poor insulation is a point where there is a "leak." That is, the current is able to flow off the aerial wire and into the roof or the walls of the house. This involves a loss which manifests itself in weaker signals.

Impulses picked up by a distant receiver are so very minute that the most effective collective device possible should be used, and every possible method of insulation be utilized in order to give them a "clear track" into the set. When an aerial is on the roof, the lead-in should be held away by insulation from the sides of buildings. The lead-in should also be run through the wall or window in a porcelain tube or like insulation.

Inside the room short leads are best, but regardless of whether the lead is long or short, it should be insulated just as well as the wire on the outside of the house or partment. The popular theory that inside or outside wooden, stone or brick walls will not deduct from the efficiency of an aerial is false. The Radio listener who has his lead-in tacked to the surface of a building may not think that power is diminished, yet there is probably a loss here that is reducing his range and selectivity. Even if the wire has an insulating covering it should not be run directly against a wall. The very proximity of the wall may cause a loss.

Ground Wire Needs Insulation

After passing through the receiving instruments the signal currents flow into the ground, and here insulation is again highly important. At first sight it seems unimportant by what path the impulses get into the ground. One would think that the more paths that were provided, the better. This, however, is not the case. Only one ground should be provided and that one the best ground available.

The important thing about the ground connection is that it have as low a resistance as possible. High resistance reduces the signal strength. The singular thing about Radio currents is that they do not follow the path of least resistance. The word resistance is here used in its technical sense of electrical resistance. They follow the easiest path to be sure, but this is not necessarily the path of least resistance. The easiest path for Radio currents is the shortest path. We can, therefore, have the following queer condition:

Ground Resistance Comparisons

Suppose a Radio receiving installation has two ground connections, one near the receiver and the other at some distance from it. Most of the signal current will flow into the ground through the nearer ground connection. Very little of it will flow through the distant ground connection. If, therefore, the nearer ground connection happens to have a large resistance, the signal strength will be reduced. Now, if the nearer ground is removed the current must flow through the distant ground connection—it has nowhere else to go, and if the resistance of this ground is low, the signal strength will be greater than when there were two grounds.

The practical application of all this is to be sure to support the ground wire on insulators up to the point where it is connected to ground. Water pipes are about the best thing onto which to connect the ground wire, and the connection should be as positive as possible.

Most people simply open the window, bring the lead-in across the sill and close the window. A short piece of porcelain tubing should be used to prevent leakage.

It is a waste of time and money for an amateur to try to make head receivers, audio frequency transformers and homemade battery chargers.

From time to time the aerial should be lowered and the insulators cleaned off to avoid leakage.

Never leave the high-tension battery leads near the filament leads when they are disconnected, as contact will result in the burning out of the tube.

ROTATING STRIP PINS ON MAP AT YOUR CITY

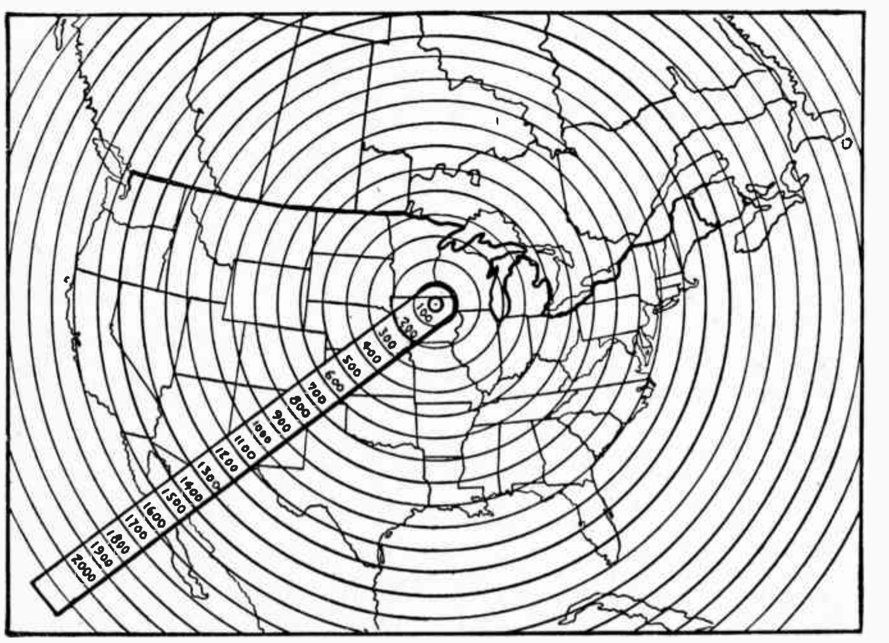


Chart Useful for Logging Mileage

Have you any way of quickly finding the distance of any station heard If not, the illustration shows a practical method. Procure a map of the United States. The pocket maps that sell at the book stores will do very well. Mount this map smoothly on heavy cardboard, building board or some other substantial material. After this is done make a scale from stiff cardboard about one inch wide and long enough to reach on the map from your own town to the farthest border of the United States.

At one end of this scale make a dot and then measure back from this dot equal distances according to the scale upon which the map is drawn, usually about 125 miles to the inch, to show 100 miles for each division. When completed, stick a pin through the dot and pin the scale to the dot on the map representing your station.

By rotating the scale, you can find instantly just exactly the distance from the station heard. You can also check up the distances claimed by the other chaps. By marking this map with colored crayon for every station you have heard you will have an interesting record to show your friends.

Various Types of Radio Aerials and Grounds

Their Comparative Efficiency and Value

By M. W. Thompson

THE aerial of a Radio station is, properly speaking, the one or more wires suspended as high as possible between two insulators and from which a lead-in wire goes to the set. Its purpose when used with a transmitter is to act as one side of a huge condenser and also as inductance, in the first case working with the ground to create electrostatic waves, and in the second to create electro-magnetic waves, a Radio wave being composed of both kinds. When used with a receiving set, its purpose is to intercept that part of the waves which travels above the ground, while the ground intercepts that part which travels in the earth. The aerial system gets its name from its similarity to the two feelers or aerial of a moth which are constantly in the air absorbing facts of importance to the moth.

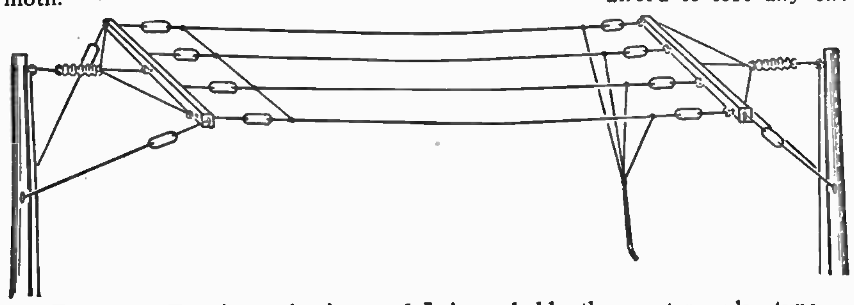


Figure 1—The four-wire inverted L is probably the most popular type.

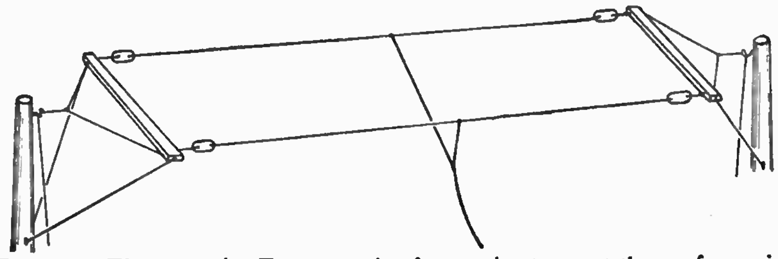


Figure 4—The two-wire T-antenna is often easier to erect than a four-wire inverted L.

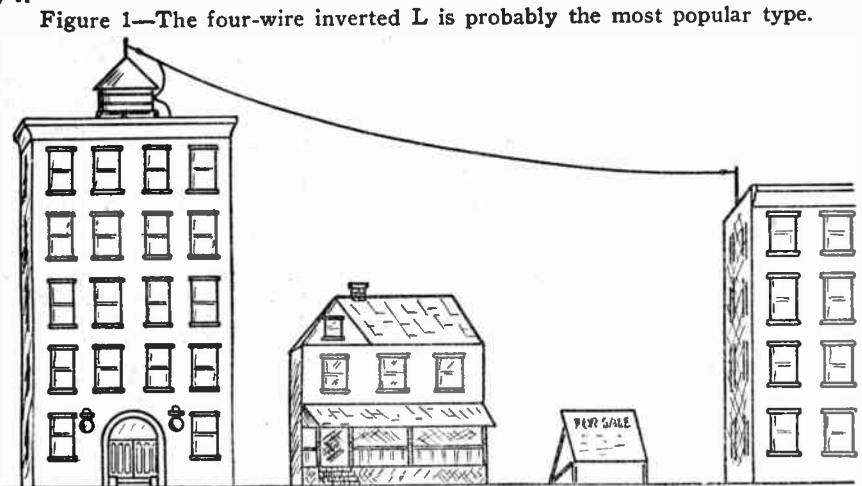


Figure 2—Buildings several lots apart may provide ideal aerial supports.

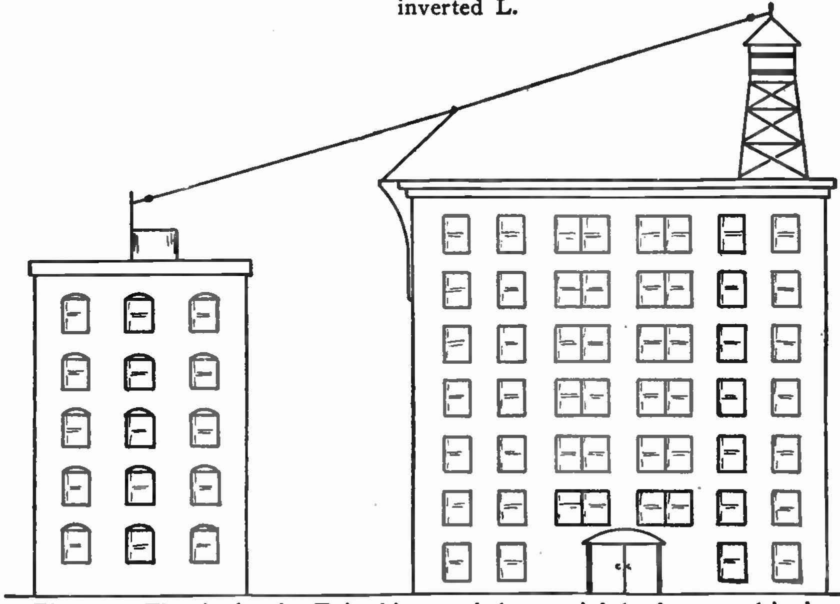


Figure 5—The single wire T, in this case, is less unsightly than a multi-wire inverted L would be.

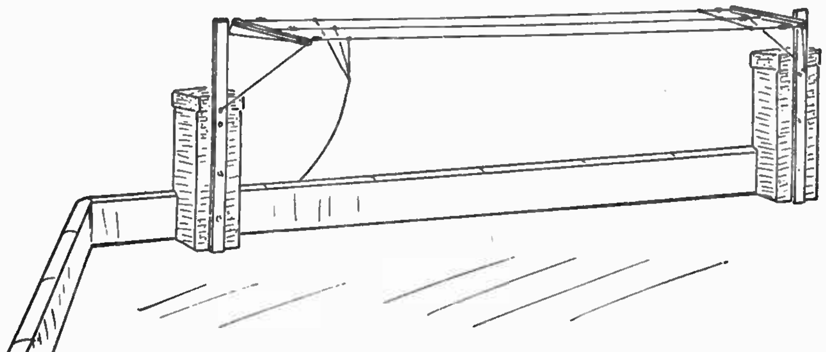


Figure 3—This three-wire inverted L utilizes two chimneys as anchors for short two-by-fours

Buildings and trees absorb Radio waves and it is, therefore, of great importance to get one's aerial installed as high and as clear of everything as possible. It is not alone the distance above the earth that counts, but the distance from houses and trees—the distance from the nearest objects that will absorb energy from the incoming waves and weaken them.

It has been stated that an aerial should be as high as possible. That statement is correct only as it applies to those types of aerials which have been in use for many years and are in use now with most of the sets on the market—outside aerials.

There are a few receiving sets available so sensitive that high outside aerials are not necessary. Here, height is not essential, but the insulation of the indoor aerials used is doubly important as less energy reaches them than the outdoor type. At present we will deal chiefly with outdoor aerials, although some space will be given to discussion of the indoor variety.

Types of Aerials

Outdoor aerials, for reception only, have been successfully erected and used in many shapes and sizes, the choice being largely governed by local conditions and the relative positions of high points. We have, in the order of their popularity, the inverted L, the T, the V, the umbrella, the cage, the fan and the spiral. The names in each case give an idea of the shape these aerials assume. The erection of aerials will be considered more from the viewpoint of the metropolitan amateur than from that of the rural enthusiast, as there are, by great odds, more receiving sets in cities than in the country. The erection of an aerial on a farm is a comparatively easy matter. There are many kinds of wire that may be used in aerials and in the order of their desirability they are: stranded phosphor bronze, stranded copper, solid copper, copperclad, bell wire and ordinary cotton-covered.

One of the many variations of the inverted L aerial is shown in Figure 1. As will be seen, one side of the L is formed by the horizontal wires, the other side by short converging leads and the lead-in wire proper. There are two important points that apply not only to this aerial, but to all other types—insulation and good joints: The insulation cannot be overdone; the joints cannot be too perfect. Only very minute currents traverse the receiving aerial and we cannot afford to lose any energy. For this reason we have inserted, in the drawing, an insulator at each end of every individual wire, and another large insulator in the support-ing ropes where they converge. These ropes, converging from the ends and center of the wooden cross bar, are known collectively as the bridle. The cross bar is termed the spreader—it keeps the wires spread apart. The insulators in the wires may be the white porcelain cleats used in house wiring; they may be made of some composition such as electrose; pieces of scrap bakelite or, when economy is important, strips of wax-impregnated wood. Wood strips boiled in wax will do but are inferior to the others. The insulators used just above the bridle must be larger and possess greater tensile strength as they support the heavy spreaders and wires through wind, sleet, rain and snow. The inverted L with four wires is shown, but it may be made with one, two, three, four, five or six. Where more than one is used, the wires require 3-foot spreaders; three wires 6-foot; four wires 9-foot; five wires 12-foot and six wires 15-foot spreaders.

Aerial Inductance and Capacity

An aerial provides both inductance and capacity to the aerial circuit. The greater these two factors, the longer the natural period or the wave lengths to which the aerial best responds. We increase the inductance rapidly and the capacity a little as we increase the length of the wires. We increase the capacity rapidly and the inductance but little as we add wires. Therefore one long wire, two medium-length wires, or four short wires can all have approximately the same natural period. For reception, one long wire is best, but that is, more often than not, impossible, especially in cities. For the reception of Radiocast signals on 360 meters, one single wire 130 feet long with a lead-in of 40 feet or less is excellent.

If you live in an apartment house and the landlord of a building four or five doors either side will not permit you to attach the wire to his building, try a landlord three doors away and if he agrees put up two wires 70 to 80 feet long. Should that be impossible, but your own building offers 30 to 45 feet of straight-away, put up four wires as shown in the sketch. But whether you erect one, two, three or four wires put one of those all-important little insulators at the ends of each wire. If one wire is used, the lead-in should, if possible, be soldered to the aerial wire. Even if you must measure out the wire, then roll it up and take it over to a friend who has a soldering iron, do this if you can. If not, scrape a length of 3 inches on the aerial wire, scrape the end of the lead-in to a distance of 1 foot, and wrap the lead-in around the scraped portion of the aerial tightly and closely. Then cover the joint well with black electrician's tape. This is to prevent corrosion as much as possible. Figure 2 shows one variation of the inverted L type as erected in the city. Take advantage of watertanks, chimneys, flagpoles, elevator shaft housings, anything and everything that projects above the roof.

The T-type aerial is best suited for use where one's station is located midway between two high points.

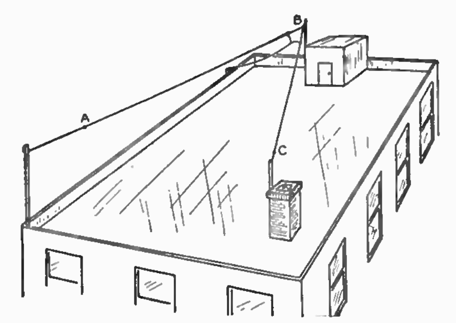


Figure 6—The arrangement of high points often makes a V-aerial possible.

Figure 4 shows an aerial of this kind. The natural period is equivalent to that of a four wire inverted L, one-half as long. Figure 5 illustrates a situation in which this aerial may be advantageously used. If a pole were to be erected at the left hand edge of the taller building and two wires strung, the pole and spreaders would be unsightly and considered undesirable by the landlord, but a single thin wire attracts no attention and is noticed by no one.

The V-aerial is really a variety of the inverted L yet should be considered a different type. Figure 6 illustrates the use of this aerial on a roof. One thing

(Continued on next page)

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should be noted here. The distance from the little stair house at the far end to the flagpole at the left is not the same as the distance from stair house to chimney. The two wires, however, should be the same

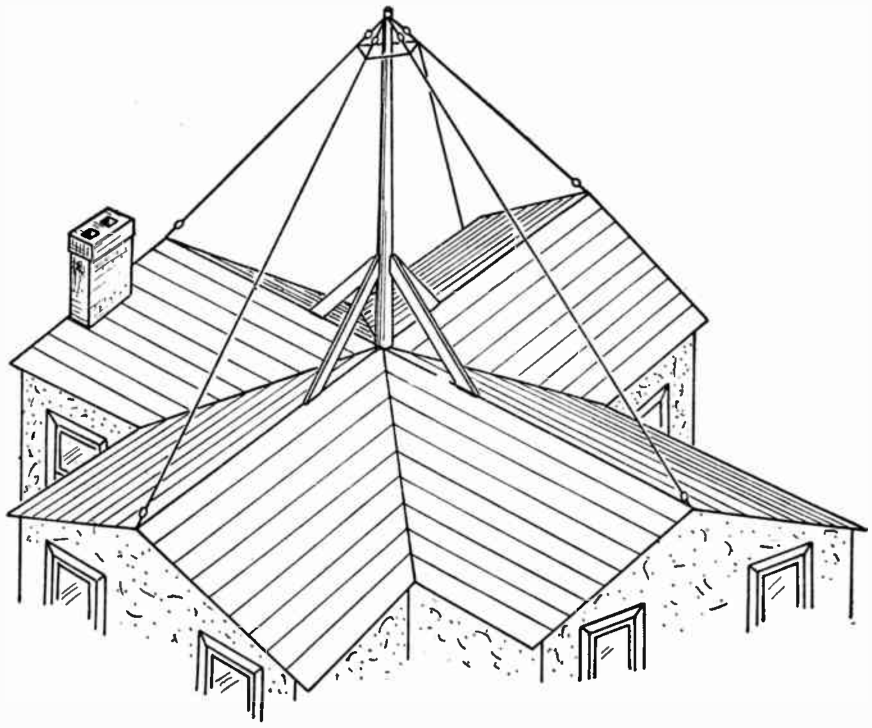

Figure 7—The umbrella aerial used where large area cannot be obtained

length, so that wire AB is cut the same length as wire BC, and a long support wire connects the insulator A to the flagpole. Insulators are inserted in each about 2 feet from pole B and a short lead connected to each close to these insulators. The two leads are then connected together and to the lead-in wire. The V-aerial has the advantage over the parallel-wire inverted L that each wire receives energy from a strong, unweakened part of the advancing wave, whereas in the latter type the wire reached first absorbs energy and the next wire does not receive as much unless the distance between the wires is increased from 6 to 10 feet.

The umbrella aerial is used when the horizontal area is very limited and there is no objection to a tall pole (see Figure 7). In this case the distance from one end of the house to the other is likely to be only

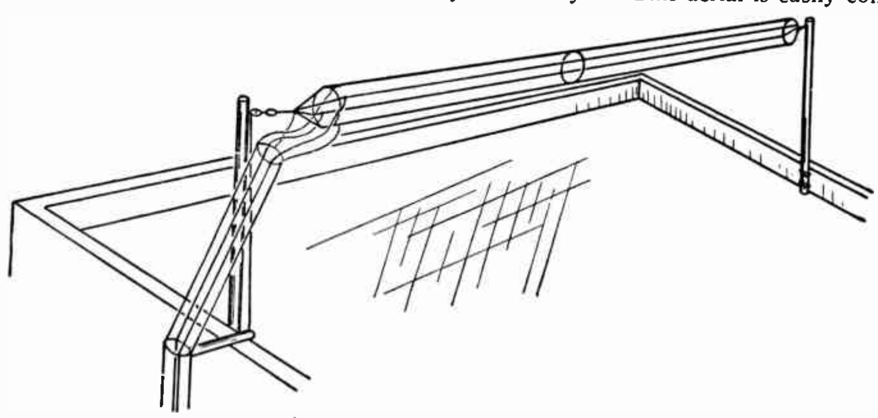

Figure 8—Cage aerial used by amateurs for transmission is good for reception

30 feet. By erecting a 30 to 40-foot pole in the center we can obtain sufficient distances from its top to the ends of the wings to erect very satisfactory aerial wires. The same idea can be applied to an apartment house roof when a watertank, chimney or other point of support projects upward from the center. As in the other types, insulators are inserted in each end of every wire. The individual wires are connected together at the upper ends and to a lead-in wire.

Figure 8 shows a cage aerial, which is more of a transmitting than a receiving aerial, though the owner of a receiving set may erect it for reception, if he likes. The supporting hoops should be about 3 feet in diameter, made of any material, and of sufficient tensile strength not to break and twist. The argument advanced by users of this aerial for transmitting is that the energy is more evenly distributed, it being claimed that, with a four-wire inverted L, most of the energy is in the two outer wires. The hoops for the cage lead-in are 6 inches across and serve both to keep the wires separated and to support them away from the wall.

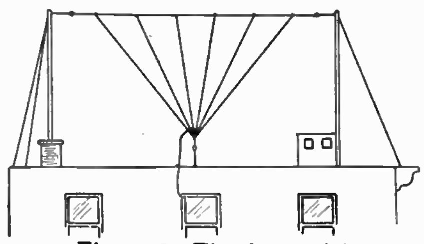

Figure 9—The fan aerial.

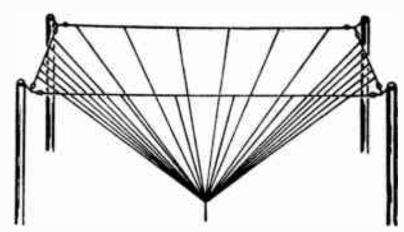

Figure 10—The four-fan aerial

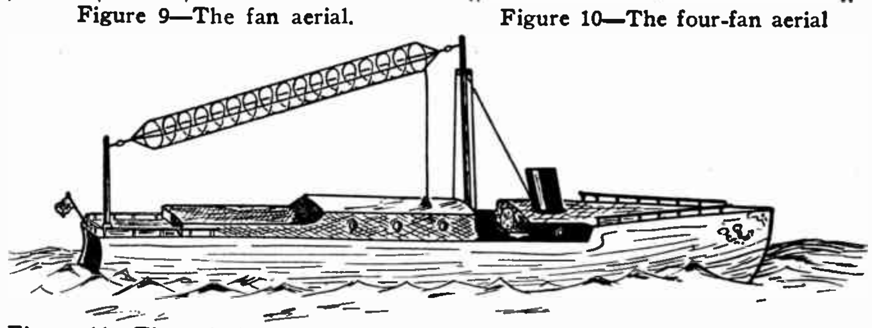

Figure 11—The spiral as applied to use on a motorboat is equally good on an automobile.

The fan aerial was one of the earliest types used and the only good reason for its less frequent employment now is the fact that other types are more easily erected. Figure 9 illustrates the fan type, and it should be noted that an insulator is placed at each end of the support wire about 1 foot from the poles and another just below the point where all wires come together, the lower end of this last insulator being attached to a short length fastened to the roof. Figure 10 shows a four-fan aerial, this being given for those who wish to and can experiment with aerials. The four-fan aerial should prove excellent, being equally efficient in all directions.

Last, we have the spiral. Where space is limited, as on an automobile, motorboat, houseboat, etc., the spiral will give excellent results. It may be hung either vertically or horizontally (see Figures 11 and 12).

This aerial is easily constructed by taking two light brass hoops, about 2 feet in diameter, and connecting them with four pieces of fishline about 12 feet long, these being fastened equidistantly around each hoop. Beginning at one end, the wire is wound around in the form of a spiral, the turns being fastened each time they cross the fishlines. Twenty-five turns spaced 6 inches apart will give excellent results. The chief advantage of the spiral lies in the fact that it is collapsible, being only a coil of wire and two brass hoops when folded.

Good Ground Connections Essential

Grounds have never received enough attention, either by the Radiophan or Radio publications. A man will erect a wonderful aerial, will put in large expensive insulators, will bring the lead-in through a porcelain tube in the wall—and then hastily twist a piece of wire around the radiator valve for a ground. The aerial and ground are both in the same circuit—with the capacity between aerial and ground they form an oscillating circuit—and one should receive as much attention as the other.

The gas pipe should be avoided as a ground as there may be rubber hose connections in it somewhere. The radiator frequently makes an excellent ground, but one cannot be certain that it is the best available. The water pipe has always been considered the best place to connect the ground lead, and has proved itself better than either of the other two.

It will be found that the best connection of all is the grounded side of the electric light circuit. To connect onto this, some care should be used and the following test made. Take an ordinary electric lamp bulb intended for use on 110 volts and twist a piece of heavy bare wire (bell wire with the insulation removed will do) around the threaded base. Now connect this wire to the cold-water pipe. From your electric light socket bring the two wires out through a plug and keep them carefully separated so that they do not make a short circuit. Holding the bulb in one hand by the glass part, touch one of the wires to the little brass button in the center of the bottom of the base. Then lay that wire down and touch the other wire from the socket to the little brass plug in the bottom of the bulb. Touching one of these will cause the bulb to light; touching the other will not. Use for a ground the one that does not; that is, the grounded side of the electric light circuit. The second wire from the socket should be removed.

However, should the reader not have an electric light circuit available, or should he not care to use it, the cold-water pipe should be used as the next best connection. But you will find its surface corroded and it is essential that this be removed for good results. With a file or a knife scrape off the pipe all around for a length of 3 inches. The lead from the ground post of your set should now be run to this point and

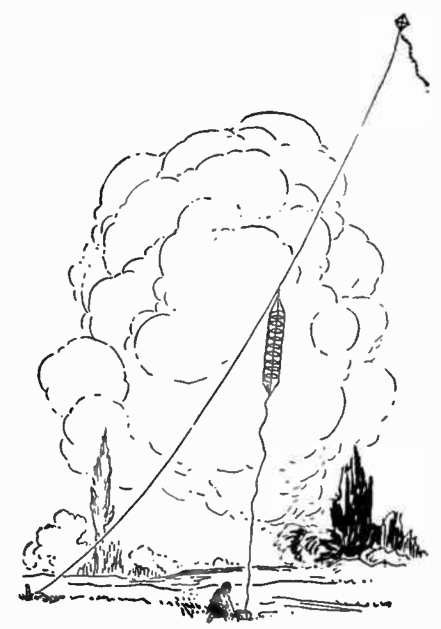

Figure 12—The spiral elevated by a kite for use with portable sets.

a length of wire, about 3 feet long, carefully scraped shiny. Wrap this around the pipe closely and tightly ten or twelve times and solder it.

If it is absolutely impossible to solder the connection, cover it with black electrician's tape.

Length of Aerial

When the aerial is too long (over 150 feet), it may be reduced to a better value by putting in a variable condenser in series. For the aerial that is too short (under 75 feet), it is advised to put in either a variable condenser across the aerial inductance, or a loading inductance in series with the aerial to boost the wave length range to a higher value.

Kinds of Aerials

A flat top aerial is an aerial that has more than one wire in it arranged so that it is parallel to the earth. The T aerial is the same type with the lead-in coming from the center. In the inverted L aerial, the lead-in comes from one end. The cage aerial is the type that has several wires arranged on hoops forming sort of a cage. The single wire aerial is as efficient as any when use for receiving only.

Water Pipe Ground

To get a good ground at a lake cottage which is not supplied with water pipes, drive into the ground a piece of pipe, about 12 feet long, plugged at one end to keep out the dirt. Drill a few holes above the plug and drive end into the ground. Pour water in through a funnel to make the soil wet at the bottom of the pipe. This makes a good ground for the set.

Protection Against Lightning

It is not necessary to dismantle a Radio set during the summer weather because of the danger of lightning striking the aerial. The aerial is actually a protection against lightning, and the chances of a real bolt hitting such a small target are very remote. The aerial, if properly grounded, either through a switch or arrester, will serve to drain the electricity from any really heavy discharges. Do not be afraid of lightning; its actual danger in the city is very small indeed, on account of the grounded steel frames of the buildings absorbing all the energy. The Radio set may be used successfully all summer with the exception of the time when a storm is in the immediate neighborhood.

Inside Aerial

Remarks about excellent quality indoor aerials with crystal sets are as frequent as comments upon their efficiency. This difference is, of course, due to the conditions under which the aerials were operated. As a rule, indoor aerials are unsuccessful on the first floor of a building or where surrounding high structures may intercept the waves before they strike the aerial. In suburban locations or in elevated sections of the city considerably better results may be obtained.

The Batteries Used With Radio Sets

For Plate and Filament Circuits

By Thomas W. Benson

THE earlier forms of tubes used for Radio required a six-volt battery to operate the filament; each tube required one ampere of current, which made a storage battery a necessity. At the present time the tubes using heavy filament currents are practically unused, preference being given to the tubes that can be operated from dry cells, thus making the set more compact and portable.

Many fans still use a storage battery, especially when they have in operation a loud speaker requiring current for the field windings. Much has been written as to the care of the storage battery, but many persons continue unintentionally to abuse the battery. When the battery is charged at home it is more than likely the filling is neglected. The filling should be carefully attended to, especially during the summer months. When the solution gets below the top edge of the plates they are exposed to the air, which results in

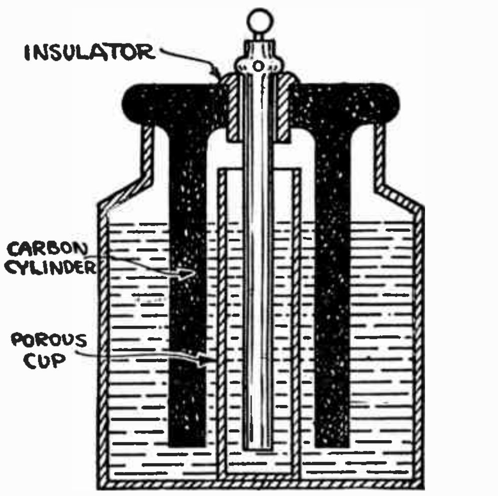

Figure 1—Cross sectional view of homemade Fuller battery for lighting tube filaments.

sulphation. The thin film of sulphate on the plates prevents the current from reaching the surface, which reduces the capacity of the battery. Keep the batteries well filled by adding distilled water when the solution gets low.

Another point is the corrosion of the terminals. The noisy operation of a set can often be traced to a corroded battery terminal giving an erratic current flow to the filament.

It is well to check the corrosion as soon as possible. When taking the battery off charge, wipe the top of it with a rag dipped in ammonia. The ammonia counteracts any acid sprayed on the top and keeps the terminals free from corrosion.

Many fans fail to realize the danger of bringing open flames near a battery while charging. It is well to remember that hydrogen gas is given off freely when the charge is complete; this gas mixed with air is highly explosive. An explosion may break the top of the battery or even throw acid on the face and into the eyes. For the same reason do not disconnect the charging wires from a battery with the charging current on, for in many cases the arc caused by removing the wires will ignite the gases with disastrous results.

Recharge Batteries at Regular Intervals

During the summer many persons do not use their sets as frequently as in the fall and winter, with the result that the battery is not recharged very often. This is poor practice; the battery should be recharged every month at least to keep it in good shape and to prolong its life. Do not add acid to the battery unless it is definitely known that the battery has leaked or the acid spilled. The proper method of adding the acid is to give the battery a full charge and then pour out the solution. A new solution can be mixed, having a specific gravity of 1,250. and poured in after it is cool. Add the acid to the water while mixing, stirring constantly and pouring in the acid slowly.

When connecting the battery to the set do not neglect to install proper fuses to protect the circuits. It is rather unpleasant to see a set start to smoke and on opening it find the wires partly fused away and the insulation destroyed.

A short circuit in the set may ruin it or start a fire in the room, besides damaging the battery by overheating and buckling the plates. To prevent this, install a fuse block near the battery, using the proper size fuses. Remember, a fuse is intended to blow; if a fuse of the right capacity continues to blow out there is something wrong.

Users of dry batteries for filament current are more lax in protecting their filament circuits, thinking that a dry cell can do no harm Regardless of the damage that it may do the set, a shorted dry battery may spoil an evening's pleasure. These cells are termed dry cells, when as a matter of fact they contain some moisture and when shorted have a tendency to ooze a sticky liquid around the top. If enclosed in the set this chemical solution may damage the furniture or destroy the insulating qualities of parts of the instruments.

It is well to protect the cells with fuses of the proper size. Determine the amount of current the set uses and obtain automobile fuses of the right size so an excess current will blow them. The fuse can be mounted at some convenient point inside the set close to the filament battery terminals.

The cost of dry cells has led many to make use of various types of wet cells for lighting the filaments. The voltage of the Edison cell is rather low, about .7 on a closed circuit; it requires two of them for each dry cell used. They are remarkably constant in service, and when once set up need not be disturbed till the elements are exhausted.

The Edison cell consists of a zinc plate forming the negative terminal and a positive terminal made of an oxide of copper, the solution being a saturated solution of caustic soda in water. The plates are difficult to make; they should not be made at home. The solution is very destructive and should be handled with care, for if it is spilled on the hand bad burns or the destruction of articles of animal fibre will result. A thin layer of paraffin oil is poured on the surface to prevent the air destroying the active properties of the solution.

Types of Batteries to Be Used

There are several types of batteries that can be made at small cost and which will serve in the place of dry cells. The common sal-ammoniac cell cannot be used for the purpose since the current drops off rapidly while in use. The Fuller cell is perhaps the best suited to the purpose; it is shown in the illustration Figure 1. The voltage of this cell is 2; one of them is sufficient for tubes having a filament voltage of 1.5. Two or three cells may be connected in series for higher voltages, but they should be used only with tubes using one quarter ampere or less.

The container is any glass vessel about 4 inches in diameter and 6 inches high. A porous cup of unglazed earthware or porcelain, which can be purchased for a few cents from any chemical supply house, is placed in the center of the jar A plate of carbon is placed in the outer jar and a zinc rod in the porous cup. These may be suspended from a wooden cover or two carbon rods and a zinc rod supported, as shown in the illustration. The zinc rod is amalgamated with mercury by first rubbing with a cloth dipped in dilute sulphuric acid and then applying mercury, which will coat the zinc and give it a shiny surface.

To set up the cell, place two teaspoonsful of table salt in the porous cup and fill it three-quarters full with water. Into the jar pour a solution made by mixing 3 ounces of potassium bichromate, ½ pint of sulphuric acid and 1 quart of water. Mix the acid and water first and add the bichromate The level of the solutions in the porous cup and jar should be the same. The zinc and carbon rods may now be inserted and the cell put into service This cell can be put in some out of the way place and left until exhausted, when it is necessary only to renew the zinc and solution to give it a new lease of life These cells can be purchased from electrical supply houses, ready to set up and use. This is perhaps the cheapest form of primary battery and will give good service where it is possible to use a battery containing liquids.

The common sal-ammoniac battery can be converted to the bichromate type by using a porous cup to separate the zinc and carbon, as shown in Figure 2. The porous cup fits inside the carbon cylinder as shown, and the solution mentioned above may be employed. This is an inexpensive form of construction which should appeal to the experimenter.

Use of Plate Batteries

The plate, or as it is usually termed, the B battery, builds up the energy that operates the loud speaker or other reproducing device. And no set can operate at its best unless the batteries are in good condition. The question is sometimes raised as to why they are termed B batteries—the answers are oftimes amusing. The truth is that in the early days of the audion or triode tube the filament battery was usually lettered A in the circuit, and the battery for the plate, B. In speaking of the battery it was referred to as the B battery; the name has stuck to the present day.

Small flashlight batteries connected in series were used in the early days, but special batteries of the dry cell type are now being manufactured for the purpose. The wide application of multi-stage amplifiers made this a necessity; the old type batteries had too high an internal resistance. A good B battery has a very low internal resistance for the following reason: we learned in a previous chapter that it was possible to couple tubes in cascade with resistances, the principle being to locate a high resistance in both the plate and grid circuits of adjacent tubes. Now, were the B battery to have a high resistance it will be clear that when two tubes are fed from such a battery there is a resistance coupling between them.

The action taking place is as follows: as additional current is drawn from the battery by changes in the resistance of the tube due to changes in grid potential the voltage of the battery will vary. Thus when the plate current in the last tube of a two stage audio frequency amplifier increases it pulls down the voltage of the battery which affects the current in the plate circuit of the first tube and by induction through the transformers acts upon the grid of the last tube, giving a feedback effect.

And for the same reason an old B battery makes a set noisy. As the battery becomes run down its resistance increases the coupling between circuits so formed and gives rise to noises that are annoying to say the least. When the voltage of the plate battery has dropped 20 per cent it is advisable to replace them; thus a 22½-volt battery becomes useless when it has dropped to about 17 volts. Larger batteries can be figured in the same proportion.

In testing B batteries do not use an ammeter. A high resistance voltmeter should be used for the purpose while the battery is under load, that is, while operating the set. When a battery is old it is said to polarize quickly. When current is being drawn from a battery the chemical action taking place liberates hydrogen gas at the carbon rod. Certain chemicals in the battery absorb this hydrogen and prevent its collecting. After a time these chemicals become exhausted and are unable to absorb the hydrogen as rapidly as it is formed and the bubbles collecting on the carbon offer a high resistance to the flow of the current.

Reliability of Voltage Reading

After standing unused awhile the battery will recuperate, that is the hydrogen will either escape through the sealing compound on the battery or will be slowly absorbed by the weak chemicals remaining. Therefore a battery that has stood unused for a time will show a good reading on the voltmeter, but when put into service the voltage will drop off rapidly.

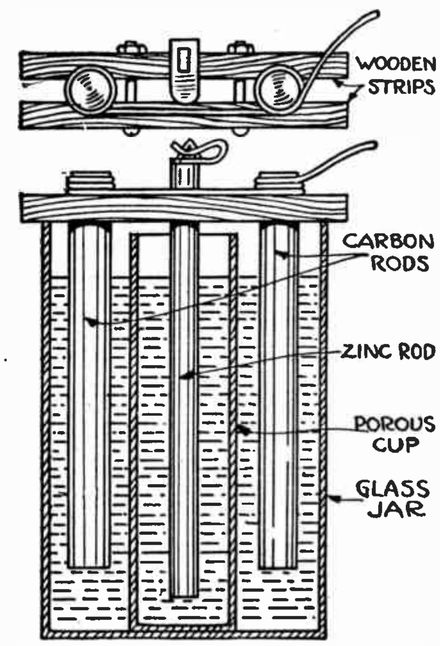

Figure 2—Converting sal-ammoniac cell to bichromate cell.

For that reason a voltage reading is reliable only when the battery is actually working.

Many fans have discovered that heating the B battery gives it a short lease of life after it is seemingly exhausted. The reason is apparent—the application of heat always assists chemical reactions—the hydrogen absorbing chemicals are made to work more energetically when nearly exhausted while no doubt the heat assists in the escape of the hydrogen around the seal. This revival of action is at best very short and serves only in an emergency.

As mentioned under filament batteries, a dry cell contains much moisture; this is necessary for the chemical reaction to take place. It is the gradual loss of this moisture around the sealing compound which accounts for a dry cell's going bad even when not in use. Therefore any method of preventing loss of moisture would prolong the active life of the battery. To that end it is advisable to keep the B battery in a cool place.

A short circuit on a B battery will destroy it in a very short time because the cells are small and the chemicals are rapidly exhausted under heavy currents.

Too often the first warning of this condition is when the warmth of the battery is noted. The only preventive is to connect a fuse in the circuit that will blow when too much current is drawn. This is a protection that few sets have; it is standard practice in all other fields of electrical application. A fuse can be easily made by mounting two brass bolts on a small piece of slate or formica and connecting the device in series with the B battery, locating it close to where the positive lead enters the set or, better still, right at the B battery itself. A short length of ½-ampere fuse wire should be clamped under the nuts on the bolts to serve as a protection to the circut. Should the wires become shorted this fuse will blow and open the circuit.

Many of us have had the unpleasant experience of accidentally connecting the B battery to the filament circuit and thereby burning out the filament. It is extremely difficult to protect the filament of the dry battery tubes with fuses, the current consumption of the filament being so low. Accidents of this nature

(Continued on next page)

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can be eliminated only by removing the tubes from the sockets while making changes in the wiring. It takes only a minute; if it saves a tube it's a well paid bit of work. Where only one tube is in use it is possible to prevent the B battery burning out the filament accidentally by connecting a limiting resistance close to the B battery. This resistance may take the form of a 25 watt incandescent lamp.

The high resistance of the lamp will prevent enough current flowing to damage the filament. One lamp should be used for every 22½ volts in the plate circuit. These lamps cannot be used when more than one tube is employed because the feedback phenomena will enter as mentioned in the first paragraph of this chapter. The best way is to take the tubes out of the set.

Storage B Battery

From the above discussion it is apparent that a storage battery is the ideal form of B battery, not only because of its rechargeable feature but because of its low resistance. For broadcast receiving they are not usually desired; this is due to their bulkiness. Their use is advised where possible and where compactness is not essential. When of the lead and acid type the same instructions for maintenance apply to the B as the storage A battery, the only special care being not to charge the former at too high a rate. The charging rate advised by the manufacturers should not be exceeded; otherwise they will heat badly; the plates may buckle and the paste fall out. Cells of the nickel-iron, caustic soda type are more rugged and stand more abuse, but the voltage is lower per cell and the efficiency is very low, rarely exceeding 60 per cent; lead batteries run as high as 80 per cent. By following these suggestions the Radiophan may be able to reduce the frequency of his B battery renewals and prevent noises that are now puzzling him.

Keeping Up Battery Average

THOUGH the introduction of the dry cell vacuum tube has in many instances eliminated the use of the storage battery, where a number of tubes are employed in a circuit, the storage battery is still worth while. The owning of a rectifier which permits the charging of a storage battery from the house lighting current is a feature which will pay for itself.

Many rectifiers are constructed so that the connecting of the rectifier terminals is not governed by the polarity of the battery markings. In rectifiers where this feature is not incorporated the connecting of the battery with the charger should be carefully done; be sure to make the positive connection of the charger to the positive pole of the battery. Do the same with the negative of course. If this is not done it is likely that the battery will be permanently damaged.

Batteries Rated at Ampere Hours

Batteries are generally rated at their ampere hours. That is, a 60 ampere-hour battery is rated as being able to deliver one ampere an hour during a period of 60 hours. Generally the actual delivery of current falls below this rating, but it is sufficiently accurate to enable you to judge how long a fully charged battery will supply current to any Radio set where the amperage of the tubes used is known.

A hydrometer reading of the electrolyte will show 1,300 when the battery is fully charged; it is a fairly accurate method of knowing the condition of the battery.

As to Removing Suhphation

It is a good idea to let the battery become pretty well exhausted about every third or fourth charge and then to give a slight overcharge. Sulphation is a condition which shortens the life of the cells; bringing the hydrometer readings up to 1,300 and allowing the charging to continue for a short time after this reading is reached, about every third or fourth charge, will remove sulphation which might not have been removed by previous charges not so complete.

Keep the battery terminals clean; when a terminal corrodes scrape it clean and apply a coating of valeline or cup grease, which will have a tendency to eliminate this condition.

Whenever a battery is charged be sure to see that the electrolyte just covers the plates. When the solution drops below this level add nothing but pure distilled water; by no means use a metal container to do this.

Filling the batteries too full will cause the cells to spray out of the holes during the charging operation; the corks must be removed at this time. Never add an acid solution to your battery. If, for any reason, you think this should be done, first consult an expert.

Don't touch the lead wires together to see the sparks; fireworks are cheaper and more fun.

Batteries for Tube Filaments

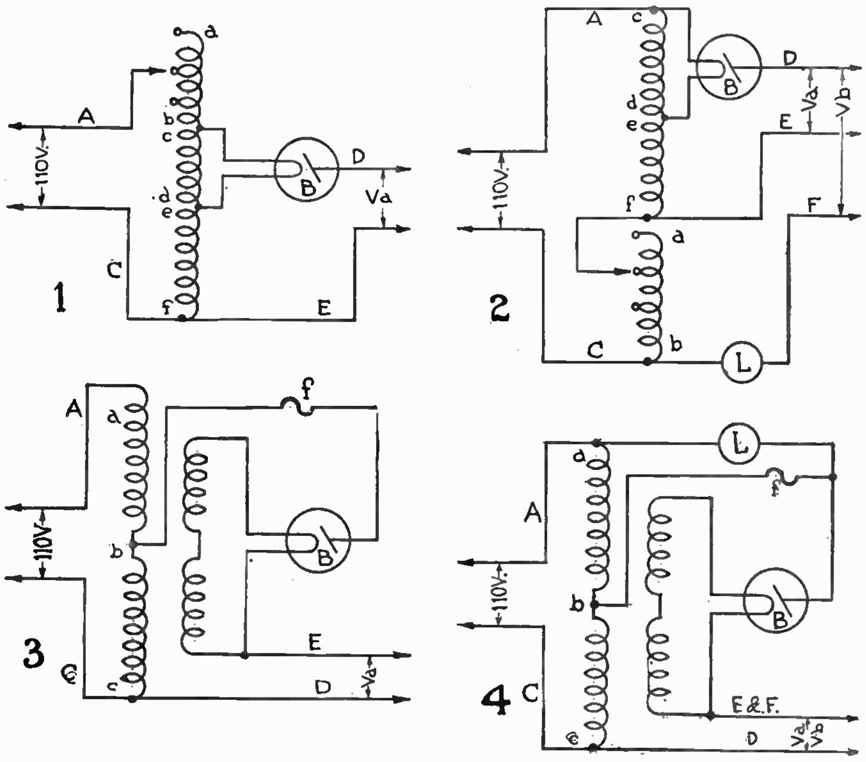
It is not advisable to use wet primary batteries as a source of current supply for heating the filament of the ordinary types of 6-volt vacuum tubes inasmuch as constant use of the tubes will cause the batteries to become exhausted in a comparatively short time. This would necessitate frequent renewal of the elements of the battery and the electrolyte.

For a circuit employing one or more stages of amplification, a storage battery should be used unless it is desired to heat the filaments of the amplifier tubes by stepping-down the 110 volt house-lighting circuit to a potential of 6 volts by means of a special transformer. Alternating current should not be used to heat the filaments of detector tubes as the hum due to the rapid reversal of current drowns out the Radio signals.

Charging Your Storage B Batteries

DOUBTLESS every possessor of a storage B battery has tried the electrolytic rectifier method of recharging it and found it rather unsatisfactory and bothersome. A much simpler and more convenient method is to use the bulb rectifier that is used to charge the A battery. All that is necessary is to make a slight change and addition to the wiring. The writer has been using this method for over a year with excellent results and has changed quite a number of rectifiers for friends.

In the diagram 1, a bulb rectifier schematic diagram is shown of the internal connections. The same thing with the necessary changes made is shown in 2. The standard connections of the old type charger is shown in 3 and the revised connections are given in 4.



Although the diagrams tell the whole story, a step by step description of the necessary changes will be given.

Making the Change

If it is desired to charge a battery of about 60 or 70 volts or less, it is only necessary to add one wire to the diagram 1. This wire should be attached to the 110 volt feed wire marked A, the other end being attached to the positive or plus side of the battery, making sure to connect a lamp in the series of about 100 watts. The negative side of the battery is connected to the wire marked D, which is the lead with the black or unmarked lead. The battery lead with the red mark or red lead marked E on the diagram is not used when charging the B battery. Leads D and E, the leads equipped with clamps, may be used as before for charging the A battery. Caution—Do not attempt to charge both A and B batteries at the same time, as that will put alternating current through the B battery and probably ruin it. This method will provide about 60 volts direct current reading on a direct current voltmeter when no battery is connected. When charging a higher voltage will be obtained. It is not necessary to trace out any wires or even remove the charger from its case to get this connection. Merely attach the wire specified for attaching to A, one of the 110 volt leads and connect to the battery as directed above. If the battery starts gassing, the right wire was selected. If not, change to the other wire. No diagram is given for this case.

Connections for Charging B Batteries

If it is desired to charge a battery of 90 to 100 volts or less the schemes shown in 2 and 4 should be used. These may also be used for larger batteries by dividing it into two or more parts and connecting them in parallel. To change from 1 to 2, disconnect A from a, b from c, and C from f. A should then be connected to c, one side of the tube socket. C goes to b with another wire attached at the same point, which is connected to a lamp socket and from there (wire F) to positive B battery. A short lead is run from f (leaving E there also) to a, the connection block provided at the top for taking care of different alternating current voltages of 105, 115, and 125. Va, the voltage between D and E, is the supply for charging the A battery (these are the same leads as previously used, the one provided with clamps) and the black lead D and the new lead F are used for the B battery, D being negative or minus and F positive or plus. Vb the voltage between D and F, is used for charging the B battery, the black lead D going to the negative side of the battery. The same caution given for the previous case applies here, for both A and B batteries cannot be charged at the same time.

In the case of the old style rectifier, considerably less work is required. In this, as in the one above, the case should be removed. A wire will be seen running from the plate (top) of the tube to a fuse block. At the point where this wire is attached to the latter, attach another wire which should go to a lamp socket. From the lamp socket, this wire should go to the 110-volt lead A. As in the first case, it is not necessary to trace out the 110-volt leads in order to find the correct one (though it will probably be most convenient to attach same inside of the case), but it can be attached to one of the leads and the battery connected. If the battery gasses, it is O. K. If not, change to the other 110-volt lead. When charging the A battery, the lead marked E and F with the red lead and clamp should be connected to positive and D, the black lead to negative, with no lamp in the socket. To charge the B battery, remove the fuse and put a lamp in the socket just provided for it. Never try to charge either battery with both a lamp and a fuse in circuit. A lamp and no fuse for the B and a fuse and no lamp for the A is required.

It will be noted that a 100-watt lamp was specified in the first case. This is not an iron-clad rule, as any suitable size lamp may be used. When charging a large battery in several parallel sections, a larger lamp will be required. The author, for example, is using a bulb charger connected like the circuit 2 to charge a 108 cell (approximately 150 volts) battery in two parallel sections, using a 200-watt lamp. The best charging rate to use is one-quarter ampere, though it is only necessary to adhere closely to this value for lead plate batteries, as the batteries composed of Edison elements are practically impossible to injure. If the battery gasses moderately but not violently, the charge is about right.

Automobile Battery Connection

THE motorist fan usually uses the battery in his car, thus saving the trouble and space taken up by a heavy A battery. As car batteries are nearly always under the floor of the car, you get your hands dirty and waste about five minutes every time you connect the set to go driving. This trouble is avoided by making a plug connection from the battery to the set that will fit the lighting sockets of the car. To connect the battery simply remove the bulb from the most convenient socket, which will probably be the one on the instrument board, and insert the plug from the set. The plug may be made from a burnt-out light bulb that fits the socket.

Break the glass and the sealing wax that holds it from the burnt out bulb, saving only the brass shell and the small round disk that makes the contact at the center of the socket. To each of these solder one of the strands at the end of a piece of twisted light cord, long enough to reach from the set to the socket. Now, after making sure that the two wires of the cord do not short circuit and that the disk is in the same relation to the shell that it was before it was broken out, fill the shell with hot sealing wax, taking care to keep the disk in the correct position, so that it will make proper contact when inserted in the socket. Attach the other end of the cord to binding posts on the set and turn on the switch. The strands of the cord may have to be reversed at the binding posts before the plus and minus terminals of the battery are correctly matched with those of the set.

The Hydrometer

UNDER some conditions hydrometer readings may be misleading as to whether a battery is charged or not, or as to the extent of the charge. For example, when fresh distilled water is added to a cell to bring up the level of the electrolyte, the additional water does not actually combine with the electrolyte until the cell has been on charge for some time. Consequently, if a hydrometer reading were taken of that particular cell just after the water had been added, the test, owing to the low specific gravity reading obtained, would show the cell to be nearer the fully discharged state than it actually was.

If fresh electrolyte or acid had been added to the cell just before taking readings, the hydrometer would show the cell to be fully charged, although the reverse might actually be the case.

In taking hydrometer readings always be careful to return the electrolyte taken out by the hydrometer to the same cell it was taken from. Failure to replace the electrolyte in the same cell from which it was drawn will result in destroying the uniformity of the cells. For instance, if electrolyte has been drawn from cell A and discharged into cell B, the amount taken from A must later be made up by adding water and the solution in cell A will be that much weaker, while that in cell B will be correspondingly stronger.

Wise experimenters have already reached the stage where they disregard fancy Radio parts and are looking for rugged, well-built, efficient apparatus.

The How and Why of Crystal Detectors

Current Rectification Explained

By Thomas W. Benson

FOR several years in the earlier stages of Radio and before the development of Radiocasting stations most Radio reception was accomplished with crystal detectors. Although they are scoffed at today for long range work, very remarkable records were hung up in other days. Perhaps this was due to the fact that one had to use a crystal and for that reason coaxed the most out of it. Even today it stands superior to the tube for clearness and freedom from noise as one can testify after listening to a reflex set using a crystal detector.

Just how the crystal detector functions is still a matter for debate, but the prevailing theory is that of rectification. The currents induced in the receiving apparatus, are, as we have learned previously, of extremely high frequency. At 400 meters the current has a frequency of 750,000 cycles. If this current was made to act on the diaphragm of a telephone receiver it would vibrate back and forth that many times per second. The human ear, however, cannot respond to frequencies above 18,000 to 20,000 vibrations and it would not be heard.

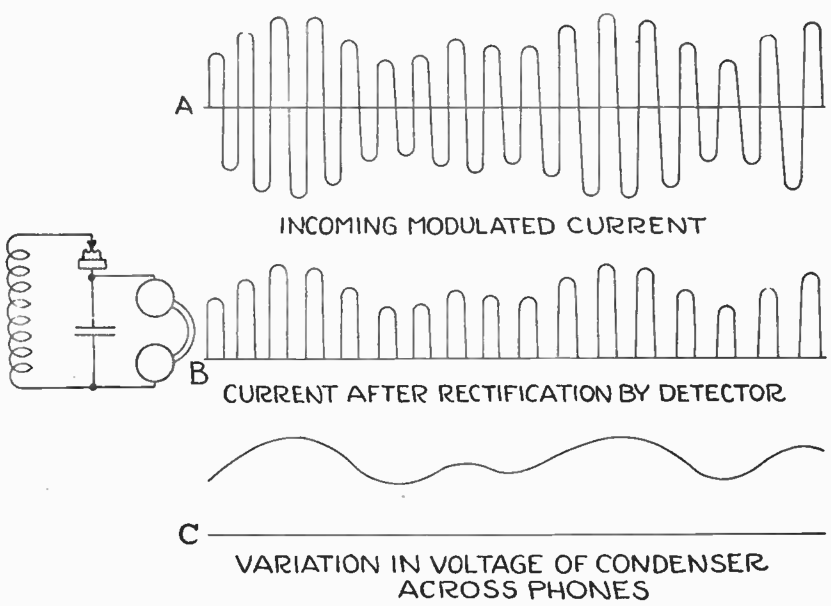


Figure 1—Showing Action of Detector in Radio Receiving Circuit

A crystal detector connected into the circuit acts to rectify the current, that is, allows the current to flow in only one direction and retards or prevents it from flowing the other half of the cycle.

This may be better understood from Figure 1. At A we have the current induced in the detector circuit showing the modulation of the waves by the microphone at the transmitter. At B is shown the same current after being rectified, that is, with the lower halves of the cycles cut off. The current is now direct but is pulsating, that is, flows in jerks. The effect of this current is to charge the condenser connected across the phones and the potential of the condenser will vary as the amplitude of the current waves. Thus the voltage of the condenser is shown at C and the changes in voltage represented by the curve cause a movement of the telephone diaphragm in synchronism with the music or words striking the microphone at the sending station.

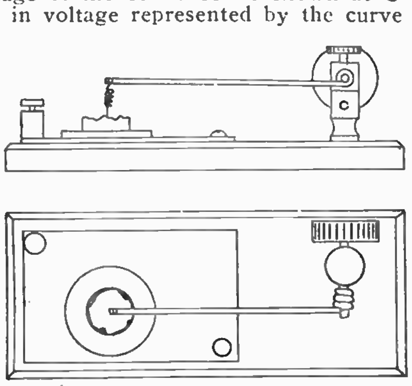


Figure 2—Details of Detector Stand

Materials for the Detector

Many substances have been used for detecting purposes with more or less success and each day sees the birth of some new substance or an old one in a new dress. The two most popular minerals that have been found the most sensitive are galena and iron pyrites. Galena is a natural sulphide of lead, its crystals being cubical in form, having a bright metallic luster and can be readily split up into regular cubes. Iron pyrites is also a natural ore known sometimes as "Fool's Gold" from its yellowish sheen. It is of a bronze-yellow color and fractures very unevenly when split.

For Radio work a good piece of galena is superior to iron pyrites but a good piece is rare and to be treasured. Galena is very sensitive to heat and its detecting properties are ofttimes completely destroyed by the heating incurred during its mounting in metal. For that reason the crystal should be obtained loose and held in the cup with a set screw in preference to being set in molten metal.

The type of stand used with galena should be fitted with a fine cat whisker so the contact will be light. And therein lies the disadvantage of this crstyal, for to obtain great sensitiveness an extremely light contact is necessary. This is easily jarred out by slight vibrations. A short silver wire makes a very good cat whisker. A form of detector stand easy to construct and particularly suited to galena is shown in Figure 2. It can be made easily by anyone, the standard being a double binding post with a short brass rod through the top hole having a knob fitted to one end and a stiff wire wrapped around the other end. A small spiral of about No. 30 silver wire soldered to the stiff wire serves as a contact for the crystal. The crystal itself is mounted in a rather thick brass washer and wedged into place with tinfoil. A brass plate on the base makes contact to the crystal holder and permits the crystal being moved until the most sensitive spot is found.

Experiments have been tried using various substances other than metal wires for contacts. Graphite is said to be superior to either silver or gold cat whiskers. The lead from a hard lead pencil sharpened at one end and attached with a small spring to the arm of the detector stand, shown in Figure 2, makes what is classed the best form of galena detector both as regards sensitiveness and freedom from burning out from static.

Iron Pyrites Detector

Let us now consider the iron pyrites. This crystal is shown preference by the Radiophans chiefly because it gives good results without much care in adjusting. It permits of more pressure being put on the cat whisker and hence is not so liable to be jarred out of adjustment. Not being so sensitive to heat it can be mounted in metal without difficulty.

It is not necessary that the stand used with iron pyrites have very delicate contact so any stand on the market can be used with success. However, the form of detector stand, shown in Figure 3, possesses several features to make it worthy of construction by those desiring the most from their crystal sets. With some changes several of the detector stands on the market can be adapted to this principle. It consists simply of a glass or other insulating tube mounted between two brass standards. A crystal of iron pyrites is put in one end as shown and a thin sheet of mica placed over the crystal. The contact member is made from silver. A dime may be soldered to a thick brass disk for the purpose and its face cut into fine ridges with a sharp, three-cornered file, making cuts at right angles. The face of the dime is then covered with many fine points.

The contact plate is slipped in against the mica and a screw threaded into the other brass post used to force it against the crystal. With the detector connected into the circuit the screw is run in slowly forcing the points on the sliver plate through the mica and making contact with the iron pyrites. When the loudest signals are heard the detector is left adjusted and will continue to function indefinitely. This is as near perfect a fixed detector as it is possible to construct.

As with galena, iron pyrites used in a stand with a pointed piece of antimony fitted to the cat whisker for a contact, gives excellent results and is an arrangement recommended to users of the adjustable type of detector stand.

There are numerous other crystals advertised at present, the greater number of which are compounds of lead or silver and sulphur.

Synthetic Crystals; Clipping Contact

One method of making these synthetic crystals is to bury two dimes in flowers of sulphur for a week or so. On removing one of the dimes it will be found covered with black silver sulphide and will function as a detector crystal. After using for a week the second dime can be brought into service and the first replaced in the sulphur for renewal. Thus the two are used alternately and will last indefinitely. This is worth trying.

When a metallic wire is used as a contact on the crystal it oxidizes rapidly and poor reception is often blamed on the crystal when it is the fault of the cat whisker. The obvious cure is to clip the end of the cat whisker when the signal strength falls off so a clean, fresh surface of the metal is presented to the crystal.

An enclosed form of detector is advisable when the apparatus is subject to dust or moisture and not only reduces the oxidizing of the cat whisker, but protects the crystal as well.

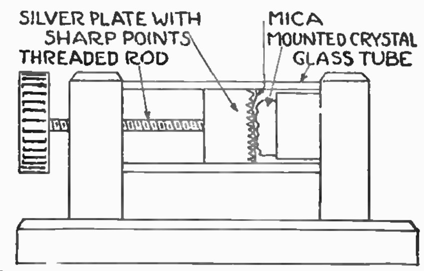


Figure 3—Detector Stand for Iron Pyrites

Restoring Sensitiveness of Crystal

Handling a crystal has been said to destroy its sensitiveness when as a matter of fact the sensitive points have been covered with a fine film of oil from the fingers and will not function in that condition. The crystal can be restored to its original sensitive state by washing with pure alcohol or ammonia, scrubbing the surface with an old tooth brush. Allow the crystal to dry without wiping and the crystal will be found as good as ever. When completely insensitive, simply cleaving the surface of the crystal with a knife or cutting pliers will usually uncover more sensitive spots and make the crystal still of value.

There is sometimes a slight advantage in using a battery in connection with a crystal detector and for the benefit of those who care to experiment with this arrangement a method of connecting the battery and potentiometer is shown in Figure 4, so slight currents may be impressed on the detector by adjusting the potentiometer.

Two or four dry cells may be used with a 400-ohm potentiometer, opening the battery circuit while the set is not in use. The method of procedure is to first adjust the detector to maximum sensitiveness with the potentiometer at the center point and then by turning it one way or the other a slight current of the proper potential is applied to the detector.

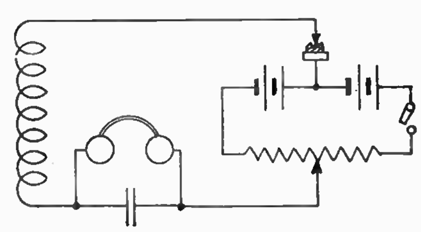


Figure 4—Circuit Employing Potentiometer and Local Battery

Maximum signal strength can only be obtained when the condenser used across the phones is of a good grade. Use a mica condenser, or better still, one with air as the dielectric. Receivers will work without a condenser but it will be found the phone cords form a small condenser and thus permit reception.

There is still a wide field open for experimenting on crystal detectors or some similar rectifying device. A peculiar fact about any pair of contacts that will rectify high frequency currents, such as galena and silver, iron pyrites and brass, silicon and brass and so on through the list of crystals is that one of the substances has photo-electric properties while the other has not. That is, one of them emits negative electrons under the influence of light, the other does not. Whether this has any bearing on the phenomena of rectification is still an open question, the solution of which may lead to some very important discoveries.

Avoid Loose Contacts

MANY condensers are designed so there is a friction contact to the movable plates, that is, the contact is made by the shaft touching a piece of metal. This is a cheap and easy way to make a connection, but it will develop into a loose contact and dust collecting between the shaft and the contact point decreases the efficiency of the entire set. Good firm connections, usually made in the form of pigtails by wire fastened to the shaft and bearing, form a superior contact. Scratching and grinding noises in the phones are often traced to a friction contact on a variable condenser.

Sliding and friction contacts are all loose connections and are a source of trouble. It must be remembered that most of the energy radiated by the transmitting station is lost in space. Only the smallest fraction of the current Radiocast is picked up by a receiving station. A loose contact places resistance in the path of the feeble impulses passing through the receiving set and the sound is greatly decreased if not inaudible in the phones.

Functions of Vacuum Tubes in Radio

How They Work in the Set

By Thomas W. Benson

IN describing the action of the vacuum tube detectors it might be well to discuss briefly the underlying principle of rectification that takes place in tubes containing a heated body and a cold electrode. It was first noticed by Edison, in working with the electric lamp, that the globe blackened after use and on experimenting on the action, discovered that when a cold plate was mounted inside the lamp, a current would flow from the filament to the cold plate but not from the plate to the filament. This is due to the fact that a heated filament throws off negative electrons; thus when a battery is connected to the filament and plate with the positive of the battery connected to the plate a current will flow.

Recalling the action of a crystal detector and its use to rectify the high frequency Radio currents, it would appear that where the secondary tuning circuit of a Radio receiver is connected to the plate and filament of a simple two element tube, a current will

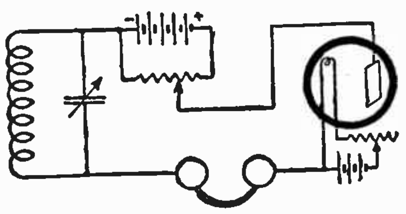


Figure 1—Fleming Valve as Used with Plate Battery

flow in one direction only, thus rectifying the current. Fleming tried this experiment and found it worked out satisfactorily and termed his device the Fleming valve. The diode tube is but a modern type of tube employing the same principle. However, the amount of current flowing between the filament and plate through ionized gases does not exactly follow Ohm's law.

It has been found that up to a certain point the current flow varies directly as the voltage between the plate and filament. Beyond this point, termed the saturation point, a slight increase in the voltage on the plate causes a decided increase in plate current. The obvious thing to do then is to maintain the plate at a voltage just below the saturation point, by means of a battery, so that the increase of voltage on the plate by the high frequency current will be sufficient to push the potential over the saturation point and get the maximum response in the phones. A circuit employing this principle is shown in Figure 1, where a potentiometer connected across the plate battery enables the operator to work the tube at its highest efficiency.

The three element vacuum tube is a similar arrangement but has in addition a grid mounted between the filament and plate to act as a control element and changes the entire action of the device. It should be borne in mind that all three element tubes, comprising a heated filament, a grid or control element, and a cold electrode or plate, act in the manner to be described when used as detectors.

The filament is used as a source of negative electrons. A tungsten filament is used in tubes that light up brightly, such as the UV-200, UV-201, DV6 and others, while those that just glow red, such as the WD-12, have a filament coated with a chemical that causes them to emit electrons at a lower temperature. The grid is a control element and may be mounted outside the tube as in the peanut tube which, by the way, was the first form of control element tried by De Forest, but it is best to place the gird between the filament and the plate. The plate or anode completely encloses the grid and filament in the best types of tubes although it is mounted above the filament when an external control element is used.

Controlling Current

Now let us consider a three element tube connected as shown in Figure 2. Here we have a constant voltage, say 22 volts, applied to the plate and a potentiometer and battery connected to the grid to change the voltage of the grid with respect to the filament. With the filament lighted and brought up to full brilliancy, the electrons are thrown off from the filament and act to allow a certain plate current to flow. With the potentiometer lever moved to the positive end of the battery, the milliammeter will indicate maximum plate current. This is due to the positive charge on the grid helping to draw the electrons off the filament by electrostatic attraction. Consequently more electrons pass through the grid, despite the fact that some strike the grid, increasing the plate current.

As the potentiometer is moved towards the negative end, the plate current will fall off as the positive charge on the grid is decreased. As the neutral point is passed and a negative potential is applied to the grid, the current flow from the filament to the plate further decreases because the negative charge on the grid repels the negative electrons and will not permit as many to pass through to the plate. The current keeps on decreasing as the negative potential increases till a point is reached at which no current flows from the filament to the plate. At this point the negative charge on the grid is strong enough to repel all the electrons and shut off the current.

Were the current in the plate circuit plotted in the form of a curve with respect to the grid voltage, we would have a curve similar to that shown in Figure 3. It will be noted that the curve is flat at the ends

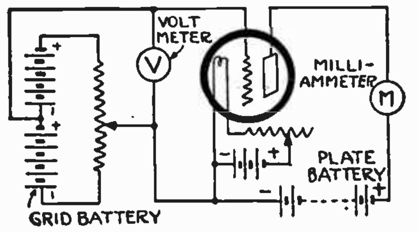


Figure 2—Circuit to Determine Characteristics of Vacuum Tubes and Demonstrate Effect of Inserting Control Element Between Filament and Plate

and quite steep in the center. This shows that at the higher negative voltage and the higher positive voltage quite a change in the grid voltage affects the plate current very little, but near the center of the curve a slight change in grid potential results in an appreciable change in the plate current and therein lies the secret of the vacuum tube as an efficient detector.

Function of Tube in Circuit

Now let us consider how the tube functions when connected in a Radio circuit as a plain detector. The usual circuit is shown in Figure 4, which shows a variable condenser in the grid circuit with a grid leak connected across it.

If no Radio signals are acting upon the tube a steady current will flow from the plate to the filament and back through the phones depending upon the voltage of the plate and the temperature of the filament. When an incoming signal acts upon the inductance

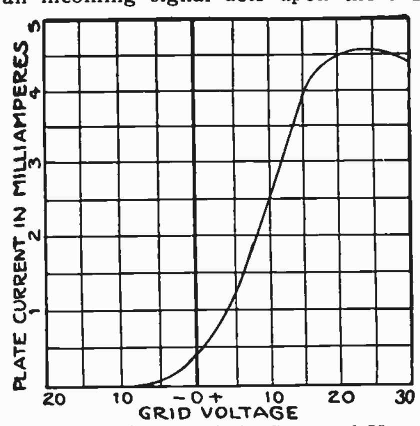


Figure 3—Characteristic Curve of Vacuum Tube Detector Showing Relation Between Changes in Gird Voltage and Current in Plate Circuit

a current will flow in the grid circuit. When the direction of this flow is such as to put a positive potential on the grid, some of the electrons from the filament will be attracted to the grid, but when the potential is reversed, the electrons on the grid cannot escape being held there by the blocking condenser in the grid circuit. On the next reversal more electrons are attracted to the grid and hence at each oscillation the negative charge on the grid is built up to such a value that it repels the electrons from the filament and thus interrupts the plate current, causing a sound in the receivers.

Were the grid completely insulated from the rest of the circuit by the dielectric in the condenser, the negative charge thereon would constantly increase till it shut off the plate current completely and the tube would "block" or cease to function. However, a leak is connected across the condenser as shown and allows the charge to leak off slowly. The effect of this leak then is to prevent the condenser holding too much charge on the grid but should not be so small as to permit too much of the charge to escape quickly. Then by experimenting, the proper value of a leak is determined that will permit the potential of the condenser to rise and fall with the amplitude of the incoming waves and the varying negative charges on the grid thereby vary the plate current to reproduce the audio frequency waves impressed on the carrier wave at the transmitting station.

Changes in Grid Potential

The curve in Figure 3 shows that it is advantageous to work on the middle part of the curve so that slight changes in the grid potential will cause greater variations in the plate current and thus produce the loudest signals in the phones. It should be remembered that it is simply the amount of change in the plate current that gives the signals and not the amount of current flowing. To this end it is advisable to either regulate the constant potential of the grid or shift the curve by varying the plate voltage or filament temperature. Shifting the curve, as it is called, simply means that by varying the plate voltage the curve is moved to the right or left of the center line of the grid voltage. So with a fixed grid potential a change in voltage enables us to shift the steep part of the curve to suit that particular grid potential. That is the reason for variable B batteries for detector tubes.

Although not the usual practice the highest efficiency is obtained from a tube detector when the grid condenser is made variable so that the potential of the condenser itself can be controlled. Those desiring the best results with tubes should use a small variable air condenser in the grid and use the best leak obtainable.

Hardness of Tubes

The main difference between a detector tube and the amplifier tubes is their "hardness." A hard tube is one that has been pumped to a high vacuum; the soft tubes contain a very small amount of gas. A soft tube functions best as a detector for the following reason: When a slight amount of gas is present, the electrons emitted by the filament strike the molecules

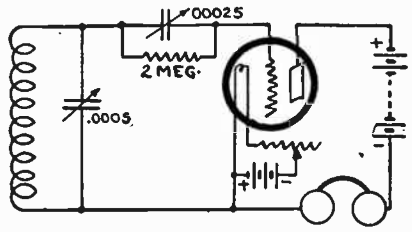


Figure 4

of gas and break them up into their electrical components and the gas is said to be ionized, that is, split up into ions, negative and positive. In this state the gas is conductive and a large plate current is obtainable with a low plate voltage. With the low plate voltage the attraction of the plate for the negative electrons is naturally lower and the smallest change in grid potential will affect the electronic stream.

On the other hand, the hard tube functions best as an amplifier because higher voltages can be impressed on the plate and since the grid potential changes are greater in the amplifier stages by reason of the step-up effect in the detector, the grid can control the heavy electron stream with the high plate voltage. A high voltage cannot be used on the detector because it would exert too much attraction on the electrons and small grid charges would not deflect them. Also, when the gas in a soft tube is ionized, a high plate voltage would force too heavy a current through the tube and it would give a blue glow and "spill over."

We can see now that the function of the vacuum tube is to act as a sort of relay by means of which the weak incoming signal is made to control a local source of current and vary its intensity in accordance with the modulation impressed upon the incoming waves. The crystal detector uses only the received current to actuate the telephone receiver, while the vacuum tube controls current furnished by batteries to give louder signals.

Solder All Connections Well

IT IS of the utmost importance that all connections on a Radio receiver be soldered. An exceedingly small amount of energy operates the telephone receivers, and if maximum audibility is desired every small bit of energy must be made use of in the telephone circuit. Loose connections and poor contact offer a high resistance to the flow of current, and much energy is lost which could advantageously be employed to obtain louder signals.

Soldering does away to a large extent with loose or imperfect connections, that is, if it is properly done. Once a few points in soldering have been learned, there will be no trouble in making a perfect connection. A well-wired circuit not only works better, but it also looks very much neater than a carelessly connected one.

Three things must especially be remembered while soldering. It is always important to have the surface or surfaces to be soldered perfectly clean. Emery cloth or a fine file may be used in some cases. Unclean surfaces do not permit the solder to flow freely.

The second point to bear in mind is to tin the surfaces properly. This is done by first applying a soldering flux, such as resin, acid or paste, to the surfaces, and then the well-tinned iron is run over them. This will leave a thin coating of solder on the surfaces, thus making them ready for the connection.

The final operation should not be attempted unless the soldering copper is of the proper heat. It should never be heated above the point where the solder begins to turn gray. To tin the iron, dip the end in the soldering flux and rub a piece of solder on the surface. A thin coat of solder will remain on the soldering tip.

When soldering, the iron is placed on the surfaces to be joined together. When the solder has melted around the parts being soldered, the iron is removed and the solder will quickly set. Precaution should be taken not to jar the pieces while the solder is setting. Care should be taken to allow only the minimum necessary amount of solder to flow and thus prevent an unsightly joint.

Regeneration and Circuit Applications

What Feed Back Means

By Thomas W. Benson

REGENERATION is possible only by reason of the fact that the energy or current flowing in the plate circuit of a tube is many times greater than the controlling current in the grid circuit. Obviously it should be possible to take a small part of this energy and feed it back into the grid circuit and thus cause a still greater change in the plate current. It should be remembered that it is the extent of the change in the plate current that determines the strength of the signals in the head phones or loud speaker.

It simply remains then to arrange some means of transferring energy from the plate to the grid circuit to convert the regular tube detector into a regenerative detector. There are a number of methods of accomplishing this but, these can all be divided into three classes, inductive, capacitive or resistive. The first two methods are in more general use and we shall first consider their application to single circuit tuners.

Considering the simpler form of single circuit tuner as shown in Figure 1, we find a second coil connected between the plate and the positive B battery. This coil is placed in inductive relation to the inductance in the aerial circuit, the two coils usually taking the form of a variocoupler, the stator in the aerial circuit, the rotor in the plate circuit. The function of the coil in the plate circuit is to transfer energy by means of its inductive properties back into the grid circuit.

The action of the arrangement is as follows: Consider the tube lighted and a signal striking the aerial circuit. The tube functioning as described under tube detectors acts to vary the plate current. The plate current flowing through the "tickler," as it is termed, induces a current in the aerial circuit to cause greater electrostatic charges to reach the grid and hence greater changes in the plate current with an increase of signal strength.

The adjustment of the tickler is rather critical; when the coupling is too close, too much energy reaches the grid and the whole circuit oscillates, acting as a Radio transmitter. In fact, the device will transmit speech for a half mile or so if a telephone microphone is connected in the ground lead to modulate the waves emitted from the antenna circuit.

Loose Coupling Between Coils

On the other hand, with too loose a coupling between the coils the maximum effect upon the plate current will not be obtained and the loudness of the signals decreased. The proper point of operation is just before the oscillating point. The circuit is then just balanced, a hollow purring sound being heard in the receivers. An incoming signal just unbalances the circuit so to speak and trips it into oscillation, but the oscillations stop immediately upon the removal of the disturbing medium.

However, when receiving Radiophone Radiocasts, it will usually be found that the sound is distorted when the regeneration is pushed this far, so the coupling is reduced till the speech clears up and the signals are the loudest.

To obtain maximum results with this circuit, two things are essential. The winding on the tickler must be in such a direction that the current induced in the aerial circuit will be in the correct direction as regards the incoming received waves. Should the set not function when first connected, the leads to the tickler can be reversed. The other factor is the grid leak value. This should be variable and carefully adjusted.

Too low a value will cause the tube to block, that is, give clicks in the receiver which may have quite a time interval between them. The leak should then be increased, when the clicks come closer together, till finally they are just inaudible At this point the grid leak is of proper value.

Having laid down the theory of the regenerative circuit, possible variations come rapidly to mind. Thus

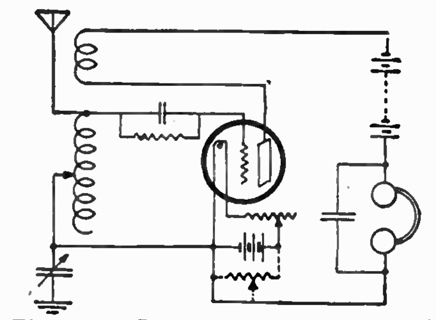


Figure 5—Conventional Single Circuit Using Tickler Feed Back

the two windings may be honeycomb coils, or spider web coils. A variometer with the stator in the aerial circuit and the rotor in the plate circuit will serve the same purpose.

It will be found that the filament brilliancy and plate voltage have a decided effect upon the operation of the circuit and should both be varied till best results are obtained. A vernier rheostat is well worth the extra cost, and a potentiometer shunted across the A battery as shown by the dotted lines will enable one to control the plate voltage to a nicety. It will be noted that a fixed condenser is connected across the phones. This functions to bypass the Radio frequency currents that flow in the plate circuit to obtain regeneration and will make the set more stable.

The Ultra audion circuit devised by Deforest was possibly the first form of the capacity feedback type of regenerative circuit and is shown in Figure 2 in its original form. Its action is based on the presence of the capacity across the phones being in both the grid and plate circuits. Thus when a difference of potential across this condenser was varied by variations in the plate voltage, the changing values were impressed upon the grid circuit, giving a feedback effect and regeneration. This circuit is used in a somewhat different form at present, shown at B in Figure 2.

The variable condenser in the aerial circuit will be found to have a positive potential applied to one set of plates and the other plates being connected to the negative of the B battery through the phones. Thus when the plate current is varied by the original signal wave current the potential across this condenser will vary and current impulses will be impressed upon the grid circuit to assist those from the wave, thus giving regeneration.

The action is assisted by the inductive effect of the variometer in the aerial lead, the self induced current in it increasing the variation in the potential differences across the variable condenser.

With this circuit the grid leak is very critical, for the postive of the B battery reaches one side of the grid condenser and if too much escapes across through the leak, the grid will be unable to assume an appreciable negative charge from the incoming wave and the set will not be sensitive.

Modification of the Circuit

A modification of this circuit that is somewhat superior to that just described is shown at C in Figure 2. The action is identical but the regeneration is easier to control and the signals are somewhat louder by reason of the tuning inductance being connected to the grid and plate.

The application of regeneration to double circuit tuners is identical in principle the only difference being that the energy is transferred to the secondary tuning circuit instead of to the aerial circuit, although the latter method is occasionally used, the aerial circuit in turn transferring it to the secondary. The simplest form of inductive feedback in the two circuit tuners is the three-coil honeycomb or spider web circuit. In this arrangement, three coils are arranged close together, the center one or secondary being fixed in position, the other two being so mounted that they may be swung to the side. The coil on the left is usually made the primary or aerial inductance, while that on the right the tickler

In operation, the left hand coil is used to vary the coupling between the aerial and secondary circuit for best selectivity. Then by moving the coil on the right the proper amount of current can be transferred from the plate circuit to the secondary circuit to get good regeneration without distortion.

Sometimes a variable condenser is shunted across the tickler coil to help control the regeneration, which is highly critical. A better method is to connect the variable across the phones, in which position it acts as a throttle to control the amount of Radio frequency currents flowing in the plate circuits and thus assist in controlling the regeneration.

As a rule, a variable condenser across the phones instead of the fixed condenser used there in most regenerative circuits, will permit better control of the operation and may overcome the squealing and howling that cannot be completely cleared up in many sets.

There are numerous methods of inductively coupling the plate circuit to the secondary, but as a general rule no circuit should be used where a change in tuning will vary the feed-back effect.

For instance, at B in Figure 3 is shown a circuit used by many where one inductance is made to act as the tickler and aerial tuner. It will be very apparent that any attempt to vary the coupling to obtain selectivity will alter the feed-back, or in attempting to control the feedback the selectivity of the set must be sacrificed.

Various other arrangements of inductively coupled methods are described by the technical press, but a study of the above will show the principle used and will assist in the selection of a suitable set.

Feedback in the Reinartz

The well-known Reinartz tuner is a form of capacity feedback with a special untuned or aperiodic aerial circuit. In Figure 4 is shown a modification of the Reinartz tuner that is somewhat easier to build and will be found very simple in operation. As shown, a tap is taken off the variometer between the stator halves and grounded through a variable condenser. Another variometer is connected to the plate and the other terminal to a .0005 mfd. condenser, which is connected to the aerial lead.

This set functions as a closely coupled two circuit tuner. Half of one variometer stator and the aerial circuit condenser form the primary while the balance of the variometer forms the secondary circuit. Regeneration is obtained in the following manner: The variometer being connected to the plate, the small fixed condenser and the aerial tuning inductance form a tuned circuit between the positive and negative terminals of the B battery. Should a change of potential on the grid cause a variation of the plate current, the voltage applied to the tuned circuit will vary and the currents will flow therein at Radio frequencies.

When this circuit is tuned to the same wave length as the secondary circuit, the currents therein build up rapidly and flowing through the aerial inductance part will be transferred to the grid circuit, and being in phase with the currents therein, will assist them and increase the changes in grid potentials, giving greater signal strength. This circuit is recommended for trial by those not familiar with it, for it has given excellent results wherever used. The action in the regular Reinartz circuit is similar, except that the inductances are varied by taps and the condenser in the plate aerial circuit is made variable.

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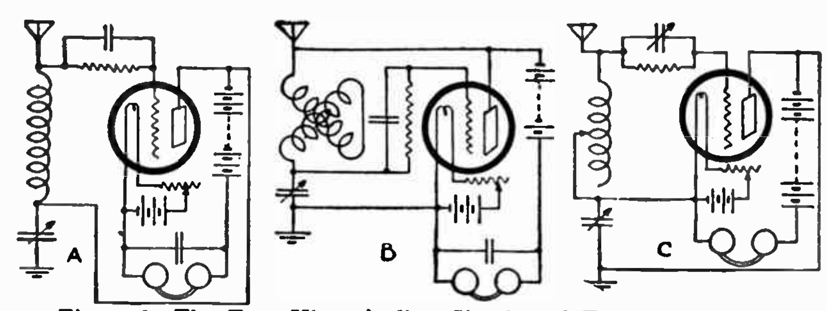

Figure 2—The True Ultra Audion Circuit and Two Modifications

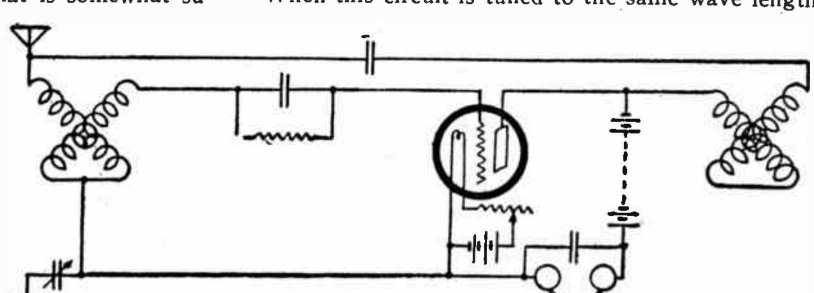

Figure 4—Capacitive Feed Back as Applied in a Circuit

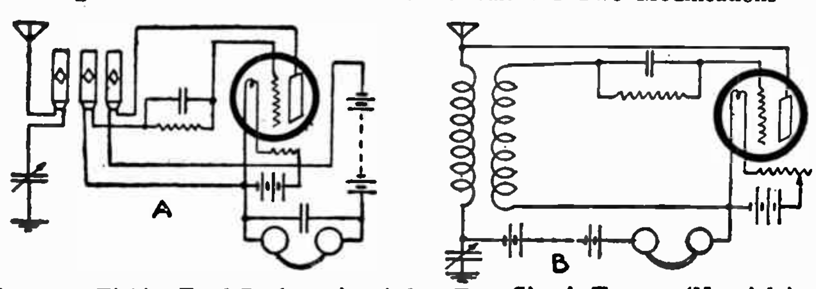

Figure 3—Tickler Feed Back as Applied to Two Circuit Tuners. (Not Advised.)

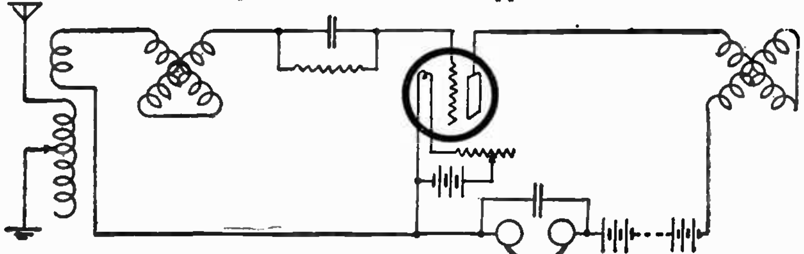

Figure 5—Three Circuit Tuner Using Tuned Plate Feed Back Switches Control Capacity Values

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The Three Circuit Tuner

We come now to the three circuit tuner which is exclusively regenerative and the earliest type of feed-back circuit discovered by Armstrong. The circuit is shown in Figure 5 and is usually known as the variocoupler-two variometer circuit. The action here is rather difficult to explain.

When the set is operating the plate current is varied by the changing potentials on the grid. Each change of the plate current is opposed by the inductive action of the plate variometer. Thus when the plate current is decreased by a negative charge on the grid, the plate variometer tends to keep the current flowing through the tube and builds up the plate voltage.

The increase of positive potential on the plate induces a greater negative charge on the grid by electrostatic attraction, which in turn reduces the plate current still lower, giving a greater change in plate current than would result from the original negative charge on the grid. The plate circuit is tuned to the incoming wave and thus the inductive action of the plate variometer is properly timed to act in synchronism with the Radio frequency currents in the grid circuit.

The proper operation of this circuit demands the adjustment of three different circuits to obtain maximum signal strength and therefore is more difficult to adjust. As a rule, it is unsatisfactory to the beginner for its great selectivity and difficulty in tuning a station, but once the knack of handling the tuner is mastered, it is second to none for long distance reception with amplifiers.

Body Capacity

In most regenerative tuners the approach of the hands to adjust the dials untunes the set. This is termed body capacity and is due to the fact that any conductor brought near the set forms one plate of a condenser and thus changes the tuning of the circuits. This is prevented by shielding the set by fastening sheets of conducting material to the back of the panel and grounding to the ground terminal or to the negative filament.

The wiring of a regenerative set should be such as to prevent any feedback to the grid circuit other than that provided for in the instruments themselves. It is apparent that any lead in the plate circuit which lies parallel to the grid circuit lead would induce currents in the latter either by inductive or electrostatic action. Therefore separate all wires carefully and let them cross only at right angles.

Points to Watch in Buying

When purchasing a variable condenser the mechanical construction should be considered. Are the contacts good? Are the bearings smooth running? Are the plates accurately spaced and strongly clamped? Is a counterweight provided for the panel mounting types? Is the dial well calibrated? Are the rotary plates locked together and firmly secured to the shaft?

Good insulating material is essential. Quartz, porcelain and hard rubber are good. Bakelite is fair and fibre poor. A good condenser does not have small insulating bushings between metal parts which are at different potentials such as the stationary and movable plates, and where a vernier plate is insulated from the main shaft.

Trouble Shooting for Radio Sets

A TROUBLE shooter's key for locating troubles and defects in Radio receiving sets has been devised and given out for the benefit of Radiophans. It is the combined work of several engineers who have worked out the various problems and boiled down the information for handy use.

Opposite the various letters of the key are placed the different troubles encountered by the Radiophan; opposite the line diagnosing each difficulty combinations of numbers will be found which tell where the trouble is. Since difficulties arise from a number of causes, the different numbers tell each individual item of trouble. If one cause given is not the reason for the difficulty, each of the other items given should be followed until the source of the trouble is located. This key is invaluable to those who cannot read a diagram or who do not know the different Radio construction symbols. It will also aid advanced amateurs.

Trouble Shooter's Key

(A) No signals, no noises. Weak signals, no noises.
  (a) No signals in detector circuit. No noises. **2, 3, 4, 13, 29, 32, 41.**
  (b) Signals in detector weak. **1, 2, 4, 6, 7, 13, 29, 32, 34, 35.**

(B) With knocking, scraping scratching or popping sounds in the detector circuit.
  (a) Noises affected by tuning. **9, 17, 18, 21, 25, 26, 30, 31.**
  (b) Noises not affected by tuning. **11, 12, 13, 25, 26, 28, 30, 31, 38, 41.**

(C) Knocking, scraping, scratching or popping sounds in amplifier circuit, but not in detector. Turn filament of detector off and listen in on the amplifiers. If knocking continues, it is the amplifier units. **5, 12, 27, 41.**

(D) Howls, hisses, squeals, whistles and grunts in detector circuit.
  (a) That are affected by tuning. **17, 18, 19, 21, 26, 40.**
  (b) That are not affected by tuning. **3, 6, 20, 21, 26.**

(E) Howls, hisses, squeals, whistles and grunts in amplifiers. **16, 23, 24, 41.**

(F) Humming or buzzing sounds. **22, 33, 34, 36, 37.**

(G) Unsteady or wavering signals. **8, 9, 10, 12, 25.**

Appendix

1—Tickler coil connections reversed, no regeneration. Remedy, reverse coil or leads.

2—Batteries run down.

3—Tubes not making proper contact with socket terminals. Tighten.

4—Polarity of battery reversed.

5—Transformer burned out.

6—Grid condenser shorted.

7—Aerial or ground disconnected.

8—Coils loose and vibrating, causing unsteady signals by varying induction between coils.

9—Too low capacity in antenna. Regeneration is difficult to control at extremely low capacity, where 11 or 13-plate condensers are used in the antenna and set is unstable. Place fixed condenser of .00025 mfd. in parallel.

10—Rain causes leaks of the aerial, etc., making signals unsteady.

11—Poor connections to aerial or ground.

12—Defective rheostat and unsteady filament current.

13—Telephone windings broken or burned out.

14—Storage battery capable of delivering current to detector tube but drain on battery from amplifiers is sufficient to reduce voltage in detector current filament below critical point.

15—Lighting amplifier tubes, after adjusting detector, throw the detector tube out of adjustment when operated on the same battery; always tune in detector with amplifiers lighted if using same battery.

16—Primary of transformer reversed.

17—Too much B battery voltage on detector plate.

18—Too much inductance on tickler coil.

19—Too high grid leak resistance.

20—Plate leads touching grid condenser or its leads or near them.

21—Excessive detector filament voltage.

22—Ground and plate leads parallel and close together.

23—Causes of howling in stages in excess of two are difficult to assign. A good remedy is to place a fixed condenser of .001 capacity across the secondary of last transformer.

24—Transformers too close together.

25—Tube oscillating intermittently because of poor connections to antenna or ground. This is often a difficult trouble to locate.

26—Excessive grid charge; detector tube paralyzed. This may result in a howl of any pitch at intervals of ten to twenty per second. Remedy, decrease filament voltage, loosen tickler coupling, or decrease plate inductance and lower the grid leak resistance.

27—Moisture in transformer, causing shorts between turns or layers. In this case the noise may be heard with primary of transformer, telephone and battery in series. Remedy: place transformer in oven and dry out at moderately high temperature and impregnate with paraffin.

28—Plate and grid coil leads interchanged with B battery shorted to negative filament. This produces a terrific knocking.

29—Phone condenser shorted.

30—Dust, etc., between plates of variable condenser. When the antenna condenser is shorted, a knock or click is heard as the train of oscillations in receiver is stopped with increase of wave length.

31—Getting fingers against metal parts connected to oscillating circuit while tuning.

32—Primary circuit not tuned.

33—Grid condenser on bottom of cabinet or on the table may pick up vibrations or hum from high circuit.

34—Grid coil disconnected.

35—Tube oscillating below critical filament temperature. This is often the cause of weak signals. Remedy: less plate inductance, less B battery, higher antenna capacity, lower head phone by-pass capacity.

36—Caused by having plate directly connected to aerial or by a faulty connection causing leaks from plate circuit to ground.

37—Battery charger connected.

38—Static.

39—Improper bank windings.

40—Two Radiocasters of the same wave, or your neighbor listening in with his set oscillating.

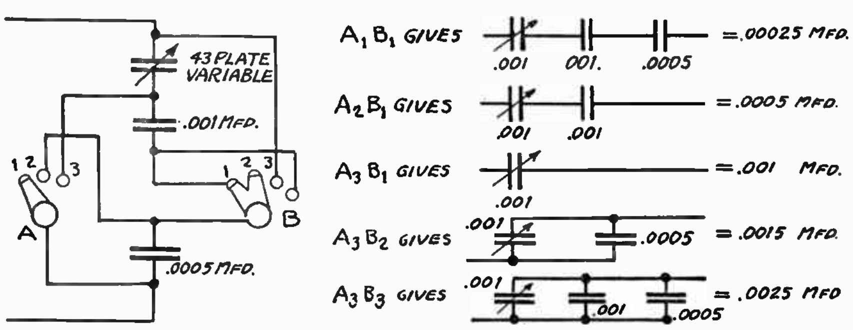
41—Poor connections and worn apparatus. Pull set apart and re-wire.

Building Up Condenser Values

FOR THE experimenter who wishes to use the larger size variable condenser in the circuits now popular requiring small condensers, the following stunt will prove valuable. The capacity curve of the large variable may be reduced all along the scale by using a small fixed condenser in series with it. Thus a .001 mfd. variable may be made into a .0005 by using in series with a .001 fixed condenser; or it may be changed to .0002 by using a .00025 fixed condenser.

This method of reducing the capacity of a variable somewhat distorts the capacity curve; i. e., reduces the upper part of the scale in greater proportion than the lower part, but this is especially desirable with condensers of the type of the Connecticut variable.

In the diagram two fixed condensers of .001 mfd. and .0005 mfd. are used with a 43-plate variable so that five different series and shunt combinations are possible, varying from a miximum capacity of .00025 mfd. when all are in series, to a maximum of .0025 mfd. when all are in shunt. Switch A is used to obtain the series combinations, switch B being left in the first position (to the left). With A in the third position, the variable only is in the circuit. The fixed condensers are shunted across it to increase its capacity by moving switch B to the second and third positions, switch B being left in the third position (to the right). It will be noted that switch B has two blades. The condensers used should be mica insulated and of guaranteed capacity.



Switches Control Capacity Values

Do not forget to solder every joint in the set and antenna, otherwise joints will corrode and offer resistance to the very feeble currents which try to flow in the antenna.

Filament Aids Regeneration

Owners of ultra audion sets who obtain long distance results are always those who pay attention to the lighting of the tube. It is characteristic of this kind of set that it will regenerate with the filament at almost any brilliancy, but its maximum efficiency occurs only when the grid leak and rheostat are set at one particular point. With many tubes the feedback is at its maximum without howl or distortion when the filament is barely heated. A vernier rheostat is necessary for proper control of regeneration.

Good Tools Essential

AFTER one becomes interested in receiving Radiocast concerts and the novelty of just listening wears off the experimental bug usually gets a headlock on most every one, and then comes the time when the new and sensational hook-ups are tried. Now in order that these diagrams may be properly constructed into sets there are centain tools that should be used and that should always be at hand.

The first is the soldering iron. This should be preferably an electric iron, because it will stay hot and one can solder twenty or thirty wires at the same time without running from the stove to the set all the time. Then some soldering flux and some strip solder. Never use acid core solder. Rosin core solder is the best but it takes much practice before it is possible to use it.

Next would be a few pairs of pliers. The first pair to be bought is a pair of combination cutting, pressure and jaw pliers. These are the most handy things for any kind of work. Then comes a pair of cutting pliers. These should be fairly small so that one can cut in tight corners.

A pair of flat pliers with long nose is the next accessory. These are handy in most any ticklish position. The comes the round nose pliers for making loops in the wire to fit over bolts or binding posts.

Screw drivers are most important for various uses. There should be at least three sizes.

Connecting Tube Sets

When the construction of a receiving set employing vacuum tubes either as detectors or amplifiers is complete, the filament or A battery should first be connected up to be certain that all the connections to the tubes and control rheostats are correct for filament lighting. The plate or B battery should always be connected last so as to eliminate the possibility of having the tubes burnt out through improper connection of the B battery to the filament terminals.

A single-circuit set will pick up almost as many stations as a more complicated one, but it may happen that it picks up more than one station at a time.

Construction and Operation of Wave Traps

Showing Choice of Three Different Types

WAVE TRAPS are not indeed new to the Radio world, but their use has been limited chiefly because of little experimentation and because the "air" has not been crowded so badly heretofore. But every distant station hunter, or "DX hound" as Radio slangsters have named him, will tell you that the ether is crowded to the utmost now.

Classes of Wave Traps in Use.

Not so with proper wave traps! The broadest tuning (least selective) set can plunge right through troublesome interference when equipped with any of the more effective devices as the experiments of Radio Digest's technicians have proven.

Wave traps have numerous forms and applications. Some are directly connected in series with the aerial or even the ground lead, others are inductively coupled to some portion of the primary circuit, and then again a few traps are integral parts of the tuning unit of the receiving set.

The Series Wave Trap

One form of wave trap which is connected in series with the aerial or ground lead, is shown in Figure 1. This consists merely of a 25-turn honeycomb coil with a 23-plate (.0005 mfd.) variable condenser connected across it. The cost is low even though the most expensive type of condenser is purchased.

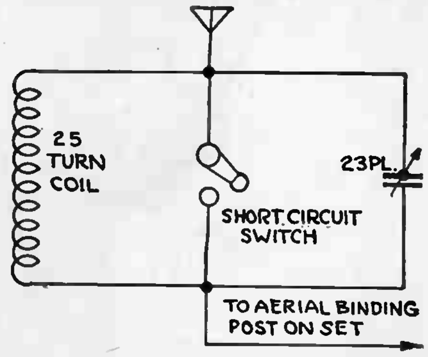


Figure 1—Series Type of Wave Trap

A switch is provided so that the trap may be short-circuited when its use is not desirable. This is a very simple and inexpensive form and therefore presents the most attraction for the average fan.

Parallel Type of Trap

In the second illustration, Figure 2, is shown the style of wave trap in which the honeycomb coil or other coil inductance and condenser are connected in series, but with the resultant unit connected as a whole in parallel with the primary circuit of the receiving set.

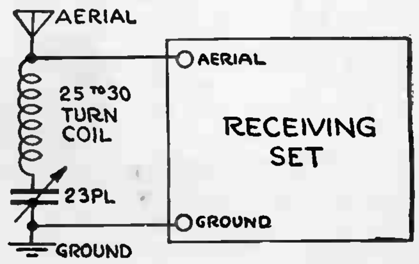


Figure 2—Parallel Type of Wave Trap

In this type, the tuned circuit acts as a by-pass to the ground for those wave lengths which interfere and therefore. as with the first type considered, all that is needed is a good varible condenser and an inductance coil of the sizes specified before.

Inductively Coupled Trap

Undoubtedly the most efficient form of wave trap today is the inductively coupled type. In this style, Figure 3, a small inductance of about 10 turns of wire, number 18 or 16 preferred, is connected in series with the antenna lead of the set. On each side of

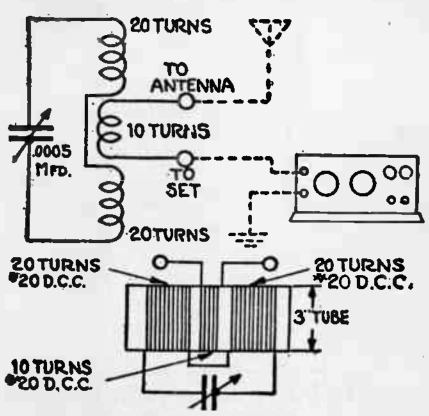


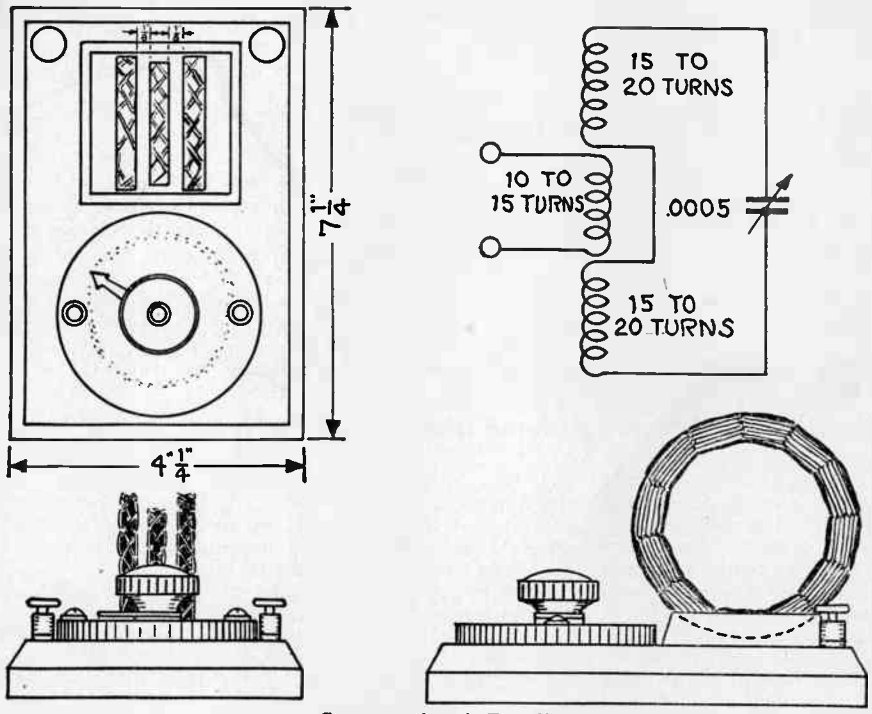
Figure 3—Inductively Coupled Wave Trap

this coil are two 20-turn coils connected in series with one another and a .0005 mfd. variable condenser, the two larger coils being inductively coupled with the smaller, 10-turn coil. The two 20-turn coils, wound also with number 18 or 16 wire, are really but one 40-turn coil which has been separated in the center to allow room for the winding of the 10-turn coil.

Good materials and careful workmanship will give a unit that eliminates even the most powerful interfering Radiocaster.

How to Make Inductive Type

Procure a piece of cardboard, fiber or hard rubber tubing 3 inches in diameter by 3 inches long. On this, beginning ¼-inch from the center, wind 10 turns of number 18 double cotton or silk covered wire. On

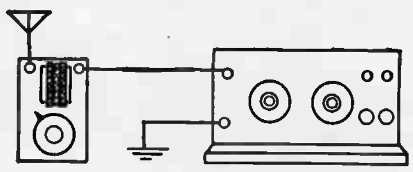


Constructional Details

each side of the center coil (winding in the same direction) wind 20 turns of the same kind of wire.

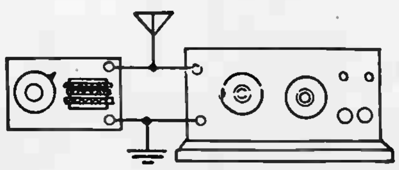
Now connect the two outside coils in series, using one end of each of the two windings, and being sure to see that the turns all run in the same direction. Across the remaining two ends of these coils connect the .0005 mfd. variable condenser.

The center winding should also run in the same direction as the outside windings, but its two terminals are connected respectively to the aerial lead-in itself and to the aerial binding post of the receiving set as shown in Figure 3.



Influence in Tuning

When after having constructed and connected in one of the forms of wave traps described, the set is to be tuned, adjust your set as before but leave the trap variable condenser set at zero (no plates interleaving). In comes the favorite noisemaker, the one for which you've been "baiting your trap." Just turn the trap variable condenser over slowly from zero toward full capacity until you "catch" the offender. You will know this point by the absence of his interference.



Now tune your set for distance. The dials will not all register the familiar readings, but will be a little different on account of the influence of the added capacity and inductance of the wave trap.

Constructional Details

In deciding on the construction of a wave trap the following factors must be considered: First, efficiency; second, simplicity; third, low cost; fourth, compactness.

In considering the first requirement there is little question or doubt that the inductivity coupled types not only are more efficient, but also are not as apt to have an effect on the tuning range of the receiver. As far as simplicity is concerned there is no question or doubt that Radio in itself has enough complication without introducing more to even increase the difficulty that confronts the new fan. After digging deeply into the pocketbook for an efficient receiver with its accessories few feel like investing much more for a wave trap. The receiving set with its batteries present quite a problem as to where they will fit best in a home. Obviously we must avoid adding some more bulky apparatus or parts that would possibly detract from the appearance of a well constructed receiver. The wave trap illustrated should be, then, within the limits of all and affords no serious problems of construction.

Its requirements are a baseboard, a small mounting block for the coils and disc type condenser, two binding posts, three 25-turns special inductances similar to those that have been previously described in articles and some connection wire. Inasmuch as these small inductances only come in 25-turn units it will be necessary to remove some of the turns from them. The two outside coils require about 15 to 20 turns, while the inside coil requires about 10 to 15 turns. Best values are determined by a little experimentation with the particular receiver with which the trap is supposed to operate. Undoubtedly it is advisable to remove the wire on the coils only to the maximum number as 15, 20 and 20, then for a trial if the lower wave length range is not suitably covered, some more turns can be removed.

These coils should be mounted on a small block in which three slots or cuts have been made so that the coils are held upward and spaced about 1 inch apart. The two outside coils are connected together in series. The inner terminal or wire on one side should connect to the outer side of the other coil. The wiring diagram shows how the connections are made to the condenser. It is immaterial which way the binding posts are connected, either to the coil or to the set.

In the two smaller illustrations two methods are shown for connecting the wave trap which simply add one additional control to the set, **but this is sufficient to eliminate all unpleasant interference.**

Selecting Proper Wire

WIRE for winding inductances comes in many sizes and different insulations. There are single and double cotton-covered wires, usually listed as scc. and dcc., respectively. And single and double silk-covered wire—ssc. and dsc. There is also a wire with an enamel covering. Any of these wires may be used for coils, but with slightly different results.

The enamel-covered wire takes up the least space for a given length, but it also has the disadvantage of having the greatest distrbuted capacity, which means that a coil of it would not tune sharply. In regard to space, the silk-covered wire comes next. This wire is very good, but rather expensive. The wire with the cotton covering has the greatest bulk, but is quite cheap and efficient, and most coils are wound with it.

The matter of the double or single covering is one that must be determined by the particular case, depending upon the insulating value, the spacing of the wires and the mechanical strength that is needed.

The size of the wire depends upon its use. In the wire gauge that is used for copper wire, the higher the number the smaller the wire. For coils that are to be inserted in the aerial circuit, the size should be preferably between 18 and 22. In the secondary and other circuits, the size may range from 20 to 26. Smaller wire than this would reduce the efficiency.

Concerning Condensers

In selecting variable condensers make sure that there is no lost motion between the shaft and the bearing, and that the provisions for panel mounting, if of that type, are suitable for the thickness of the panel in your set. To test a condenser for short circuits, connect the filament lighting battery across the two binding posts on the condenser and then rotate the movable plates. Sparking will indicate when and where the plates touch.

Material for Winding Forms

Bakelite, kiln-dried wood, hard rubber or composition winding forms should be used, rather than treated cardboard. The initial cost is greater, but the increased efficiency will more than compensate this.

If cardboard forms are used, untreated board is preferable to the treated kind. The shellac and varnish used in treatment affect the winding and add surprisingly large losses to coils that are used in high frequency short wave work.

Comments on Audio Frequency Amplification

Function and Operation

By Thomas W. Benson

AUDIO frequency amplifiers serve to increase the volume of sound obtained from the receivers or loud talker connected to the Radio set. Where the Radio frequency amplifiers act to increase the range of a set by taking the very weak impulses and amplifying them till they will operate the detector efficiently, audio frequency amplification takes the audible signals and amplifies them till they can be heard for quite a distance or all over the large room. In deciding how to use a certain number of tubes it is well to keep the above in mind. Thus if one desires maximum range and is willing to sacrifice signal strength one or two stages of Radio frequency amplification should be employed and fewer audio stages. Where volume of sound is desired regardless of range then two stages of audio amplification should be used.

The problem of connecting tubes in cascade for audio amplifiers is somewhat simpler than in the case of Radio amplifiers. When the Radio currents have been converted to audio currents the frequency has been reduced and capacity losses in the tube and circuits are greatly reduced. On the other hand, we have currents that vary greatly in frequency and the transformers used must work efficiently over a comparatively wide band of frequencies.

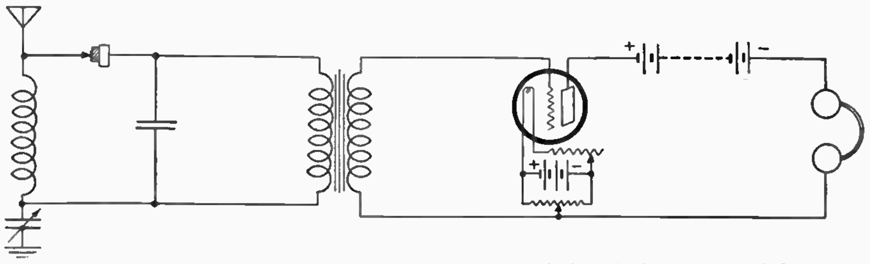


Figure 1—How a tube is used to increase strength of signals from crystal detector

To accomplish this the transformers are designed with what is termed a flat wave characteristic which simply means that the transformer has no sharp point of resonance or is not tuned to a particular frequency. The transformer will then handle currents varying widely in frequency with maximum efficiency.

Operation with Three-Element Tubes

The operation of a three-element tube as an audio frequency amplifier is very similar to its action as a Radio frequency amplifier. Its operation may best be understood when considering its action when amplifying the signals from a crystal detector as shown in Figure 1. Here we have a standard crystal detector circuit with the exception that an audio frequency transformer has its primary winding connected in place of the telephone receivers. The secondary of the transformer is connected to the grid and filament of a hard tube having 45 to 90 volts on the plate.

A potentiometer is shown to control the potential of the grid. The grid potential is adjusted to such a value that the plate current is halfway down the curve as mentioned in connection with the Radio frequency amplifiers.

When signals are being received the current that would normally flow in the telephone receivers now flows in the primary of the transformer. These currents induce a current in the secondary of the transformer that acts to vary the grid potential. In this manner the current flowing through the telephone receivers is caused to reproduce the music or speech in much greater volume.

The higher the voltage used on the plate the louder will be the resulting signals, and, as we have learned previously, the greater the change in grid potential the louder the signals received. To this end, use is made of transformers with a step up ratio. Thus we see transformers advertised with ratios of 2 to 1 or 5 to 1, which means that the voltage of the secondary is twice or five times as great as that applied to the primary. This step up in voltage increases the variations in grid voltage but we must be careful not to overdue this increasing of voltage. The curve shown in connection with tube detectors flattens out at both ends. That is, after a certain voltage is applied to the grid an increase of voltage will no longer cause a change in plate current and the tube is said to be at its saturation point. Now were we to use a high ratio transformer that would increase the voltage applied to the grid of the tube so as to pass the saturation point, signals would be distorted, for part of the wave on the grid would be clipped off because the plate current could not respond.

Transformers and Filament Control

For that reason the transformer ratios may be larger in the first stage and smaller in the second stage. This is due to the voltage in the first stage being low, but after being amplified by the first tube the voltage is increased and a high ratio transformer may push it too high. Increasing the voltage on the plate increases the length of the plate current curve and when distortion results from too high a ratio in the transformers it may be eliminated by increasing the plate voltage.

Increasing the filament brilliancy has the same effect but should only be done with caution for pushing the filament shortens its life and may make the proceeding rather expensive.

A fully developed circuit using a regenerative tuner with tickler feedback and two stages of audio frequency amplification is shown in Figure 2. It will be noted that two potentiometers are used. One acts to vary the voltage on the plate of the detector to obtain the best point of operation. The second is for the purpose of controlling the grid potential of the amplifying tubes. The set will work without a potentiometer, but the maximum results are seldom obtained without some means of bringing the tubes to the point of best response.

The circuit shown employs no jacks and it is the writer's opinion that it is preferable to eliminate the jacks. They are often a source of noise that is difficult to locate, needlessly complicate the circuit, and in many cases are not used at all. When the volume of sound is too great it is only necessary to slightly reduce the filament brilliancy to control the intensity of the signals.

It is not practical to carry the amplification beyond two stages with apparatus as usually purchased for, by the very nature of the amplifier, it will increase the intensity of audible sounds that interfere with the signals being received. These sounds originate in many different ways and are often extremely difficult to locate.

A poor contact in any part of the circuit will give rise to disturbances and can only be guarded against by soldering all connections Tubes loose in the socket, corroded prongs on the tubes, low B batteries, irregular emission of electrons by the tube filaments and even vibration of the tube elements give rise to interfering sounds that are greatly amplified and cause much annoyance. These various items should all be checked up when a set proves very noisy.

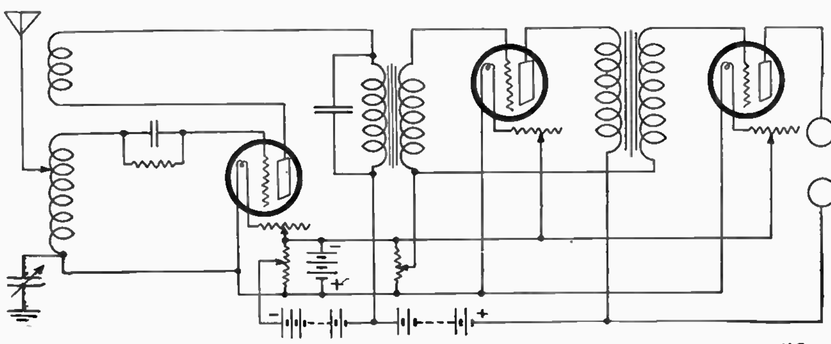


Figure 2—A fully developed circuit for two stage audio frequency amplifier

Squealing and Howling

Another source of great annoyance with audio frequency amplfiers is squealing and howling. This is due to the plate circuits feeding back into the grid circuits giving regeneration. This can only be prevented by proper wiring and location of the instruments.

The transformers should be separated as far as practical and placed at right angles to each other. The wiring must be kept well spaced and not run parallel to any point and should always cross at right angles. Squealing in a set can often be prevented by reversing the leads to the transformer terminals, trying different arrangements till the trouble is eliminated. Jacks are a frequent cause of squealing and their removal will often cure a chronic case.

So far we have considered only transformer coupling between tubes. Another method of coupling audio frequency amplifiers that deserves attention is impedance or choke coil coupling. This method of coupling was the first to be experimented with and work on it was stopped by the amateurs during the war but the army carried on the work and an efficient choke coil amplifier is possible of construction at a cost lower than with transformers. This should appeal to the Radiophan who must watch expenses closely and, strange to say, this amplifier will give just as good results as transformer coupling and with a little experimenting can be made even more efficient. A circuit employing this type of coupling is shown in Figure 3.

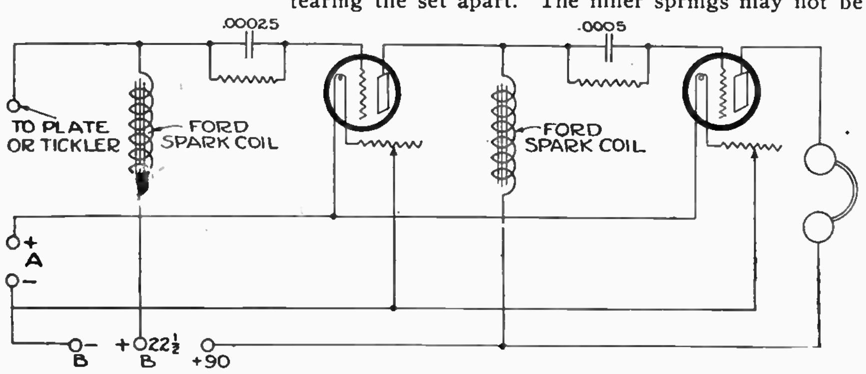


Figure 3—Two stage impedance coupled amplifier using Ford coils

A fixed impedance is connected into the circuit in place of the transformer and a small fixed condenser inserted to prevent the positive B potential reaching the grids of the amplifier tubes. The grid condenser is shunted by a small grid leak to control the potential of the grids.

The action of this form of coupling is similar to the tuned or impedance coupled Radio frequency amplifier depending for its operation on the change in drop of potential across the impedance which is transferred to the grid of the next tube through the small fixed condenser.

Homemade Impedances

For the benefit of those who may care to experiment with this circuit some construction data might not be out of place. The impedances are made from Ford spark coils. Simply remove the vibrator and make connections to the secondary winding and the impedances are ready for use. It is not even necessary to remove the primary winding. The coils when mounted in the cabinet should be placed at right angles to each other and at opposite ends of the box. The values of the fixed condensers are given in the illustration but these values must not be taken as final. It is well to experiment a little, trying different capacities till the loudest signals are obtained.

The grid leaks may be homemade and of the simplest construction. The adjustment of the leaks is rather critical and should be carefully done while the set is operating. The important part in making up this amplifier is to make all leads as short as possible, particularly the leads to the grids of the tubes and for that reason do not attempt to use jacks in the circuit. The posts on the left of the circuit are to be connected to the phone terminals of the detector circuit, the condenser across them serving as a bypass for the Radio frequency currents when a regenerative receiver is used.

This type of audio amplifier when properly adjusted will be very efficient and not only give louder signals but be freer from stray noises. It takes a little patience but is well worth the trouble and will be found much cheaper than transformer coupled amplifiers.

Grounding Transformer Cores

If adjusting the filaments of an amplifier does not stop it from howling, try attaching a wire from the negative terminal of the battery used for lighting the filaments of the tubes to the ground post of the set. Should the howling continue, try grounding the iron core of the amplifying transformers by attaching a wire to the core and bringing it to the ground terminal.

Watch Your Jacks

Jacks frequently cause great trouble by reason of one of the contact leaves or springs failing to make contact, or being so closely spaced that a spark discharge takes place.

The contact points of the best jacks are made of silver. Atmosphere in a home where small amounts of gas fumes are present will corrode these contacts. Sea or salt air will cause corrosion very quickly during the summer time.

If you cannot hear signals when you plug into the third jack, examine the second jack carefully before tearing the set apart. The inner springs may not be making contact with the two longer ones. This applies to the first jack also.

Good Rules to Observe in Building

Cheap parts with poor electrical qualities and sloppy workmanship which add resistance and cause leaks in the circuit are responsible for virtually every failure in Radio. An amateur should exercise every effort in hooking up a set, so as to make a good job of it. Use good parts, arrange them neatly and efficiently in the cabinet, keep all wires well separated and exercise great care in soldering connections. If these rules are followed, success is almost certain.

How to Make a Push Pull Power Amplifier

Increasing the Volume of the Set

EVERY fan at some time or other gets the power amplifier fever. The manufactured article in most cases is way beyond the reach of his pocketbook, so he looks about for instructions to make his own. Unfortunately there has been a decided lack of data. In addition it's no small task to wind transformer primaries and secondaries considering the high number of turns and the frail wire (gauge 40) this requires. These factors have been the real reason for lack of more definite articles on the subject.

There is no reason why the fan cannot construct his transformers by using coil windings from standard audio frequency transformers. Undoubtedly there are numerous transformers lying around inactive that can be used for the purpose. This reservation, however, is recommended for attention. It is advisable to use only such windings where the ratio is not greater than five to one. High ratios in power amplifiers are very likely to create unnecessary distortion.

Using Separate Transformers

Before taking up the construction of these duo transformers a few words may well be devoted to the statement, that, for trial, the transformers can be connected as separate units. For example, in type PP-1 in the circuit, connect the B+ of one to P of the other (primary windings), using only the P of the first transformer, and B+ of the second as the input connections. Then connect the F of the first to the G of the second (secondard windings). In connecting to the circuit the grid of one tube connects to the G terminal of the first secondary, and the grid of the other tube is connected to the F terminal of the second. The joined connection at the center is then connected to the negative side of the C or biasing battery.

The same procedure is followed for the PP-2 combination except that a connection is made to the primary joint which leads to the B+ or plate battery. The secondary joint has no connection, and the loud speaker is connected across the outside of the two secondaries.

Theory

The principle of the push-pull transformers is the use of two tubes working in conjunction. One builds up the current while the other is at its weakest point of grid potential and vice versa. In this way, one stage using two tubes gives higher efficiency of amplification without the attendant distortion. The final result is a much more uniform and desirable operation of the loud speaker.

Construction of Single Core Unit

Take your transformers of the same type and ratio; if four alike are not available two and two will do, but the two sets of windings in the same unit must be alike. Remove the windings (primary and secondary in one unit) from their core. It is best to tag the four ends so that no mistake will be made afterwards in identifying them.

Procure a sheet of silicon transformer steel not thicker than .02 inches. Cut this into strips ½ inch wide. Measure the length of two windings and add 1½ inches. Cut about 100 pieces this length. Now measure the thickness of one winding from inside edge of hole to outside. To this add 1¼ inches and cut 20 pieces. Then cut 40 pieces ⅝ inches shorter than the last.

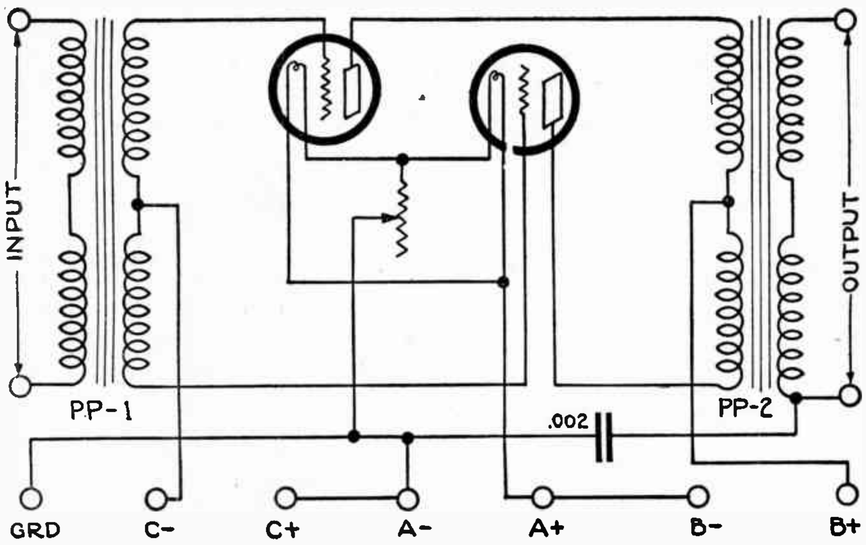
The illustrations show how these strips are assembled to build up the core. Not more than four of the middle-sized strips are used on the ends. These simply bind the complete core unit together. The idea is to create a magnetic gap between the two ends of the core. As many strips should be used as will compactly fit into the hole of the windings. Holes are drilled through all the strips at the four corners.

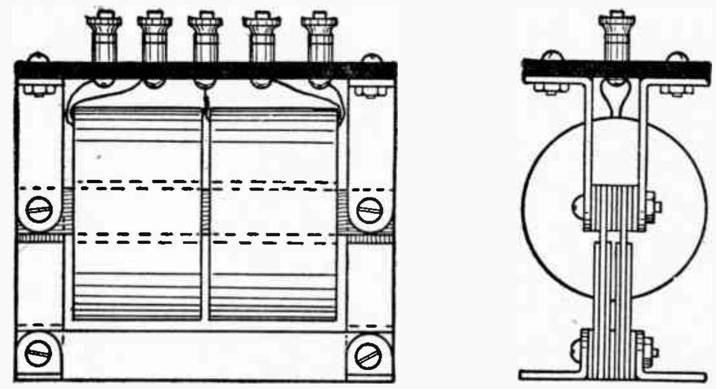
They are then assembled with the coils as shown. The coils should have their windings in the same direction. This is best taken care of by observing that the respective leads from the primary and secondary project from the same sides on both coils.

The small angles used on the base for mounting, and on top for holding the terminal strip, can be made up of strip brass or bought. A small strip of panel stock mounted on top serves very effectively for mounting the binding posts to which the connections are made.

These angles should be clamped underneath the four machine screws and nuts that hold the core together. No shielding is necessary. The same method of connecting the windings as described before holds true here. The type PP-1 has the central secondary tap and the type PP-2 has the central primary tap.

The two types and the binding posts should be correctly marked in order to avoid any confusion when connecting them in the circuit.





The view above shows the method of assembling the transformer
The view to the left shows the push pull amplifier hook-up

The Amplifier Circuit

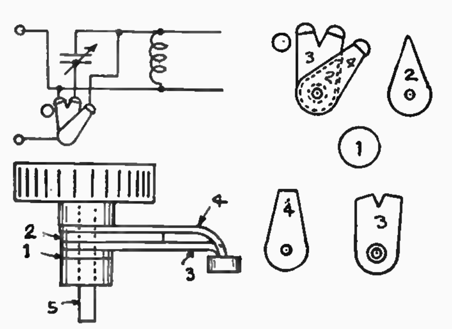
The proper circuit for using these transformers is shown in the illustration. The first, or type PP-1, is connected in the circuit as transformers are usually used, with the exception that the secondaries are connected to the grids of two tubes. In order to build up the negative potential on the grids of the two tubes, a C, or biasing, battery of 6 to 9 volts is connected as shown. The plate current of the two tubes must now be added together, and the energy thrown into one circuit to operate the loud speaker. The two plates cannot be connected directly together as the action of the one will oppose the other. Therefore they are connected to the ends of the two primaries of the transformer PP-2, the center of which is connected to the usual B battery positive. By induction, then, the two are combined in the secondary of this transformer, to which the loud speaker is connected.

This amplifier circuit can be used in conjunction with a detector or even one or two stages of audio frequency amplification, as desired.

Series-Parallel Switch for Use in Any Circuit

A SERIES-PARALLEL switch for the primary condenser is almost a necessity now that stations have such a wide range of wave lengths. The present type requires eight taps and a great deal of panel space.

In constructing a portable set in which the panel space was very limited, a series-parallel switch using only four taps, taking no more space than the ordinary tap switch, was made, as shown in the illustration.



This switch is a very small condenser within itself but the primary condenser will offset this effect.

By making over a common switch, as shown, and using a little care the new switch can be made with little trouble. Note that the double blade is in no way connected to the rest of the instrument but that the single blade is connected as usual. The diagram shows how to put it in the circuit.

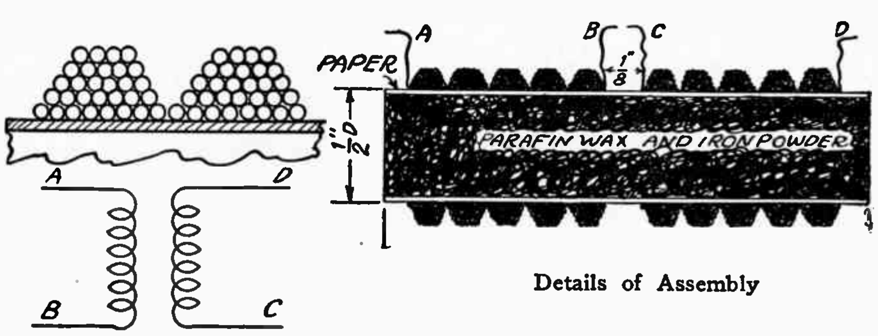
How to Make an R. F. Transformer

REFLEX sets and Radio frequency amplification are becoming more and more popular every day. The average fan wishes to add a stage or two of Radio frequency amplification to his set, but his purse usually balks at the prices asked for transformers.

The author has constructed one as described in this article. A Radio frequency transformer is very easily built, and one of this type will give wonderful results. The complete cost is twenty-five to thirty cents. This is quite different from what the amateur usually puts out for a transformer.

From a chemical supply house get a bottle of iron powder. This is chemically pure, and very soft. Melt a small piece of paraffin wax, and stir the iron powder into the wax. Make a mixture the consistency of bread dough then make a cylinder of paper, about ½ inch in diameter. and 2 inches long. Stand it on end, and pack the mixture tightly in it. When this has hardened, give the cylinder a coat of shellac, and set it aside to dry. To make the windings, use number 30 enamel or scc., and starting at one end, make a banked winding of 30 turns. When this is finished, continue the winding by making another bank beside this, and similar to the first. Make five of these banks. This is the primary winding. Now, at a distance of ⅛ inch from this, make another winding of five banks of 30 turns each, in exactly the same manner as the first. When both windings are finished, give the whole thing a coat of shellac, to keep the wire in place. Connect each of the four leads to a binding post. The transformer can be used as it is or it can be placed inside of a cardboard or bakelite tube. Fill the tube with paraffin, sealing wax or rosin. Connect the transformer as shown by the diagram.

This transformer acts very efficiently over a wave length band of 200 to 500 meters, with a peak at about 360 meters. It is therefore ideal for Radiocast reception.



Details of Assembly

Loop Aerials and How to Make Them

Details for Two Popular Types

THERE are two good ways of building a loop. These are shown in Figures 1 and 5. In the first, the wires lie all in the same vertical plane and the turns grow smaller as they approach the center. In the second, all wires are parallel in 90° planes and all turns are the same length. In the construction of the first type, select two straight pieces of wood, 1 inch square, one 3 feet 6 inches long, and the other 3 feet 10 inches long. Notch each of these, halfway through, 1 foot 9 inches from one end so they may be laid together at right angles and lie in the same plane. Then, from a piece of ¼-inch board cut a piece 5 inches square and bore holes near each of the four corners so that screws can be put through to fasten this piece to the cross, as in Figure 1. Then, from 3/16-inch bakelite cut four pieces like Figure 2. Fourteen holes should be drilled and twelve of them tapped for 6-32 machine screws. The two end holes are not tapped, as wood screws fasten these bakelite pieces to the cross members (again see 1). Before fastening these to the wooden members, insert 3/16-inch, 6-32 round-head machine screws into the 12 tapped holes but screw them only about two-thirds of the way through, leaving 1/16-inch projecting.

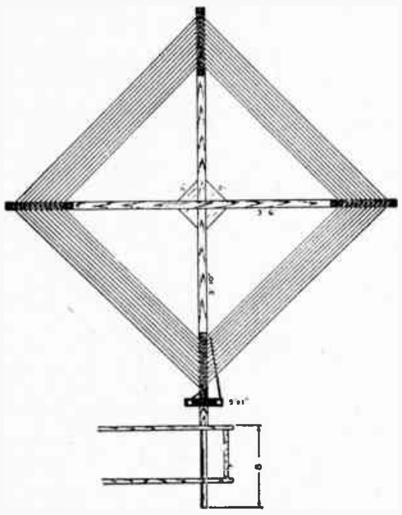


Figure 1

Now fasten these bakelite pieces to the cross arms, 1 foot 2 inches from the center. Leaving 6 inches for connections, wind your wire a couple of times around the bottom screw, carry it to the outer screw on the left side of the horizontal arm; then around the top screw of the vertical piece; then to the outer screw on the right side of the crosspiece, and finally to the second from bottom, next to the one where you started. Continue until eleven turns are on, twist the wire around the last screw, and carry it loosely to lower end. Figure 3 shows a 5 by 1-inch crosspiece of bakelite with binding posts on it. Connect the inner and outer ends of the loop to these.

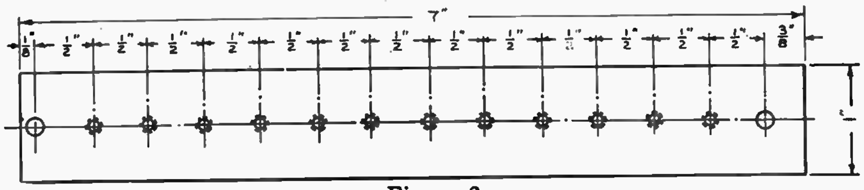


Figure 2

The lower end of the vertical arm should now be drilled with a 3/8-inch bit and a piece of 3/8-inch bakelite rod, 10 inches long, inserted to a depth of 2 inches. This should be a tight fit. The supports are made of ½ by ¾-inch material, 5 inches wide and kept 6 inches apart by another piece of the same material.

Figure 3

In constructing the second type of loop refer to Figure 5. The crosspieces and method of supporting this loop are like those of the first. The bakelite wire supports are made as shown in Figure 4, four being necessary. From left to right: edge to notch ½-inch: then 1-inch to second notch; then three more notches 1-inch apart; then 1½-inch to notch 6: four more notches, 1-inch apart. Ten turns of wire are wound around this structure and leads are brought to the binding posts for connection.

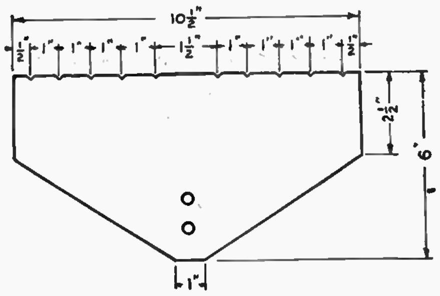


Figure 4

Mounting and Wire

No particular kind of wire can be said to be better than others for loops as they have been wound, and have performed satisfactorily, with bell wire, lamp cord, silk-covered and cotton-covered, "Litz" and braided bare copper wire. While the larger size loops, 5 to 8 feet square, may be slightly more efficient, they are cumbersome and too large to be used in the average home, and the 3 foot size is to be preferred.

Now a few words about the support of loops. The method shown in the construction of the two loops is, in the writer's opinion, best, but loops may be suspended from above, hinged at the side or set upon a base. They may be fastened to the back of a door and the door swung to obtain directions. Remember, the plane of the loop must be parallel to the direction of travel from various stations. The reader will at once appreciate how this property of the loop serves to eliminate interference from undesired stations.

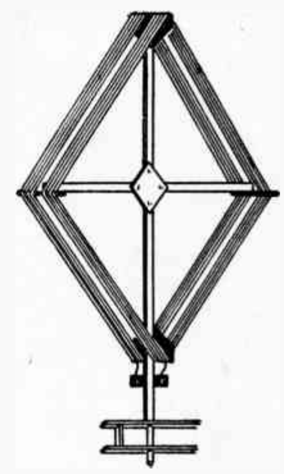


Figure 5

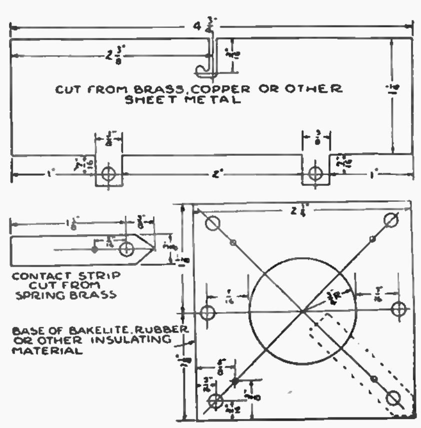
How to Make Tube Sockets

THE following instructions for making a tube socket will produce a very serviceable and economical socket if followed closely.

The main advantage of this socket lies in the fact that it may be made in the sub panel upon which the ordinary socket is often mounted. This feature conserves space and, being combined with the sub panel and extending beneath, it is very convenient to clean and adjust contact springs. More than one socket can be made on one base.

The walls of the socket are bent around any round object of suitable size and the ends soldered—very little solder should be used. A piece of wire may be wrapped around the walls to hold them in place while soldering. The projecting legs are then bent out at right angles to the sides of the socket.

The base is cut from the rubber of an old battery jar. This rubber should be thoroughly washed and cleaned with steel wool to get out the acid which may be in the pores of the rubber. Warm the rubber



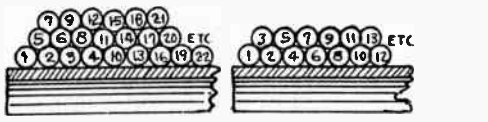
and the center hole may readily be cut out with a large drill or knife. The base is drilled as shown. The four large holes at the corners are to hold the contact springs in place, and the four small holes are to take the pins on the contact springs to prevent the contact springs from moving sideways with the movement of the tube.

The contact springs are also cut as shown, the large hole being large enough to pass through a 6-32 bolt. The small hole may be punched in if a drill small enough is not available. This hole should be large enough to just take a small brass brad. The brad is put through the hole, up to the head, then the head soldered to the contact.

The contact spring is bolted underneath the base by means of a 6-32 bolt. The bolt should be long enough to have an extra nut on it under the base by which means connection is made to the springs. It is better to solder the leads directly to the contact spring if the wiring of the set is to be permanent. The brad on the contact spring should extend slightly through the base when no tube is in the socket.

Bank Winding

Give the surface to be wound a coat of shellac and bake it on to prevent shrinkage. The surface is then covered with adhesive tape with the coated side out.



The best width of tape is 1½ inches. Wrap one turn of the tape around the part at the end where the winding of the wire is to start. If necessary to cover space for the wire, wrap another piece on with the edges joining. Wind the wire on the tape.

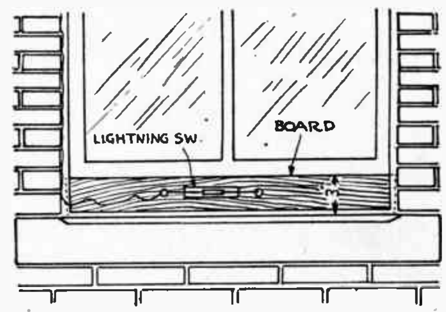
The gum on the tape will hold the under layers so that they will not slip. This will make winding easy. Triple winding is done as shown in the left of the sketch and double winding at the right.

Some Causes of Interference

Interference in a Radio set is often due to the action of a simple electric device in the home. A toy electrical train may become a miniature transformer of Radio waves, a defect in an arc light or in an electric power transformer, such as is found on many electric poles, X-ray machines, passing trolley cars, motors in factories, vacuum cleaners and other electrical devices cause interference, although fortunately these disturbances mostly are limited to a very small radius.

Lead-in Board

VERY often it is impossible to drill a hole in a window or anywhere near it for the lead-in wire. To overcome this difficulty procure a board about 3 inches wide and long enough to fit securely under



the window sash. All the holes are drilled through this board; the lightning switch may be mounted on the outside of it. No damage is done to the window sash or casing when using such a board.

Sponge Rubber Mounts for the Tube Sockets

The vacuum tubes now on the market are rather delicate instruments and are subject to microphonic noises unless mounted correctly. This is easily accomplished by fastening the sockets on sponge rubber.

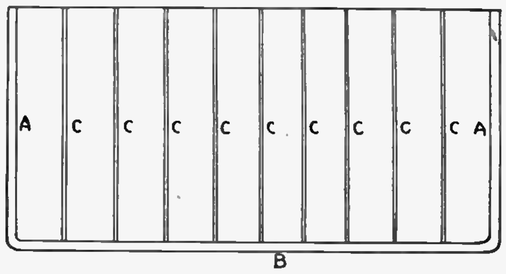
But the mistake the fans make in doing this is to leave a lot of rubber in the center of the socket, which makes connection to the tube prongs. This causes a high resistance path for the Radio frequency currents and lowers the efficiency of the set to a great extent. Be sure to remove the rubber in the center of the socket.

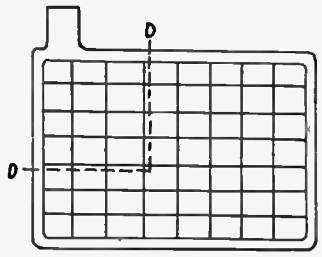
Use for Bits of Old Panels

Odds and ends of old panels, even if they are full of holes, make good battery terminal panels for the interior of the set. Put small bolts through with binding posts on each side or with the wires from the set soldered to the bolts. Then bring your battery wires in through small holes in the back of the cabinet. It makes a neat job, keeps the tangle of battery wires from the front panel, allows more direct connection and utilizes junk. Pieces of the rubber cells of old storage batteries are also good for this use.

How to Make a Good Storage B Battery

Old Battery Parts Used in Construction





THE following B storage battery was entirely made out of the parts of an old storage or automobile lighting and starting battery. There are enough parts in one 6-volt battery to make three very neat and serviceable 20-volt storage B batteries.

Each jar of the B battery is made from a jar of the A battery. The jar is cut off 3½ inches from the bottom. The rubber should be warm when working it. If possible leave it in the sun for two or more hours and then it may be cut by drawing a sharp knife across the surface point downward. This will not cut the rubber through but it may be turned over and the cut repeated on the other side and then the rubber will break where the cut was made by bending it back. When cutting the jar off it is best not to have it too warm, and to use a hack saw instead of a knife. If the rubber is cut while cold there is great danger of breaking it and damaging the whole jar.

Out of the remaining upper half of the jar cut nine strips as wide as the inside of the jar and as high as the inside height of the jar. These are for the partitions to separate the cells of the battery and should fit as snug as possible when they are in place as shown.

Making Partitions

Heat some battery compound until it becomes liquid. Stand a partition in place and pour the heated battery compound in the first cell. Turn the jar sideways so as to let the compound run in and seal the strip to both walls and the bottom. Use as little compound as possible. This may be done best by having the compound very hot and pouring plenty in the cell, then pouring out the surplus. If just a little has been poured in it cools too quickly and cannot be made to fill the crevices. Let this cell stand for a minute and then proceed with the next cell in the same manner.

After the cells have all been sealed they should be tested by pouring water into every other one and let them stand for a while. If one of the strips is not properly sealed it will show up in the adjoining cell, filling it with water.

Ten positive and ten negative plates are cut out of the positive and negative lead plates, respectively, from the old A battery. The plates should be cut about ½ inch narrower than the inside of the jar and about ¾ inch shorter. The plates may be cut with a hack saw, or, by cutting a groove in both sides of the plate with a knife and breaking it on the cut. The separators should be about ¼ inch larger than the plates. The former are cut from the old separators in the A battery.

Assembly and Charging

One positive and one negative plate and a separator is used to make up the elements of one cell, the negative of one cell being soldered to the positive of the next cell.

If you are not sure that the old battery torn down for making this battery was in a charged condition (which they seldom are), it is a good plan to fill the old battery with distilled water and then charge it for a few hours. This will bring the old acid out of the plates and into the distilled water. Then it is poured off.

After the battery has been charged with the distilled water in it and the water taken out, fill the battery with a sulphuric acid solution until it tests to 1250 on the hydrometer, and charge it at a ½ ampere charging rate. When the battery has been fully charged it will gas or bubble, a condition that will be readily recognized. Then it is ready for service. This initial charge may take some time, depending on the condition of the plates. The battery should be placed on charge as soon as possible after the acid has been placed in it. When fully charged the battery should give about 22½ volts, but as the charge runs down it will drop to about 20 volts.

Care and Treatment

Such a battery should stand up for several weeks when used only on a single tube. If used on more tubes the life, of course, will be accordingly shorter. One of these batteries made up like this has been used on a five-tube set in series with a manufactured B storage battery and it has compared splendidly.

When the voltage drops to about 20 it is time to recharge it. This can be done much quicker than the original charge. When fully charged the acid specific gravity should test to about 1250. If, however, the battery was not previously charged with distilled water as directed, the gravity may run higher than this figure on account of the acid that was in the plates before the new acid was poured in, thus raising the amount of acid in the battery.

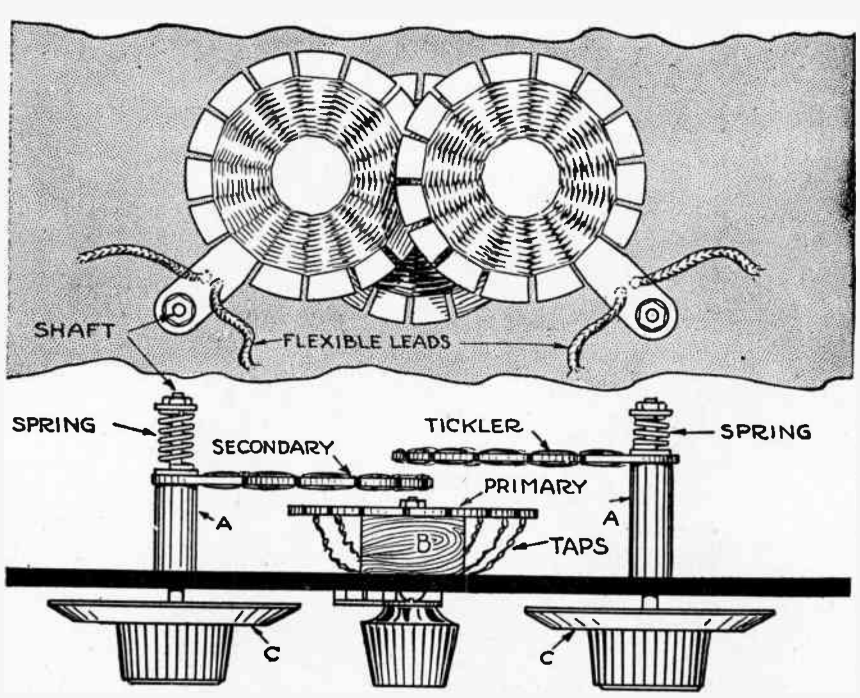
The specific gravity method of testing is not to be relied upon entirely in such small batteries, as the amount of acid required to neutralize the plates may be so small as not to affect the solution. This holds true more especially where small plates are used in a comparatively large container or jar.

When charging the battery the best way is to charge it each time until it gases. When a battery gases it is a sure indication that there is no acid left in the positive plates and the battery is therefore fully charged.

The battery should never be shorted to test its condition, and it should never be left standing long discharged.

Homemade Spider Web Mounting

THE coil control described in this article takes the place of three honeycomb coils and it gives many advantages over these coils. The coils are mounted back of the panel, thus improving the appearance of the set and protecting the coils from dust. The primary coil may be easily tapped for fine tuning, and the panel in front of the coils is shielded with a piece of tinfoil, thus reducing capacity effects.



Coils are Back of Panel

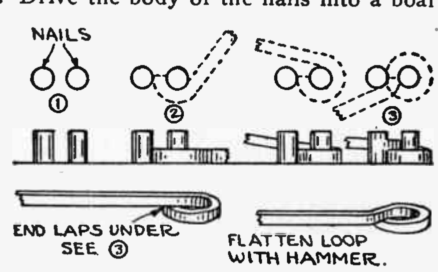
The coils are similar to spider web coils in construction, and the form for winding the coils is the same except for one of the winding legs which is made longer for connection to the shaft, as shown. All arms on the primary or stationary coil are the same length, and the coil is fastened to the panel with a small block B, and a bolt as shown. This stationary coil may be very easily tapped, the leads being led to contact points on the panel. A threaded shaft is required for each movable coil, this being fastened to the coil form with two nuts. A section of brass tubing A, is cut and used to space the coils and keep them from touching. A spring, together with the necessary washers and nuts, keeps the shaft with the coil mounting pressed against these pieces of tubing. A dial C is fastened onto the other end of each shaft to turn the coils to and from the others. The coils are arranged in order as is clearly shown in the illustration. They are wound with the proper number turns of wire, about 60 for the primary, from 40 to 90 or more for the secondary, and from 40 to 120 for the tickler, the number of turns being in accordance to the manner in which the coils are to be used.

Two of the coils may be used as a variocoupler, or three as with honeycomb coils.

The night range of sending and receiving stations is much greater than the daylight range. Do not expect to hear stations a great distance away in the day time. The reception, as regards summer and winter, is similar; in December and January reception is much better than in July and August.

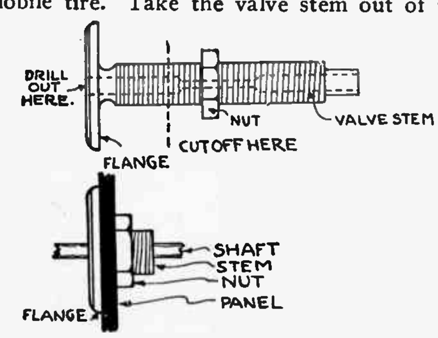
Wire Bending Tool

WHEN it becomes necessary to make several loops on the ends of bus bar wires while wiring a set, time will be saved in making the bends if a tool is constructed as shown in the illustration. To make the tool procure two ten penny nails and remove their heads. Drive the body of the nails into a board, placing them just far enough apart so that the ends of the wire may be slipped between them. Place the end of the wire against the side of one of the nails; it then becomes easy to bend the wire around the other nail, making a uniform loop.



Panel Bushings

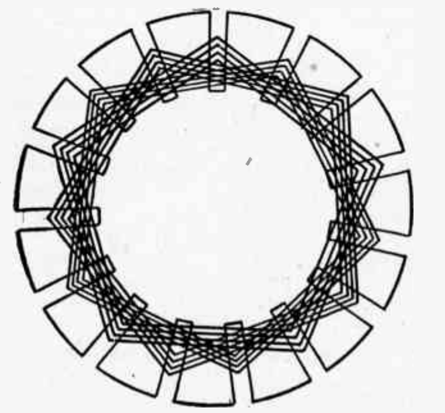
FOR those of you who "make your own" the following kink may be of interest. Procure one or more inner tubes from a garage, if you do not have an old automobile tire. Take the valve stem out of the tire



and put it in the vise with the flanged end in front. Run in a 13/64 or 17/64-inch drill, depending on whether the shaft is 3/16 or ¼-inch. Drill the hole in 1 inch or more and cut the flanged end off the right length. The illustration is self-explanatory.

Winding Spider Web Coils

I procured several fiber disks with fifteen spokes all 4 inches in diameter. When winding in the usual spider web manner I found that 50 turns of wire could not be run on them. In order to overcome this difficulty I first wound on a five-sided figure or pentagon. This left two slots free. I wound on 18 or 20 turns then skipped to one of the vacant slots. After 18



turns I skipped to the other vacant slot and wound on turns as before.

This makes a very neat looking coil and about twice as many turns can be wound on the same form. When finished the coils will look like a fifteen point star. This system of winding can be adapted to any form having any number of spokes.

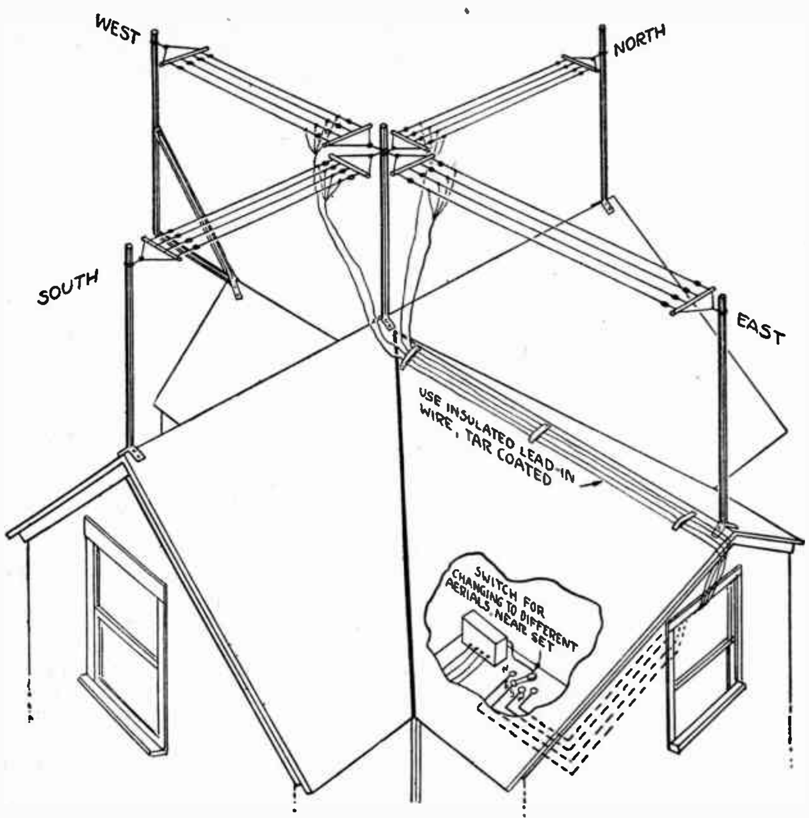
Efficient Arrangement of Four Aerials

WITH the arrangement of aerials as shown in the illustration excellent results can be obtained. There are four aerials, each pointing in a different direction from the others.

A small switch is mounted near the window and the aerial post on the set is connected to the blade of this switch. There are four switch points marked N., S., E. and W., and the aerial pointing to the north goes to the point marked N., etc.

With this arrangement more distant stations were received than when the aerial which pointed in one direction, was used.

Measurements have shown that signals are stronger when the incoming waves strike the aerial first at the end from which the lead-in is taken. The aerial pointing east from the center of the house would, therefore, be used for Radiocast coming from the west. The close proximity of the other antennas may alter this, but it forms a starting point for experimentation.



Filament Heating Transformer

DATA on how to build a filament transformer seems to be very scarce in the Radio magazines.

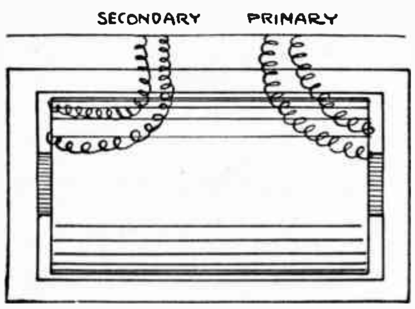
Have the tinner cut on his machine (hand-cut strips are worthless) from number 28 gauge black iron enough 1 by 3-inch strips to form two piles 1 inch high and enough strips 1 by 5-inches to make two more 1-inch piles. Pile up the 5-inch strips to form two piles 7 inches long by making every other strip project 1 inch. Tape them well except for 1 inch at each end. Cut two pieces of 1/16-inch black fiber 3 inches square. With a ruler lay out a 1-inch square hole in the center of each and cut out with the sharp point of a knife. Slip one on each end and bend back one lamination on each side at the ends to hold them from slipping off. Drill a small hole in one head, near the core, to start the wire and wind on 1,600 turns of number 21 enamel scc. magnet wire. This will require a little less than 3 pounds if neatly wound on in layers. Drill a hole in the head to bring out the end and tape the winding well. Drill another hole in the other head to start the wire, and wind on 140 turns of number 14 enamel scc. wire, winding over to center, back to end and then to center. These three layers between the end and the center should make 70 turns. Bring out a tap; then wind over the other half in the same manner. You will now have a 1-inch core wound with about 17 layers of primary and 3 layers of secondary wound over primary, making the winding about 3 inches in diameter. Assemble the other long leg of the core in the same manner as the one upon which the wire is wound and close the core by leaving in the short pieces across the ends.

Not having an alternating current ammeter handy I cannot say just what amperage this transformer gives, but I am using it with three 5-watt tubes and believe it would carry six. The voltage is 5.25 which I find is fine for three tubes using a 1.5-ohm. rheostat.

Audio Frequency Transformer

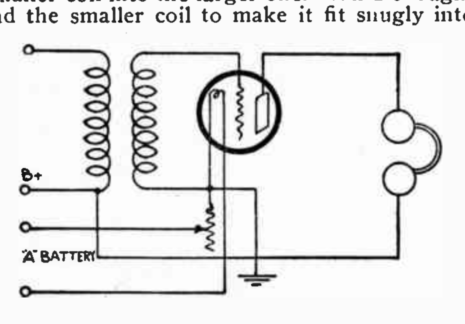
PICK up from your neighboring garage a few Ford coils. These coils are divided into two small coils each about 1½ inches long which constitute the secondary. These two coils and the cores are used in the transformer. If the case, binding posts, vibrator and the various equipment are still in place, save them. Many things not needed at first will become of value later.

Separate the coils to make two independent coils. Take the primary winding—the larger wire around the



core—out of both; and keep the core—the bunch of annealed wire in the center. If you want to know how many layers are on a coil count them. It's good practice. On most coils there are 35 and 37 layers. If we have a 35-layer coil and desire a 10 to 1 ratio it is necessary to have a 30 to 3 coil.

First, five layers of the coil are pulled out of the inside and the ends are brought out free. Remove 30 layers from the outside of the remaining coil and bring the ends out free. It will not be easy to place the smaller coil into the larger one. Wind enough tape around the smaller coil to make it fit snugly into the



large coil. Bring the ends from the large coil out at one end and the ends from the small coil out at the other end and keep in mind which is which. The larger coil is the secondary and the smaller the primary. Wind the core with enough tape to fit well into the inside of the small coil.

If you want a closed core transformer, the usual kind, bend back the ends of the core; it will serve the purpose admirably. If you want an open core type leave the core as it is shown.

Always Use Short Lead-in

Never run the antenna lead-in any long distance through the house. Make it as short as possible from the window where the wire is brought in. If the lead-in is long inside the house the walls and ceilings will absorb most of the Radio-frequency energy that should be used in the set for producing signals; in other words, the signals will be much reduced in strength.

Place the receiving apparatus near the window and run the ground wire to a water pipe.

Homemade Coil Winder

USUALLY the maker of home built apparatus has a hand or breast drill. This handy tool can be used for a number of things besides just drilling holes. The

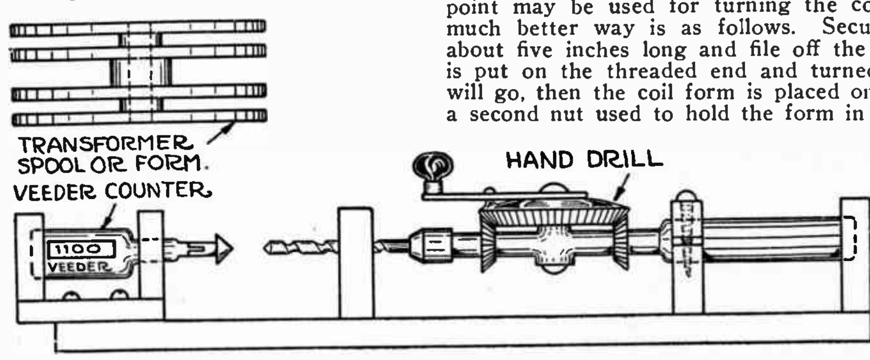


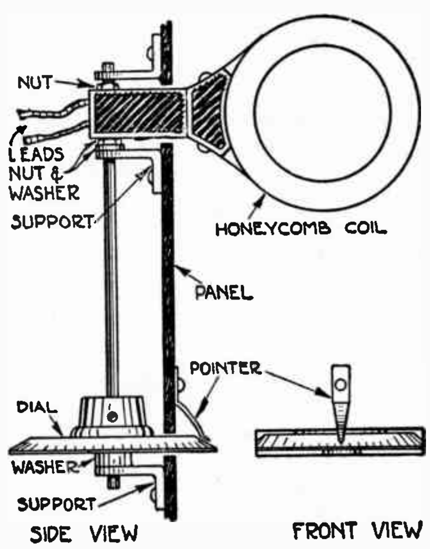
illustration shows a way in which coils may be wound for the Radio apparatus by the application of this drilling tool.

No dimensions are given as these will depend on the hand drill used. Three standards mount the drill on a base that is long enough to mount a small numbering machine or shaft revolution counter. A drill point may be used for turning the coil core but a much better way is as follows. Secure a ¼" bolt about five inches long and file off the head. A nut is put on the threaded end and turned as far as it will go, then the coil form is placed on the bolt and a second nut used to hold the form in place.

The end from which the head was removed is placed in the drill chuck. If insufficient threaded portion has been provided, more threads will have to be turned on the bolt.

Coil Mounting

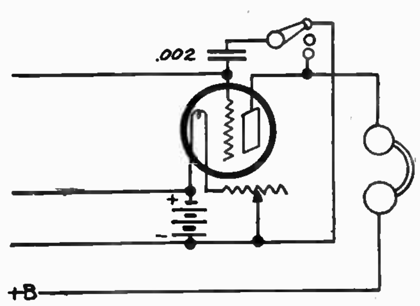
Herewith is a coil mounting that is free from capacity effects, easier to handle than the old style, and furthermore the positions of the coils may be read and the reading preserved for further use when the desired station is wanted again.



The construction of this mounting is quite simple, as may be seen in the illustration. Two openings are cut in the panel as shown, one for the coil mounting to extend through and the other for the edge of the dial. Three small brass or other non-magnetic metal supports are cut and mounted on the panel as shown. These are bent in the form of a right angle. A special coil mounting will probably have to be made as the ordinary ones are somewhat short. This may be made out of formica, hard rubber, wood or other insulating material. A hole is drilled in one end to admit the shaft, which is none other than a threaded brass rod. This shaft is fastened securely to the coil mounting with two or more nuts. On the lower end of the shaft is mounted a dial as shown, so its edge will extend through the opening in the panel. This dial may be one of the small 2-inch kind. These may be bought cheaply, and they are quite easily drilled. As is seen the hole for the shaft is drilled completely through the dial. A small pointer is fixed on the front of the panel so a reading may be taken of the position of the coils with each station. Two of these mountings will be required for a three honeycomb coil set.

Improving Quality of Loud Speaker

The quality of music from a loud speaker can often be improved by the addition of the condenser and switching device shown in the illustration. A .002 fixed condenser and three-point switch are connected into the last audio frequency amplifier tube circuit as shown. By adjusting the switch, much of the harsh-



ness of the music is removed, and the tones are reproduced much more clearly and sweetly. The effect is not so pronounced when headsets alone are used on a Radio set, but on a loud talker the effect is very noticeable.

All crystals can be injured by touching them with the fingers. It is best to handle them with tweezers or with a piece of cloth and keep them in some kind of container when they are not in use.

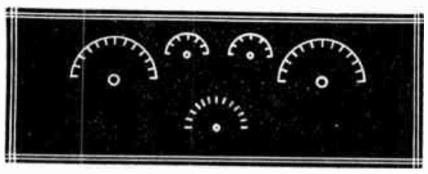
PANEL FINISHING

It is a difficult game for the builder of homemade receivers to vie with some of the commercial sets now on the market, but there is one way in which this difficulty may be lessened to some degree, and that is in improving the appearance of the panel. The layout, drilling, etc., will not be taken up here, as each particular hook-up requires a different arrangement of the panel mountings. It is the aim in this article to offer a few hints on engraving and rubbing down the otherwise plain and shiny surface of the panel material.

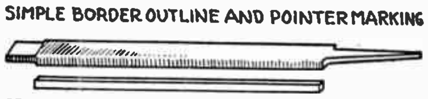
Manufactured sets usually have panels engraved on what is shown as a pantograph machine, the cutting or engraving tool following the outlines of straight and curved lines, circles, semi-circles, and other characters engraved in a metal template. This method of engraving is, of course, not available to the constructor of homemade sets. To engrave a panel at home proceed as follows:

Hand Engraving

For the straight fine work procure a small flat file and grind off the cutting teeth or ridges at the end until the file is between 1/64 inch to 1/32 inch thick and has two sharp square corners. A screwdriver will answer the purpose, but being of a softer material will soon dull. It may, however, be simpler to use the screwdriver, as this can be filed sharp, whereas the file



SIMPLE BORDER OUTLINE AND POINTER MARKING



GROUND FILE AND STEEL CUTTER FOR DIVIDERS

would necessarily have to be ground on an emery wheel. For the circles and semi-circles a small piece of steel that will fit in a pair of dividers similar to a piece of lead is ground or filed to a sharp blunt at one end, so that when scribing a circle it will act in a similar manner to the file on straight lines. The sharpened end should measure about 1/64 inch square. This, with the file, a rule and a soldering iron constitutes the necessary tools for doing the engraving. At the hardware store purchase a stick of white marking crayon. This kind of crayon is much used by lumbermen and is of a wax composition.

Rubbing the Surface

It is taken for granted that all the necessary holes have been drilled in the panel and that it is now ready for the mountings, but the rubbing process precedes the mountings. Lay the panel face up on a smooth table or bench and mark lightly with a pencil where you wish to do the engraving. In the illustration is shown a neat design that is very simple to do. The border lines are about ¾ inch from the edge of the panel and are spaced about ¼ inch apart. The semi-circles are marked off wherever a pointer is used, such as on rheostats, potentiometers, etc. The graduations may be marked equal distances apart by using a protractor or spacing with a pair of dividers.

Marking the Marks

After the layout is completed in pencil lay the rule along one of the outside border lines and hold firmly in place with one hand while with the other follow the line with the sharp cutting edge of the file or screwdriver. This will cut a square cut path the width of the tool, which, as mentioned above, should be from 1/64 inch to 1/32 inch. Do not try to cut too deeply the first time over. The file might slip and ruin the panel. Go over the same line a number of times until is has reached a depth of about 1/64 inch. Then proceed with all the other straight lines in the same manner. On the circles or semi-circles the dividers are used instead of the file resulting in a curved instead of a straight line path being cut. A small wooden plug placed in each shaft hole in the panel will afford a place for the pivot side of the dividers. It will be found that a small furrow has been raised on each side of the lines made. Rub these furrows down smooth with the surface with a piece of sandpaper, but always rub lengthwise of the panel. Brush all dust out of the grooves thus made and proceed to heat a soldering iron. When the iron has attained a heat sufficient to melt the crayon run the crayon and soldering iron over all the lines cut in the panel. Of course, the melted wax will run over quite a broad surface, but in a minute or two the wax will have set and by using the edge of a smooth wooden block or piece of bakelite this can be easily removed without affecting that which is embedded in the grooves. Clean the surface as thoroughly as possible in this manner. That is all there is to the engraving.

Finishing the Panel

Now to rub down the panel to give it that soft velvety appearance. Use a very fine grit sandpaper, about 00 size. Wrap a piece of this around a flat wooden block and, going back and forth lengthwise of the panel, press rather firmly and rub until all shine has disappeared. Remember to always rub absolutely parallel with the longer sides of the panel. Brush all dust off lightly with a clean cloth. Moisten a piece of cloth or cotton with olive oil and rub over the entire surface. Follow this by wiping as dry as possible with a soft dry cloth.

Varnishing and Finishing Cabinets

By Charles F. Smisor

ONE of the first things to consider is the wood which was used in the construction of the cabinet. This matter is of the utmost importance and should be looked into before proceeding with the finished work. The open grained woods are ash, oak, chestnut, walnut, mahogany and butternut. These woods require fillers. The close grained woods are pine, maple, cherry, redwood, birch, beech, cypress, sycamore, whitewood and poplar. These woods do not require fillers and they can be finished in natural colors or stained if preferred.

To obtain the best results it will require five operations, but in the close grained woods the filling process can be omitted. Sandpapering, staining, filling, varnishing and the final polishing completes the list.

Preparing the Wood Surfaces

The wood is supposed to have been planed and sandpapered, but the finished work should be gone over again with what is called 00 sandpaper attached or held on a smooth block and the rough surface rubbed with the grain of the wood, using a moderate pressure, taking care when approaching a square edge not to round it. Wipe all the dust from the surface with a cloth.

Pine or poplar woods will take a stain that will represent the more costly woods. When using pine, cabinets can be made so that the surface will look as if an expensive natural colored wood was used. In wood finishing much trouble in working will be avoided if the best stains are used. There are two kinds of stains, oil and water, each having their good points.

Covering Sap in Wood

Woods like pine, contain considerable sap and after applying the stain the grain becomes somewhat rough. Such a surface should be given two coats of white shellac after the stain has dried. When the shellac has dried, smooth the surface again with sandpaper. The shellac keeps the sap from discoloring the finish. Varnishing, rubbing down and polishing are the things to do in order named.

The stains may be applied with a brush, after which they are rubbed in with a piece of cheesecloth. This distributes the color evenly and absorbs the surplus moisture which, in the case of water stains, is apt to raise the grain of the wood, thus making it necessary to do more sandpapering. If the rubbing-in process is done properly there will be a uniform tone. If the first application does not give as deep a color as desired, give it another coat.

If it is desired to use an open grain wood, such as mahogany or walnut, using stains to make them a deeper color, the pores will need to be filled after staining; otherwise staining can be omitted, but not filling, which is necessary. Suppose that such a wood has been stained. Procure a paste filler of a color to match the stain as nearly as possible; put some of the filler on a piece of cloth and rub into the wood. As soon as this filler has dried a little, not too hard, continue to rub the surface until all pores are filled, rubbing off any surplus. The object is to have all pores filled but no filler on the surface.

Applying the Varnish

The next thing to do is to apply the varnish. Be sure your work is dry and the surface smooth then apply a thin coat of white shellac varnish. If the shellac is thick thin it with alcohol only. Dip the brush into the varnish and wipe off all surplus before applying it to the surface. Never try to apply too thick a varnish. This will allow the stain to show. The first coat should be given three or more hours time to dry before applying the second coat. Rub the dried surface with the finest grained sandpaper until the wood is smooth. In rubbing use light strokes, otherwise the varnish will be rubbed through.

The application of the finish varnish comes next. Be sure to use the best brushes for the work. Procure a good grade of varnish and keep it warm while using it. When too cold it will not flow easily and give a smooth surface. Have just enough varnish on the brush to just give a level coating when it is brushed across the grain. Finish by rubbing lightly with the grain. Set it aside for a couple of days to dry.

Final Polishing

The hand rubbing process is the only method that will give that beautiful smooth gloss finish. This is done with pumice stone. Procure some FF grade pumice stone from a paint store, also some linseed oil and a rubbing felt. Dip the felt into the oil, then the pumice stone which will adhere to the oil soaked felt and rub the varnished surface lightly along the grain. Continue this process until all depressions have disappeared. Hold the work to the light and look diagonally across the surface. Any depressions can be seen as the hollow places will show as dark spots. Remove the surplus pumice with a dry cloth. Apply another coat of varnish and repeat the operation with the pumice stone. The surface will then appear as a dead finish without gloss.

If it is desired to have a glossy finish, dip a piece of felt into the linseed oil and then powdered rotten stone and go over the surfaces in the same manner as with the pumice stone. A higher polish can be procured on the last coat by giving the rotten stone treatment and then rubbing the hard varnish with a soft cloth dipped in linseed oil, using plenty of pressure until a high polish is obtained. The surplus oil is wiped off with chamois skin.

Varnished and polished surfaces of all descriptions should not have any strong soap powders applied for cleaning purposes to remove finger marks as it will turn white in spots. Use nothing but a good furniture polish which will clean it and restore the finish at the same time.

Vertical Aerials

What is the advantage of a vertical aerial? With a vertical aerial there is a two-fold advantage. First, because it is a good, high wave getter. Second, because a vertical aerial is not so capacitative with the ground as is a horizontal aerial which tends to get worse and worse with length.

With the vertical aerial this capacitance with the ground and consequent tendency to choked reception is practically overcome. This can be noticed in connection with the grid-leak which can be discarded or just used in very low resistance. This shows you that with a vertical aerial you are using your tubes to better advantage without having to drown them down with so many megohms. It is understood, then, that this local buzzing is caused by the capacitance between horizontal aerial and the ground.

The vertical aerial system is obtained by the use of an umbrella aerial, or for peak reception, the balloon aerial. It has been found that this vertical aerial functions with the same intensity whether it be a fine wire or a heavy gauge wire, for the reason that this vertical aerial does not lose its charge of high frequency Radio currents like the horizontal aerial does.

It is remarkable the natural amplitude of such an aerial. In comparison with the regular horizontal aerial 100 feet long and 30 feet high, the initial amplitude of the respective aerials was five times as great on the vertical aerial, which was 200 feet high.

This initial amplitude without any particular "directional hard pan" is what is wanted the same as in photography. If you have a good, full negative you can enlarge indefinitely, but a deformed or faded negative is very difficult to enlarge.

Solid Wire Connection

When wiring a Radio receiving set most fans use bus bar. There seems to be the impression that this is the only wire that can be used if the set is to operate efficiently. In place of bus bar wire, solid copper wire number 14 can be used with equal and generally better results. For a neat job the wire should be hard drawn, but for efficiency it should be soft drawn. This wire comes in large rolls and is sold by the pound. To straighten the wire it should be cut into foot lengths and then the bends taken out of each strip with a pair of pliers.

Voltage is the pressure behind electrical current. Amperage is the current.

Simple Efficiency Test

A simple method of testing aerials, grounds, condensers and other Radio parts is to take advantage of the fundamental of regeneration. It is well known that the object of using regeneration in a receiving set is to overcome the resistance of the circuit. To test various parts it is necessary to have a three-circuit tuner and a constant supply of filament and plate potential and current. It would be of course preferable if one stage of audio frequency were used with the secondary of a second transformer connected to a crystal detector and a microammeter, but that is expensive and can be eliminated. To find out whether any Radio part, aerial or ground has more losses, or less, than that which is now being used, tune the set to a station just below the oscillating point. Record the variometer setting. Then substitute the new part for the old one and again tune in the same station and note the variometer setting. If this last reading is higher than formerly then the new part is worse than the old one. If the reading is lower then use the new part, as it is better.

Holes Improve Loud Speaker

An original suggestion comes from an amateur in southern France regarding the improvement of a loud speaker if the effects of resonance are too marked in the horn. Some loud speakers are inclined to accentuate certain tones above others, thus ruining an otherwise perfectly good transmission.

The way to diminish this trouble, says the investigator, is to pierce holes along the length of the horn; at the half-way point, the quarter-point, and the eighth-point distances being measured outward from the narrow end of the horn.

To Eliminate Howling

Howling in a set can probably be overcome by separating the plate and grid leads, and running them at right angles. If this fails to stop the noise, shield the back of the panel by covering it with a thin sheet of tinfoil and connecting the foil to the ground. Care should be taken, however, to see that no metal part of an instrument touches the grounded foil.

Don't lay your set out in such a manner that the grid and plate leads will run parallel to each other.

Stations in Order of Call Letters

United States

AT9, Fort Bragg, N. C. 435 meters. 750 watts. U. S. Government. Announcer, Lieut. James Y. LeGette. Slogan, "The Pioneer Broadcasting Station of the Army." Tues, Thurs, Sat, 8-9:55 pm, dance music, talks, bands, fights. Sun, 8-9:55 pm, service. Eastern.

KDKA, E. Pittsburgh, Pa. 309.1 meters. 1,000 watts. Westinghouse Elec. & Mfg. Co. Announcer, H. W. Arlin. Slogan, "The Pioneer Broadcasting Station of the World." Daily ex Sun, 9:45-10 am, 11:55, time, 12, market reports, weather; 2:30-5:30, baseball, music; 7, baseball; 9:55, time, daily except Sun, Sat; 12:15 pm; 7:45 pm, talks. Daily ex Sat, Sun, 8:30 pm; 8:45, concert; 9:55, time. Sat, 8:45 pm, concert; 9:55, time. Tues, Thurs, 10:30 pm. Sun, 9:45 am, 8 pm, 3:45, 6:45. Eastern.

KDLR, Devils Lake, N. Dak. 231 meters. 5 watts. * Radio Elec. Co.-Wilson Ins. Agency. Daily ex Sun, 12:10 pm, weather; orchestra. Mon, 9:30-11:30 pm. Sun. 4:30-6. Central.

KDPM, Cleveland, O. 250-1817 meters. 750 watts. Westinghouse Elec. & Mfg. Co. Announcer, H. W. Irving. Experimental station.

KDYL, Salt Lake City, Utah. 245.8 meters. 50 watts. Newhouse Hotel. Announcer, Gene Pack. Slogan, "Out on the Great Divide." Daily ex Sun, 3-4 pm, 6:30-8, news, music, entertainment. Sun, 11-1 am. Mountain.

KDZB, Bakersfield, Calif. 209.7 meters. 100 watts. Frank Siefert. Daily ex Sun, 8-9 pm, reports, music. Pacific.

KFAB, Lincoln, Nebr. 340.7 meters. 1,000 watts. Ne- * braska Buick Auto Co. Announcer, Gayle Grubb. Daily ex Sun, Thurs, 3-4 pm; 5:30-6:30; 8:30-10:30. Thurs, 3-4 pm. Sun, 4 p. m. Central.

KFAD, Phoenix, Ariz. 273 meters. 100 watts. Electrical * Equip. Co.-McArthur Brothers Mercantile Co. Announcer, Arthur C. Anderson. Slogan, "Where Summer Winters." Daily ex Sun, 7:30-8:30 pm, news, weather, stock reports, music. Mountain.

KFAJ, Boulder, Colo. 261 meters. 100 watts. Univ. of Colo. Announcer, F. M. Orsborn. Tues, Sat, 9 pm, time, music, addresses by faculty. Thurs, 7:30 pm Sat, 2:30-5 pm, sports. Mountain.

KFAU, Boise, Idaho. 278 meters. 750 watts. Boise H. * S. Announcer, Hoyt Cooper. Slogan, "Intermountain Station." Daily ex Sat, Sun, 4-4:45, pm, markets, weather, news. Mon, Fri, 8-10 pm, concert. Wed, 8-9 pm. Mountain.

KFAW, Santa Anna, Calif. 214.2 meters. 50 watts. Radio * Den. Off the air temporarily.

KFBB, Havre, Mont. 275 meters. 50 watts F. A. Buttrey Co. Announcer, C. O. Boettger. Daily ex Sun, 12:45 pm, music, markets, weather, reports. Mountain.

KFBC, San Diego, Calif. 244 meters. 100 watts. W. K. * Azbill. Sun, 9-10 am, Bible lesson, sermon. Tues, Thurs, 8-9 pm. Pacific.

KFBG, Tacoma, Wash. 249 meters. 50 watts. First *Presbyterian church. Pacific.

KFBK, Sacramento, Calif. 248 meters. 100 watts. Sacra- *mento Bee. Mon, Thurs, Sat, 7:30-10 pm. Pacific.

KFBL, Everett, Wash. 224 meters. 100 watts. Lesse Bros. Daily, 7:15-8:15 pm. Pacific.

KFBS, Trinidad, Colo. 238 meters. 15 watts. School *District No. One.

KFBU, Laramie, Wyo. 270 meters. 500 watts. Bishop * N. S. Thomas.

KFCB, Phoenix, Ariz. 238 meters. 100 watts. Nielsen Radio Supply Co. Announcer, E. A. Nielsen. Slogan, "When It's Wintertime in Michigan, It's Summer Time Down Here." Daily 7-7:30 pm, bedtime stories. Mountain.

KFCF, Walla Walla, Wash. 256 meters. 100 watts. Frank A. Moore. Slogan, "The Valley They Liked So Well They Named It Twice." Mon, 8-10 pm. Thurs, Fri, 8-12 midnight. Pacific.

KFCY, Le Mars, Ia. 252 meters. 50 watts. Western Union College. Announcer, D. O. Kime. Slogan, "College on the Hill." Fri, 9-11 pm, central.

KFDD, Boise, Idaho. 275 meters. 50 watts. St. Michael's Episcopal Cathedral. Announcer, E. Mark Hanford. Sun, 11:15-12:30 pm, 7:30-9:15. Mountain.

KFDH, Tucson, Ariz. 258 meters. 50 watts. Univ. of Ariz. Announcer, Max Voss Kuehler.

KFDJ, Corvallis, Ore. 254 meters. 500 watts. Oregon Agricultural College.

KFDM, Beaumont, Tex. 315.6 meters. 500 watts. Magnolia Petroleum Co. Announcer, Magnolene Mike. Slogan, "Kall for Dependable Magnolene." Tues, Fri, 12:30-12:55 pm, band concert; 7-7:30, children's hour; 8-10:30, concerts. Sun, 11-12 m, 8-9 pm. Central.

KFDX, Shreveport, La. 250 meters. 100 watts. First *Baptist church. Announcer, Hugh Claycomb. Sun, 10:50 am; 7:45 pm. Wed, 9-10 pm. Central.

KFDY, Brookings, S. D. 273 meters. 50 watts. S. *D. State College. Announcer, G. A. Rietz. Daily ex Sun, 12:15 pm, livestock markets. Tues, 11-12 m, exercises. Thurs, 8-9 pm, programs. Central.

KFDZ, Minneapolis, Minn. 231 meters. 10 watts. Harry O. Iverson.

KFEC, Portland, Ore. 248 meters. 50 watts. Meier & Frank Co., Inc. Daily ex Sun, 12 m, weather, reports; 4-5 pm, music; 6:30 pm, weather, crop, markets, reports. Sat, 11 am-12 m, children's hour. Pacific.

KFEL, Denver, Colo. 254 meters. 50 watts. W. L. Win- * ner, Inc. Announcer, Eugene P. O. Fallon. Daily ex Sun, 11 am, 2 pm, 4. Thurs, Sat, 8-12 midnight, Sleep Wrecker program. Mountain.

KFEQ, Oak, Nebr. 268 meters. 500 watts. J. L. Scrog- *gin. Announcer, Clarence Koch. Daily ex Sun, 2-3 pm, orchestra. Sun, 4:30-6 pm, Central.

KFEY, Kellogg, Ida: 233 meters. 10 watts. Bunker Hill & Sullivan Mining & Con. Co. Announcer, Walter C. Clark. Slogan: "Voice of the Coeur D'Alene." Closed for the summer.

KFFP, Moberly, Mo. 242 meters. 50 watts. First Baptist Chuch. Announcer, Granville Ray. Slogan, "The Gospel Messenger of the Air."

KFFV, Lamoni, Ia. 250 meters. 100 watts. Graceland College. Mon, Thurs, 7:30 pm. Sun, 7:45 pm, service. Central.

KFGC, Baton Rouge, La. 268 meters. 100 watts. Louisiana State University. Temporarily off the air.

KFGD, Chickasha, Okla. 252 meters. 200 watts. Okla. College for Women. Tues, Thurs, 8 pm, music, lectures. Wed, 10 am, chapel service. 11 pm, special jazz program. Central.

KFGH, Stanford Univ., Calif. 270.1 meters. 500 watts. Leland Stanford Junior University. No regular schedule.

KFGQ, Boone, Ia. 226 meters. 10 watts. Crary *Hardware Co. Announcer, Harold E. Wilcox. Slogan: "Daniel Boone Station." Wed, 8-9 pm. Sun, 3-4 pm. Central.

KFGX, Orange, Tex. 250 meters. 500 watts. First Presbyterian church.

KFHA, Gunnison, Colo. 252 meters. 50 watts. Western State College of Colorado. Announcer, E. Russel Wightman. "Where the Sun Shines Every Day." Tues, Fri, 6:30 pm, bedtime story; 8 pm, musicale; 10:30, orchestra. Mountain.

KFHL, Oskaloosa, Iowa. 240 meters. 10 watts. Penn College.

KFI, Los Angeles, Calif. 467 meters. 3000 watts. Earle *C. Anthony, Inc. Announcer, Glen Rice. Slogan, "The Radio Central Super-Station." Daily ex Sat, Sun, 5:30-6:30 pm, 6:45-11. Sat, 5:30-6:30 pm, 6:45-3 am. Sunday, 10-10:45 am, 4-5 pm, 6:30-11, 11-12:30 pm, first and third Sun of month. Pacific.

KFIF, Portland, Ore. 248 meters. 100 watts. Benson Tech. School.

KFIO, Spokane, Wash. 265.3 meters. 100 watts. Radio Club of North Central H. S. Fri, 8-9:30 pm. Pacific. Wed, 7:30 pm, organ. Sat, 7 pm. Sun, 11 am, 7:30 pm. Pacific.

KFIQ, Yakima, Wash. 256.3 meters. 100 watts. First Methodist Church. Announcer, Dr. I. M. Miller.

KFIU, Juneau, Alaska. 226 meters. 10 watts. Alaska Elec. Light & Power Co. Announcer, O. E. Shoembell. Mon, Wed, Fri, 6-7 pm. Alaskan.

KFIZ, Fond du Lac, Wis. 273 meters. 100 watts. Daily Commonwealth and Wisconsin Radio Sales, Inc. Announcer, Albert Mayer. Daily ex Sun, 5 pm, music, news, markets, weather. Central.

KFJB, Marshalltown, Iowa. 248 metrs. 10 watts. Marshall Elec. Co. Announcer, E. N. Peak. Slogan: "Marshalltown, the Heart of Iowa." Daily ex Sun, 10 am, markets. Tues, Fri, 8:30 pm. Central.

KFJC, Junction City, Kan. 218.8 meters. 10 watts. R. B. Fegan.

KFJF, Oklahoma City, Okla. 261 meters. 500 watts. *National Radio Mfg. Co. Announcer, Tired Hand. Slogan: "Radio Headquarters." Daily ex Sun, 9:40 am, 12:15 pm, markets; 2:15, markets; 6:30, weather news. Mon, Fri, 8:30-10:30 pm, orchestra. Wed, 7:30 pm. Thurs, 9 pm, band concert. Sun, 11 am; 8 pm, church services. Central.

KFJI, Astoria, Ore. 246 meters. 10 watts. E. E. Marsh and Liberty Theater. Announcer, E. E. Marsh. Wed, Fri, 10-11 pm, organ. Sun, 10:30-11 pm. Pacific.

KFJM, Grand Forks, N. D. 278 meters. 100 watts. University of North Dakota. Slogan: "Grand Forks, the Educational Center of the State."

KFJR, Portland, Ore. 263 meters. 50 watts. Ashley C. *Dixon & Son. Mon, Tues, Wed, Thurs, 7:30-8 pm. Mon, 8-8:30 pm. Tues, 9-10:30 pm. Wed, 8-8:30 pm. Thurs. 7:30-10:30 pm. Sat, 1:30-2 pm. Pacific.

KFJX, Cedar Falls, Iowa. 258 meters. 50 watts. Iowa State Teachers' College. Educational programs.

KFJY, Fort Dodge, Iowa. 246 meters. 50 watts. Tun-Wall Radio Co. Announucer, Carl Tunwall. Daily 5:15 pm, markets, news, weather, bulletins. Sun, 11 am. Central.

KFKA, Greeley, Colo. 273 meters. 50 watts. Colorado *State Teachers' College. Announcer, Charles F. Valentine.

KFKQ, Conway, Ark. 250 meters. 100 watts. Conway Radio Lab.

KFKU, Lawrence, Kan. 275 meters. 500 watts. University *of Kansas. Announcer, John F. Patt. Slogan, "Up at Lawrence on the Kaw." Mon, Thurs, 6:55-8 pm, Central.

KFKX, Hastings, Nebr. 288.3 meters. 2000 watts. * Westinghouse Elec. & Mfg. Co. Slogans, "The Empress of the Air," "The Pioneer Re-Broadcasting Station of the world." Daily ex Sat, Sun, 9:30 am, 10:30, 12:30 pm, markets. Mon, Wed, Fri, 9-11 pm, music. Sat, 9:30 am, 10:30, 12:30 pm. Central.

KFKZ, Kirksville, Mo. 226 meters. 10 watts. F. M. * Henry. Wed, 9-11 pm; Thurs, 9-10 pm, dance music. Sun, 8-9 pm. Central.

KFLR, Albuquerque, N. M. 254 meters. 100 watts. * U. & N. M. Announcer, Phillip S. Donnell. Slogan, "The Sunshine Center of America."

KFLU, San Benito, Texas. 236 meters. 10 watts Benito Radio club. Announcer, R. W. Thacker. Slogan, "Heart of the Magic Valley." Mon, Thurs, Sat, 8:30-10 pm, concert. Sat. 8:30 pm, Sunday school lesson. Central.

KFLV, Rockford, Ill. 229 meters. 200 watts. Swedish Evangelical Mission Church. Announcer, A. T. Frykman. Fri, 8:30 pm. Sun, 12:30 pm, service for shut-ins (Swedish); 9:30, service (English). Central.

KFLX, Galveston, Texas. 240 meters. 10 watts. George R. Clough.

KFLZ, Anita, Iowa. 273 meters. 100 watts. Atlantic Automobile Co. Operated by Walnut Grove Hog Remedy Co. Announcer, H. A. Marshall. Daily ex Sun, 11:50-12:15 pm, question box, markets. Tues, Thurs, 8:30-10 pm, music. Central.

KFMQ, Fayetteville, Ark. 299.8 meters. 750 watts. U. * of Arkansas. Mon, 7:30 pm. Tues, Thurs, 8 pm. Central.

KFMR, Sioux City, Ia. 261 meters. 100 watts. Morningside College. Announcer, Jesse C. Ducommun. Daily ex Sat, Sun, 10:30 am. Wed, 7 pm. Central.

KFMW, Houghton, Mich. 263 meters. 50 watts. M. G. Sateren (announcer). Sun, 3-4:30 pm.

KFMX, Northfield, Minn. 336.9 meters. 500 watts. *Carlton College. Announcer, Merrill O. Bolen. Tues, Fri, 9:30 pm. Wed, 9 pm. Sun, 7 pm, vesper. Central.

KFNF, Shenandoah, Ia. 266 meters. 500 watts. Henry *Field Seed Co. Announcer, Henry Field. Slogan, "Friendly Station in a Friendly Town." Daily ex Sun, 12:15-1:30 pm, 3-4. Daily ex Sun, 7-9 pm. Sun, 10:45 am, 2:30 pm, 3-4, services; 6:30-7:30, Golden Rule; 7:30-8:30, church service. Central.

KFNV, Santa Rosa, Calif. 227 meters. 5 watts. L. A. Drake. Daily 2-3 pm; 6-6:30, news, music. Pacific.

KFOA, Seattle, Wash. 454.3 meters. 1,000 watts. Rhodes *Dept. Store. Slogan, "The Gateway to the Orient." Daily ex Sat, Sun, 12:30-1:30 pm. Daily ex Sun, 4-5:15, Times bulletins, concert. Daily ex Sun, Thurs, 6-6:45 pm, orchestra, baseball; 8:30-10 pm. Times program. Mon, Tues, Wed, Fri, 6:45-8:15 pm, studio music. Tues, Fri, Sat, 10:15-11:30 pm, orchestra. Pacific.

KFOB, Burlingame, Calif. 226 meters. 50 watts. Bur- * lingame Chamber of Commerce. Daily, 8-10 pm. Pacific.

KFOJ, Moberly, Mo. 242 meters. 10 watts. Moberly *High School.

KFON, Long Beach, Calif. 233 meters. 100 watts. Echophone Radio Shop. Slogan, "Where Your Ship Comes In." Daily ex Sun, 5:30-11 pm. Thurs, 5:30-6:30 pm. Sun, 8-9 pm. Pacific.

KFOO, Salt Lake City, Utah. 236 meters. 250 watts. Latter Day Saints University. Announcer, Don C. McRae.

KFOR, David City, Nebr. 226 meters. 100 watts. David * City Tire & Elec. Co. Slogan, "The Voice of David City." Announcer, Howard A. Shuman.

KFOT, Wichita, Kansas. 231 meters. 50 watts. College Hill Radio Club. Announcer, Leon Garnett. Slogan, "Radiocasting Church." Sun, 11-12:30 pm; 7:30-9, church services. Mon, 9-10:30 pm, music. Central.

KFOX, Omaha, Nebr. 248 meters. 100 watts. Board of of Education. Technical High. Announcer, Juno Johnson.

KFOY, St. Paul, Minn. 252 meters. 50 watts. Beacon Radio Service. Thurs, 11-12 m. Sun, 3:30-4:30 pm. Central.

KFPG, Los Angeles, Calif. 238 meters. 100 watts. *K. M. Turner Radio Corp.

KFPL, Dublin, Tex. 252 meters. 15 watts. C. C. Baxter, announcer.

KFPM, Greenville, Tex. 242 meters. 10 watts. The New Furniture Co. Announcer, Dave Ablowich, Jr. Slogan: "The New Furniture Co., the Home of Good Furniture," Located at Greenville, Texas, Where You Find "The Blackest Land, the Whitest People." Daily ex Sun, 2 pm, music. Tues, Wed, Thurs, Fri, 8 pm. Sun, 11 am, services; 7:30 pm, irregularly. Central.

KFPR, Los Angeles, Calif. 231 meters. 500 watts. Los Angeles Co. Forestry Dept. Irregular schedule.

KFPW, Carterville, Mo. 258 meters. 20 watts. St. * John M. E. church, S. Slogan, Keeping Pace with Christ Means Progress." Tues, Fri, 8-10 pm, popular program. Sun, 1-3 pm, chapel service. Central.

KFPY, Spokane, Wash. 266 meters. 100 watts. Symons *Investment Co. Announcer, E. B. Craney. Daily ex Sun, Tues, 7-7:45 pm. Wed, 9-11 pm. Sun, 9-10 pm. Sat, 2-4 pm. Pacific.

KFQA, St. Louis, Mo. 261 meters. 100 watts. The *Principia. Sun, 8 pm, church service. Central.

KFQB, Fort Worth, Tex. 263 meters. 2,500 watts. The * Searchlight Pub. Co. Announcer, Horace B. Greene.

KFQC, Taft, Calif. 231 meters. 100 watts. Kidd Bros. Radio Shop.

KFQP, Iowa City, Iowa. 224 meters. 10 watts. George * S. Carson, Jr. Wed, 8-9 pm. Central.

KFQT, Denison, Tex. 252 meters. 10 watts. Texas National Guard. Announcer, Robert Cox.

KFQU, Holy City, Calif. 217.3 meters. 100 watts. W. * Riker. Announcer, Arthur J. Landstrom. Daily ex Mon, 9-10 pm. Sun, 11-12 m., 9-10 pm. Pacific.

KFQW, North Bend, Wash. 215.7 meters. 50 watts. The Photo Radio and Elec. Shop. Announcer, Carl F. Knierim. Slogan: "At the Western Entrance of Snoqualmie Pass." Daily ex Sun, 7:30-8:30 pm. Pacific.

KFQZ, Hollywood, Calif. 226 meters. 250 watts. Taft Radio company. Tues, Fri, 9-11 pm. Pacific.

KFRB, Beeville, Tex. 248 meters. 250 watts. Hall Brothers. Temporarily off the air.

KFRC, San Francisco, Calif. 268 meters. 50 watts. City of Paris Dry Goods Co.

KFRM, Fort Sill, Okla. 242 meters. 50 watts. James *P. Boland.

KFRU, Columbia, Mo. 499.7 meters. 500 watts. Steph- *ens college. Wed, 8 pm. Sun, 7:30, 9:30 am, 7:30 pm. Central.

KFRW, Olympia, Wash. 218.8 meters. 50 watts. United *Churches of Olympia. Slogan, "Make the World a Brotherhood." Thurs, 9-10 pm. Sun, 11-12:15 pm. Pacific.

KFRX, Pullman, Wash. 217 meters. 10 watts. J Gordon Klemgard. Announcer, Gordon Klemgard. Slogan: "The Only Farmers Radio Station in the World."

KFRY, State College, N. M. 266 meters. 50 watts. New Mexico College of Agriculture and Mechanic Arts.

KFRZ, Hartington, Nebr. 222 meters. 15 watts. The Electric Shop. Announcer, P. M. Thies. Daily ex Sun, 11:55 am, news, markets; 4:15-5:15 pm, entertainment. Sun, 12-1:30 pm, entertainment. Central.

KFSG, Los Angeles, Calif. 275 meters. 500 watts. Angeles Temple. Tues, Thurs, Fri, Sat, 3:30-4:30 pm. Tues, 6:30-7:30 pm. Wed, 2:30-4:30 pm; 6:30-7:30. Thurs, Fri, Sat, 7:30-11 pm. Sun, 10:30-12:30 pm, 2:30-4:30, 7-9:30. Mon silent. Pacific.

KFUJ, Breckenridge, Minn. 242 meters. 50 watts. Hoppert Plumbing & Heating Co. and Hoppert Radio Electric Co. Announcer, F. H. Rettig. Slogan, "Where the Red River of the North Finds Its Source." Daily ex Sun, 10:30 am. 5:40 pm, weather. Daily ex Sun, 10:40 am, 1:30 pm, 5:45 pm, markets. Mon, Wed, 8-9 pm. Central.

KFUL, Galveston, Texas. 258 meters. 50 watts. Thomas *Groggan & Bros.

KFUM, Colorado Springs, Colo. 242 meters. 100 watts. W. D. Corley. Slogan, "Known for Unsurpassed Mountain Scenery." Tues, Sat. 8:30-10:30 pm. Sun, 11 am, 7:30 pm. Mountain.

KFUO, St. Louis, Mo. 545.1 meters. 500 watts. Con- * cordia Theological Seminary (Lutheran). Announcer, Herm. H. Hohenstein. Mon, 8 pm. Wed, 9:15 pm. Sun, 9:15 pm. Central.

KFUP, Denver, Colo. 234 meters. 50 watts. Fitzsimons General Hospital.

KFUR, Ogden, Utah. 224 meters. 100 watts. Peery Building Co. Tues, Thurs, Sat, 9:50-11:50 pm, dance music. Mountain.

KFUS, Oakland, Calif. 234 meters. 50 watts. The Sher- *man School. Slogan, "The City of Opportunity."

KFUT, Salt Lake City, Utah. 261 meters. 100 watts. University of Utah. Tues, Thurs, 12:10 pm. Mountain.

KFUU, Oakland, Calif. 215 meters. 50 watts. Mathew- * son Motor Co. Announcer, H. C. Colburn. Slogan, "The Voice of Automobile Row." Mon, Wed, Sat, 9:30-11 am; 8-10:30 pm. Pacific.

KFVD, San Pedro, Calif. 205.4 meters. 50 watts. McWhinnie Elec. Co.

KFVE, University City, Mo. 240 meters. 500 watts. *Film Corp. of America. Slogan, "You Will Always Know KFVE by the Tick of Her Clock." Daily ex Thurs, Sun, 10-12. Central.

KFVG, Independence, Kan. 236 meters. 10 watts. First Methodist Episcopal church. Sun, services.

KFVH, Manhattan, Kan. 218.8 meters. 10 watts. Whan Radio Shop. Announcer, Herbert Whan. Slogan, "Kansas Fans Very Happy." Daily ex Sun, 12 m, markets. Thurs, 8-12 midnight, dance music. Fri, 7:30-9 pm. Central.

KFVI, Houston, Texas. 240 meters. 10 watts. Head- *quarters Troop 56th Calvary Brigade.

KFVN, Welcome, Minn. 227 meters. 10 watts. Carl E. Bagley. Announcer, C. F. Gaarrenstroom. Slogan, "The Voice of Martin Country." Mon, Wed, Fri, 12:30 pm, markets; 9. Sun, 3 pm, Central.

KFVR, Denver, Colo. 244 meters. 50 watts. Moon- * light Ranch Broadcasting Station. Mon, Fri, 10-12 midnight. Tues, Sat, 8-9 pm. Wed, Thurs, 12-1 am. Mountain.

KFVS, Cape Girardeau, Mo. 224 meters. 50 watts. Cape Girardeau Battery Station.

KFVU, Eureka, Calif. 209.7 meters. 5 watts. Standard * Pub. Co. Slogan, "On the Redwood Highway." Announcer, B. M. Ellis. Daily ex Sun, 12:30 pm, markets, news; 6:30. Mon, Fri, 8-10 pm. Wed, 8-12 midnight. Pacific.

KFVW, San Diego, Calif. 246 meters. 500 watts. Airfan Radio Corp.

KFVX, Bentonville, Ark. 236 meters. 10 watts. Radio Shop. Daily ex Sun, 9-12 midnight. Central.

KFVY, Albuquerque, N. M. 250 meters. 10 watts. Radio Supply Co. Announcer, J. F. Walsh. Slogan, Center of the Sunshine State." Daily ex Sun, 5:30-6:30 pm, dinner concert; baseball. Tues, Fri, 8-9:30 pm, dance music. Mountain.

KFWA, Ogden, Utah. 261 meters. 500 watts. Brow- *ing Brothers Co. Announcer, H. C. Mailander. Slogan, "Keeping Friends with All." Daily ex Sun, 4-5 pm, Zenith hour, stocks, markets, time. Mon, Wed, Fri, 9-10 pm, music. Mon, Wed, 10-11 pm. Sun, 9-12 midnight, music. Mountain.

KFWB, Hollywood, Calif. 252 meters. 500 watts. Warner Brothers.

KFWC, Upland, Calif. 211.1 meters. 50 watts. L. E. Wall.

KFWH, Chico, Calif. 254 meters. 100 watts. F. * Wellington Morse, Jr. Slogan, "Kind Friends We're Here." Daily 6:30-7:15 pm, dinner concerts. Daily ex Sun, 6:15-6:30 pm, news, music. Mon, Wed, Fri, 8-10 pm. Pacific.

KFWI, South San Francisco, Calif. 220 meters. 500 Watts. Radio Entertainments, Inc.

KFWF, St. Louis, Mo. 214.2 meters. 250 watts. St. Louis Truth Center.

KFWM, Oakland, Calif. 206.8 meters. 500 watts. Oakland Educational Society.

KFWO, Avalon, Calif. 211.1 meters. 250 watts. Major *Lawrence Mott-Signal Corp. Slogan, "Katalina for Wonderful Outings." Daily, 7:30-9 pm. Tues, Thurs, Fri, Sun, 5-6 pm. Pacific.

KFWP, Brownsville, Tex. 214.2 meters. 10 watts. Rio Grande Radio Supply House.

KFWU, Pineville, La. 238 meters. 100 watts. Louisiana, La.

KFWV, Portland, Ore. 212.6 meters. 5 watts. Wilbur Jerman.

KFXB, Big Bear Lake, Calif. 202.6 meters. 500 watts. * Bertram O. Heller. Announcer, Charles Stillwell. Slogan, "Rim of World Super Station." Mon, 5-5:30 pm; 9-11. Daily ex Sun, 8-9 pm. Pacific.

KFXC, Santa Maria, Calif. 209.7 meters. 100 watts. *Santa Maria Valley Railroad Company.

KFXD, Logan, Utah. 205.4 meters. 10 watts. L. H. *Strong.

KFXE, Waterloo, Ia. 236 meters. 10 watts. Electrical * Research & Mfg. Co. Announcer, G. Pelton.

KFXF, Colorado Springs, Colo. 250 meters. 1200 watts. * Pikes Peak Broadcasting Company. Announcer, W. D. Pyle. Slogan, "The Pikes Peak Station."

KFXH, El Paso, Tex. 242 meters. 50 watts. Bledsoe *Radio Company. Slogan, "The Voice of the Rio Grande." Mon, Wed, Fri, 8-10 pm. Central.

KFXJ, Colorado. 215.7 meters. 10 watts. Mountain *States Radio Distributors, Inc. (Portable).

KFXM, Beaumont, Tex. 227 meters. 10 watts. Neches *Elec. Co.

KFXY, Flagstaff, Arizona. 205.4 meters. 50 watts. *Mary M. Costigan.

KFYD, Muscatine, Iowa. 256 meters. 250 watts. N. *Baker.

KFYF, Oxnard, Calif. 205.4 meters. 10 watts. Carl's *Radio Den.

KGB, Tacoma, Wash. 249.7 meters. 100 watts. Tacoma Daily Ledger. Announcer, Alvin Stenso. Slogan, "This is KGB in Tacoma, Washington, the Lumber Capital of America and the Gateway to Mount Tacoma." Mon, Wed, Fri, 7-9 pm. Tues, Thurs, Sat, 7-12 midnight. Pacific.

KGO, Oakland, Calif. 361.2 meters. 3000 watts. Gen. *Elec. Co. Announcer, Howard I. Milholland. Daily ex Sun, 7:15-7:45, 8:15, am, exercises; 8:30, daily strength; 11:30 am, luncheon concert. Daily ex Sat, Sun, 1:30 pm; Sat, 12:30 pm, markets, weather. Mon, Wed, Fri, 3 pm, music. Daily ex Sun, Mon, 4-5:30 pm, concert orchestra. Mon, Tues, Wed, Fri, 6-7 pm, music; Mon, Tues, Thurs, Sat, 8-10 pm lectures, music. Thurs, Sat, 8-12. Mon, 5:30-6 pm, Children's half hour; Mon, Tues, Wed, Thurs, Fri, 7 pm, stocks, markets, weather, baseball. Thurs, 5:30-6:30 pm, boys' hour. Fri, 5-5:30 pm, girl's half hour; Sun, 11-12 m, 8 pm, church services; 3:30-5 pm, Little Symphony orchestra. Pacific.

KGTT, San Francisco, Calif. 206.7 meters. 50 watts. * Glad Tidings Tabernacle.

KGU, Honolulu, Hawaii. 270 meters. 500 watts. Marion A. Mulrony, The Honolulu Advertiser. Announcer, W. K. Karmen. Daily, 7:30-9 pm. Tues, Thurs, Sat, special program. Sun, 11 am; 7:30 pm. 150 meridian. 2½ hours earlier than Pacific.

KGW, Portland, Ore. 491.5 meters. 500 watts. Port- *land Morning Oregonian. Announcer, Dick Haller. Slogan, "KGW, Keep Growing Wiser." Daily ex Sun, 11:30-11:45 am, weather; Mon, Wed, Fri, 7:15-7:30 am. exercises. Daily ex Sun, 12:30-1:30 pm. Mon, Tues, Wed, Thurs, Fri, 7:30-7:45 pm, weather, police, markets, news. Mon, Tues, 8-10 pm. Tues, Sat, 10-12. Wed, 8-9 pm. 10-11. Fri, 9-10:30 pm; 10:30-12, Hoot Owls. Sun, 10:30-12 m, 7:30-9. Pacific.

KGY, Lacey, Wash. 246 meters. 50 watts. St. Martins *College. Announcer, Sebastian Ruth. Slogan, "Out Where the Cedars Meet the Sea." Sun, Tues, Thurs, 8:30-9:30 pm. Pacific.

KHJ, Los Angeles, Calif. 405.2 meters. 500 watts. Los Angeles Times. Announcer, John S. Daggett. Slogan, "Kindness, Happiness, Joy." Daily ex Sun, Mon, 7 am, 7:30, 12 m, 1:30 pm, 2:30, 3:30, 5:30, 11. Mon, 7-7:30 am, 12-1:30 pm. Sun, 10-12:30 pm, 6-7:30, 8-11. Pacific.

KHQ, Spokane, Wash. 273 metersf. 1,000 watts. Louis Wasmer.

KIAF, Sihtipoc, Minn. 421 meters. 500 watts. Steele Co. Slogan, "Far from the Maddening Crowd." Mon, Wed, Fri, 7-8 pm. Sun, 2-3 pm. Central.

KJBS, San Francisco, Calif. 220 meters. 5 watts. *Julius Brunton & Sons Co. Announcer, Edward Ludes. Daily 2-2:30 pm. Tues, Thurs, Fri, 9-11:30 am. Fri, 8-11:30 pm, "Royal Order Smoked Herring." Pacific.

KJR, Seattle, Wash. 384.4 meters. 1000 watts. North- *west Radio Service Co. Announcer, Ross W. Swift. Slogan, "Radio Headquarters." Daily ex Sun, 10:30-11:30 am, educational program; 1-1:15 pm, stocks; 1:15-2, organ; 2-2:15, cooking; 2:15-2:30, produce report; 6-6:30, theater news; 7-11. Sun, 11-12:30 pm, service; 7-7:30, organ; 7:30-9, service. Pacific.

KLDS, Independence, Mo. 440.9 meters. 1,000 watts. * Reorganized Church of Jesus Christ of Latter Day Saints. Announcer, Arthur B. Church. Tues, Thurs, 8 pm. Sun, 11 am, 6:30 pm; 9. Central.

KLS, Oakland, Calif. 250 meters. 250 watts. Warner *Bros. Radio Supplies. Announcer, S. Warner. Slogan, "The City of Golden Opportunity." Sun, 10-11 am. Pacific.

KLX, Oakland, Calif. 508.2 meters. 500 watts. Oakland *Tribune. Announcer, Charles H. Gabriel, Jr. Slogan, "Where Rail and Water Meet." Mon, Fri, 6-7:30 pm; 8-10:30. Tues, Wed, Sat, 7-7:30 pm. Tues, 6-7 pm. Wed, 8-11:30 pm. Pacific.

KLZ, Denver. Colo. 266 meters. 250 watts. Reynolds Radio Co. Announcer, Mrs. William D. Reynolds. Slogan, "Its a Privilege to Live in Colorado." Closed for the summer.

KMA, Shenandoah, Ia. 252 meters. 500 watts. May *Seed & Nursery Co. Daily ex Sun, 11:30-12:30 pm, 6-7, 9-11. Sun, 4-6 pm. Central.

KMJ, Fresno, Calif. 234 meters. 50 watts. Fresno * Bee. Mon, Wed, Fri, 7:15-9:15 pm. Pacific.

KMO, Tacoma, Wash. 250 meters. 100 watts. Association Station. (Love Electric Co.) Mon, Wed, Fri, 6-7 pm, popular program; 9-10, artist's program. Pacific.

KNRC, Los Angeles, Calif. 208.2 meters. 250 watts. *Kierulff & Ravenscroft Co. Announcer, "Hastings." Daily ex Sun, 10 am. Mon, 1:30 pm. Tues, Wed, Thurs, Fri, 7-9 pm. Pacific.

KNX, Hollywood, Calif. 336.9 meters. 500 watts. Los *Angeles Evening Express. Announcer, "Town Crier." Daily ex Sun, 7:30 am, gym; 8, talk; 9, time; 10, Town Crier; 10:30, home hour; 12-1, pm, organ; 2-4, matinee; 5, markets; 5:30-6:15, organ; 5:55, 6:15, 6:30-7. Mon, 4 pm, 7-12. Thurs, 7-11 pm. Tues, Wed, 7-10 pm. Fri, Sat, 7-2 am. Pacific.

KOA, Denver, Colo. 322.4 meters. 5,000 watts. General *Elec. Co. Daily ex Sun, 12:20 pm, organ; 1, weather, markets. Mon, 6 pm, stocks; 8, concert. Tues, 8 pm, matinee for housewives; 6, dinner music; 6:30, stocks; 7:05, golf. Wed, 6 pm, stocks; 6:35, bedtime hour; 8, 10-12. Thurs, 3 pm, matinee; 6, dinner music; 6:30, stocks; 7:05, golf lesson. Fri, 6 pm, stocks; 6:35, Book of Knowledge; 8, music. Sun, 11 am, service; 4 pm, music; 7:45, service. Mountain.

KOB, State College, N. M. 348.6 meters. 1000 watts. N. M. College of Agri. & Mech. Arts. Announcer, Robert Stewart. Solgan, "The Sunshine State of America." Daily 11:55-12 pm, time; 12-12:02, weather; 12:02-12:10, highway reports; 12:10-12:30, news; 9:55-10, time; 10-10:02, weather; 10:02-10:10, road reports. Mountain.

KOCH, Omaha, Neb. 258 meters. 250 watts. Central * H. S. Announcer, Norwood Woerner. Mon, Tues, Thurs, 7:30-9 pm. Sat, 10:30 pm. Central.

KOIL, Council Bluffs, Iowa. 278 meters. 500 watts. * Monarch Mfg. Co. Announcer, Howard Martin. Mon, Tues, Thurs, 7:30 pm, 8:05, 9, 11-12. Wed, Fri, 7:30 pm; 8:05, 11-12. Sat, 7:30 pm; 11-12. Sun, 11-12 m; 7:30 pm. Central.

KOP, Detroit, Mich. 278 meters. 500 watts. Detroit *Police Dept. Announcer, B. D. Fitzgerald. Slogan, "Safety First." Daily ex Sun, 1 pm, 5:30; reports, police information, emergency. Safety talks. Eastern.

KPO, San Francisco, Calif. 428.3 meters. 1000 watts. Hale *Bros., and the Chronicle. Announcer, Clair E. Morrison. Slogan, "The City by the Golden Gate." Daily ex Sun, 7-7:30 am, 8 daily dozen; 10:30 am, amusement service; 12 m, time, scriptures. Daily ex Sun, Fri, 1-7:30, music, markets. Mon, Tues, Wed, Thurs, Fri, 8-11 pm, entertainment. Tues, Thurs, 10 am, household hour. Tues, Wed, Thurs, 10:35 am, markets. Wed, 3:30 pm, style talk. Fri, 12:45 pm, luncheon; 5:30-7:30 pm, Sat, 8-12 midnight. Sun, 9:45 am, service; 5-6 pm, organ; 6-6:30, orchestra; 6:30, baseball; 6:35-7:30, orchestra; 8-10, music. Pacific.

KPPC Pasadena, Calif. 228.9 meters. 50 watts. Pasadena Presbyterian church. Announcer, G. Anton Pohlman. Wed, 7:30-9 pm; Sun, 10:30-12:30 pm; 6:45-9. Pacific.

KPRC, Houston, Texas. 296.9 meters. 500 watts. Houston *Post-Dispatch. Slogan, "Kotton Port Rail Center." Announcer, Alfred P. Daniel. Daily ex Sun, 10:55 am, time; 11, weather; 12 m, entertainment. Daily ex Sat, Sun, Fri, 5:30 pm, Uncle Judd's Kiddies hour; 7:30-9:30, concert. Sat, Wed, 11-12 midnight. Sun, 10:45 am, 8 pm, services; 10-11 pm, music. Central.

KPSN, Pasadena, Calif. 315.6 meters. 1000 watts. Pasadena Star-News.

KQV, Pittsburgh, Pa. 275.2 meters. 500 watts. Double- *day-Hill Elec. Co. Daily ex Sat, Sun, 10:30 am, music; 11, weather; 12:15, weather, music; 3, music. Eastern.

KQW, San Jose, Calif. 227 meters. 500 watts. Charles D. Herrold. First Baptist church.

KRE, Berkeley, Calif. 256 meters. 150 watts. Daily *Gazette. Announcer, Harrold Kirby. Mon, Tues, 8-10 pm. Wed, 5-6 pm, kiddies hour; 8-12, dance program; Thurs, 8-12, midnight. Fri, 8-8:30 pm, travel stories; 8:30-12, dance program. Sat, 8-12, dance program. Sun, 10-11 am, church; 6:30-7:30 pm; 8-9, 9-10. Pacific.

KSAC, Manhattan, Kan. 340.7 meters. 500 watts. Kansas State Agricultural College. Announcer, Sam Pickard. Closed for the summer.

KSD, St. Louis, Mo. 545.1 meters. 550 watts. St. Louis *Post Dispatch. Daily ex Sun, 8:40 am, 9:40, 10:40, 11:40, 12:40 pm, 1:40, 2:40, 3:40. Mon. 9 pm, 10, 11. Tues, 6:45 pm, 8, 9. Wed, 7 pm, Fri, 7:30 pm, 8, 9, 10, 11. Sat, 7 pm, 8:30. Sun, Thurs, silent nights. Central.

KSL, Salt Lake City, Utah. 299.8 meters. 1,000 watts. Radio Service Corp. of Utah. Announcer, Charles H. Hays. Mon, Wed, Fri, 7-11 pm. Tues, Thurs, Sat, 7:30-11 pm, Sun, 9-11 pm. Mountain.

KTAB, Oakland, Calif. 240 meters. 500 watts. Tenth *Ave. Baptist Church. Daily ex Sun, 9-9:30 am, prayer service. Mon, Tues, Thurs, Fri, 8-10 pm. Wed, 9-10:30 pm. Sun, 10 am, 11; 7:45, 9:30-11 pm. Pacific.

KTBI, Los Angeles, Calif. 293.9 meters. 750 watts. Bible Inst. of Los Angeles. Announcer, M. E. Carrier. Mon, 8-9:30 pm, Tues, Wed, Thurs, 8-9 pm. Fri, 7-9 pm. Sun, 10:45-12:30 pm, 6-6:45, 7:15-9:30, church services. Pacific.

KTBR, Portland, Ore. 263 meters. 50 watts. Brown's *Radio Shop.

KTCL, Seattle, Wash. 305.9 meters. 1,000 watts. KTCL *Broadcasting Co. "Know the Charmed Land." Mon, 8-9 pm, 9-10. Tues, 7-8 pm, Wed, 7-8 pm, 9-10. Thurs, 6:30-7:30 pm. Fri, 7-8 pm, 9-10, 10:15-12. Sat, 6:50-7:15 pm; 9-11:30. Sun, 7:50-9:15 pm, church service. Pacific.

KTHS, Hot Springs National Park, Ark. 374.8 meters. *750 watts. The New Arlington hotel. Announcer, G. C. Arnoux. Slogan, "Kum to Hot Springs." Daily ex Sun, 12-1 pm, markets, weather; 9:15 pm, sports; 9:25-10:45, concert. Sun, 11-12:30 pm, church services; 9:15-9:25, sports; 9:25-10, classical. Central.

KTW, Seattle, Wash. 454.3 meters. 1,000 watts. First Presbyterian church. Announcer, J. G. Priestly. Slogan, "Hear Ye, hear ye, the Gospel." Sun, 11-12:30 pm, 3-4:30, 7-9:30, church service. Pacific

KUD, San Francisco, Calif. 246 meters. 150 watts. San Francisco Examiner. Slogan, "The Voice of the West." Temporarily off the air.

KUOM, Missoula, Mont. 244 meters. 250 watts. University of Montana.

KUSD, Vermilion, S. D. 278 meters. 200 watts. *Univ. of S. D. Announcer, Sidney Lawton. Slogan, "South Dakota for South Dakotans." Wed, 8-9:30 pm. Central.

KWG, Stockton, Calif. 248 meters. 50 watts. Portable Wireless Telephone Co. Announcer, Paul C. Schulz. Slogan, "Voice of the San Joaquin Valley." Daily ex Sun, 4-5 pm, news, concert, markets. Tues and Fri, 8-9 pm, concert. Sun, 2-3 pm, concert. Pacific.

KWKC, Kansas City, Mo. 236 meters. 100 watts. Wilson Duncan studios. Slogan, "Keep Watching Kansas City."

KWKH, Kennonwood, La. 261 meters. 500 watts. W. G. *Patterson, Henderson Iron Works & Supply Co. Announcer, W. G. Patterson. Mon, 8-9 pm, music. Tues, Sat, 9-12 midnight. Sun, 9:30-10:30 pm. Thurs, 8-9:30 pm. Sat, 9-12, dance. Sun, 9:30-10:30 am, music. Central.

KWSC, Pullman, Wash. 348.6 meters. 500 watts. State *College of Washington. Announcer, George Bayles. Mon, Wed, Fri, 7:30-9 pm, music. Pacific.

KWWG, Brownsville, Texas, 278 meters. 500 watts. Brownsville Municipal Broadcasting Station. Slogan, "Kum to the World's Winter Garden." Tues, Thurs, Sat, 8:30 pm. Central.

KYW, Chicago, Ill. 535.4 meters. 2,000 watts. Westing- *house Elec. & Mfg. Co. Announcer, Edward Borroff. Daily ex Sun, Sat, 5:30 am, exercises; 6:30, church; 9:55, time; 10, markets; 10:35, table talk; 11, weather; 12:30 pm, reports; 1:15, reports; 5:02-5:18, markets; 5:30, baseball. Tues, Wed, Thurs, Fri, 5:35 pm, children's hour; 6-6:30, dinner. Tues, 9:30 am, farm hour; 7-8:15 pm, 9-10:30. Tues, Wed, Thurs, Sat, 1 pm, motor club, talks. Mon, 1:30 pm, markets. Tues, Thurs, 1:35-3 pm, frolic. Wed, 6:33 pm, 6:45, 7-9, 9-11:30. Thurs, 9:30 am, 6:30-6:50 pm, farm bureau; 7-8:15, 8:20, talk; 9-10:30. Fri, 7-7:30 pm, 9-11:30. Sat, 5:30 am, 6:30, 8:30, 10:35, 11, 12:30 pm, 1, 1:15, 1:35-8, 5:02-5:18, 6-6:30, 7-8, 8:35-10:30. Sun, 10 am, 3-4 pm. World Crier every half hour. Central.

KZKZ, Manila, P. I. 272 meters. 500 watts. Radio Corporation of the Philippines.

KZM, Oakland, Calif. 242 meters. 100 watts. Western Radio Institute (Hotel Oakland). Announcer, H. Lewis. Daily ex Sun, 6-7 pm, orchestra. Pacific.

KZRQ, Manila, P. I. 375 meters. 500 watts. Far Eastern Radio, Inc. Slogan, "Radio Manila."

KZUY, Baguio, P. I. 360 meters. 500 watts. F. John- *son Elser.

NAA, Radio, Va. 435 meters. United States Navy Dept. Daily ex Sun, 10:05-10:20 am, 3:45-4 pm, 10:05-10:20. Wed, 7:25-7:40 pm, civil service lecture. Mon, 7:45-8 pm, lecture, War dept. Tues, Thurs, 7:45-8 pm, Dept. of Commerce. Fri, 7:45-8 pm, Treasury dept.

WAAB, New Orleans, La. 273 meters. 100 watts. Valdemar Jensen. Sun, 2-4 pm. Central.

WAAC, New Orleans, La. 275 meters. 100 watts. Tulane Univ. Announcer, P. S. Lelaup. Fri, 7:15-7:30 pm, reports; 8-9:30, educational and entertainment program. Central.

WAAD, Cincinnati, O. 258.6 meters. 25 watts. Ohio Mechanics Inst. No regular schedule.

WAAF, Chicago, Ill. 278 meters. 200 watts. Chicago Daily Drovers Journal. Announcer, Carl Ulrich. Daily ex Sun, 8:40 am, 10:30, 10:45, 12:30 pm. Daily ex Sun, Sat, 12:45, 3, 4:30, live stock and weather reports. Central.

WAAM, Newark, N. J. 263 meters. 500 watts. I. R. Nelson Co. Announcer, H. E. Beaver. Slogan, Sat, Sun, 11-12 m, music, talks, markets. Daily ex Thurs, Sun, 7-11 pm. Eastern.

WAAW, Omaha, Neb. 384.4 meters. 500 watts. Omaha Grain Exchange. Slogan, "Where Agriculture Accumulates Wealth." Daily ex Sun, 9:30 am; 9:45 am, 10:15, 10:45, 11:15, 11:45, 12:15 pm, 12:45, 1:15, markets; 8-8:30, marketgrams talk. Central.

WABC, Asheville, N. C. 254 meters. 10 watts. Asheville Battery Co., Inc.

WABD, Rochester, N. Y. 278 meters. 100 watts. Lake Avenue Baptist church. Announcer, Morse Clark. Sun, 10:15-12 m, 7:15-9 pm. Eastern.

WABQ, Haverford, Pa. 261 meters. 50 watts. Haver- *ford College Radio club. Announcer, Gerald C. Gross. Thurs, 10-11 pm, lectures, music. Eastern.

WABR, Toledo, O. 263 meters. 50 watts. Scott High *School. Sat, football game.

WABW, Wooster, O. 206.8 meters. 50 watts. The College of Wooster, Dept. of Physics. Announcer, Frank C. Isely. Irregular schedule.

WABX, Mt. Clemens, Mich. 246 meters. 150 watts. Henry B. Joy.

WABY, Philadelphia, Pa. 242 meters. 50 watts. John Magaldi, Jr. Slogan, "Quaker City Sleep Dodgers" Club. "The American Broadcasting Club." Sun, 9 pm, music; 10:30, "Sleep Dodgers' Session." Eastern.

WABZ, New Orleans, La. 275 meters. 50 watts. The Coliseum Place Baptist church. Announcer, V. W. Bradbury. Slogan, "The Station with a Message." Sun, 11-12:15 pm, 7:30-8:45, church service. Central.

WADC, Akron, Ohio. 258 meters. 100 watts. Allen *Theater Broadcasting station. Daily xe Sun, 11 am, 6:30 pm. Mon, Wed, Sat, 7:30 pm. Tues, 8 pm. Thurs, 8:30 pm, 9. Fri, 8 pm, 9, 10. Sun, 12:30 pm, 6:30 pm. Eastern.

WAFD, Port Huron, Mich. 275 meters. 500 watts. *Albert B. Parfet Co. Announcer, John D. Walsh. Slogan, "Gateway to the Great Lakes." Mon, Wed, 9-11 pm. Sat, 11-1 am. Sun, 10-11:30 am. Eastern.

WAHG, Richmond Hill, N. Y. 315.6 meters. 500 watts. *A. H. Grebe & Co. Slogan, "Wait and Hear Grebe." Daily ex Sun, 12:30-1:15 pm. Mon, Wed, Fri, 7:30-11:30 pm, Sat, 12-2 am. Eastern.

WAIT, Taunton, Mass. 229 meters. 10 watts. A. H. Waite & Co., Inc.

WAMD, Minneapolis, Minn. 243.8 meters. 1,000 watts. Hubbard Co. Hotel Radisson. Slogan, "The Voice of the Great Northwest." Daily ex Sun, Mon, 12-1 pm, organ; 6-7, orchestra; 7-8, popular farm hour. 10-12, popular program. Sun, 8:30-11, old fashioned program. Central.

WAPI, Auburn, Ala. 248 meters. 500 watts. Alabama *Polytechnic Institute.

WBAA, W. Lafayette, Ind. 273 meters. 250 watts. Purdue University. Announcer, J. W. Stafford. Daily ex Sun, 9:50 am, stocks, markets, weather. Mon, Fri, 7:15 pm, special program. Central.

WBAK, Harrisburgh, Pa. 275 meters. 500 watts. Pennsylvania State Police. Announcer, A. E. Poorman. Daily ex Sun, 10 am, 1:30 pm, 5:45, police reports, fire protection, markets; 12 mid. police reports. Mon, Tues, Wed, 7:30 pm, special. Eastern.

WBAO, Decatur, Ill. 270 meters. 100 watts. James Millikin Univ. University activities. No definite schedule.

WBAP, Fort Worth, Tex. 475.9 meters. 1000 watts. Fort Worth Star-Telegram. Announcer, "The Hired Hand" Club, "Radio Truth League." Daily ex Sun, 10, 11, 12 m, 1 pm, 2, market reports, weather; 4, "Port of Missing Men." Mon, Tues, Wed, Thurs, Fri, 12:05-12:30 pm, 7:30-8:30, 9:30-10:45, concert. Sat, 7 pm, Bible lesson. Sun, 11 am, church; 4 pm, concert: 11, midnight frolic. Central.

WBAR, Sisiht, Wis. 406 meters. 500 watts. Kopp Radio Co. Slogan, "The Station of Northern Wisconsin." Mon, 9-10 pm. Wed, 8-9 pm. Thurs, 7:30-8:30. Sun, 10-11 pm. Central.

WBAV, Columbus, O. 293.9 meters. 500 watts. The *Erner and Hopkins Co. Announcer, H. E. Day. Slogan, "We Broadcast a Variety." Daily ex Sun, 12-1 pm; 6-7. Fri, 8-10 pm. Eastern.

WBAX, Wilkes-Barre, Pa. 256 meters. 100 watts. John H. Stenger, Jr. Slogan, "In Wyoming Valley, Home of the Anthracite." Closed for the summer.

WBBA, Newark, Ohio. 225.5 meters. 20 watts. Plymouth Congregational church. Closed for the summer.

WBBG, Mattapoisett, Mass. 248 meters. 100 watts. *Irving Vermilya. Mon, Wed, Fri, 8-10:30 pm, music. Sun, 10:45-12 m, church service. Eastern.

WBBL, Richmond, Va. 229 meters. 150 watts. Grace *Covenant Presbyterian church. Announcer, Herbert C. Taylor. Tues, 8 pm. Sun, 11 am, 8 pm. Eastern.

WBBM, Chicago, Ill. 226 meters. 1500 watts. Atlass *Investment Co. Announcer, Nate Caldwell. Slogan, "World's Best Broadcast Medium." Daily ex Sun, 5:30-6 pm. Mon, 6-7 pm. Tues, Thurs, Sat, 8-12 m. Wed, Fri, 8-10. Wed, Sat, Sun, 12-2. Sun, 4-6 pm, 8-10. Central.

WBBP, Petoskey, Mich. 288 meters. 200 watts. Petoskey High School. Announcer, Carl Bowman. Wed, 9:30-10:30 pm, popular program. Fri, 8-9:30 pm. athletics. Sun, 10:30 am, service; 3 pm, sacred concerts. Central.

WBBR, Staten Island, N. Y. City, N. Y. 272.6 meters. *500 watts. International Bible Students' Association. Mon, Thurs, Sat, 8-9 pm, lectures, music. Sun, 10-11:30 am, 9-10:30 pm. Eastern.

WBBS, New Orleans, La. 252 meters. 50 watts. First Baptist church. Slogan, "The Gospel Wave." Sun, 11 am, 7:45 pm, services. Central.

WBBU, Monmouth, Ill. 224 meters. 10 watts. Jenks Motor Sales Co. Mon, Thurs, 8 pm. Central.

WBBW, Norfolk, Va. 222 meters. 50 watts. Ruffner Junior High School. Announcer, Lee M. Klinefelter. Slogan, "The School You'd Like to Go to."

WBBY, Charleston, S. C. 268 meters. 10 watts. Washington Light Infantry. Announcer, Hugh Easterly. Eastern.

WBBZ, Chicago, Ill. 215.7 meters. 50 watts. C. L. *Carrell.

WBCN, Chicago, Ill. 266 meters. 500 watts. Southtown *Economist. Announcer, Harry A. Zook, Jr. Slogan, "World's Best Community Newspaper." Daily ex Sun, 5-5:15 pm, police. Daily ex Sun, Mon, 7-8 pm. Mon, 3-5 pm. Tues, 10-11:30 pm; 11:30-2 am, pirate ship. Wed, Fri, Sat, 10-12 midnight. Thurs, 10-1 am. Sun, 10:30-12 m, church service; 4-5 pm, 7-8, 8-9:30. Central.

WBDC, Grand Rapids, Mich. 256 meters. 50 watts. Baxter Laundry and Dry Cleaning Co. Announcer Richard Smith.

WBES, Takoma Park, Md. 222 meters. 100 watts Bliss Elec. School. Closed for the summer.

WBNY, New York, N. Y. 209.7 meters. Warners' *theater.

WBOQ, Richmond Hill, N. Y. 236 meters. 100 watts A. H. Grebe & Co., Inc.

WBR, Butler, Pa. 1199 meters. 100 watts. Pa. State *Police. Announcer, E. T. Denton.

WBRC, Birmingham, Ala. 248 meters. 50 watts. Bell Radio Corporation. Mon, Wed, Fri, 8 pm.

WBRE, Wilkes-Barre, Pa. 231 meters. 10 watts. Baltimore Radio Exchange.

WBZ, Springfield, Mass. 333.1 meters. 2000 watts. West- *inghouse Elec. & Mfg. Co. Announcer, A. E. Bach. Daily ex Sat, Sun, 6-9:55 pm, music, baseball, markets; 9:55, time. Sun, 8 pm, organ; 8:30, concert. Eastern.

WBZA, Boston, Mass. 242 meters. 250 watts. West- *inghouse Elec. & Mfg. Co.

WCAC, Storrs, Conn. 275 meters. 500 watts. Con *necticut Agri. College. Announcer, Daniel E. Noble. Slogan, "From the Nutmeg State." Mon, Wed, Fri. 7-9 pm. Eastern.

WCAD, Canton, N. Y. 263 meters. 250 watts. St Lawrence Univ. Announcer, Ward C. Priest. Slogan, "The Voice of the North Country." Daily, 11 am, weather, reports, time. Wed, 8 pm. Eastern.

WCAE, Pittsburgh, Pa. 461.3 meters. 500 watts. Kauf- *man & Baer Co., Pittsburgh Press. Announcer, Joseph Sartory. Daily ex Sun, 12:30 pm, news; 3, theater program; 4:30, reports; 6:30, music; 7:30, Uncle Kaybee. Mon, 7:45 pm, police reports; 8:30, 9, 11. Tues, 7:45 pm, 8, 8:30, 9, 10. Wed, 7:45 pm, 8:30, 9, 11. Thurs, 8 pm, 9, 10. Fri, 7:50 pm, 8:30, 10. Sat, 7:45 pm, 8, 8:15, 8:30. Sun, 3 pm, 4, 6:30, 7:20. Eastern.

WCAH, Columbus, O. 266 meters. 500 watts. Entrekin Elec. Co. C. A. Entrekin, annnouncer. Slogan, "The Heart of Ohio." Daily, 11:30-12:30 pm. Tues, 8:30 pm. Sun, 4 pm, vesper. Eastern.

WCAJ, Univ. Place, Nebr. 254 meters. 300 watts. Nebr. Wesleyan Univ. Announcer, J. C. Jensen. Daily 11 am, weather. Fri, 9 pm, music, lectures. Central.

WCAL, Northfield, Minn. 336.9 meters. 500 watts. Dept. of Physics, St. Olaf College. Announcer, Kenneth Onsgard. Slogan: "The College on the Hill." Daily ex Sun, Thurs, 9:45 am, chapel. Thurs, 9 pm, music. Fri, 8:30 pm, talk. Sun, 8:30 pm, sermon, music. Central.

WCAO, Baltimore, Md. 275 meters. 100 watts. Albert A. and A. Stanley Brager. Announcer, R. E. Brunner. Slogan, "The People's Store." Mon, Wed, Fri, 6:30-8 pm, dinner music; 8-9:30; 9:30-11. Eastern.

WCAP, Washington, D. C. 468.5 meters. 500 watts. Chesapeake & Potomac Tel. Co. Announcer, O. P. Gascoigne. Mon, 7-12 pm. Wed, 7-12 pm. Fri, 7-12 pm, Sun, 11 am, 4 pm, 7:20-10:15 pm. Eastern.

WCAR, San Antonio, Tex. 263 meters. 100 watts. Southern Radio Corp. of Texas. Announcer, L. Tatom. Club, "Royal Order of Prevaricators." Mon, Thurs, Sat, 8:30-9:30 pm, concert. Wed, Sat, 11 pm. Central.

WCAT, Rapid City, S. D. 240 meters. 50 watts. S. D. State School of Mines. Announcer, J. O. Kammerman. Daily ex Sun, 9:30 am, 12:30 pm, weather, reports. Thurs, 7:30 pm, concert. Mountain.

WCAU, Philadelphia, Pa. 278 meters. 500 watts. Uni- *versal Broadcasting Company. Announcer, Eddie Malle. Mon, Wed, 8-10:30 pm. Tues, 6:30-10:30 pm. Thurs, 5:30-10:30 pm. Fri, 7-10:30 pm. Sun, 5-7 pm. Eastern.

WCAX, Burlington, Vt. 252 meters. 100 watts. University of Vermont. Slogan, "The Voice of the Green Mountains." Mon, 8-9:30 pm. Closed after August 16 for rest of summer. Eastern.

WCAZ, Carthage, Ill. 246 meters. 50 watts. Carthage *College. Wed, 9-10 pm. Central.

WCBA, Allentown, Pa. 254 meters. 15 watts. Queen City Radio station. Wed, 8:15-11 pm. Fri, 6:45-7:45 pm, bedtime stories, Bible lessons. Sun, 7 pm, church service. Eastern.

WCBD, Zion, Ill. 345 meters. 5,000 watts. Wilbur Glenn *Voliva. Announcer, J. H. DePew. Slogan, "Where God Rules, Man prospers." Tues, Thurs, 8-10:30 pm, concert. Wed, 12:30-1 pm, organ. Thurs, 1:30-2:45 pm, service. Sun, 8-9:45 am, Bible school; 1:30-5 pm, church services. Sun, 8-10:30 pm. Central.

WCBE, New Orleans, La. 263 meters. 5 watts. Uhalt Brothers Radio Co. Announcer, Johnnie Wilson. Slogan, "Second Port U. S. A." Sat, 7:30-8:30 pm, dance. Sun, 12:30-2 pm, dinner concert; 9, dance music. Central.

WCBG, Herrin, Ill. 268 meters. 10 watts. Howard S. Williams. Closed for the summer.

WCBH, Oxford, Miss. 242 meters. 50 watts. U. of *Mississippi. Announcer, W. L. Kennon.

WCBM, Baltimore, Md. 229 meters. 50 watts. Hotel Chateau. Announcer, Harry J. Dobe. Tues, 11:30-1 am. Thurs, 9:30-11 pm. Sat, 10-12. Sun, 9:45-11:30 pm. Eastern.

WCBQ, Nashville, Tenn. 242 meters. 100 watts. First Baptist church. Announcer, Harry Stone. Sun, 7:30 pm. Central.

WCBR, Providence, R. I. 205.4 meters. 30 watts. Charles H. Messter. (Portable.)

WCCO, Minneapolis-St. Paul, Minn. 416.4 meters. 5,000 *watts. Washburn-Crosby Co. Announcer, Paul Johnson. Slogan, "Service to the Northwest." Daily ex Sun, Sat, 8:40 am, 9, 9:30, markets; 9:35, program; 9:40, news; 10:30, weather, markets; 12:15 pm, farm program; 12:30, weather, markets; 2, markets; 2:05, woman's hour; 6, sports. Daily ex Sun, 9 pm, closing grain markets. Mon, Wed, 2:30 pm, concert. Mon, Thurs, 5:30 pm, children's hour. Mon, 6:05 pm, reports; 6:45, F. & R. Family; Tues, 6:05 pm, 7, 8, 9. Wed, 6:30 pm, reports; 7, 8:30, 9, 10:30, 11:30. Thurs, 7-9 pm, 9, weather, baseball. Fri, 6:15 pm, music; 8, 9, 10. Sat, 2 pm, football; 8:40, 9, 9:30, 9:35, 9:40, news; 10:30, 11:30, markets; 6, markets, baseball; 6:05, music, 8, 9, 10. Sun, 10:20 am, church; 4:10 pm, service; 7:45, 9, weather, baseball; 9:15, concert. Central.

WCEE, Elgin, Ill. 275.1 meters. 1,000 watts. Charles E. Erbstein. Mon, 10:30-12 midnight. Tues, Wed, Fri, Sat, 7-8 pm, 10:30-12. Central.

WCLD, Camp Lake, Wis. 231 meters. 50 watts. C. E. *Whitmore.

WCLS, Joliet, Ill. 214.2 meters. 150 watts. Harold M. *Couch. Slogan, "Will County's Largest Store." Mon, Wed, Fri, Sat, 8-12 midnight. Central.

WCSH, Portland, Maine. 256.3 meters. 500 watts. Congress Square Hotel.

WCSO, Springfield, O. 248 meters. 100 watts. Wittenberg college. Announcer, Lester Crowl. Closed for the summer.

WCUW, Worcester, Mass. 238 meters. 250 watts. Clark *University, Collegiate Dept. Fri, 8-11 pm, concert. Eastern.

WCX, Detroit, Mich. 516.9 meters. 5,000 watts. The *Detroit Free Press. Announcer, R. C. L'Amoreaux. Club, "Red Apple Club." Daily ex Sun, 2 pm, news; 2:15, stock reports, weather, markets; 6, dinner concert; 8, orchestra. Tues, 10-1, club. Fri, 10-12, dance. Sun, 10:30 am, 6 pm, orchestra. Eastern.

WDAD, Nashville, Tenn. 226 meters. 150 watts. Dad's *Auto Accessories, Inc. Announcer, L. N. Smith. Slogan, "The Athens of the South." Daily ex Sun, 3:30-4:30 pm; 7:30-9. Central.

WDAE, Tampa, Fla. 273 meters. 250 watts. Tampa Daily Times. Announcer, Dave Ginsburg. Daily, 7:30. Tues, 8-10 pm, Thurs, 8-10 pm.

WDAF, Kansas City, Mo. 365.6 meters. 500 watts. Kan- *sas City Star. Announcer, Dean Fitzer. Club, "Nighthawks." Daily ex Sun, 3:30-4:30 pm, music; 5:50, markets, weather; 6-7, educational, bedtime story, music; (alternate nights). 11:45, Nighthawks. Mon, Wed, Fri, 8-9:15 pm, concert. Daily, 3:30 pm, 4, 4:30, 5, 6, baseball. Daily ex Sat, Sun, 10:45 am, home service talks. Sun, 4-5 pm, music, 5-5:30, Sunday school lesson, music. Central.

WDAG, Amarillo, Tex. 263 meters. 100 watts. J Lau- *rence Martin. Slogan, "Where Dollars Always Grow." Daily ex Sun, 8 pm. Central.

WDAY, Fargo, N. D. 261 meters. 50 watts. Radio *Equip. Corp. Announcer, K. M. Hance. Slogan, "The Biggest Little City in the World." Daily ex Sun, 9:30 am, markets, weather, news; 10-11:30, markets; 12:30, music; 1 pm, Radio farm school; 1:10, markets; 5, music; 5:30, news, baseball. Tues, Thurs, Sat, 7:30 pm, musical. Sun, 10:30 am, church services. Sun, 4 pm, music. Central.

WDBC, Lancaster, Pa. 258 meters. 50 watts. Kirk Johnson & Co., Inc.

WDBE, Atlanta, Ga. 278 meters. 100 watts. Gilham-Schoen Elec. Co. Announcer, E. E. Floyd. Slogan, "We Distribute Better Equipment." Tues, Sat, 9-10 pm, music. Central.

WDBJ, Roanoke, Va. 229 meters. 50 watts. Richardson *Wayland Elec. Corp. Announcer, Glen Baylor. Slogan, "Roanoke Down in Old Virginia." Daily ex Sun, 12-1 pm, music; 5:30-6:45, music, news, weather, baseball, Wed, Sat, 9 pm, concert. Eastern.

WDBK, Cleveland, Ohio. 227 meters. 100 watts. M. F. *Broz Furniture. Tues, Sat, 8-12:30 am. Eastern.

WDBO, Winter Park, Fla. 240 meters. 100 watts. Rollins College, Inc. Slogan, "Wander Down by Orlando."

WDBQ, Salem, N. J. 234 meters. 10 watts. Morton Radio Supply Co. Announcer, Wm. T. Gallaway. Irregular weekly schedule. Closed for the summer.

WDBR, Boston, Mass. 261 meters. 100 watts. Tre- *mont Temple Baptist Church. Announcer, Raymond B. Meader. Fri, 7:30-8:30 pm. Sun, 10:30 am; 6:30 pm, church services. Eastern.

WDBY Chicago, Ill. 258 meters. 500 watts. North Shore Congregational church. Announcer, Rev. J. C. O'Hair. Wed, 7-8 pm. Fri, 7:30-9 pm. Sun, 11-12:30 pm; 3:30-5, 8, service. Central Daylight.

WDBZ, Kingston, N. Y. 233 meters. 10 watts. Boy Scouts of America. Announcer, G. Henry Nessiage. Closed for the summer.

WDCH, Hanover, N. H. 256 meters. 100 watts. *Dartmouth College.

WDOD, Chattanooga, Tenn. 256 meters. 500 watts. Chat- *tanooga Radio Co., Inc. Announcer, Dick L. Park. Slogan, "Wonderful Dynamo of Dixie." Mon, 7-8 pm, 8:15, 8:30-10:30. Tues, 2 and 4 of each month, 9-10 pm. Wed, 7-8 pm, 8:30-10:30. Fri, 7-8 pm, 8:30-11:30. Sun, 7:30 pm. Central.

WDRC, New Haven, Conn. 268 meters. 100 watts. Doolittle Radio Corp. Mon, Thurs, 8-10 pm. Sun, 11 am. Eastern.

WDWF, Providence, R. I. 440.9 meters. 500 watts. *Dutee W. Flint, Inc. Slogan, "Quality First." Tues, 8:30 pm. Thurs, 6:30-8 pm, talks. Sun, 10 am, 5 pm. Eastern.

WDZ, Tuscola, Ill. 278 meters. 100 watts. James L. *Bush. Daily ex Sun, 9:30 am, 10, 10:30, 11, 11:30, 12 m, 12:30 pm, 1, 1:15, Chicago Board of Trade quotations. Central.

WEAF, New York, N. Y. 491.5 meters. 4,500 watts. *A. T. & T. Co. Slogan, "The Voice to the Millions." Daily ex Sun, Sat, 6:45-7:45 am, 4-5 pm. Tues, Wed, Thurs, Fri, 11-12 m. Mon, 6-11:30 pm. Tues, Wed, Thurs, Fri, Sat, 6-12 m. Sun, 8-5 pm, 7:20-10:15. Eastern.

WEAH, Wichita, Kan. 268 meters. 100 watts. Hotel Lassen.

WEAI, Ithaca, N. Y. 286 meters. 500 watts. Cornell Univ. Irregular.

WEAM, North Plainfield, N. J. 261 meters. 250 watts. Borough of N. Plainfield. Announcer, H. W. Blackford. Slogan, "America's Pioneer Municipal Broadcasting Station." Fri, 8-12 pm, concert, talks. Eastern.

WEAN, Providence, R. I. 270 meters. 250 watts. *The Shepard Stores. Announcer, Chester H. Miller Daily ex Sun, 12-1 pm, 4-5, music, reports, weather, concert. Mon, Tues, Wed, Fri, 8-10, concert. Sat, 9-11 pm, dance music. Sun, 10:45-11:30 am, 7:30-8:45 pm, church service. Eastern.

WEAO, Columbus, O. 293.9 meters. 500 watts. Ohio *State Univ. Announcer, Ann Charles. Daily ex Sun, 9:45 am, 11-1 pm, markets, weather; talks to farmers, markets, music; 4, markets. Wed, 8 pm, music, lectures. Eastern.

WEAR, Cleveland, Ohio. 389.4 meters. 750 watts. *The Goodyear Tire & Rubber Co. Announcer, H. K. Carpenter. Slogan, "Goodyear Tires WEAR." Daily ex Sun, 11-12:10 pm. Daily ex Sat, Sun, 3:30-4:10 pm, markets, weather, baseball. Daily, 7-8 pm. Tues, Thurs, Fri, 8-11 pm. Sun, 3:30-5 pm, 7-10. Eastern.

WEAU, Sioux City, Ia. 275 meters. 100 watts. Davidson Bros. Co. Announcer, B. M. Smith. Slogan, "The Heart of the Corn Belt." Daily ex Sun, 9 am, 10, 11, 12 m, 1 pm, 5, markets, weather, sports. Central.

WEBA, New Brunswick, N. J. 233 meters. 15 watts. The Electric Shop, George N. DeLaplaine. Slogan, "Wonderful Evenings by Air WEBA." Mon, Thurs, 8-10 pm, music. Eastern.

WEBC, Superior, Wis. 242 meters. 100 watts. Walter Cecil Bridges. Daily ex Sun, 6:15-8 pm. Mon, 8:30-9:30 pm. Wed, Sat, 9-11 pm. Central.

WEBD, Anderson, Indiana. 246 meters. 10 watts. Elec. *Equip. & Service Co. Announcer, F. R. Fulwider. Tues, Fri, 8:30 pm. Sun, 7:30 pm, service. Central.

WEBE, Cambridge, Ohio. 234 meters. 10 watts. Roy W. *Waller. Fri, 7:30. Central.

WEBH, Chicago, Ill. 370.2 meters. 1000 watts. An- *nouncer, Robert Boniel. Slogan, "The Voice of the Great Lakes." Edgewater Beach Hotel Co., Chicago Evening Post. Daily ex Sun, Mon, 7:30-8:30 pm; 9:30-10:30, 11:30-1 am. Sun, 5-6 pm, twilight musicale, 7-9. Central.

WEBJ, New York, N. Y. 272.6 meters. 500 watts. Third *Avenue Railway company. Announcer, H. A. Bruno. Tues, Fri, 7-9 pm. Wed, 8-10 pm. Eastern.

WEBK, Grand Rapids, Mich. 242 meters. 100 watts. Grand Rapids Radio Co. Announcer, Maurice Wetzel. Slogan, "The Furniture City." Daily ex Sun, 11-11:30 am; 6:30-7 pm; 8-9. Sun, 4:30-5 pm, 7:30-9. Central daylight.

WEBL, (Portable Station). 226 meters. 10 watts. Radio Corp. of America.

WEBM, Mobile, Ala. 226 meters. 100 watts. Radio Corp. of America. (Portable.)

WEBQ, Harrisburg, Ill. 226 meters. 10 watts. Tate Radio Co. Announcer, Joseph R. Tate. Slogan "Blue Bird Station." Daily ex Sun, 7:15 pm, news, weather. Central.

WEBR, Buffalo, N. Y. 244 meters. 100 watts. H. H. *Howell. Slogan, "We Extend Buffalo's Regards." Daily ex Sun, 7:45-8:30 pm, bedtime stories. Mon, Wed, Fri, 8:30-11:30 pm. Sun, 12 m, 3 pm. Eastern.

WEBT, Dayton, Ohio. 256 meters. 5 watts. The Dayton Co-op. Industrial High School. Announcer, Irwin Snyder. Slogan, "Worthy Effort Brings Triumph."

WEBW, Beloit, Wis. 268 meters. 500 watts. Beloit *College. Announcer, Glenn Armstrong. Sun, 4:30 pm, Central.

WEBZ, Savannah, Ga. 263 meters. 50 watts. Savannah Radio Corp. Mon, Wed, Fri, 8:30 pm. Eastern.

WEEI, Boston, Mass. 348.6 meters. 500 watts. Edison *Elec. Illuminating Co. Announcer, C. R. Emery. Slogan: "The Friendly Voice." Daily ex Sun, 6:45 am, exercises; 7:45, watch. Mon, 4 pm, 5:30, 6:30-10:30, 10:30. Tues, 3 pm, 4, 6:30-10, 10. Wed, 4 pm, 6:30-10, 10. Thurs, 4 pm, 6:30-10, 10. Fri, 4 pm, 6:30-10, 10. Sun. 7:20 pm, 9:20. Eastern.

WEHS, Evanston, Ill. 205.4 meters. 20 watts. Robert E. Hughes.

WEMC, Berrien Springs, Mich. 285.5 meters. 500 watts. *Emanuel Missionary College. Slogan, "The Radio Lighthouse."

WENR, Chicago, Ill. 266 meters. 1,000 watts. All-Ameri- *can Radio Corp. Announcer, Frank Westphall. Wed, Fri, Sat, 6-7 pm; 8-10; 12-2. Tues, Thurs, 6-7 pm; 8-10. Sun, 3-4 pm; 9:30-11:30.

WEW, St. Louis, Mo. 248 meters. 100 watts. St. *Louis University. Daily ex Sun, 9 am, 10, 2, 5 pm, reports. Tues, Thurs, 7 pm, lectures, music. Sun, 7:30 pm. Central.

WFAA, Dallas, Tex. 475.9 meters. 500 watts. Dal- *las News and Dallas Journal. Announcer, Adams Colhoun. Slogan, "Working for All Alike." Daily, 6:30-7:30 am, exercises. 10:30 am, reports; 12:30-1 pm, address; 2:30-3, 3:30-4, 4:30-5, reports, news; 5:30, children's hour; 8:30-9:30, concert, weather (silent Wed.). Mon, Tues, Thurs, Fri, Sat, 6:30-7:30 pm, vesper recital, sports. Tues, Thurs, Sat, 11-12 pm, music. Sun, 6:30-7:30 pm, Bible class; 8, church service; 9:30-11, music. Central.

WFAM, St. Cloud, Minn. 273 meters. 10 watts. St Cloud Daily Times. Slogan: "Granite City of the World." Announcer, Otto A. Rupp. Daily ex Sun, 4:45 pm, markets. Central.

WFAV, Lincoln, Nebr. 275 meters. 500 watts. Univ. of *Nebraska. Central.

WFBC, Knoxville, Tenn. 250 meters. 50 watts. First Baptist church. Announcer, St. John Reynolds. Sun, 10:45 am; 7:30 pm, services; 4 pm, sacred music. Central.

WFBD, Philadelphia, Pa. 234 meters. 5 watts. Gethsemane Baptist church. Off the air in the summer.

WFBE, Seymour, Ind. 226 meters. 10 watts. Van de *Walle Music and Radio company. Announcer, John Van de Walle.

WFBG, Altoona, Pa. 278 meters. 100 watts. The Wm. F. Gable Co. Announcer, Roy F. Thompson. Slogan, "The Original Gateway to the West." Daily ex Sat, Sun, 11:45 am, music; 3:45 pm; 6:15. Mon, 7:15 pm, 7:30, 8, 9:15. Tues, 8:30 pm, 11:15. Thurs, 7:15 pm, 8:30, 10:30. Fri, 7:15 pm; 7:30, 8:30, 11:15. Sat, 7:30 pm. Eastern.

WFBH, New York, N. Y. 272.6 meters. 500 watts. Con- *course Radio Corp. Announcer, Alvin E. Hauser. Slogan, "Voice of Central Park." Mon, Tues, Fri, 2-7 pm. Wed, Thurs, Sat, 2-8 pm. Mon, Sat, 11:30 pm. Sun, 5-8 pm. Eastern.

WFBI, Camden, N. J. 236 meters. 500 watts. Galvin *Radio Supply Co.

WFBJ, Collegeville, Minn. 236 meters. 50 watts. St. *John's university. Announcer, Hilary Doerfler. Slogan, "In the Heart of the Landscape Paradise." Sun, 7-7:30 pm. Central.

WFBL, Syracuse, N. Y. 252 meters. 100 watts. Onondaga Hotel company. Announcer, Ernest E. Chappell. Daily ex Sun, 12-1 pm; 6:15-7:15. Tues, Thurs, Sat, 10:12 midnight. Fri, 9-9:45 pm. Sun, 5-6 pm; 6:15-7:15. Eastern.

WFBM, Indianapolis, Ind. 268 meters. 250 watts. Merchants Heat and Light company. Announcer, John C. McPhee. Slogan, "The Convention City of America." Closed for the summer.

WFBR, Baltimore, Md. 254 meters. 100 watts. Fifth Infantry, Maryland National Guard. Slogan, "Home of the Star Spangled Banner." Announcer, H. J. Lepper. Mon, Wed, Fr. matinee programs. Thurs, Thurs, Sat, evening programs. Sun, morning program. Eastern.

WFBZ, Galesburg, Ill. 254 meters. 20 watts. Knox college.

WFDF, Flint, Mich. 234 meters. 100 watts. Frank D. *Fallain. Slogan, "The Vehicle City." Fri, 8 pm. Eastern.

WFI, Philadelphia, Pa. 394.5 meters. 500 watts. Straw- *bridge & Clothier. Announcer, John Vandersloot. Daily ex Sun, 10:15 am, reports; 10:30, music; 10:40, home service; 1-1:50 pm, orchestra; 1:50, reports; 3-4:30, concert; 6:30-7, orchestra. Tues, Thurs, Sat, 8, concert. Sun, 10:30 am, 7:30 pm, church services alternating. Eastern.

WFKB, Chicago, Ill. 217.3 meters. 500 watts. Francis *K. Bridgman. Announcer, Horace Kehm. Daily ex Sun, Mon, 7-10 pm. Central.

WFRL, Brooklyn, N. Y. 205.4 meters. 100 watts. *Robert Morrisson Lacey.

WGAL, Lancaster, Pa. 248 meters. 10 watts. Lancaster Elec. Supply & Construction Co. Announcer, J. R. Gaintner. Slogan: "World's Gardens at Lancaster." Mon, Wed, Fri, 5:45-6:15 pm, dinner concert. Wed, 11:15-1 am, organ. Eastern.

WGBA, Baltimore, Md. 254 meters. 100 watts. Jones Elec. & Radio Mfg. Co., Slogan, "Watch Greater Baltimore Advance." Announcer, Winters Jones. Club "Staying up with the Jones." Daily ex Sun, 12-1:30 pm. Mon, 7-8 pm, 9:30-12. Thurs, 7-12. Sun. 9:30-11:30 pm. Every other Sun, 2-4 pm. Eastern.

WGBB, Freeport, N. Y. 244 meters. 100 watts. Harry H. Carman. Sun, 10:45 am, church. Eastern.

WGBC, Memphis, Tenn. 266 meters. 10 watts. First Baptist church. Announcer, M. L. Martin. Slogan. "Radio Bible Class." Sun, 9:55 am, 7:30 pm. Central.

WGBF, Evansville, Ind. 236 meters. 100 watts. The *Finke Furniture Co. Announcer, Harold Finke. Daily ex Sun, 7:15 am, family alter; 12:10 pm, weather, markets, news; 5:20, baseball. Tues, Fri, 8-10 pm. music. Fri, 11-12:30 am. Midnight Air Raiders. Sun, 9-10:30 am, service; 7:30-9 pm. music. Central.

WGBI, Scranton, Pa. 240 meters. 10 watts. Frank S. Megargee.

WGBK, Johnstown, Pa. 248 meters. 5 watts. Lawrence *W. Campbell. Daily ex Sun, 5-6:30 pm. Sat, 8:45-11:45 pm, dance music. Sun, 3-5 pm. Eastern.

WGBL, Elyria, Ohio. 227 meters. 10 watts. Elyria Radio Assn.

WGBM, Providence, R. I. 234 meters. 30 watts. Theo. *dore N. Saaty. Mon, 10 pm. Wed, Fri, 6:30 pm. Eastern.

WGBQ, Menominee, Wis. 234 meters. 100 watts. Stout Institute.

WGBR, Marshfield, Wis. 229 meters. 10 watts. George S. Ives. Sun, 2-4 pm, 7-9. Central.

WGBS, New York, N. Y. 315.6 meters. 500 watts. Gim- * bel Brothers. Announcer, Floyd Neale. Daily ex Sun, 10-2:30 pm, entertainment; 3-7:30. Tues, 8:30-12. Thurs, 8:30-1 am. Sat, 7:30-12. Sun, 3:30-4:30 pm; 9:30. Eastern.

WGBU, Fulford By-the-Sea, Fla. 278 meters. 500 watts. Florida Cities Finance Co. Chamber of Commerce. Announcer, Robert H. Nolan. Daily ex Sun, 12-1 pm, music; 6:30-7:30, 10-1 am. Sun, 9-11 pm. Eastern.

WGBW, Spring Valley, Ill. 256 meters. 10 watts. *Valley Theater. Announcer, Verner Hicks. Thurs, 10-11:30 pm. Sun, 10:30-12 m. Central.

WGBX, Orono, Me. 252 meters. 100 watts. University of Maine.

WGCP, New York, N. Y. 252 meters. 500 watts. Grand Central Palace. Announcer, Alfred Hall. Slogan. "Four Leaf Clover Station." Daily ex Sun, 3-6 pm. Mon, Wed, Fri, Sun, 8-11 pm. Eastern.

WGES, Oak Park, Ill. 250 meters. 500 watts. Coyne *Elec. School. Announcer, John Stamford. Daily ex Sun, Mon, 5-7 pm, 10:30-1 am. Sun, 5-7 pm, 10:30-12. Central.

WGHP, Detroit, Mich. 270 meters. 1,500 watts. George *Harrison Phelps, Inc. Announcer, C. D. Tomy.

WGMU, Richmond, Hill, N. Y. 236 meters. 100 watts. *A. H. Grebe & Co., Inc. (Marine), Yacht M. U. 1.

WGN, Chicago, Ill. 370.2 meters. 1000 watts. Chicago *Tribune. Announcer, Quin A. Ryan. Daily ex Sun, 11:57 am, time; 12:40-2:30 pm, music, 2:30-3 music; 3-3:30; 5:30-5:50. Skeezix time; 5:50-5:57, stocks; 5:57, time; 6-6:30, organ; 6:30-7:30, dinner music; 8:30-9:30, 10:30-11:30. Tues, Thurs, 12:30 pm, farm talk. Sun, 12-1 pm, 1-2, 2-5, 9-10. Central.

WGR, Buffalo, N. Y. 319 meters. 750 watts. Federal *Radio Corp. Announcer, Otto Becker. Slogan, "Key City of Industry." Daily 12 m, reports; 12:45, concert. Daily ex Sun, 2:30; 7:30, news. Tues, Thurs, Sat, 6:30 pm, music. Mon, Wed, Fri, 9-11 pm; Tues, Thurs, 8-11 pm, from New York. Sun, 10:30 am, church; 3 pm, vesper services; 8:30. Eastern.

WGST, Atlanta, Ga. 270 meters. 500 watts. Georgia *School of Technology. Announcer, J. H. Persons. Slogan, "The Southern Technical School with a National Reputation."

WGY, Schenectady, N. Y. 379.5 meters. 3,500 watts. *General Electric Company. Announcer, Kolin Hager. Daily ex Sun, 11:55 am, time; 12:30 pm, stocks, markets; 12:45, weather. Daily ex Sun, 12:40 pm, fruit, vegetable reports; 6, stocks; 6:10, markets; 6:15, sports, news. Mon, Tues, Thurs, Fri, 2 pm, woman's hour. Tues, Thurs, 2:30 pm, organ. Mon. Tues, Thurs, 6:30-7 pm, dinner program. Thurs, 11:30 pm, organ. Fri, 7 pm; Wed, 6:30, stories. Fri, 6:30 pm, Sunday school lesson; 10:30, late program. Second and last Mon, 7:15 pm, agricultural talk. Wed, Fri, 7 pm, orchestra. Sat, 9:30 pm, dance program. Sun, 10:30-12 am, service; 7:30-8:45 pm, service; 8:45 pm, orchestra from WJZ. Eastern.

WHA, Madison, Wis. 535.4 meter 750 watts. Univ. *of Wis. Mon, Wed, Fri, 7:30 pm. Central.

WHAD, Milwaukee, Wis. 275 meters. 500 watts. Mar- *quette University. Milwaukee Journal. Announcer, Ed. Renft. Daily, 11 am, weather, news; 4-4:30 pm, news, markets, current topics, music; 6-7, organ; 7-7:30, sports, financial reports. Mon, Wed, 8-10 pm. Wed, 11:30-12:30. Fri, 8:30-10 pm. Central.

WHAG, Cincinnati O. 233 meters. 100 watts. Univ. of Cincinnati. Dept of Elec. Eng. Announcer, W. C. Osterbrock. No definite schedule.

WHAM, Rochester, N. Y. 278 meters. 100 watts. *Univ. of Rochester. Rochester Times-Union, Democrat and chronicle. Daily ex Sun, 3:30-4 pm, 5-6, 7-7:40. Sun, 3:15, Radio Chapel. Eastern.

WHAP, Brooklyn, N. Y. 240 meters. 100 watts. Wil- *liam H. Taylor Finance Corp. Announcer H. Alvin Simmons. Slogan, "The Station for Public Service." Daily ex Sun, 6-7:30 pm. Eastern.

WHAR, Atlantic, City, N. J. 275 meters. 500 watts. *Seaside Hotel. Announcer, E. Dennison. Daily ex Sun, Wed, 2 pm, 7:30, 7:45, 8. Sun, 2:45 pm, 3, 7:50, 9. Eastern.

WHAS, Louisville, Ky. 399.8 meters. 500 watts. Courier- *Journal and Louisville Times Co. Announcer, D. H. Ives. Daily ex Sun, 3:30 pm, baseball; 4-5, 7:30-9. Sun, 9:57-10:45 am, 4-5 pm, church service. Mon night, silent. Central.

WHAT, Minneapolis, Minn. 263 meters 500 watts. *Twin City Business Men's Broadcasting station. Announcer, Dr. George Young. Mon, 6-8 pm, 9-11. Tues, 7-9 pm. Wed, 6-10 pm. Fri, 7-11 pm. Central.

WHAV, Wilmington, Del. 266 meters. 100 watts. Wilmington Elec. Spec. Co. Slogan, "The First Broad casting Station of the First City of the First State." Temporarily discontinued.

WHAZ, Troy, N. Y. 379.5 meters. 500 watts. Rensselaer *Polytechnic Inst. Announcer, Rutherford Hayner. Slogan, "Transcontinental and International Broadasting Station Located at the Oldest College of Science and Engineering in America." Club, R. P. I. students. Mon, 9-12 midnight, concert, educational talks, orchestras, features. Second Monday of Month, 12-1:30 am. International test program. Eastern.

WHB, Kansas City, Mo. 365.6 meters. 500 watts. Sweeney Auto & Electric School. Announcer, John T. Schilling. Slogan, "Heart of America." Daily ex Sun, 8:25 am, 8:30, 8:35, 9:25, 9:30, 10:25, 10:30, 10:40. Daily ex Sat, Sun, 11:20, 11:30, 11:40, 11:56, 12, 12:10 pm, 12:25, 1:25, 3, stocks, weather, news, at, 11:20 am, 12:10 pm, 1:25. Daily ex Sat, Sun, 2-3 pm, ladies' hour. Tues, Thurs, 7-7:30 pm, 8-10. Mon, Wed, Fri, 7-8 pm. Sun, 9:40 am, 11:15, 8 pm. Central.

WHBA, Oil City, Pa. 250 meters. 10 watts. Shaffer Music House.

WHBC, Canton, Ohio. 254 meters. 10 watts. Rev. E. P. Graham.

WHBD, Bellefontaine, Ohio. 222 meters. 20 watts. Charles W. Howard.

WHBF, Rock Island, Ill. 222 meters. 100 watts. Beardsley Specialty company. Announcer, C. L. Beardsley. Mon, 8-11 pm. Wed, 7:30-10 pm. Sat, 2-4 pm; 7-9. Central.

WHBG, Harrisburg, Pa. 231 meters. 20 watts. John S. *Skane. Mon, Fri, 11:30-12:15 pm. Wed, 8:30-10 pm. Sun, 2-4 pm. Eastern.

WHBH, Culver, Ind. 222.1 meters. 100 watts. Culver *Military Academy. Announcer, Charles C. Mather. Mon, 7:30 pm. Sat, 6:30 pm. Central.

WHBJ, Ft. Wayne, Ind. 234 meters. 50 watts. Lauer *Auto company.

WHBK, Ellsworth, Maine. 231 meters. 10 watts. Franklin St. Garage, Inc.

WHBL, Logansport, Ind. 215.7 meters. 50 watts. James H. Slusser. (Portable).

WHBM, Chicago, Ill. 233 meters. 20 watts. C. L. Carrell. (Portable).

WHBN, St. Petersburg, Fla. 238 meters. 10 watts. First Avenue Methodist church.

WHBP, Johnstown, Pa. 256 meters. 100 watts. Johnstown Automobile Co. Announcer, J. C. Tully. Slogan, "The Voice of the Friendly City." Wed, 9 pm. Sat, 10 pm. Eastern.

WHBQ, Memphis, Tenn. 233 meters. 20 watts. Scien- *Fellowship class. St. John's M. E. church. Announcer, Dr. George L. Powers. Slogan, "We Have Best Quartet." Wed. 8-9 pm, music. Sun, 9:45-10:45 am, 11, 7:45 pm, services. Central.

WHBR, Cincinnati, Ohio. 215.7 meters. 20 watts. Scien- *tific Elec. & Mfg. Co. Announcer, Radio Rouse. Slogan, "That's Us." Tues, 8-10:30 pm. Thurs, 10-12 midnight. Sun, 2-4 pm, 9-11. Central.

WHBU, Anderson, Ind. 218.8 meters. 10 watts. Bing's *Clothing-Riviera Theater. Announcer, O. B. Robey. Slogan, "The Home of Chief Anderson." Daily ex Sun, 9-9:30 am, 12-12:30 pm. Wed, Fri, Sun, 7-9 pm. Central.

WHBW, Philadelphia, Pa. 242 meters. 100 watts. D. R. Kienzle. Wed evening.

WHBY, West De Pere, Wis. 250 meters. 50 watts. St. Nobert's College.

WHDI, Minneapolis, Minn. 278 meters. 500 watts. Wm. Hood Dunwoody Industrial Institute. Announcer, Hal Marston. Mon, 8-9 pm. Wed, Fri, 9-10 pm. Central.

WHEC, Rochester N. Y. 258 meters. 100 watts. Hickson Electric company, Inc. Announcer, J. F. Hitchcock. Slogan, "With Hickson Elec. Co." Daily ex Sun, 6:30-7:30 pm. Eastern.

WHK, Cleveland, Ohio. 273 meters. 250 watts. Radiovox Company, Winton hotel. Announcer, Art Cook. Slogan, "Voice of the Fifth City." Daily ex Sun, 1-1:20 pm, farm school; 4-5:30, 6:30-7:30. Thurs, 9-12 mid, Karnival Klub. Fri, 10-12, dance music. Sat, 12-3 am. Sun, 10:30 am, church service; 9-11 pm. Eastern.

WHN, New York, N. Y. 360 meters. 500 watts. Loew's *State Broadcasting Station. Announcer, N. T. Grandlund. Slogan, "The Voice of the Great White Way." Daily ex Sun, 12-1 pm, 2:15-3:15, 3:45-5:30, 6:30-12 midnight. Sun, 3-6 pm, 9:30-12. Eastern.

WHO, Des Moines, Ia. 526 meters. 5,000 watts. Bankers *Life Co. Announcer, N. Dean Cole. Daily ex Sun, 9:45 am, 12 m, 2 pm, markets, weather. Mon, Tues, Thurs, Fri, 7:30-9 pm. Wed, 6:30-7:30 pm, 7:30-9, 9-10, 10-11:30. Fri, 11-12 mid. Mon, Tues, Thurs, 11-12 midnight. Sun, 11 am, 1 pm, 7:30-8:30. Central.

WHT, Deerfield, Ill. 238-400 meters. 1,500 watts. Wrig- *ley Bldg. Announcer, Pat Henry Barnes. Daily ex Sun, Mon, (399.8), 11-2 pm, 7-8:30, 10:30 -1; (238), 8:45-10:15. Mon (399.8), 11-2 pm, 7-1 am. Sun, 12-10:30 pm, Paul Rader. Central.

WIAD, Philadelphia, Pa. 250 meters. 100 watts. *Howard R. Miller. Slogan, "The Voice from the Birthplace of Liberty." Tues, Fri, 9 pm. Eastern.

WIAS, Burlington, Ia. 254 meters. 100 watts. Home Elec. Co. Announcer, Harry H. Waugh. Slogan, "Burlington, on the Mississippi." Tues, 8-9 pm. concert. Thurs, 7-8 pm, concert. 10:30-11, organ. Sun, 10:30 am, church services. Central.

WIBA, Madison, Wis. 236 meters, 100 watts. The Capital Times. Announcer, Don Patterson. Slogan, "Four Lakes City." Mon, Wed, Fri, 8:45-10 pm. Sat, 12-1 am. Central.

WIBC, St. Petersburg, Fla. 222 meters. 100 watts. L. M. Tate Post No. 39, Veterans of Foreign Wars. Mon, Wed, 8-10:30 pm. Sat, 8-9 pm, 10:30-12. Eastern.

WIBG, Elkins Park, Pa. 222 meters. 50 watts. St. Paul's Protestant Episcopal church. Announcer, Charles T. Asbury. One Monday a month Ogontz Forum speaks. Sun, 10:45 am, 3:45 pm. Eastern.

WIBH, New Bedford, Mass. 210 meters. 5 watts. Elite Radio Stores. Announcer, J. T. Moriarty. Slogan, "The Voice of New Bedford." Morning and afternoon programs.

WIBI, Flushing, N. Y. 218.8 meters. 5 watts. Frederick B. Zittell, Jr.

WIBJ, Chicago, Ill. 215.7 meters. 50 watts. C. L. *Carrell. (Portable.)

WIBM, Chicago, Ill. 215.7 meters. 10 watts. Billy Maine. (Portable.)

WIBO, Chicago, Ill. 226 meters. 1,000 watts. Nelson *Brothers. Announcer, Harry Geise. Daily ex Sun, 2-4 pm. Daily ex Sun, Mon, 6-8 pm. Tues, Thurs, 12-3 am. Wed, 10-12 midnight. Fri, 10-2 am. Sun, 10:15 am, service; 2-4 pm, concert; 6-8, 10-12. Central.

WIBR, Weirton, W. Va. 246 meters. 50 watts. Tri-State Radio Co. Announcer, W. D. Johnston. Slogan, "The Town Where Everybody Works." Fri, 8:30-11 pm. Sun, 2-3 pm. Eastern.

WIBS, Elizabeth, N. J. 202.6 meters. 20 watts. New Jersey National Guard.

WIBU, Poynette, Wis. 222 meters. 20 watts. The Electric Farm.

WIBV, Henderson, N. C. 263 meters. 20 watts. Jewell Radio Co.

WIBW, Logansport, Ind. 220 meters. 100 watts. Dr. L. L. Dill.

WIBX, Utica, N. Y. 205.4 meters. 5 watts. Grid-Leak, Inc.

WIBZ, Montgomery, Ala. 231 meters. 10 watts. Powell Elec. Co.

WIL, St. Louis, Mo. 273 meters. 250 watts. St. Louis *Star and Benson Radio Co. Announcer, Billy Knight. Slogan, "Watch It Lead." Mon, Sat, 10-12 midnight. Wed, Fri, 9-11 pm. Thurs, 8-10 pm. Central.

WIP, Philadelphia, Pa. 508.2 meters. 500 watts. Gimbel *Bros. Announcer, E. A. Davies. Slogan, "Watch Its Progress." Daily ex Sun, 7-7:30 am, 1-2 pm, 3-4:30, 6-6:45, music; 7-7:30, pm. Tues, Thurs, Sat, 8-12 pm, concert. Sun, 10:45-12 m, 4:15-5:30 pm, 7:45-9, 10-12. Eastern.

WJAD, Waco, Tex. 352.7 meters. 500 watts. Frank P. *Jackson. Mon, Fri, 8:30-10 pm. Central.

WJAG, Norfolk, Nebr. 276 meters. 250 watts. Norfolk Daily News. Announcer, Karl Stefan. Slogan, "The World's Greatest Country Daily, and Home of Printer's Devil." Daily ex Sun, 12:15 pm; Sun, 3:30-6 pm, music. Central.

WJAK, Greentown, Ind. 254 meters. 100 watts. Clifford L. White. Slogan, "The Radio Parson." Daily ex Sun, 12-1 pm, chapel. Thurs, 6:30 pm, music. Sat, 6:30 pm, Bible school lesson. Central.

WJAM, Cedar Rapids, Ia. 268 meters. 100 watts. D. M. Perham. Daily ex Sun, 9 am, 10:30, 12:30 pm, markets reports. Tues, Thurs, Sat, 6-6:30 pm, children's hour. 6:30-10:30. Sun, 4 pm, vesper service. Central.

WJAR, Providence, R. I. 305.9 meters. 500 watts. The *Outlet Co. Announcer, J. A. Reilly. Slogan, "The Southern Gateway of New England." Daily ex Sun, 1:05-2:15 pm, weather, reports, music. Mon, Wed, Fri, 10 am, household hints. Mon, Tues, 7:30-10 pm. Wed, 7:30-10:30 pm, Thurs, 8-11 pm. Fri, 8-10 pm, 11-12. Sun, 7:20-10:15 pm. Eastern.

WJAS, Pittsburgh, Pa. 275 meters. 500 watts. Pitts- *burgh Radio Supply House. Pickering's Studio. Announcer, Bryan McDonald. Slogan, "Worl 's Jolliest Aerial Station." Daily ex Sun, 7-8 pm, dinner concert; 8-11. Sun, 2 pm. Eastern.

WJAZ, Mt. Prospect, Ill. 322.4 meters. 1,500 watts. *Zenith Radio Corp.

WJBA, Joliet, Ill. 206.8 meters. 50 watts. D. H. Lentz, Jr. Tues, 8-11 pm. Central.

WJBB, St. Petersburg, Fla. 206.8 meters. 10 watts. L. W. McClung.

WJBC, La Salle, Ill. 234 meters. 100 watts. Hummer *Furniture Co. Announcer, Harry Halpin. Daily ex Sun, 12:30-1 pm. Mon, Thurs, 8-11 pm. Central.

WJBD, Ashland, Wis. 233 meters. 100 watts. Ashland *Broadcasting committee. Announcer, C. W. Pfeifferkoin. Slogan, "The Voice of the Great North Woods."

WJBI, Red Bank, N. J. 218.8 meters. 250 watts. Robert S. Johnson.

WJBL, Decatur, Ill. 270 meters. 500 watts. Wm. Gus- *hard Dry Goods Co.

WJD, Granville, O. 217.3 meters. 10 watts. Denison Univ. Announcer, Richard H. Howe. Fri, Sat, 5-6 pm, music, educational lectures. Athletics. Eastern.

WJJD, Moosheart, Ill. 302.8 meters. 500 watts. Loyal Order of Moose Station. Announcer, Jack Nelson. Slogan, "The Call of the Moose." Daily ex Sun, Mon, 3:30-4:30 pm, children's program; 6:45-8 pm, 10:30-1. Sun, 8:45-10 am, services; 10:45-12, services; 12-2. Central.

WJR, Detroit, Mich. 516.9 meters. 5,000 watts. Jewett *Radio and Phonograph Co. Slogan, "Where Joy Reigns." Announcer, Leo Fitzpatrick. Daily ex Sun, 7-8 pm, 9-10. Thurs, 10-11 pm. Eastern.

WJY, New York City. 405.2 meters. 1000 watts. R.C.A. *Announcer, J. Lewis Reid. Tues, Thurs, Fri, 7:30-11:30 pm, concert. Sun, 8:15-10:30 pm. Eastern.

WJZ, New York, N. Y. 454.3 meters. 1,000 watts. *R. C. A. Announcer, Milton J. Cross. Daily ex Sun, 10-11 am, 1-2 pm, 4-6, entertainment; 7-11:30 pm, special program. Sun, 11 am-1 pm, church services; 2:30-5 pm, 7-10:30 pm. Eastern.

WKAA, Cedar Rapids, Ia. 278 meters. 500 watts. H. F. Parr, announcer. Mon, Wed, Fri, 4-5 pm; 8:30-10:30. Sun, 11 am, 5 pm, church service. Central.

WKAF, Milwaukee, Wis. 261 meters. 250 watts. WKAF Broadcasting Co.

WKAP, Cranston, R. I. 234 meters. 50 watts. Dutee Wilcox Flint, Inc.

WKAQ, San Juan, Porto Rico. 340.7 meters. 500 watts. *Radio Corp. of Porto Rico. Announcer, Joaquin Agusty. Slogan, "The Island of Enchantment, Where the World's Best Coffee Grows." Wed, 8-10 pm, band; Thurs, 8:30-10 pm; Fri, 9-10 pm, band. Intercolonial.

WKAR, East Lansing, Mich. 285.5 meters. 1,000 watts. *Mich. State College. Announcer, J. B. Hasselman. Mon, 8-9 pm. Eastern.

WKAV, Laconia, N. H. 209.7 meters. 50 watts. Laconia Radio Club (Portable).

WKBE, Webster, Mass. 231 meters. 100 watts. K. *& B. Electric Co. Tues, 8-12 midnight. Eastern.

WKBG, Chicago, Ill. 215.7 meters. 100 watts. C. L. Carrell. (Portable).

WKBK, New York, N. Y . 209.7 meters. 500 watts. *Shirley Katz.

WKRC, Cincinnati, Ohio. 422.3 and 325.9 meters, al- *ternate months, 1,000 watts. Kodel Radio Corp. Announcer, Eugene S. Mittendorf. Mon, 6:15-7 pm. 8-10, 12-1. Tues, Thurs, Sat, 10-12 midnight. Wed, 8-10 pm. Sun, 6:45-7:30 pm; 10-12. Central.

WKY, Oklahoma City, Okla. 275 meters. 100 watts. E. C. Hull, H. S. Richards. Daily ex Sun, 3-4 pm, markets, weather, news. Daily ex Sun, 6:30-8:30 pm. Sun, 9:30-12:30 pm; 7:45-9:45. Central.

WLAL, Tulsa, Okla. 250 meters. 150 watts. First Christian church. Announcer, R. W. Burkhart. Slogan, "The Voice of the Church." Sat, 7:30 pm, Bible class. Wed, 9:30 pm. Sun, 7:30 pm, church. Central.

WLAP, Louisville, Ky. 275 meters. 20 watts. W. V. Jordon. Tues, Fri, 9:20-10 pm. Central.

WLAX, Greencastle, Ind. 231 meters. 10 watts. Greencastle Community Broadcasting Station. Announcer, C. W. Otis. Tues, Thurs, 8 pm. Sun, 7:45 pm, church services. Central.

WLB, Minneapolis, Minn. 278 meters. 500 watts. U. of Minn., Dept of Elec. Eng.

WLBL, Stevens Point, Wis. 278 meters. 500 watts. Wisconsin Dept. of Markets. Slogan, "Wisconsin, Land of Beautiful Lakes." Daily ex Sun, 8:45 am, 9:45, 10:45, 11:45, 12:30 pm, 1:45, markets. Tues, Thurs, 8 pm. Central.

WLIT, Philadelphia, Pa. 394.5 meters. 500 watts. *Lit Bros. Announcer, Harry E. Ehrhart. Club, "Morning Glory." Daily ex Sun, 12:02 pm, music; 2, music. Mon, 4:30 pm, 7:30, 8, 10. Tues, 11 am. Wed, Thurs, 4:30 pm. Wed, 7:30 pm, 8, 10, 11. Fri, 7:30 pm, 8:45, 10. Eastern.

WLS, Chicago, Ill. 344.6 meters. 500 watts. Sears, Roe- *buck & Co. Announcer, George D. Hay. Slogan. "World's Largest Store." Daily ex Sun, 9 am, 10, 11, 12, 1-2. Tues, 6:30-7:55 pm. Wed, 6:30-12:30 am. Fri, 6:30-11:30. Thurs, 6:30-8:55. Sat, 12-12:45 pm, Junior R. F. D. program; 7:45-1. Sun, 7:30-8:55. Central.

WLTS, Chicago, Ill. 258 meters. 100 watts. Lane *Technical High school. Thurs, 1-2 pm. Central.

WLW, Cincinnati, O. 422.3 meters. 5000 watts. The *Crosley Radio Corp. Announcer, William Stoess. Daily ex Sun, 10:45 am, 11:55, time; 1:30 pm. Daily ex Sun, Fri, 7, dinner hour; 7:30, baseball; 6:55, markets. Daily ex Sat, Sun, 7:45 am, morning devotions; 8, exercises; 12:15, program; 3, 4, reports. Mon, Tues, 8-10 pm. Wed, Thurs, 10-12 mid. Sun, 9:30 am, 11, 7:30 pm, 8:30. Central.

WLWL, New York, N. Y. 288.3 meters. 1,000 watts. *Missionary Society of St. Paul the Apostle. Announcer, James F. Cronin. Slogan, "For God and Country." Sun, Tues, Fri, 8 pm. Eastern.

WMAC, Cazenovia, N. Y. 275 meters. 100 watts. C. B. Meredith. No definite schedule.

WMAF, South Dartmouth, Mass. 440.9 meters. 1,000 watts. Round Hills Radio Corp.

WMAK, Lockport, N. Y. 266 meters. 500 watts. Norton Laboratories. Announcer, I. R. Lounsberry. Thurs, 11 pm, midnight serenaders. Eastern.

WMAN, Columbus, Ohio. 278 meters. 50 watts. First Baptist church. Announcer, Dr. D. F. Rittenhouse. Sun, 10:30-12 m. 7:30-9 pm, church services. Eastern.

WMAQ, Chicago, Ill. 447.5 meters. 500 watts. The Chi- *cago Daily News. Announcer, Roberty Whitney. Daily ex Sun, Mon, 12-3 pm, 4-7. Daily ex Sun, Mon, 8-10 pm. Central.

WMAY, St. Louis, Mo. 248 meters. 100 watts. Kingshighway Presbyterian church. Slogan, "May Every By-Way Hear Kingshighway." Sun, 11 am, 8 pm. Central.

WMAZ, Macon, Ga. 261 meters. 500 watts. Mercer university. Announcer, Carey O. Pickard. Mon, Thurs, Fri, 10-11 pm. Mon, Fri, 9-10 pm. Tues, Thurs, 8-9 pm. Wed. 11-12. Eastern.

WMBB, Chicago, Ill. 250 meters. 500 watts. American *Bond & Mortgage Co.-Trianon. Announcer, Clyde Hager. Slogan, "World's Most Beautiful Ballroom." Daily ex Mon, 7-8 pm; 9-11. Sun, 3-5 pm. Central.

WMBF, Miami Beach, Fla. 384.4 meters. 500 watts. *Fleetwood hotel. Daily, 7-8 pm, dinner concert; 8-8:15, news; 8:15-8:30, dance; 10-12. Eastern.

WMC, Memphis, Tenn. 499.7 meters. 500 watts. The Com- *mercial Appeal. Announcer, Francis S. Chamberlin. Slogan, "Station WMC, Memphis." "Down in Dixie." Club, "Midnight Frolic." Daily ex Sun, 9:45 am, 2:30 pm, weather, markets, music. Daily ex Sun, Wed, 8:30 pm, program; Tues, Fri, 11 pm, Midnight frolic. Sun, 11 am, church service. Central.

WMCA, New York, N. Y. 340.7 meters. 500 watts. *Greeley Square Hotel Co. Announcer, A. V. Ilufrio. Slogan, "Where the White Way Begins." Daily ex Sun, 11-12 m; 6:30-12 am. Sun, 11-12:15 pm; 7-10. Eastern.

WNAB, Boston, Mass. 250 meters. 100 watts. The Shepard Stores. Announcer, John J. Fanning.

WNAC, Boston, Mass. 280.2 meters. 500 watts. The *Shepard Stores. Announcer, John J. Fanning. Daily ex Sun, 10:30-11:30 am, 12:53-2 pm, 4-5, 6-7:30, 8-10. Sun, 11 am, 1:30-3 pm, 3-4, 6:45-8:30. Eastern.

WNAD, Norman, Okla. 254 meters. 250 watts. Univ. of Okla. Announcer, C. E. Bathe. Slogans, "Oklahoma." "Voice of Sooner Land." Daily 9:15 pm, weather, news. Wed. 8:30-9:30 pm, music. Central.

WNAL, Omaha, Nebr. 258 meters. 50 watts. Central H. S. Announcer, Ronald J. Rockwell. Slogan, "Pioneer Broadcast of Omaha." Fri, Sat, 7:30-9 pm. Central.

WNAR, Butler, Mo. 231 meters. 20 watts. First Christian church. Announcer, Perry V. Riley. Sun, 11 am, 8 pm. Central.

WNAT, Philadelphia, Pa. 250 meters. 100 watts. Len- *nig Bros. Co. Announcer, Jess Brinton Young. Slogan, "We Never Are Tired." Wed, 6:50 pm. Eastern.

WNAX, Yankton, S. D. 244 meters. 100 watts. Dakota Radio Apparatus Co. Daily ex Sun, 11:30-11:45 am, markets, weather; 5-6 pm, music. Central.

WNJ, Newark, N. J. 252 meters. 500 watts. Radio Shop of Newark, Inc. Announcer, W. A. Bingenheimer. Slogan, "The Voice of Newark." Tues, Wed, Fri, Sat, Sun, 6-6:30 pm, 8:30-12, dance music. Eastern.

WNOX, Knoxville, Tenn. 268 meters. 500 watts. Peoples Telephone & Telegraph Co.

WNYC, New York, N. Y. 526 meters. 1000 watts. New York Municipal Radio Station. Announcer, Christie R. Bohnsack. Slogan, "Municipal Broadcasting Station of the City of New York." Daily 7 pm, markets; 7:30 pm, 10:30, police; 7:35, entertainment; 10:30, weather. Sun, 9-11 pm, Mark Strand theater. Eastern.

WOAC, Lima, O. 261 meters. 50 watts. Page Organ Co. (H. P. Maus). Tues, Thurs, Sat, 7:30-8:30 pm. Central.

WOAI, San Antonio, Tex. 394.5 meters. 1,500 watts. Southern Equip. Co. (Evening News-Express), Announcer, J. G. Cummings. Slogan, "The Winter Playground of America, Where the Sunshine Spends the Winter." Daily ex Sun, 9:30 am; 12:15 pm; 3, 7, news, baseball, markets, music. Daily ex Sun, Fri, 8:30-9:30, entertainment. Tues, Thurs, 9:30-10:30 pm. Sun, 11 am; 8 pm, services; 9:30-10:30, musical program. Central.

WOAN, Lawrenceburg, Tenn. 282.8 meters. 500 watts. James D. Vaughan. Announcer, James D. Vaughan. Daily ex Sun. 12:15-12:45 pm, concert. Daily ex Sat, 9-10 pm, concert. Central.

WOAW, Omaha, Neb. 526 meters. 1000 watts. Wood- *men of the World. Announcer, "GR," Gene Rouse. Slogan, "The City Surrounded by the United States." Daily ex Sun, Wed, 12:30-1:15 pm; 6-7:30, 9-11. Sat, 11-12 midnight, dance. Sun, 9-10:45 am; 2:30-4 pm; 9-11. Central.

WOAX, Trenton, N. J. 240 meters. 500 watts. F. J. *Wolff. Slogan, "The Voice from Trenton." Daily, 12:15 pm, 1:15, weather; Wed, 1:15 pm, midweekly crop report. Sun, 9:30-11:30 pm, orchestra. Eastern.

WOC, Davenport, Iowa. 483.6 meters. 5,000 watts. The *Palmer School of Chiropractic. Slogan, "Where the West Begins and in the State Where the Tall Corn Grows." Daily ex Sat. Sun, 12:30 pm, Radio Farm school; 12:57 pm, time; 1, weather; 1:05, closing markets; 3, home hour; 6, bulletin, baseball. Daily ex Sun, Mon, 5:45-6 pm. Tues, 6:30-7 pm, New York program; 8-9. Wed, 4-4:45 pm; 9-10. Thurs, 7 8, 8-9, 11:12. Fri, 4-5 pm. Crescent orchestra; 8-9. Sat, 9-10 pm; 11-12. Sun, 1-2 pm. Sun, 6:30-7:30 pm, church; 8:15-9:15, program; 9:45-11:45. Central.

WOCG, Sycamore, Ill. 205.4 meters. 10 watts. Triple Alliance Radio Station.

WOCL, Jamestown, N. Y. 275.2 meters. 15 watts. Hotel *Jamestown, Inc. Announcer, William A. McCutcheon. Slogan, "We're on Chautauqua Lake." Mon, 9 pm. Sun, 10:30 am, 7:30-9. Eastern.

WODA, Patterson, N. J. 221 meters. 250 watts. O'Dea *Temple of Music. Slogan, "A Voice from the Silk City." Daily ex Sun, 12-1 pm; 5-7, 8:30-11. Eastern.

WOI, Ames, Ia. 270 meters. 750 watts. Iowa State College. Announcer, H. B. Deal. Daily ex Sun, 9:30 am, weather reports; 12:30 pm, chimes, market, weather, educational talks; 9:30, weather. Central.

WOK, Homewood, Ill. 217.3 meters. 5,000 watts. Neutrowound Radio Mfg. Co. Announcer, George W. Allen. Daily ex Mon, Sun, 12-2 pm, 6-7, 10-1. Mon, 12-2 pm, 6-1. Sun, 7-1 am. Central.

WOKO, New York, N. Y. 233 meters. 50 watts. The Dyckman Radio Shop. Announcer, Eugene Delman. Mon, Thurs, Sat, evening program.

WOO, Philadelphia, Pa. 508.2 meters. 500 watts. John Wanamaker. Announcer, Jos. N. Nassau. Daily ex Sun 11 am, organ recital; 11:55, time; 12-1 pm, concert; 4:30, weather; 4:45, organ recital; 7:30, police reports; 9:55, time; 10:02, weather. Mon, Wed, Fri, 7:30-11 pm, music, concert. Sun, 2:30 pm, Sunday school; 6, organ recital; alternate am and pm services. Eastern.

WOQ, Kansas City, Mo. 278 meters. 1,000 watts. Unity *School of Christianity. Tues, 8-9 pm. Thurs, 7-7:45 pm, 7:45-9. Sat, 8-9 pm, 10-11 pm. Sun, 8-9:15 pm. Central.

WOR, Newark, N. J. 405.2 meters. 500 watts. L. Bam- *berger & Co. Announcer, J. M. Barnett. Daily ex Sun, 6:45 am, 2:30-4 pm. Mon, Wed, Sat, 6:15-12 midnight. Tues, Thurs, Fri, 6:15-7:30 pm. Eastern.

WORD, Batavia, Ill. 275 meters. 5,000 watts. Peoples Pulpit association. Announcer, B. M. Rice. Slogan, "Watchtower Station WORD." Daily ex Sat, Sun, 8:30-10 pm. Sat, 8 pm. Sun, 10 am, 6:45 pm, 7:80, talk, Central.

WOS, Jefferson City, Mo. 440.9 meters. 500 watts. Missouri State Marketing Bureau. Slogan, "Watch Our State." Daily ex Sun, first 15 min. of every hour from 9 am-2 pm, markets; 2, N. Y. stocks and markets. Daily ex Sat, Sun, 5 pm, markets. Mon, Wed, Fri, 8-10 pm, concert. Sun, 8-9 pm, church service. Tues, Fri, 5 pm, children's story hour. Central.

WOWL, New Orleans, La. 270 meters. 100 watts. Owl Battery company.

WOWO, Fort Wayne, Ind. 227 meters. 500 watts. Main Auto Supply Co.

WPAK, Fargo, N. D. 275 meters. 100 watts. N. D. Agricultural College. Announcer, Gordon Laing.

WPG, Atlantic City, N. J. 299.8 meters. 500 watts. Municipality of Atlantic City. Slogan, "World's Playgrounds." Mon, Tues, Fri, 7 pm. Tues, Thurs, Fri, Sat, 9 pm; 10, classics. Mon, 8 pm, Thurs, 11 pm. Sat, 6:30 pm, concert; 10. Sun, 3:15 pm, organ; 4:15, service; 10, service. Eastern.

WPRC, Harrisburg, Pa. 215.7 meters. 100 watts. Wil- *son Printing & Radio Co.

WPSC, State College, Pa. 261 meters. 500 watts. Pa. State College. Slogan: "The Voice of the Nittany Lion."

WQAA, Parkesburg, Pa. 220 meters. 500 watts. Horace A. Beale, Jr. Temporarily discontinued.

WQAC, Amarillo, Tex. 234 meters. 100 watts. Gish Radio Service. Irregular schedule.

WQAE, Springfield, Vt. 246 meters. 50 watts. Moore Radio News Station. Announcer, Ernest S. Newell. Slogan, "Boost Springfield." Sat, 11-1 am. Sun, 10:30 am, church service; 7 pm, service. Eastern.

WQAM, Miami Fla. 263 meters. 100 watts. Electrical *Equip. Co. Announcer, Frederick W. Mizer. Slogan, "The Most Southern Radiocasting Station in U. S." Daily ex Sun, 8:30-9:30 pm. Tues, Thurs, Sat, 10:30-11:30 pm. Eastern.

WQAN, Scranton, Pa. 250 meters. 100 watts. Scranton Times. Announcer, T. V. Nealon. Slogan, "The Voice of the Anthracite." Daily ex Sun, 12:30-1 pm, 4:45-5:15, news, reports, baseball, music. Tues, Fri, 8 pm, entertainment. Sat, 10-12 midnight, dance music. Eastern.

WQAO, New York City, N. Y. 360 meters. 100 watts. Calvary Baptist Church. Announcer, R. E. Bogardus. Slogan: "The First Church Owned and Operated Broadcasting Station in the World." Sun, 11:30 am, 7:30 pm, church services. Eastern.

WQJ, Chicago, Ill. 447.5 meters. 500 watts. Calumet *Baking Powder company—Rainbo Gardens. Announcer, Jerry Sullivan. Daily ex Sun, 11-12 m., women's hour. Daily ex Sat, Sun, 3-4 pm. Daily ex Sun, Mon, 7-8 pm, 10-1, 1-2, Ginger hour. Sat, 1:45-2:45 pm; 10-3 am. Sun, 3-4 pm; 8-10. Central.

WRAF, La Porte, Ind. 224 meters. 100 watts. Radio Club, Inc. Announcer, Charles Middleton. Slogan, "The Voice of the Maple City." Mon, Thurs, Sun, 8:30 pm. Central.

WRAK, Escanaba, Mich. 256 meters. 100 watts. Economy Light Company. Announcer, Ken Voght. Slogan, "The Gateway to Cloverland." Mon, Fri, 8:30 pm. Eastern.

WRAM, Galesburg, Ill. 244 meters. 100 watts. Lombard *College. Mon, 7-11 pm. Central.

WRAV, Yellow Springs, O. 263 meters. 100 watts. Antioch College. Announcer, Charles Hoffman. Wed, 8 pm, music; 9, educational. Sun, 7 pm. Central.

WRAW, Reading, Pa. 238 meters. 10 watts. Avenue *Radio & Elec. Shop. Slogan, "The Schuylkill Valley Echo." Announcer, C. M. Chafey. Thurs, 10-11:30 pm. Eastern.

WRAX, Gloucester City, N. J. 268 meters. 500 watts. Flexon's Garage. Announcer, J. Montgomery Lee. Mon, Wed, Fri, 10-11:30 pm. Tues, Thurs, Sat, 10:30-12 midnight. Eastern.

WRBC, Valparaiso, Ind. 278 meters. 50 watts. Im*manuel Lutheran church. Announcer, Forrest Jones. Slogan, "World Redeemed by Christ." Mon, 7:30 pm. Sun, 7:30 pm, church service. Central.

WRC, Washington, D. C. 468.5 meters. 1000 watts. Radio *Corp'n. of America. Announcer, Norman Brokenshire. Slogan, "The Voice of the Capitol." Mon, Wed, Fri, 10 am-6:30 pm. Tues, Thurs, Sat, 10 am-12, midnight. Eastern.

WRCO, Raleigh, N. C. 252 meters. 100 watts. Wynne *Radio Co. Daily ex Sun, 7 pm. Sun, 11 am, church. Eastern.

WREC, Coldwater, Miss. 254 meters. 10 watts. *Wooten's Radio & Elec. Co. Announcer, S. D. Wooten. Slogan, "The Most Powerful 10-Watt Station in the World." Sat, 9:30-10:30 pm; Sun, 4-5 pm. Central.

WREO, Lansing, Mich. 285.5 meters. 500 watts. Reo *Motor Car Co. Announcer, Roy E. Davis. Slogan, "Watch Reo." Daily ex Sun, 6-7 pm, dinner concert; 10, weather, sports. Tues, Thurs, 8:15-10 pm. Sat, 10-12 midnight. Sun, 10 am, chimes; 10:30 am, 7:30 pm, church. Eastern.

WRHF, Washington, D. C. 256 meters. 50 watts Washington Radio Hospital. Daily ex Sun, 11 am, police reports, news. Eastern.

WRHM, Minneapolis, Minn. 252 meters. 50 watts. *Rosedale Hospital, Inc. Announcer, Troy S. Miller. Thurs, 9-11 pm, music. Sun, 1:30-2:30 pm, children's hour; 2:30-4:30, music, lectures. Central.

WRK, Hamilton, O. 270 meters. 200 watts. Doron Bros. Elec. Co. Slogan, "The Oldest Station in Existence." Fri, 8:15 pm, music, lecture. Sun, 10:15 am, 7:30 pm, church services. Central.

WRM, Urbana, Ill. 273 meters. 500 watts. Univ. of Ill. Irregular schedule.

WRMU, New York, N. Y. 236 meters. 100 watts. A. H. Grebe & Co., Inc. Motor Yacht "MU-1."

WRNY, New York, N. Y. 258.5 meters. 500 watts. Ex*perimenter Pub. Co. Daily ex Sat, Sun, 9:44 am, 12:29 pm, 4:14, 6:59. Sat, 9:44 am, 2:29 pm, 6:59, 12-1. Sun, 3-5 pm. Eastern.

WRR, Dallas, Tex. 272.6 meters. 350 watts. City of Dallas. Announcer, C. H. Garrett.

WRST, Bay Shore, N. Y. 215.7 meters. 250 watts. *Radiotel Mfg. Co., Inc.

WRW, Tarrytown, N. Y. 272.6 meters. 500 watts. Tarrytown Radio Research Laboratory. Announcer, Frederick Koenig. Slogan, "Everything in Radio." Daily ex Sun, Wed, 9-11:30 pm. Mon, 7-8 pm. Wed, 10-11:30 pm. Sun, 8-9 pm, 10:30-11:30. Eastern.

WSAC, Clemson College, S. C. 336.9 meters. 500 watts. Clemson Agrl. College. Announcer, H. E. Gaffney.

WSAI, Cincinnati, O. 325.9 meters. 5,000 watts. *United States Playing Card Co. Announcer, P. A. Greene. Mon, 8-12 m. Tues, 7-10 pm. Wed, 8-12 midnight. Thurs, 7-10 pm. Sat, 7:45-10; 12-1:45 am. Sun, 2:45-4:30 pm; 7:45-10:15. Central.

WSAJ, Grove City, Pa. 229 meters. 250 watts. Grove *City College. Announcer, H. W. Harmon. College activities. Wed. 7:30-9 pm, music, irregular programs. Eastern.

WSAN, Allentown, Pa. 229 meters. 100 watts. Allen*town Call Pub. Co. Announcer, C. Fred Ritter. Tues, Thurs, 8:15 pm. Sat, 8:15 pm, 11:30. Eastern.

WSAR, Fall River, Mass. 254 meters. 100 watts. Doughty & Welch Elec. Co., Inc. Announcer, Barton G. Albert. Daily ex Sun, 12-1 pm. Sun, 10:30-12 m. Eastern.

WSAX, Chicago, Ill. 268 meters. 100 watts. Zenith *Radio Corp. (Portable.)

WSAZ, Pomeroy, Ohio. 244 meters. 50 watts. Chase Elec. Shop. Announcer, Glenn E. Chase. Wed, 9:30 pm, music. Sun, 10:30 am, 2:30 pm. Eastern.

WSB, Atlanta, Ga. 428.3 meters. 1,000 watts. Atlanta Journal. Announcer, Lambdin Kay. Slogan, "The Voice of the South." Daily ex Sun, 12-1 pm, music, weather; 2:30, reports; 5, orchestra, time story; 8-9, concert (ex Wed) 10:45-12, concert. Sun, 5-6, 7:30-9:15, church services. Central.

WSBC, Chicago, Ill. 209.7 meters. 200 watts. World Battedy Co.

WSBT, South Bend, Ind. 275 meters. 250 watts. *South Bend Tribune. Announcer, C. G. Livengood. Mon, Wed, Fri, 7-9:30 pm, concert. Central.

WSBF, St. Louis, Mo. 273 meters. 250 watts. Stix *Baer & Fuller Dry Goods Co. Announcer, Helen G. Hatfield. Daily, 12-12:30 pm, 3-3:30. Mon, Wed, Fri, 7:30-9 pm. Tues, 8 pm. Mon, 12-1 am. Tues, Thurs, Fri, 11-1 am. Sun, 9-10 pm; 11-1 am. Central.

WSDA, New York, N. Y. 263 meters. 250 watts. City *Temple. Thurs, 7:45-9:30 pm. Sat, 10:45-1 pm. Sun, 7:30-9:30 pm. Eastern.

WSKC, Bay City, Mich. 261 meters. 100 watts. World's *Star Knitting Co. Announcer, L. M. Nims. Slogan, "Where the Summer Trails Begin." Mon, 9-11 pm, dance. Wed, 9-11 pm, concert. Eastern.

WSM, Nashville, Tenn. 282.8 meters. 1,000 watts. *National Life and Accident Insurance Company. Announcer, Jack Keefe.

WSMB, New Orleans, La. 319 meters. 500 watts. Saenger Amusement Co. and The Maison Blanche Co.. Daily ex Sun, 12:30-1:30 pm, 6:30-7:30. Mon, Wed, Thurs, Sat, 8:30-10:30 pm. Central.

WSMH, Owosso, Mich. 240 meters. 10 watts. Shattuck Music House. Announcer, Don Shattuck. Wed, 8 pm. Sat, 10 pm. Sun, 10 am. Central.

WSMK, Dayton, Ohio. 275.2 meters. 500 watts. S. M. *Krohn, Jr. Slogan, "The Home of Aviation." Daily ex Sun, 12-1 pm; 4-4:30. Daily ex Sun, Tues, 6-7 pm. Sun, 8-12 midnight. Central.

WSOE, Milwaukee, Wis. 246 meters. 500 watts. School of Engineering of Milwaukee. Announcer, O. W. Meissner. Slogan, "In the Land of the Sky-blue Waters." Daily ex Sun, 9-10 am, lecture; 1-3 pm, talk; 5:30-6; 6-6:30, markets. Mon, Tues, Fri, Sat, 8-10 pm. Wed, 7:30-8 pm. Thurs, 7:30-8 pm; 8-9. Central.

WSRO, Hamilton, Ohio. 252 meters. 100 watts. Radio Co. Announcer, Harry W. Fahrlander. Slogan, "We Sell Radio Only." Wed, Fri, Sun, 10-12 midnight. Central.

WSUI, Iowa City, Ia. 483.6 meters. 500 watts. Univ. of *Iowa. Announcer, Carl Menzer. Mon, Tues, Wed, Thurs, Fri, 12:30-1 pm. Mon, Wed, 7:30 pm. Sun, 9-9:30 pm. Central.

WTAB, Fall River, Mass. 266 meters. 100 watts. Fall River Daily Herald. Daily, 6 pm, organ. Tues, Thurs, 8-10 pm. Mon, Thurs, 10:45 am. Eastern.

WTAC, Johnstown, Pa. 267.8 meters. 100 watts. Penn. Traffic Co. Announcer, D. B. Cole. Mon, Fri, 7:30-10 pm. Eastern.

WTAD, Carthage, Ill. 236 meters. 50 watts. Robert E. Compton.

WTAG, Worcester, Mass. 268 meters. 500 watts. Worcester Telegram. Announcer, Chester Gaylord. Slogan, "The Voice from the Heart of the Commonwealth." Daily ex Sun, 10:30-2 pm, music, reports; 4-5, music, stocks. Mon, Wed, Fri, 7:15 pm. Tues, Thurs, Sat, 5:15 pm, "The Twinkle-Twinkle Story Teller." Daily ex Sat, 8 pm. Eastern.

WTAL, Toledo, Ohio. 252 meters. 10 watts. Toledo Radio & Elec. Co. Announcer, E. R. Frank. Slogan, "The Gateway to the Sea." Daily ex Sun, 7:30 pm. Eastern.

WTAM, Cleveland, Ohio. 389.4 meters. 3,500 watts. *Willard Storage Battery Co. Announcer, A. R. Herske. Slogan: "The Voice from the Storage Battery." Daily ex Sun, 12:15-1:30 pm, 6-7 pm, dinner program. Mon, 8-12 pm, concert. Wed, 8-1 am. Sat, 8-12 midnight, dance. Eastern.

WTAP, Cambridge, Ill. 242 meters. 100 watts. Cambridge Radio & Elec. Co. Announcer, B. Talbot.

WTAQ, Osseo, Wis. 254 meters. 100 watts. S. H. Van Gorden & Son. Announcer, Mrs. C. S. Van Gorden. Slogan: "The Voice of the Wilderness." Daily ex Sun, 10:30 am, 12:15 pm, 6:15, weather, markets; 6:30, code. Tues, 8 pm. Fri, Sun, 7:30 pm. Central.

WTAR, Norfolk, Va. 261 meters. 100 watts. Reliance Electric Co. Announcer, J. K. Bohannon. Slogan, "Down in Old Virginia." Closed down temporarily.

WTAT, Boston, Mass. 244 meters. 100 watts. Edison Elec. Illuminating, Co. (portable). Announcer, Leon B. Hentz.

WTAW, College Station, Tex. 270 meters. 250 watts. *Agricultural and Mechanical College of Texas. Wed, Fri, 8 pm. Sun, 11 am. Central.

WTAX, Streator, Ill. 231 meters. 50 watts. Williams Hardware Co., Radio Division. Announcer, N. B. Williams. Slogan: "Tappa Kegga Nails." Mon, 6:30-8 pm. Thurs, 8-11 pm. Central.

WTAZ, Lambertville, N. J. 261 meters. 15 watts. Thomas J. McGuire. Mon, 8-10 pm, music. Eastern.

WTG, Manhattan, Kan. 273 meters. 50 watts. Kan. State Agri. College. Daily, 9:55 am, 4 pm, weather. Central.

WTIC, Hartford, Conn. 475.9 meters. 500 watts. The *Travelers Insurance Company. Slogan, "The Insurance City." Mon, 6:30-8:30 pm. Tues, 6:30-10 pm. Wed, 6:30-8:30; 8-11 pm. Thurs, 6:30-8 pm. Fri, 6:30-12 pm. Eastern.

WWAD, Philadelphia, Pa. 250 meters. 250 watts. *Wright & Wright, Inc. Announcer, H. W. Feyhl. Slogan, "Penn City Station." Mon, 7:45 pm. Thurs, 7 pm. Every other Sun, 9:30 pm. Eastern.

WWAE, Plainfield, Ill. 242 meters. 5,000 watts. *Electric Park. Announcer, Harry B. Ohlhaver. Daily ex Sun, 12:30-1:30 pm; 9-12, midnight, orchestra. Sun, 10:50-12:15 pm. Methodist church; 3:30-4:30, popular program. Central.

WWGL, Richmond Hill, N. Y. 212.6 meters. 500 watts. Radio Engineering Corp.

WWI, Dearborn, Mich. 266 meters. 500 watts. Ford Motor Co. Wed. 8-10 pm, music, lectures. Eastern.

WWJ, Detroit, Mich. 352.7 meters. 1,000 watts. The *Detroit News. Announcer, E. L. Tyson. Mon, Wed, Fri, 7:30-8 am, 8-8:30 am, setting-up exercises; 9:30-9:45, household hints; 10:25-10:30, weather; 11:55-12, time; 12:05-12:15 pm, music; 3-3:55, music; 3:55, markets. Daily ex Sat, Sun, 6-7, dinner concert; 8, music. Mon, Wed, Fri, 9 pm, orchestra. Wed, 10 pm, orchestra. Sun, 11 am, church service; 2-3 pm, concert; 6:20, Capitol theater. Eastern.

WWL, New Orleans, La. 275 meters. 100 watts. Loyola Univ. Announcer, O. L. Abell. Sat, 7:30-8:30 pm. Central.

Argentina

B-1, Buenos Aires, Argentina. Francisco J. Brusa.

LOR, Buenos Aires, Argentina. 350-410 meters. 500 watts. Cia Radio Argentina.

LOV, Buenos Aires, Argentina. 350 meters. 1,000 watts. Francisco J. Brusa.

LOW, Buenos Aires, Argentina. 325 meters. 1,500 watts. *Grand Splendid Theater. Announcer, Frederico A. Dominguez.

LOX, Buenos Aires, Argentina. 375 meters. Radio Cultura.

LOY, Buenos Aires, Argentina. Radio Nacional. Announcer, Osvaldo P. Valla.

TCR, Buenos Aires, Argentina. 325-300 meters. 100 watts. Francisco J. Brusa.

Australia

2BL, Sydney, Australia. 350 meters. 5,000 watts. Broadcasters Limited.

2FC, Sydney, Australia. 1,100 meters. 5,000 watts. Farmer & Co., Ltd.

3AR, Melbourne, Australia. 480 meters. 1,600 watts. Associated Radio Co., Ltd.

5CL, Adelaide, South Australia. 395 meters. 5,000 watts. Central Broadcasters, Ltd.

6WF, Perth, Australia. 1,250 meters. 5,000 watts. Westralia Farmers, Ltd.

Belgium

BAV, Haeren, Belgium. 1,800 meters. 1,000 watts. Daily, 1 pm, 2, 4:50, 6:50, weather.

RADIO-BELGIQUE, Brussels, Belgium. 265 meters. *1,500 watts.

Brazil

SPE, Rio de Janeiro, Brazil. 250 meters. 500 watts. Dept of National Telegraphs.

Bahia, Brazil. Radio Sociedade do Bahia.

Belle Horizontes, Brazil. 50 watts. National Telegraph Service.

Rio de Janeiro, Brazil. 6,000 watts. Marconi (Radio Sociedade do Rio de Janeiro.

Sao Paulo, Brazil. 320 meters. 20 watts. Radio Bondeirantes.

Canada

CFAC, Calgary, Alta, Can. 434.5 meters. 500 watts. Calgary Herald. Announcer, Fred Carleton. Daily ex Sun, 1 pm, news, markets, music. Mon, 9-10 pm. Wed, 7:45-8:45 pm. Thurs, 9-11 pm. (CNRC) Mountain.

CFCA, Toronto, Ont., Can. 356.9 meters. 500 watts. *Toronto Star. Announcer, E. J. Bowers. Daily ex Sun, 12 m., weather, news, stocks; 5:30-6 pm, news, bedtime story. Daily ex Sun, Fri, 8-9 pm. Thurs, 8-11:30 pm, popular program. Fri, 8-9 pm, (CNRT) Sun, 11 am, 7 pm, church services. Eastern.

CFCF, Montreal, P. Q., Can. 410.7 meters. 1,650 watts. *Canadian Marconi Co. Announcer, C. Walter Darling. Daily ex Sun, 12:45-1:40 pm, stocks, music. Mon, Fri, 7-7:30 pm, bedtime stories; 7:30-8:30, music; 9-10; 10:30-11:30, orchestra. Wed, 7-8 pm, orchestra. Eastern.

CFCH, Iroquois Falls, Ont., Can. 499.7 meters. 250 watts. Abitibi Power & Paper Co., Ltd. Slogan, "The Call of the North." Experimental station for forest protection.

CFCK, Edmonton, Alta., Can. 516.9 meters. 100 watts. Radio Supply Co., Ltd. Daily ex Sun, 4-5 pm. Wed, 9-10:30 pm. Sun, 4-5:30 pm. Mountain.

CFCN, Calgary, Alta., Can. 434.5 meters. 1,800 watts. *W. W. Grant, Ltd. Slogan, "Voice of the Prairies." Tues, 11:30 pm, Bronco Busters; Wed, 9 pm, Fri, Sat, 10 pm, Sun, (alternate) 11 am, 7:30 pm, service. Mountain.

CFCQ, Vancouver, B. C. 410.7 meters. 5 watts. Radio *Specialties, Ltd.

CFCT, Victoria, B. C., Can. 329.5 meters. 500 watts. *The Deaville Station. Slogan, "The Mecca of Tourists." Mon, Wed, Fri, 8-9:30 pm. Every second Thurs, 10:30 pm, 12 midnight. Night Birds, Sat, 10-11 pm. Sun, 11 am, 7:30 pm. Pacific.

CFCU, Hamilton, Ont., Can. 483.6 meters. 500 watts. *Jack V. Elliot, Ltd.

CFCY, Charlottetown, P. E. I. 312.3 meters. 50 watts. *Island Radio Co.

CFKC, Thorold, Ont., Can. 247.8 meters. 75 watts. *D. J. Fendell. Daily ex Sun, 12-12:30 pm; 5-6. Tues, Thurs, Sat, 8:30-10:30 pm. Sun, 11 am, church service; 2-4 pm, 8 pm, sacred concert, music.

CFMC, Kingston, Ont., Can. 267.7 meters. 20 watts. *Monarch Battery Co.

CFQC, Saskatoon, Sask., Can. 329.5 meters. 500 watts. *The Electric Shop, Ltd. Announcer, H. F. Michaelis. Slogan, "The Hub City of the West Where No. 1 Northern Hard Wheat Grows." Daily ex Sun, 9-10 am; 1:15-2 pm, markets, reports, music. Wed, 8-10 pm. Fri, 9-11:30 pm, dance program. Sun, 11 am, church service. Mountain.

CFRC, Kingston, Ont., Can. 267.7 meters. 500 watts. *Queen's University. Discontinued temporarily.

CFXC, New Westminster, B. C. 291.1 meters. 20 watts. Westminster Trust Co. and Hume & Rumble, Ltd Announcer, F. Sterling. Slogan: "Voice of the Fraser River." Mon, Wed, Fri, 7:30-8:30 pm. Pacific.

CFYC, New Westminster, B. C. 291.1 meters. 20 watts. *Commercial Radio, Ltd. Slogan, "Canada's Flourishing Young City."

CHCM, Calgary, Alta., Can. 434.5 meters. 750 watts. Riley & McCormick, Ltd. Slogan, "Western Canada's Leading Leather Goods Store." Thurs, 8-9 pm. Mountain.

CHCS, Hamilton, Ont., Can. 340.7 meters. 10 watts. *Hamilton Spectator. Announcer, H. Earnshaw. Daily ex Sun, 6:45 pm, news, markets, baseball. Sat, 10-12 midnight, dance. Sun, 11 am, 7 pm. Eastern.

CHIC, Toronto, Can. 356.9 meters. 500 watts. Northern Electric Company. Announcer, R. W. Lowman. Mon, 8-10 pm. Sat, 8 pm. Eastern.

CHNC, Toronto, Can. 356.9 meters. 500 watts. Toronto Radio Research society. Announcer, R. H. Combs. Mon, 8:30 pm, concert. Programs CHIC CKNC through this station. Eastern.

CHSC, Unity, Sask., Can. 356.9 meters. 250 watts. *Horace N. Stovin.

CHUC, Saskatoon, Sask., Can. 329.5 meters. 50 watts. *International Bible Students' association. Announcer, E. G. Esson. Tues, Thurs, 8-9:30 pm. Sun, 1-2 pm; 7:30-9:30.

CHXC, Ottawa, Ont., Can. 434.5 meters. 250 watts. J. *R. Booth, Jr. Fri, 8:30-1 am.

CHYC, Montreal, Que., Can. 410.96 meters. 850 watts. *Northern Elec. Co. Announcer, N. S. Richards. Wed, 8:30 pm. Sun, 7 pm. CNRM programs occasionally. Eastern.

CJBC, Toronto, Can. 356.9 meters. Jarvis St. Baptist *Church.

CJCA, Edmonton, Alta., Can. 516.9 meters. 500 watts Edmonton Journal, Ltd. Announcer, R. A. Rice. Slogan: "The Sunniest Spot in Sunny Alberta." Club, "Igloo Hut." Daily ex Sun, 12:45-1:30 pm, weather, markets. Mon, Tues, Thurs, Sat, 7:30-8 pm. Mon, 8:30-9:30 pm. Wed, 6-8 pm. Sat, 9-11 pm. Fri, 8:30-10:30, CNRE. Sun, 7:30-9 pm. Mountain.

CJCD, Toronto, Can. 356.9 meters. 50 watts. The T. *Eaton Co., Ltd.

CJGC, London, Ont., Can. 329.5 meters. 50 watts. *London Free Press. Daily ex Sun, 1-2 pm, news, stocks, music. Tues, Thurs, Fri, 7:15-8:40 pm. Fri, 11-12 midnight. Sun, 11 am, 7 pm, church services. Eastern.

CJKC, Burnaby, B. C., Can. 410.7 meters. 500 watts. *Pyramid Temple society.

CJSC, Toronto, Can. 356.9 meters. 500 watts. The Eve*ning Telegram.

CJWC, Saskatoon, Sask., Can. 329.5 meters. 250 watts. *Wheaton Elec. Co.

CJYC, Toronto, Can. 291.1 meters. 500 watts. De*Forest Radio Corp.

CKAC, Montreal, Que., Can. 410.7 meters. 1,200 watts. *La Presse. Announcer, Jacques Cartier. Mon, Wed, Fri, Mon. 1:45 pm, orchestra. Daily ex Sat, 4 pm, weather, markets, stocks, reports. Tues, Thurs, Sat, 7 pm, piano lessons; 7:30, concert; 8:30 pm, studio concert; 10:30, dance. Sun, 4:30 pm, sacred concert. CNRM programs 3 first Thursdays of each month. Eastern.

CKCD, Vancouver, B. C., Can. 410.7 meters. 1,000 *watts. Vancouver Daily Province. Announcer, William Rose. Slogan, "Canada's Western Gateway." Daily ex Sun, 8:30-9:30 pm, music, news, entertainment. Pacific.

CKCK, Regina, Sask., Can. 312.3 meters. 500 watts. *Leader Pub. Co. Announcer, A. W. Hooper. "The Queen City of the West." Daily ex Sat, Sun, Tues, 9:45-10:30 am; 1-1:45 pm; 7:30-8:15, music, news, markets. Tues, 9:45-10:30 am; 1-1:45 pm; (CNRR) 8-10 pm. Sat, 9:45-10:30 am; 1-1:45 pm. Sun, 9 pm, service. Mountain.

CKCW, Burketon Junction, Ont., Can. 329.5 meters. *5,000 watts. Canadian Broadcasting Corp.

CKCL, Toronto, Can. 356.9 meters. 500 watts. The *Dominion Battery Co., Ltd.

CKCO, Ottawa, Ont., Can. 434.5 meters. 100 watts. Dr. G. M. Geldert (Ottawa Radio Assn.) Announcer, Dr. O. K. Gibson. Slogans, "Ottawa's Radio Voice." "The Community Voice of Canada's Capital." Tues, 8-10 pm. Sun, 7 pm, services; 9, sacred concert. Eastern.

CKFC, Vancouver, B. C., Can. 410.7 meters. 50 watts. First Congregational church.

CKNC, Toronto, Ont., Can. 356.9 meters. 500 watts. Canadian National Carbon Co., Ltd.

CKOC, Hamilton Ont., Can. 340.7 meters. 50 watts. Wentworth Radio Supply Co., Ltd. Announcer, H. Slack. Slogan: "In the Garden of Canada" Mon, Fri, 8-9 pm, music entertainment. Sun, 7-8 pm, church services. Eastern.

CKY, Winnipeg, Man., Can. 384.4 meters. 500 watts. *Manitoba Tel. System. Announcer, D. R. P. Coats. Slogan, "Manitoba's Own Station." Daily ex Sun, 12:30-1:30 pm, music, lectures, markets, weather, etc.; 4-5, concert; Tues, Fri, 8:30 pm, lecture; 8:45-10:30, concert. Thurs, 8:30, Canadian Nat. Railways concert (CNRW). Announcer, R. H. Roberts. Sun, 7 pm, church services. Central.

CNRA, Moncton, N. B., Can. 291.1 meters. 500 watts. *Canadian National Railways. Announcer, W. V. George. Slogan, "Voice of the Maritimes." Tues, 9 pm. Fri, 8 pm. Atlantic.

CNRC, Calgary, Alta., Can. 434.5 meters. 750 watts. Canadian National Railways. Thurs, 9 pm. Mountain.

CNRE, Edmonton, Alta., Can. 516.9 meters. 500 watts. Canadian National Railways. Fri, 7:30-8 pm, 8:30-10:30. Mountain.

CNRM, Montreal, Que., Can. 410.7 meters. 1,000-1,650 *watts. Canadian National Railways. Thurs, 9 pm. Eastern.

CNRO, Ottawa, Can. 434.5 meters. 500 watts. Canadian National Railways. Announcer, A. W. Ryan. Wed, Sat, 7:30 pm, markets, bedtime story; 8, 10:30, dance program. Eastern.

CNRR, Regina, Sask., Can. 435 meters. 1,000 watts. *Canadian National Railways. Tues, 7:30-9:30 pm. Mountain.

CNRS, Saskatoon, Sask., Can. 329.5 meters. 500 watts. *Canadian National Railways. Daily ex Sun, 2:30-3:30 pm. Mountain.

CNRT, Toronto, Ont., Can. 356.9 meters. 500 watts. *Canadian National Railways. Announcer, E. W. Jackson.

CNRV, Vancouver, Can. 291.1 meters. 500 watts. Cana*dian National Railways. Announcer, G. A. Wright.

CNRW, Winnipeg, Man., Can. 384.4 meters. 500 watts. Canadian National Railways. Thurs, 8:30 pm, bedtime stories, markets, talks; 9. studio dance. Central.

Cuba

PWX, Havana, Cuba. 400 meters. 500 watts. Cuban Telephone Co. International Tel. & Teleg. Corp. Wed, Sat, 8:30-11 pm, music. Eastern.

Q2LC, Havana, Cuba. 250 meters. 50 watts. Luis Casas.

1AZ, Havana, Cuba. 275 meters. 5 watts. Antonio Sarasola.

2AB, Havana, Cuba. 235 meters. 10 watts. Alberto S. Bustamante.

2BB, Havana, Cuba. 255 meters. 15 watts. Bernardo Barrie.

2BY, Havana, Cuba. 315 meters. 100 watts. Electrical Equipment Co. of Cuba. Mon, Thurs, 7:00-8:00 pm. Eastern.

2CG, Havanna, Cuba. 350 meters. 15 watts. Humberto Giquel.

2CX, Havana, Cuba. 320 meters. 10 watts. F. W. Borton.

2EP, Havana, Cuba. 355 meters. 400 watts. El Pais.

2HP, Havana, Cuba. 295 meters. 100 watts. Credito y Construcciones Co.

2JL, Havana, Cuba. 275 meters. 5 watts. Jose Leiro.

2JP, Havana, Cuba. 270 meters. 20 watts. Julio Power.

2LR, Havana, Cuba. 235 meters. 10 watts. Jose Lara.

2MG, Havana, Cuba. 280 meters. 20 watts. Manuel Y. Guillermo Salas Music Store. Announcer, Roger Morales. Daily, 3-4 pm, music. One day each week, 8-11 pm. Eastern.

2MK, Havana, Cuba. 85 meters. 20 watts. R. V. Waters.

2OK, Havana, Cuba. 360 meters. 100 watts. Mario Garcia Velez.

2OL, Havana, Cuba. 300 meters. 100 watts. Columbus Cycle Radio Co.

2PK, Havana, Cuba. 195 meters. 10 watts. George A. Lindeaux.

2RK, Havana, Cuba. 310 meters. 100 watts. Raoul Karman. Casa De La Porte.

2RM, Havana, Cuba. 210 meters. 10 watts. Rogelio Morales.

2RY, Havana, Cuba. 170 meters. 5 watts. Salvador de la Torre.

2SZ, Havana, Cuba. 180 meters. 10 watts. Homero Sanchez.

2TW, Havana, Cuba. 230 meters. 20 watts. Roberto E. Ramirez.

2UF, Havana, Cuba. 265 meters. 10 watts. Roberto E. Ramirez.

2XX, Havana, Cuba. 150 meters. 5 watts. Antonio A. Ginard.

5AZ, Mantanzas, Cuba. 200 meters. 20 watts. Ernesto V. Figueroa.

5BY, Mantanzas, Cuba. 190 meters. 10 watts. Leon Gonzalez Velez

5EV, Colon, Cuba. 360 meters. 10 watts. Leopoldo V. Figueroa. Sun, 9-11 pm. Eastern.

6BY, Santa Clara, Cuba. 260 meters. 200 watts. Jose Ganduxe.

6DW, Santa Clara, Cuba. 225 meters. 10 watts. Eduardo Terry.

6EV, Santa Clara, Cuba. 230 meters. 100 watts. Maria Josefa Alvares. Daily, 10:30 pm.

6GR, Santa Clara, Cuba. 250 meters. 10 watts. Luis del Castillo.

6GT, Santa Clara, Cuba. 190 meters. 5 watts. Juan Pablo Ros.

6HS, Santa Clara, Cuba. 200 meters. 10 watts Santiago Ventura.

6JK, Tuinucu, Cuba. 275 meters. 100 watts. Frank H. Jones.

6JQ, Santa Clara, Cuba. 250 meters. 10 watts. Eligio Cobelo Ramirez.

6KW, Tuinucu, Cuba. 332 meters. 100 watts. Frank H. Jones. Slogan, "If You Hear the Koo of the Cuckoo You Are in Tune With Tuinucu." Mon, Fri, Sat, Sun, 12 mid. Sun, 9 p. m. Eastern.

6YR, Camaguey, Cuba. 200 meters. 20 watts. Diego Iborra.

7AZ, Camaguey, Cuba. 225 meters. 10 watts. Pedro Nogueras.

7BY, Camaguey, Cuba. 235 meters. 20 watts. Eduardo V. Figueroa.

7CX, Camaguey, Cuba. 85 meters. 10 watts. Leonard B. Fox.

7DW, Camaguey, Cuba. 90 meters. 10 watts. M. L. Quintana.

7SR, Camaguey, Cuba. 350 meters. 500 watts. Salvador C. Rionda. Slogan, "Cuba, the Land of Sunshine, Sugar and Tobacco." Mon, Tues, Thurs, 8:30 pm. Eastern.

8AZ, Santiago, Cuba. 240 meters. 20 watts. Alfredo Brooks.

8BY, Santiago, Cuba. 250 meters. 100 watts. Alberto Ravelo.

6FU, Santiago, Cuba. 225 meters. 15 watts. Andres Vinent.

3IR, Santiago, Cuba. 190 meters. 20 watts. Ceferino Ramos.

6JQ, Santiago, Cuba. 225 meters. 20 watts. Jose Fernandez Heredia.

France

FPTT, Paris, France. 458 meters. 500 watts. Superior School P. T. T. Announcer, M. Chanton.

YN, Lyons-la-Doua, France. 340 meters. French Government.

Lyons, Radio-Lyon, 280 meters. 600 watts.

Paris, France, Le Petit Parisien. 345 meters. 500 watts.

Germany

Berlin, Germany. 505 meters. 1,500 watts. Vox Haus.

Berlin, Germany, 290 meters. 100 watts. Telefunken Co.

Breslau, Germany. 418 meters. 1,500 watts. Schlesische Rundfunk, A. G.

Cassel, Germany. 288 meters. 1,500 watts. Sudwestdeutscher Rundfunk. A. G.

Dresden, Germany. 280 meters. 1,500 watts. Mitteldeutsche Rundfunk. A. G. (Mirag).

Frankfort-on-Main, Germany. 470 meters. 1,500 watts. Sudwestdeutsche Rundfunkienst.

Hamburg, Germany, 395 meters. 500 watts, Nordischer Rundfunk, A. G. Announcer, Hans Bodenstedt.

Konigsberg, Germany. 463 meters. 1,000 watts. Ostmarken Rundfunk, A. G.

Leipzig, Germany. 454 meters. 1,000 watts. Mitteldeutsche Rundfunk, A. G. (Mirag).

Munich, Germany. 485 meters. 1,000 watts. Deutsche Stunde in Bayern.

Munster, Germany. 410 meters. 2,500 watts.

Nuremberg, Germany. 340 meters. Relayed from Munich.

Stuttgart, Germany. 443 meters. 1,500 watts.

Great Britain

2BD, Aberdeen, Scot. 496 meters. 1,500 watts. Brit*ish Broadcasting Co. Announcer, H. M. Fitch.

2BE, Belfast, Ireland. 438 meters. British Broadcast*ing Co., Ltd. Announcer, W. T. Guthrie, Capt. T. O. Corrin.

2DE, Dundee, Scot. 331.5 meters. British Broadcasting *Co.

2EH, Edinburgh, Scot. 326 meters. British Broadcasting Co.

2LO, London, Eng. 365 meters. 3,000 watts. British *Broadcasting Co., Ltd.

2LS, Leeds, Bradford, Eng. 343-310 meters. British *Broadcasting Co., Ltd.

2ZY, Manchester, Eng. 377.5 meters. British Broad*casting Co.

5IT, Birmingham, Eng. 480 meters. British Broad*casting Co.

5NG, Nottingham, Eng. 229 meters. British Broad*casting Co.

5NO, Newcastle, England. 403 meters. British Broadcasting Co.

5PY, Plymouth, Eng. 338 meters. 200 watts. British *Broadcasting Co., Ltd. Announcer, J. E. C. Langham.

5SC, Glasgow, Scot. 422 meters. British Broadcasting Co.

5WA, Cardiff, Wales. 353 meters. British Broadcasting Co.

6BM, Bournemouth, Eng. 386 meters. British Broad*casting Co.

6FL, Sheffield, Eng. 302 meters. British Broadcasting Co.

6KH, Hull, Eng. 335.5 meters. British Broadcasting *Co., Ltd.

6LV, Liverpool, Eng. 314.1 meters. British Broadcast*ing Co.

6ST, Stoke-on-Trent, Eng. 306 meters. British Broadcasting Co.

Mexico

CYA, Mexico City, Mex. 185 meters. Partido Liberal Avanzado.

CYB, Mexico City, Mex. 380 meters. 500 watts. El Buen, Tono. Tues, Sat, 7:30-9 pm. Thurs, 8-10 pm, concert. Mexican.

CYF, Oaxaca, Oax., Mex. 260 meters. Federico Zorrilla. "The Voice from South of Mexico." Tues, Thurs, 7-8 pm. Sun, 8:30-10 pm. Mexican.

CYG, Mexico City, Mex. Secretara de Guerra y Marina.

CYH, Mexico City, Mex. 325 meters. 100 watts. High Life. Slogan, "Los Proveedores del Caballero Que Viste Bien." Announcer, Jorge Chulia Mallet. Fri, 8:30-10 pm. Mountain.

CYL, Mexico City, Mex. 480 meters. 500 watts. La Casa del Radio. Announcer, George Marron. Slogan: "The Land of Eternal Summer. Daily ex Sun, 1:30-2 pm, weather, financial reports, music. Tues, Fri, 8-9:30 pm. Sun, 8-9:30 pm, church. Mexican.

CYR, Mazatlan, Sin., Mex. Rosseter Y Cia.

CYS, Monterey, Mexico. 310 meters. 250 watts. Tarnava & Cia. Slogan, "The Industrial Center of the Mexican Republic." Daily ex Sun, 7:55-8:05 pm. Wed, 8:30-10 pm. Fri, 8:15-9:30. Sun, 9:45-11. Mountain.

CYX, Mexico City, Mex. 333 meters. 500 watts. Excelsior & Cia. Parker. Announcer, Rafael Hermandez dez Dominguez. Slogan, "Land of the Aztecs." Mon, 8-9:30 p. m. Fri. 8:30-9:30 pm. Mexican.

CYZ, Mexico City, Mex. 400 meters. Liga Central Mexicana de Radio.

CZA, Mexico City, Mex. 70-500-1,070 meters. Aviation Dept., War Ministry. Announcer, Ricardo S Bravo. Daily, 12:30-1 pm, time, weather, news; 6:30-7:30, time, markets, music. Mexican.

CZE, Mexico City, Mex. Secretary Public Education.

CZF, Chihauhau City, Mexico. 325 meters. 250 watts. Chihauhau State Radio Broadcasting Station. Announcer, C. A. Nieto. Slogan, "United by Radio." Tues, 8-9:30 pm. Mountain.

XDA, Mexico City, Mexico. Variable wave. 4000 watts Government station. Slogan, "Radio Chapultepec"

Location Cross Index of Stations

State, City, Call

Alabama:
Auburn, WAPI
Birmingham WBRC
Mobile, WEBM
Montgomery, WIBZ

Arizona:
Flagstaff, KFXY
Phoenix, KFAD, KFCB
Tucson, KFDH

Arkansas:
Bentonville, KFVX
Conway, KFKQ
Fayetteville, KFMQ
Hot Springs Nat'l Park, KTHS

California:
Avalon, KFWO
Bakersfield, KDZB
Bear Lake, KFXB
Berkeley, KRE
Burlingame, KFQH
Chico, KFWH
Eureka, KFVU
Fresno, KMJ
Hollywood, KFQZ, KFWB, KNX
Holy City, KFQU
Long Beach, KFON
Los Angeles, KFI, KFPG, KFPR, KFSG, KHJ, KNRC, KTBI
Oakland, KFUS, KFWM, KGO, KLS, KLX, KTAB, KZM
Pasadena, KPPC, KPSN
San Diego, KFBC, KFVW
San Francisco, KFRC KGTT, KJBS, KPO, KUO
San Jose, KQW
San Leandro, KFUU
San Pedro, KFVD
Santa Ana, KFAW
Santa Barbara, KFHJ
Santa Maria, KFXC
Santa Rosa, KFNV
South San Francisco, KFWI
Stanford Univ., KFGH
Stockton, KWG
Taft, KFQC
Upland, KFWC

Colorado:
Boulder, KFAJ
Colorado Springs, KFUM, KFXF
Denver, KFEL, KFXJ, KFUP, KFVR, KLZ, KOA
Greeley, KFKA
Gunnison, KFHA
Trinidad, KFBS

Connecticut:
Hartford, WTIC
New Haven, WDRC
Stores, WCAC

Delaware:
Wilmington, WHAV

District of Columbia:
Washington, WCAP, WMAL, WRC, WRHF

Florida:
Clearwater, WGHB
Fulford-by-the-Sea, WGBU
Miami, WQAM
Miami Beach, WMBF
St. Petersburg, WHBN, WIBC WJBB
Tampa, WDAE
Winter Park, WDBO

Georgia:
Atlanta, WDBE, WGST, WSB
Macon, WMAZ
Savannah, WEBZ

Idaho:
Boise, KFAU, KFDD
Kellogg, KFEY

Illinois:
Batavia, WORD
Cambridge, WTAP
Carthage, WCAZ, WTAD
Chicago, KYW, WAAF, WBBM, WBBZ, WBCN, WDBY, WEBH, WENR, WFKB, WGN, WHBM, WIBJ, WIBM, WIBO, WKBG, WLS, WLTS, WMAQ, WMBB, WQJ, WSBC
Decatur, WBAO, WJBL
Deerfield, WHT
Elgin, WCEE, WLIB
Evanston, WEHS
Galesburg, WFBZ, WRAM
Harrisburg, WEBQ
Herrin, WCBG
Homewood, WOK
Joliet, WCLS, WJBA, WKBB
La Salle, WJBC
Monmouth, WBBU
Mooseheart, WJJD
Mt. Prospect, WJAZ
Oak Park, WGES
Plainfield, WWAE
Rockford, KFLV
Rock Island, WHBF
Spring Valley, WGBW
Streator, WTAX
Sycamore, WJBN, WOCG
Tuscola, WDZ

State, City, Call

Illinois (Continued)
Urbana, WRM
Zion, WCBD

Indiana:
Anderson, WEBD, WHBU
Culver, WHBH
Evansville, WGBF
Ft. Wayne, WHBJ, WOWO
Greencastle, WLAX
Greentown, WJAK
Indianapolis, WFBM
Laporte, WRAF
Logansport, WHBL, WIBW
South Bend, WSBT
Seymour, WFBE
Valparaiso, WRBC
West Lafayette, WBAA

Iowa:
Ames, WOI
Anita, KFLZ
Boone, KFGQ
Burlington, WIAS
Cedar Falls, KFJX
Cedar Rapids, WJAM, WKAA
Clarinda, KSO
Council Bluffs, KOIL
Davenport, WOC
Des Moines, WHO
Fort Dodge, KFJY
Iowa City, KFQP, WSUI
Lamoni, KFFV
Le Mars, KFCY
Marshalltown, KFJB
Muscatine, KFYD
Oskaloosa, KFHL
Shenandoah, KFNF, KMA
Sioux City, KFMR, WEAU
Waterloo, KFXE

Kansas:
Independence, KFVG
Junction City, KFJC
Lawrence, KFKU
Manhattan, KFVH, KSAC, WTG
Wichita, KFOT, WEAH

Kentucky:
Louisville, WHAS, WLAP

Louisiana:
Baton Rouge, KFGC
Kennonwood, KFDX, KWKH
New Orleans, WAAB, WAAC, WABZ, WBBS, WCBE, WOWL, WSMB, WWL
Pineville, KFWU

Maine:
Bangor, WABI
Ellsworth, WHBK
Orono, WGBX
Portland, WCSH

Maryland:
Baltimore, WCAO, WCBM, WFBR
Takoma Park, WBES

Massachusetts:
Boston, WBZA, WDBR, WEEI, WNAB, WNAC, WTAT
Fall River, WSAR, WTAB
Mattapoisett, WBBG
New Bedford, WIBH
South Dartmouth, WMAF
Springfield, WBZ
Taunton, WAIT
Webster, WKBE
Worcester, WCUW, WTAG

Michigan:
Bay City, WSKC
Berrien Springs, WEMC
Dearborn, WWI
Detroit, KOP, WCX, WGHP, WJR, WWJ
East Lansing, WKAR
Escanaba, WRAK
Flint, WFDF
Grand Rapids, WBDC, WEBK
Houghton, KFMW, WWAO
Lansing, WREO
Mt. Clemens, WABX
Owosso, WSMH
Petoskey, WBBP
Port Huron, WAFD
Ypsilanti, WJBK

Minnesota:
Breckenridge, KFUJ
Collegeville, WFBJ
Minneapolis, KFDZ, WAMD, WCCO, WHAT, WHDI, WLB, WRHM
Northfield, KFMX, WCAL
St. Cloud, WFAM
St. Paul, AV7, KFOY
Sihlpok, KIAF
Welcome, KFVN

Mississippi:
Coldwater, WREC
Oxford, WCBH

Missouri:
Butler, WNAR
Cape Girardeau, KFVS
Carterville, KFPW
Columbia, KFRU
Independence, KLDS

State, City, Call

Missouri (Continued)
Jefferson City, WOS
Kansas City, KWKC, WDAF, WHB, WOQ
Kirksville, KFKZ
Moberly, KFFP, KFOJ
St. Louis, KFQA, KFUO, KFWF, KSD, WEW, WIL, WMAY, WSBF
University City, KFVE

Montana:
Havre, KFBB
Missoula, KUOM

Nebraska:
David City, KFOR
Hartington, KFRZ
Hastings, KFKX
Lincoln, KFAB, WFAV
Norfolk, WJAG
Oak, KFEQ
Omaha, KOCH, WAAW, WNAL, WOAW
University Place, WCAJ

New Hampshire:
Hanover, WDCH
Laconia, WKAV

New Jersey:
Atlantic City, WHAR, WPG
Camden, WFBI
Elizabeth, WIBS
Gloucester City, WRAX
Lambertville, WTAZ
Newark, WAAM, WNJ, WOR
New Brunswick, WEBA
North Plainfield, WEAM
Paterson, WODA
Red Bank, WJBI
Salem, WDBQ
Trenton, WOAX

New Mexico:
Albuquerque, KFLR, KFVY
State College, KFRY, KOB

New York:
Bay Shore, WRST
Buffalo, WEBR, WGR
Canton, WCAD
Cazenovia, WMAC
Flushing, WIBI
Freeport, WGBB
Ithaca, WEAI
Jamestown, WOCL
Kingston, WDBZ
Lockport, WMAK
New York, WBBR, WEAF, WEBJ, WEBL, WFBH, WFRL, WGBS, WGCP, WHAP, WHN, WJY, WJZ, WKBK, WLWL, WMCA, WNYC, WOKO, WQAO, WRMU, WRNY, WSDA
Richmond Hill, WAHG, WBOQ, WGMU, WWGL
Rochester, WABO, WHAM, WHEC
Schenectady, WGY
Syracuse, WFBL
Tarrytown, WRW
Tonodi, WONK
Troy, WHAZ
Utica, WIBX

North Carolina:
Asheville, WABC
Charlotte, WJBG
Fort Bragg, AT9
Henderson, WIBV
Raleigh, WRCO

North Dakota:
Devils Lake, KDLR
Fargo, WDAY, WPAK
Grand Forks, KFJM

Ohio:
Akron, WADC
Bellefontaine, WHBD
Canton, AQ6, WHBC
Cambridge, WEBE
Cincinnati, WAAD, WHAG, WHBR, WKRC, WLW, WSAI
Cleveland, KDPM, WDBK, WEAR, WHK, WSAI, WTAM
Columbus, WBAV, WCAH, WEAO, WMAN
Dayton, AW5, WEBT, WSWK
Granville, WJD
Hamilton, WRK, WSRO
Lima, WOAC
Newark, WBBA
Pomeroy, WSAZ
Springfield, WCSO
Toledo, WABR, WTAL
Wooster, WABW
Yellow Springs, WRAV

Oklahoma:
Chickasha, KFGD
Fort Sill, KFBM
Norman, WNAD
Oklahoma City, KFJF, WKY
Tulsa, WLAL

Oregon:
Astoria, KFJI
Corvallis, KFDJ
Portland, KFEC, KFIF, KFJR, KFWV, KGW, KTBR

State, City, Call

Pennsylvania:
Allentown, WCBA, WSAN
Altoona, WFBG
Butler, WBR
Elkins Park, WIBG
Grove City, WSAJ
Harrisburg, WBAK, WHBG, WPRC
Haverford, WABQ
Johnstown, WGBK, WHBP, WTAC
Lancaster, WDBC, WGAL
Oil City, WHBA
Parkesburg, WQAA
Philadelphia, WABY, WCAU, WFBD, WFI, WHBW, WIAD, WIP, WLIT, WNAT, WOO, WWAD
Pittsburgh, KDKA, KQV, WCAE, WJAS
Reading, WRAW
Scranton, WGBI, WQAN
State College, WPSC
Wilkes-Barre, WBAX, WBRE

Rhode Island:
Cranston, WKAP
Providence, WCBR, WDWF, WEAN, WGBM, WJAR

South Carolina:
Charleston, WBBY
Clemson College, WSAC

South Dakota:
Brookings, KFDY
Rapid City, WCAT
Vermillion, KUSD
Yankton, WNAX

State, City, Call

Tennessee:
Chattanooga, WDOD
Knoxville, WFBC, WNOX
Lawrenceburg, WOAN
Memphis, WGBC, WHBQ, WMC
Nashville, WCBQ, WDAD, WSM

Texas:
Amarillo, WDAG, WQAC
Beaumont, KFDM, KFXM
Beeville, KFRB
Brownsville, KFWP, KWWG
College Station, WTAW
Dallas, WFAA, WRR
Denison, KFQT
Dublin, KFPL
El Paso, KFXH
Fort Worth, KFQB, WBAP
Galveston, KFLX, KFUL
Greenville, KFPM
Houston, KFVI, KPRC
Orange, KFGX
San Antonio, WCAR, WOAI
San Benito, KFLU
Waco, WJAD

Utah:
Logan, KFXD
Ogden, KFUR, KFWA
Salt Lake City, KDYL, KFOO, KSL

Vermont:
Burlington, WCAX
Springfield, WQAE

Virginia:
Norfolk, WBBW, WTAR
Radio, NAA
Richmond, WBBL
Roanoke, WDBJ

Washington:
Everett, KFBL
Lacey, KGY
North Bend, KFQW
Olympia, KFRW
Pullman, KFRX, KWSC
Seattle, KFOA, KHQ, KJR, KTCL, KTW
Spokane, KFIO, KFPY
Tacoma, KFBG, KGB, KMO
Walla Walla, KFCF
Yakima, KFIQ

West Virginia:
Weirton, WIBR

Wisconsin:
Beloit, WEBW
Camp Lake, WCLO
Fond du Lac, KFIZ
Madison, WHA, WIBA
Marshfield, WGBR
Menomonee, WGBQ
Milwaukee, WHAD, WKAF, WSOE
Osseo, WTAQ
Poynette, WIBU
Sisiht, WBAR
Stevens Point, WLBL
Superior, WEBC
West de Pere, WHBY

Wyoming:
Laramie, KFBU

Alaska:
Juneau, KFIU

State, City, Call

Hawaii:
Honolulu, KGU

Philippine Islands:
Baguio, KZUY
Manila, KZKZ, KZRQ

Porto Rico:
San Juan, WKAQ

Argentina:
Buenos Aires, B1, LOR, LOV, LOW, LOX, LOY, TCR

Australia:
Adelaide, 5CL
Melbourne, 3AR
Perth, 6WF
Sydney, 2BL, 2FC

Austria:
Vienna, Radio Wien
Graz, Relay

Belgium:
Brussels, SBR
Haeren, BAV

Brazil:
Bahia, Sociedade do Bahia
Belle Horizantes, Nat'l Telg. Service
Rio de Janeiro, SPE Sociedade de Rio de Janeiro
Sao Paulo, Radio Bondeirantes

Canada:
Burketon Junction, CKCW
Burnaby, CJKC
Calgary, CFAC, CFCN, CNRC
Charlottetown, CFCY
Edmonton, CFCK, CJCA, CNRE
Hamilton, CFCU, CHCS, CKOC
Iroquois Falls, CFCH
Kingston, CFMC, CFRC
London, CJGC
Moncton, CNRA
Montreal, CFCF, CHYC, CKAC, CNRM
New Westminster, CFXC, CFYC
Ottawa, CHXC, CKCO, CNRO
Regina, CKCK, CNRR
Saskatoon, CFQC, CHUC, CJWC, CNRS
Thorold, CFKC
Toronto, CFCA, CHIC, CHNC, CJBC, CJCD, CJSC, CJYC, CKCL, CKNC, CNRT
Unity, CHSC
Vancouver, CFCQ, CKCD, CKFC, CNRV
Victoria, CFCT
Winnipeg, CKY, CNRW

Cuba:
Camaguey, 6YR, 7AZ, 7BY, 7CX, 7DW, 7SR
Santa Clara, 6BY, 6DW, 6EV, 6GR, 6GT, 6HS, 6JQ
Colon, 5EV
Havana, PWX, Q2LC, 1AZ, 2AB, 2BB, 2BY, 2CG, 2CX, 2EP, 2HP, 2JL, 2JP, 2LR, 2MG, 2MK, 2OK, 2OL, 2PK, 2RK, 2RM, 2RY, 2SZ, 2TW, 2UF, 2WW, 2XX
Mantanzas, 5AZ, 5BY
Santiago, 8AZ, 8BY, 8FU, 8IR, 8JQ
Tuinucu, 6JK, 6KW

France:
Lyons, YN, Radio-Lyon
Paris, FPTT, Le Petit Parisien

Germany:
Berlin, Vox Haus, Telefunken Co.
Breslau, Schlesische, Rundfunk
Cassel, Sudwestdeutscher Rundfunk.
Dresden, Mitteldeutsche Rundfunk.
Frankfort-on-Main, Sudwestdeutsche Rundfunkdienst
Hamburg, Norag.
Konigsberg, Ostmarken Rundfunk
Leipzig, Mitteldeutsche Rundfunk
Munich, Deutsche Stunde
Munster Station
Nuremberg, relayed from Munich
Stuttgart, Station

Great Britain:
Aberdeen, 2BD
Belfast, 2BE
Birmingham, 5IT
Bournemouth, 6BM
Bradford, 2LS
Cardiff, 5WA
Dundee, 2DE
Edinburgh, 2EH
Glasgow, 5SC
Hull, 6KH
Leeds, 2LS
London, 2LO
Manchester, 2ZY
Newcastle, 5NO
Nottingham, 5NG
Plymouth, 5PY
Sheffield, 6FL
Stoke-on-Trent, 6ST

Mexico:
Chihuahua, CZF
Mazatlan, CYR
Mexico City, CYA, CYB, CYG, CYH, CYL, CYX, CYZ, C[illegible]A, CZE, XDA
Monterey, CYS
Oaxaca, CYF

Stations in Order of Wave Lengths

United States Stations by Wave Lengths

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
202.6	1,480	2,000	KFXB	Big Bear Lk., Cal.
		20	WIBS	Elizabeth, N. J.
205.4	1,460	50	KFVD	San Pedro, Cal.
		10	KFXD	Logan, Utah
		50	KFXY	Flagstaff, Ariz.
		10	KFYF	Oxnard, Calif.
		30	WCRB	Pvdce., R. I., ptb.
		20	WEHS	Evanston, N. Y.
		100	WFRL	Brooklyn, N. Y.
		5	WIBX	Utica, N. Y.
		10	WOCG	Sycamore, Ill.
		50	WPDQ	Buffalo, N. Y.
208.8	1,450	500	KFWM	Oakland, Calf.
		50	KGTT	San Fran'co, Cal.
		20	WABW	Wooster, Ohio
		50	WJBA	Joliet, Ill.
		10	WJBB	St. Petersb'g, Fla.
208.2	1,441	250	KNRC	H'ywood, Calif.
209.7	1,430	100	KDZB	Bakersf'd, Cal.
		5	KFVU	Eureka, Cal.
		100	KFXC	Santa Maria, Cal.
		500	WBNY	New York, N. Y.
		100	WCWS	Providence, R. I.
		5	WIBH	New B'df'd, Mass.
		50	WKAV	Laconia, N. H.
		500	WKBK	New York, N. Y.
		500	WSBC	Chicago, Ill.
211.1	1,420	10	KFWC	Upland, Calif.
		250	KFWO	Avalon, Calif.
212.6	1,410	5	KFWV	Portland, Ore.
		500	KQP	Portland, Ore.
		15	WMAL	Leese Opt. Co.
		500	WWGL	R'hm'd Hl., N. Y.
214.2	1,400	10	KFAW	Santa Ana, Cal.
		250	KFWF	St. Louis, Mo.
		10	KFWP	Brownsv'e, Tex.
		150	WCLS	Joliet, Ill.
		100	WKBB	Joliet, Ill.
215.7	1,390	50	KFQW	N. Bend, Wash.
		50	WBBZ	Ind'apolis, Ind.
		50	WHBL	Logansp't., Ind.
		20	WHBR	Cincinnati, O.
		10	WIBM	Chicago, Ill.
		100	WKBG	Ch'go. Ill. (Ptb.)
		100	WPRC	Harrisb'g, Pa.
		250	WRST	Bay Shore, N. Y.
217.3	1,380	10	KFRX	Pullman, Wash.
		500	WFKB	Chicago, Ill.
		10	WJD	Granville, Ohio
		5,000	WOK	Homewood, Ill.
218.8	1,370	10	KFJC	Junct'n Cty., Kan.
		100	KFRW	Olympia, Wash.
		10	KFVH	Manhattan, Kan.
		10	WHUB	Anderson, Ind.
		5	WIBI	Flushing, N. Y.
		250	WJBI	Red Bank, N. J.
220	1,360	50	KFQH	B'lingame, Cal.
		50	KFUU	San Leandro, Cal.
		500	KFWI	S. S'n Frn'co, Cal.
		5	KJBS	San Fran'co, Cal.
		100	WIBW	Logansp't, Ind.
		500	WQAA	Parkesb'g, Pa.
222	1,350	50	KFOB	Burlingame, Cal.
		100	KFQU	Holy City, Cal.
		15	KFRZ	Hartington, Nebr.
		50	WBBW	Norfolk, Va.
		100	WBES	Takoma Pk., Md.
		20	WHBD	Bellef'taine, O.
		100	WHBF	Rock Island, Ill.
		10	WHBH	Culver, Ind.
		100	WIBC	St. Pet'b'g, Fla.
		50	WIBG	Elkins Park, Pa.
		20	WIBU	Poynette, Wis.
224	1,340	5	KFBC	San Diego, Cal.
		15	KFBL	Everette, Wash.
		10	KFQP	Iowa City, Ia.
		10	KFUR	Ogden, Utah
		100	KFUU	San Le'dro, Cal.
		5	KFVS	C'pe Gir'd'u, Mo.
		10	WBBR	Monmouth, Ill.
		250	WDOD	Patterson, N. J.
		10	WJBG	Charlotte, N. C.
		15	WRAF	Laporte, Ind.
226	1,330	10	KFGQ	Boone, Iowa
		10	KFIU	Juneau, Alaska
		10	KFKZ	F. M. Henry
		20	KFOR	David City, Neb.
		250	KFQZ	Hollyw'd, Calif.
		20	WBBA	Newark, Ohio
		1,500	WBBM	Chicago, Ill.
		150	WDAD	Nashville, Tenn.
		100	WEMB	U. S. (portable)
		100	WEBL	U. S. (p'table)
		10	WEBQ	Harrisburg, Ill.
		20	WFBE	Seymour, Ind.
		1,000	WIBO	Chicago, Ill.
227	1,320	5	KFNV	Santa Rosa, Cal.
		10	KFVN	Welcome, Minn.
		50	KQW	San Jose, Calif.
		100	WDBK	Cleveland, Ohio
		10	WGBL	Elyria, Ohio
		500	WOWO	Ft. Wayne, Ind.
229	1,310	50	KFAN	Moscow, Idaho
		100	KFLV	Rockford, Ill.
		5	KPPC	Pasadena, Calif.
		10	WAIT	Taunton, Mass.
		100	WBBL	Richmond, Va.
		50	WCBM	Baltimore, Md.
		50	WDBJ	Roanoke, Va.
		10	WGBR	Marshf'd, Wis.
		20	WHBG	Harrisburg, Pa.
		10	WIBZ	Montgomery, Ala.
		10	WKBE	Webster, Mass.
		10	WSAN	Allentown, Pa.
		250	WSAJ	Grove City, Pa.
231	1,300	5	KDLR	Devils Lk., N. D.
		5	KFDZ	Min'polis, Minn.
		50	KFOT	Wichita, Kans.
		500	KFPR	Los Angeles, Cal.
		10	KFQC	Taft, Calif.
		50	KFQG	Los Angeles, Cal.
		500	KUT	Austin, Tex.
		10	WBRE	W'kes-Ba'e, Pa.
		50	WCLO	Camp Lake, Wis.
		10	WHBK	Ellsworth, Me.
		10	WLAX	G'ncastle, Ind.
		20	WNAR	Butler, Mo.
		50	WTAX	Streator, Ill.
233	1,290	10	KFEY	Kellogg, Idaho
		100	KFON	Long Beach, Cal.
		5	WDBZ	Kingston, N. Y.
		15	WEBA	H'hl'd Pk., N. J.
		100	WHAG	Cincinnati, O.
		20	WHBM	Ch'go, Ill. (ptb.)
		20	WHBQ	Memphis, Tenn.
		100	WJBD	Ashland, Wis.
		10	WJBK	Ypsilanti, Mich.
		50	WOKO	New York, N. Y.

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
234	1,280	50	KFUP	Denver, Colo.
		50	KFUS	Oakland, Calif.
		50	KMJ	Fresno, Calif.
		10	WDBQ	Salem, N. J.
		10	WEBE	Cambridge, O.
		5	WFBD	Philad'phia, Pa.
		100	WFDF	Flint, Mich.
		5	WGBM	Providence, R. I.
		100	WGBQ	Menomonie, Wis.
		10	WHBJ	Ft. Wayne, Ind.
		100	WJBC	LaSalle, Ill.
		50	WKAP	Cranston, R. I.
		100	WQAC	Amarillo, Texas
236	1,270	10	KFLU	San Benito, Tex.
		5	KFOO	Salt Lk. City, U.
		10	KFVG	In'pendence, Kan.
		10	KFVY	Albu'que, N. M.
		10	KFXE	Waterloo, Iowa.
		100	WBOQ	R'dm'd H. N. Y.
		100	WFBI	Camden, N. J.
		50	WFBJ	Collegev'e, Minn.
		100	WGBF	Evansville, Ind.
		100	WGMU	R'hm'd, H., N. Y.
		100	WIBA	The Capital Times
		100	WMRU	R'hm'd H., N. Y.
		50	WTAD	Carthage, Ill.
238	1,260	5	KFCB	Phoenix, Ariz.
		100	KFPG	Los Angeles, Cal.
		100	KFWU	Pineville, La.
		10	KFYJ	Houston, Tex.
		100	KWKC	W'ls'n D'nc'n Stu
		250	WCUW	Worcester, Mass.
		1,500	WHT	Chicago, Ill.
		10	WHBN	St. Pet'sb'g, Fla.
		10	WRAW	Reading, Pa.
240	1,250	10	KFHL	Oskaloosa, Ia.
		10	KFLX	Galveston, Texas
		500	KFVE	Un'sity City, Mo.
		10	KFVI	Houston, Texas
		500	KTAB	Oakland, Calif.
		100	WABI	1st Uni. Church
		50	WCAT	Rapid City, S. D.
		50	WDBO	Winter Pk., Fla.
		10	WGBI	Scranton, Pa.
		100	WHAP	Brooklyn, N. Y.
		500	WOAX	Trenton, N. J.
		10	WSMH	Owosso, Mich.
242	1,240	50	KFFP	Moberly, Mo.
		10	KFOJ	Moberly, Mo.
		10	KFPM	Greenville, Tex.
		50	KFRM	Ft. Sill, Okla.
		50	KFUJ	Brec'nr'ge, Minn.
		100	KFUM	Colo. Sp'gs, Colo.
		50	KFXH	El Paso, Texas
		500	KSO	Clarinda, Iowa
		100	KZM	Oakland, Calif.
		50	WABY	Philadephia, Pa.
		250	WBZA	Boston, Mass.
		10	WCBH	Oxford, Mich.
		50	WCBQ	Nashville, Tenn.
		10	WEBC	Superior, Wis.
		20	WEBK	Gr'd R'ds, Mich.
		100	WHBW	Phila'phia, Pa.
		50	WJBP	Cambridge, Ill.
		500	WWAE	Joliet, Ill.
244	1,230	50	KFVR	Denver, Colo.
		500	KUOM	Missoula, Mont.
		100	WAMD	Mi'apolis, Minn.
		50	WEBR	Buffalo, N. Y.
		100	WGBB	Freeport, N. Y.
		100	WNAX	Yankton, S. D.
		100	WRAM	Galesburg, Ill.
		50	WSAZ	Pomeroy, Ohio
		100	WTAT	B'st'n, Mas. (ptb.)
246	1,220	500	KDYL	Salt Lk. City, U.
		10	KFJI	Astoria, Ore.
		50	KFJY	Ft. Dodge, Ia.
		500	KFVW	San Diego, Cal.
		5	KGY	Lacey, Wash.
		150	KUO	San Fran'sco, Cal.
		250	WABX	Mt. Cle'ns, Mich.
		50	WCAZ	Carthage, Ill.
		10	WEBD	Anderson, Ind.
		50	WIBR	Weirton, W. Va.
		50	WQAE	Springfield, Vt.
		100	WSOE	Milwaukee, Wis.
248	1,210	100	KFBK	Sacramento, Cal.
		50	KFEC	Portland, Ore.
		100	KFIF	Portland, Ore.
		10	KFJB	Marshallt'n, Ia.
		10	KFKQ	Conway, Ark.
		100	KFOX	Omaha, Nebr.
		250	KFRB	Beeville, Tex.
		50	KWG	Stockton, Calif.
		500	WAPI	Auburn, Ala.
		500	WBBG	M'tap'sett, Mass.
		50	WBRC	Birm'gham, Ala.
		100	WCSO	Sp'gfield, Mo.
		100	WEW	St. Louis, Mo.
		10	WGAL	Lancaster, Pa.
		5	WGBK	Johnstown, Pa.
		100	WMAY	St. Louis, Mo.
250	1,200	500	KDPM	Cleveland, O.
		50	KFBG	Tacoma, Wash.
		100	KFDX	Shrevep't, La.
		100	KFFV	Lamoni, Iowa
		500	KFKX	Orange, Texas
		10	KFVY	Albuq'que, N. M.
		500	KFXF	Colo. Sp'gs, Colo.
		10	KGB	Tacoma, Wash.
		10	KMO	Tacoma, Wash.
		100	WFBC	Knoxville, Tenn.
		500	WGES	Oak Park, Ill.
		20	WHBA	Oil City, Pa.
		250	WHBY	W. DePere, Wis.
		100	WIAD	Philadelphia, Pa.
		150	WLAL	Tulsa, Okla.
		500	WMBB	Chicago, Ill.
		100	WNAB	Boston, Mass.
		100	WNAT	Philadelphia, Pa.
		100	WQAN	Scranton, Pa.
		100	WWAD	Phil'aphia, Pa.
252	1,190	50	KFCY	Lemars, Iowa
		500	KFGD	Chickasha, Okla.
		50	KFKA	Gunnison, Colo.
		50	KFOY	St. Paul, Minn.
		15	KFPL	Dublin, Texas
		20	KFQT	Denison, Texas
		10	KFUV	Sp'gfield, Mo.
		500	KFWB	Hollyw'd, Calif.
		500	KMA	Shenandoah, Ia.
		500	WBBS	New Orleans, La.
		300	WCAJ	Uni. Pl., Nebr.
		100	WCAX	Burlington, Vt.
		100	WFBL	Syracuse, N. Y.
		10	WGBX	Orono, Maine
		500	WNJ	Newark, N. J.
		100	WRCO	Raleigh, N. C.
		50	WRHM	Min'polis, Minn.
		5	WSRO	Hamilton, Ohio
		10	WTAL	Toledo, Ohio

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
254	1,180	50	KFDJ	Corvallis, Ore.
		50	KFEL	Denver, Colo.
		50	KFJZ	Ft. Worth, Tex.
		100	KFLR	Albuq'que, N. M.
		100	KFWH	Chico, Calif.
		10	WABC	Ashville, N. C.
		500	WCAJ	Uni. Place, Nebr.
		10	WCBA	Allentown, Pa.
		100	WFBR	Baltimore, Md.
		10	WFBZ	Galesburg, Ill.
		50	WGBA	Baltimore, Md.
		10	WHBC	Canton, Ohio
		100	WIAS	Burlington, Ia.
		50	WJAK	Greentown, Ind.
		250	WNAD	Norman, Okla.
		10	WREC	Coldwater, Miss.
		100	WSAR	Fall River, Mass.
		100	WTAQ	Osseo, Wis.
256	1,170	100	KFCF	W'la W'la, Wash.
		100	KFIQ	Yakima, Wash.
		20	KFLP	Cedar R'p's., Ia.
		250	KFYD	Muscatine, Ia.
		150	KRE	Berkeley, Calif.
		20	WBAX	Wilkes-Ba'e, Pa.
		50	WBDC	Gr'd Rpds, Mich.
		500	WCSH	Portland, Me.
		100	WDCH	Hanover, N. H.
		500	WDOD	Chat'nooga, Tenn.
		5	WEBT	Dayton, Ohio
		20	WGBW	Sp. Valley, Ill.
		100	WHBP	Johnstown, Pa.
		10	WJBN	Sycamore, Ill.
		100	WMBC	Detroit, Mich.
		100	WRAK	Escanaba, Mich.
		50	WRHF	W'hingt'n, D. C.
		1,000	WRVA	Richmond, Va.
258	1,160	50	KFDH	Tucson, Ariz.
		50	KFJX	Cedar F'ls, Iowa
		20	KFPW	Carterville, Mo.
		10	KFUL	Galveston, Tex.
		50	KOCH	Omaha, Nebr.
		25	WAAD	Cincinnati, Ohio
		100	WADC	Akron, Ohio
		50	WDBC	Lancaster, Pa.
		500	WDBY	Chicago, Ill.
		100	WHEC	Rochester, N. Y.
		100	WLTS	Chicago, Ill.
		50	WNAL	Omaha, Nebr.
		500	WRNY	New York, N. Y.
261	1,150	100	KFAJ	Boulder, Colo.
		225	KFJF	Oklahoma, Okla.
		10	KFMR	Sioux City, Ia.
		50	KFQA	St. Louis, Mo.
		500	KFWA	Ogden, Utah
		50	WABQ	Haverford, Pa.
		500	KWKH	Kennonwood, La.
		50	WDAY	Fargo, N. D.
		100	WDBR	Boston, Mass.
		250	WEAM	N. Pl'nf'd, N. J.
		250	WKAF	Milwaukee, Wis.
		100	WMAZ	Macon, Ga.
		10	WOAC	Lima, Ohio
		100	WPSC	State College, Pa.
		200	WRR	Dallas, Texas
		100	WSKC	Bay City, Mich.
		100	WTAR	Norfolk, Va.
		15	WTAZ	Lambertv'e, N. J.
263	1,140	5	KFJR	Portland, Ore.
		10	KFMW	Hought'n, Mich.
		100	KFQB	Ft. Worth, Texas
		50	KTBR	Portland, Ore.
		250	WAAM	Newark, N. J.
		50	WABR	Toledo, Ohio
		250	WCAD	Canton, N. Y.
		250	WCAR	SanAntonio, Tex.
		5	WCBE	New Orleans, La.
		100	WDAG	Amarillo, Tex.
		5	WEBZ	Savannah, Ga.
		500	WHAT	Min'polis, Minn.
		10	WIBV	Henderson, N. C.
		100	WRAV	Yellow Spgs, O.
		150	WSDA	New York, N. Y.
		250	WWAO	Houghton, Mich.
266	1,130	50	KFFP	Moberly, Mo.
		50	KFIO	Spokane, Wash.
		500	KFNF	Shenandoah, Ia.
		50	KFPY	Spokane, Wash.
		100	KFRY	State Col., N. M.
		250	KLZ	Denver, Colo.
		50	WBCN	Chicago, Ill.
		200	WCAH	Columbus, Ohio
		1,000	WENR	Chicago, Ill.
		10	WGBC	Memphis, Tenn.
		500	WGHB	Clearwater, Fla.
		100	WHAV	Wilm'gton, Del.
		500	WMAK	Lockport, N. Y.
		10	WTAB	Fall River, Mass.
		50	WWI	Dearborn, Mich.
268	1,120	100	KFEQ	Oak, Nebr.
		100	KFGC	Baton Rouge, La.
		50	KFRC	SanFran'co, Cal.
		500	KGU	Honolulu, Hawaii
		10	WBBY	Charleston, S. C.
		10	WCBG	Herrin, Ill. (ptb)
		10	WDRC	New Haven, Conn.
		50	WEAH	Wichita, Kans.
		500	WEBW	Beloit, Wis.
		250	WFBM	Ind'napolis, Ind.
		20	WJAM	Cedar Rp'ds, Ia.
		500	WNOX	Knoxville, Tenn.
		100	WQAM	Miami, Fla.
		10	WRAX	Gloucester, N.J.
		50	WSAX	Chicago, Ill.
		100	WTAC	Johnstown, Pa.
		500	WTAG	Worcester, Mass.
270	1,110	100	WEAN	Providence, R. I.
		1,500	WGHP	Detroit, Mich.
		100	WGST	Atlanta, Ga.
		250	WJAG	Norfolk, Nebr.
		100	WJBL	Decatur, Ill.
		500	WOI	Ames, Iowa
		100	WOWL	New Orleans, La.
		200	WRK	Hamilton, Ohio
		250	WTAW	College Sta., Tex.
273	1,100	500	KFAB	Phoenix, La.
		100	KFDY	Brookings, S. D.
		100	KFGH	Stan. Uni., Cal.
		100	KFIZ	Fond du Lac, Wis.
		50	KFKA	Greeley, Colo.
		100	KFLZ	Atlantic, Iowa
		100	KHQ	Seattle, Wash.
		100	KZKZ	Manilla, P. I.
		100	WAAB	New Orleans La.
		500	WAFD	Port Huron, Mich.
		100	WBAA	W. Laf'ette, Ind.
		500	WBBR	Rossville, N. Y.
		250	WDAE	Tampa, Fla.
		500	WEBJ	New York, N. Y.
		10	WFAM	St. Cloud, Minn.
		500	WFBH	New York, N. Y.
		250	WHK	Cleveland, Ohio
		250	WIL	St. Louis, Mo.
		500	WRM	Urbana, Ill.
		1,000	WRR	Dallas, Texas
		500	WRW	Tarrytown, N. Y.
		250	WSBF	St. Louis, Mo.
		50	WTG	Manhattan, Kans.

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
275	1,090	50	KFBB	Havre, Mont.
		10	KFDD	Boise, Idaho.
		500	KFKU	Lawrence, Kans.
		500	KFSG	Los Angeles, Cal.
		500	KQV;	Pittsburgh, Pa.
		100	WAAC	New Orleans, La.
		50	WABZ	New Orleans, La.
		500	WAFD	Port Huron, Mich.
		500	WBAK	Harrisburgh, Pa.
		100	WBAO	Decatur, Ill.
		50	WCAO	Baltimore, Md.
		5,000	WCEE	Elgin, Ill.
		100	WEAU	Sioux City, Ia.
		250	WFAV	Lincoln, Nebr.
		500	WHAD	Milwaukee, Wis.
		500	WHAR	Atlan. City, N. J.
		500	WIAS	Pittsburgh, Pa.
		100	WKY	Oklahoma, Okla.
		20	WLAP	Louisville, Ky.
		100	WMAC	Cazenovia, N. Y.
		15	WOCL	Jamestown, N. Y.
		1,000	WORD	Batavia, Ill.
		50	WPAK	Agric. Col., N. D.
		250	WSBT	South Bend, Ind.
		500	WSMK	Dayton, Ohio.
		5	WWL	New Orleans, La.
278	1,080	750	KFAU	Boise, Idaho
		100	KFJM	Gd. Forks, N. D.
		500	KOIL	C'ncil Bluffs, Ia.
		500	KOP	Detroit, Mich.
		200	KUSD	Vermilion, S. D.
		500	KWWG	Brownsvle., Tex.
		200	WAAF	Chicago, Ill.
		100	WABO	Roch. ster, N. Y.
		500	WCAU	Philadelphia, Pa.
		100	WDBE	Atlanta, Ga.
		10-100	WDZ	Tuscola, Ill.
		100	WFBG	Altoona, Pa.
		100	WGBU	Flfd. By-Sea, Fl.
		100	WHAM	Rochester, N. Y.
		100	WHDI	Minneap., Minn.
		50	WKAA	Cedar Rap., Ia.
		5	WLB	Minneap., Minn.
		500	WLBL	Stevens Pt., Wis.
		50	WMAN	Columbus, O.
		1,000	WOQ	Kansas City, Kans.
		250	WRBC	Valparaiso, Ind.
280.2	1,070	500	WNAC	Boston, Mass.
282.8	1,060	500	WOAN	Lawrncbg., Tenn.
		1,000	WSM	Nashville, Tenn.
285.5	1,050	500	WEAI	Ithaca, N. Y.
		500	WEMC	Ber. Spgs., Mich.
		500	WKAR	E. Lansing, Mich.
		500	WREO	Lansing, Mich.
288.3	1,040	1,500	KFKX	Hastings, Nebr.
		5-100	WBBP	Petoskey, Mich.
		1,000	WLWL	New York, N. Y.
293.9	1,020	500	KTBI	Los Angeles, Cal.
		500	WBAV	Columbus, O.
		500	WEAO	Columbus, O.
296.9	1,010	500	KPRC	Houston, Tex.
299.8	1,000	500	KFMQ	Fayettv'le., Ark.
		1,000	KSL	Salt Lk. City, Utah
		500	WPG	Atlan. City, N. J.
302.8	990	500	WJJD	Mooseheart, Ill.
		1,000	WLIB	Elgin, Ill.
305.9	980	1,000	KTCL	Seattle, Wash.
		500	WJAR	Providence, R. I.
309.1	970	1,000	KDKA	Pittsburgh, Pa.
315.6	950	10	KFXJ	Colo. (Portable).
		500	KFDM	Beaumont, Tex.
		500	KPSN	Pasadena, Cal.
		500	WAHG	Rhmd. Hill, N. Y.
		1,000	WGBS	New York, N. Y.
		500	WGCP	New York, N. Y.
319	940	750	WGR	Buffalo, N. Y.
		500	WSMB	New Orleans, La.
322.4	930	1,000	KOA	Denver, Colo.
		1,000	WJAZ	Chicago, Ill.
325.9	920	500	WSAI	Cincinnati, O.
		1,000	WKRC	Cincinnati, O.
333.1	900	500	KDYL	Salt Lk. Cy., Utah
		1,500	WBZ	Springfield, Mass.
336.9	890	750	KFMX	Northfd., Minn.
		500	KNX	Los Angeles, Cal.
		500	WCAL	Northfd., Minn.
		500	WSAC	Clemson Col. S. C.
340.7	880	200	KFAB	Lincoln, Nebr.
		500	KSAC	Manhattan, Kan.
		500	WKAQ	San Juan, P. R
		500	WMCA	New York, N. Y.
344.8	870	500	WCBD	Zion, Ill.
		500	WLS	Chicago, Ill.
348.6	880	500	KOB	State Col., N. M.
		500	KWSC	Pullman, Wash.
		500	WEEI	Boston, Mass.
352.7	850	500	WJAD	Waco, Tex.
		500	WWJ	Detroit, Mich.
360	833	250	KLS	Oakland, Cal.
		500	KZUY	Baguio, P. I.
		100	WQAO	New York, N. Y.
361.2	830	2,000	KGO	Oakland, Cal.
		500	WHN	New York, N. Y.
365.6	820	500	WDAF	Kan. City, Mo.
		500	WHB	Kansas City, Mo.
370.2	810	1,000	WEBH	Chicago, Ill.
		1,000	WGN	Chicago, Ill.
374.8	800	500	KTHS	Hot Spgs., Ark.
		500	KZRQ	Manila, P. I.
379.5	790	3,500	WGY	Schenectady, N. Y.
		500	WHAZ	Troy, N. Y.
384.4	780	500	KJR	Seattle, Wash.
		500	WMBF	Miami Bch., Fla.
389.4	770	1,000	WEAR	Cleveland, O.
		1,500	WTAM	Cleveland, O.
394.5	760	500	WFI	Philadelphia, Pa.
		500	WLIT	Philadelphia, Pa.
		1,500	WOAI	San Antonio, Tex.
399.8	750	500	WHAS	Louisville, Ky.
		1,500	WHT	Chicago, Ill.
405.2	740	500	KHJ	Los Angeles, Cal.
		1,000	WJY	New York, N. Y.
		500	WOR	Newark, N. J.
416.4	720	5,000	WCCO	Minneap., Minn.
422.3	710	1,000	WKRC	Cincinnati, O.
		5,000	WLW	Cincinnati, O.
428.3	700	1,000	KPO	San Fran., Cal.
		5,000	WSB	Atlanta, Ga.
434.5	690	750	AT9	Fort Bragg, N. C.
		varies	NAA	Radio, Va.
440.9	680	1,000	KLDS	Independ., Mo.
		500	WDWF	Cranston, R. I.
		1,000	WMAF	Drtmth., Mass.
		500	WOS	Jefferson Cy., Mo.
447.5	670	500	WMAQ	Chicago, Ill.
		500	WQJ	Chicago, Ill.
454.3	660	1,000	KFOA	Seattle, Wash.
		500	KTW	Seattle Wash.
		1,000	WJZ	New York, N. Y.

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
461.3	650	500	WCAE	Pittsburgh, Pa.
468.5	640	5,000	KFI	Los Angeles, Cal.
		500	WCAP	Washington, D. C.
		500	WRC	Washington, D. C.
475.9	630	1,500	WBAP	Ft. Worth, Tex.
		500	WFAA	Dallas, Tex.
		500	WTIC	Hartford, Conn.
483.6	620	5,000	WOC	Davenport, Iowa
		500	WSUI	Iowa City, Ia.
491.5	610	500	KGW	Portland, Ore.
		2,000	WEAF	New York, N. Y.
499.7	600	500	KFRU	Columbia, Mo.
		500	WMC	Memphis, Tenn.
508.2	590	500	KLX	Oakland, Cal.
		500	WIP	Philadelphia, Pa.
		500	WOO	Philadelphia, Pa.
516.9	580	500	WCX	Detroit, Mich.
		5,000	WJR	Detroit, Mich.
528	570	500	WHO	Des Moines, Ia.
		1,000	WNYC	New York, N. Y.
		1,000	WOAW	Omaha, Nebr.
535.4	560	2,000	KYW	Chicago, Ill.
		500	WHA	Madison, Wis.
545.1	550	500	KFUO	St. Louis, Mo.
		750	KSD	St. Louis, Mo.

Canadian Stations by Wave Lengths

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
247.8	1,210	75	CFKC	Thorold, Ont.
267.7	1,120	29	CFMC	Kingston, Ont.
		500	CFRC	Kingston, Ont.
		20	CFYC	New Wstmtr., B.C.
291.1	1,030	20	CFXC	New Wstmtr., B.C.
		500	CJYC	Scarboro Stn., Ont.
		500	CNRA	Moncton, Can.
		500	CNRV	Vancouver, B. C.
312.3	960	50	CFCY	Charlotn., P. E. I.
		1,000	CKCK	Regina, Sask.
329.5	910	500	CFCT	Victoria, B. C.
		500	CFQC	Saskatoon, Sask.
		50	CHUC	Saskatoon, Sask.
		50	CJGC	London, Ont.
		250	CJWC	Saskatoon, Sask.
		5,000	CKCW	Brktn. Jct., Ont.
		500	CNRO	Ottawa, Ont.
340.7	880	10	CHCS	Hamilton, Ont.
		50	CKOC	Hamilton, Ont.
356.9	840	500	CFCA	Toronto, Ont.
		500	CHIC	Toronto, Ont.
		500	CHNC	Toronto, Ont.
		250	CHSC	Unity, Sask.
			CJBC	Toronto, Ont.
		50	CJCD	Toronto, Ont.
		500	CJSC	Toronto, Ont.
		500	CKCL	Toronto, Ont.
		500	CKNC	Toronto, Ont.
		500	CNRT	Toronto, Ont.
384.4	780	500	CKY	Winnipeg, Man.
		500	CNRW	Winnipeg, Man.
410.7	730	1,650	CFCF	Montreal, Que.
		5	CFCQ	Vancouver, B. C.
		850	CHYC	Montreal, Que.
		500	CJKC	Burnaby, B. C.
		1,200	CKAC	Montreal, Que.
		1,000	CKCD	Vancouver, B. C.
		50	CKFC	Vancouver, B. C.
		1,000	CNRM	Montreal, Que.
434.5	890	500	CFAC	Calgary, Alta.
		1,800	CFCN	Calgary, Alta.
		750	CHCA	Calgary, Alta.
		250	CHXC	Ottawa, Ont.
		100	CKCO	Ottawa, Ont.
		750	CNRC	Calgary, Alta.
		500	CNRO	Ottawa, Ont.
		1,000	CNRR	Regina, Sask.
483.6	820	500	CFCU	Hamilton, Ont.
499.7	600	250	CFCH	Iroquois, Ont.
516.9	580	100	CFCK	Edmonton, Alta.
		500	CJAC	Edmonton, Alta.
		500	CNRE	Edmonton, Alta.

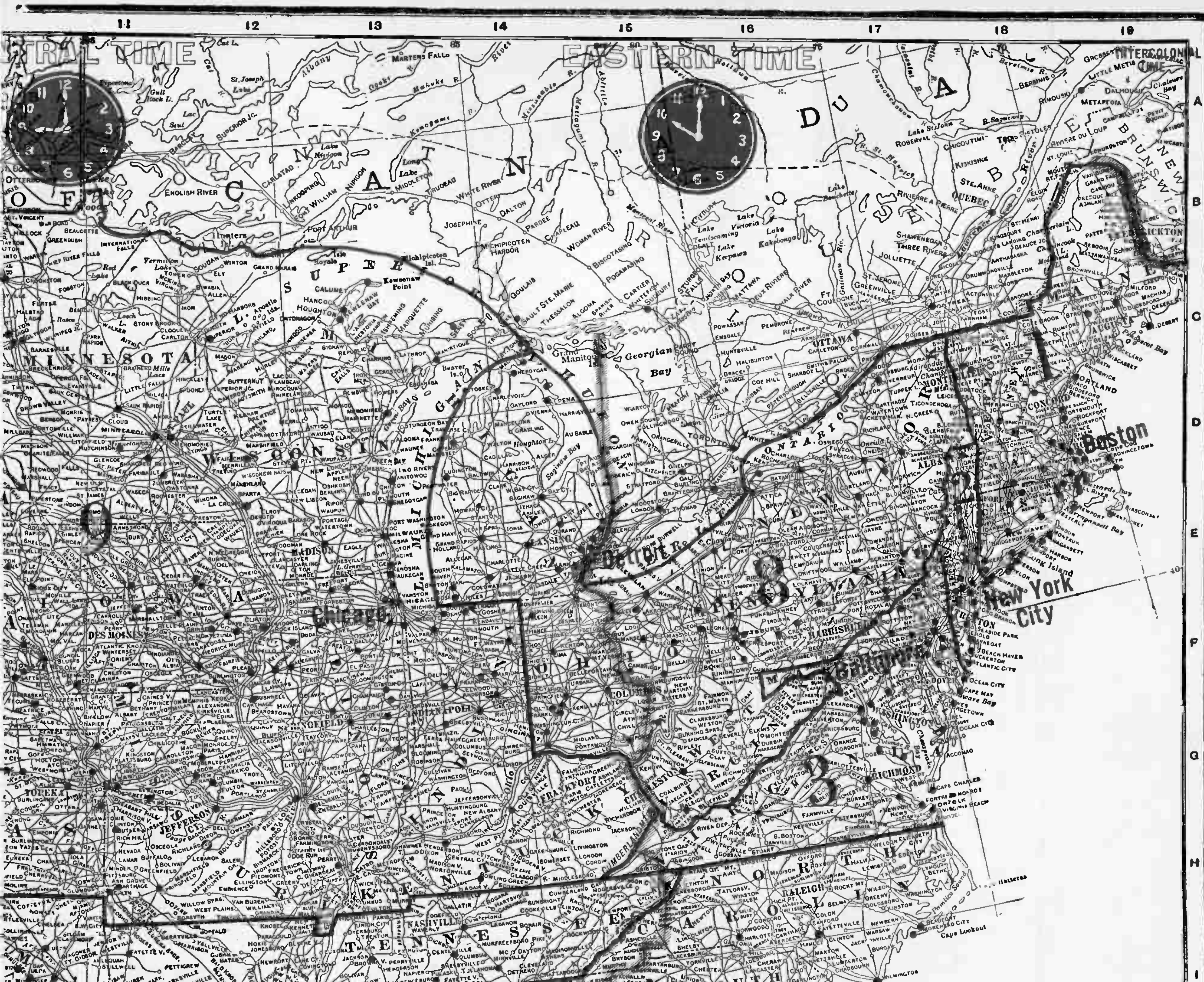
Cuban Stations by Wave Lengths

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
200	1,500	20	5AZ	Mantanazs
		10	8HS	Santa Clara
		20	6YR	Camaguey
210	1,430	10	2RM	Havana
225	1,333	10	6DW	Santa Clara
		10	7AZ	Camaguey
		15	8FU	Santiago
		20	8JQ	Santiago
230	1,304	20	2TW	Havana
235	1,277	10	2AB	Havana
		10	2LR	Havana
		20	7BY	Camaguey
240	1,250	20	8AZ	Santiago
250	1,200	50	Q2LC	Havana
		10	6GR	Santa Clara
		10	6JQ	Santa Clara
		100	8BY	Santiago
255	1,176	15	2BB	Havana
260	1,153	200	6BY	Santa Clara
265	1,132	10	2UF	Havana
270	1,110	20	2JP	Havana
275	1,090	5	1AZ	Havana
		5	2JL	Havana
		100	6JK	Twinucu
280	1,070	20	2MG	Havana
295	1,018	100	2HP	Havana
300	1,000	100	2OL	Havana
310	967	100	2RK	Havana
315	952	100	2TW	Havana
320	937	10	2CX	Havana
332	903	100	6KW	Twinucu
350	857	10	2CG	Havana
		500	7SR	Camaguey
355	845	400	2EP	Havana
360	833	100	2OK	Havana
		10	5EV	Colon
400	750	500	PWX	Havana

Mexican Stations by Wave Lengths

Wave length	Frequency (kilocycles)	Power (watts)	Call signal	Location
260	1,153		CYF	Oaxaca, Mex.
310	967		CYS	Mexico City, Mex.
325	923		CYH	Mexico City, Mex.
333	900		CYX	Mexico City, Mex.
380	790		CYB	Mexico City, Mex.
400	750		CYZ	Mexico City, Mex.
480	625		CYL	Mexico City, Mex.


PACIFIC TIME
MOUNTAIN TIME
PACIFIC
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
DOMINION
San Francisco
MILES =
150
300
450
600
750
900
1050
1200
1350
INCHES =
For fractions of an inch, add ¼ inch 37½ - ½ inch 75 - ¾ inch 112½ miles



CENTRAL TIME
EASTERN TIME
INTERCOLONIAL TIME
Boston
New York City
Chicago
Detroit
Savannah
New Orleans
Radio Map of the
UNITED STATES
EXPLANATION
• Radio Stations
Radio District Boundaries
Divisions of Standard Time
"New Orleans" District Headquarters
9 Radio District Numbers
Scale 150 Miles to One Inch
1500 1650 1800 1950 2100 2250 2400 2550 2700 2850

How to Operate

The Radiola Super-Heterodyne Receiver

RADIOLA Super-heterodyne is a Radio broadcast receiving instrument, utilizing the super-heterodyne principle, which provides unusual simplicity of operation, selectivity and sensitivity. The cabinet contains the operating mechanism and the battery equipment, as well as a loop antenna, making the set self contained. It is designed for reception over the broadcast wave length band 220 to 550 meters.

Additional Equipment Required

In addition to the Radiola Super-heterodyne, there will be required the following apparatus; 6 vacuum tubes, model UV-199, 1 loud speaker, 1 telephone plug, 1 set of A, B and C batteries. The A battery may be composed of six ordinary dry cells, 1½ volts each, for lighting the filaments. They should be connected in two parallel groups, each of three cells in series. For the B battery, four 22½-volt plate batteries connected in series, or two 45-volt plate batteries may be used if desired. The C battery is to be one of the customary 4½-volt units measuring 4 by 3 by 1⅜ inches.

Access to the space provided for the A and B batteries is secured by pulling on the knobs on the two small end doors G and removing these doors. An envelope containing four short and two long jumper connectors will be found inside.

Connecting Batteries

Connect two B batteries in series, using one of the long jumper connectors, fastening one end onto the "+22½ V." terminal of one battery, and the other end onto the "—" terminal of the other battery. (Should the large size 45-volt blocks be used, the two jumper connectors will not be needed.) Connect these batteries to the set, fastening the lead marked "+B", coming through the hole in the side of the battery compartment onto the battery terminal marked "+22½ V." as yet unconnected; (or onto the "+45 V." terminal of the 45-volt battery if one is used). Connect the other lead marked "—B" onto the "—" terminal of the other battery. Stand the batteries (or battery) on end and place them in the compartment, pushing them into the corner as near toward the center of the set as possible.

Connect three of the A dry cells in series, using two of the four short jumper connectors. Connect the lead marked "+A" to the center binding post (not yet connected); and connect the lead marked "—A" onto the outside binding post (not yet connected). This procedure with A and B batteries is to be followed in each end of set.

Place the C or grid bias battery in the compartment at the rear of the central section of the set. Connect the lead marked "+C" to the "+" terminal on the battery; and connect the other lead marked "—C" to the "—4½ V." terminal of the battery.

With the batteries installed and connected, replace the battery doors. Radiola super-heterodyne may now be located in any part of the home, convenient and desirable to its owner. It need not be located in any particular place or turned in any particular direction with respect to the room or to the received signal.

This super-heterodyne utilizes six tubes, model UV-199, which should be handled with due care. Pull the Radio panel forward to the half open position, allowing it to rest against the stay joint.

Before inserting the tubes, turn the "battery setting" knob K to "off" or push in the filament switch E in the lower center of the panel. Remove the six vacuum tubes from their individual cartons. Insert one in each of the six tube sockets by placing it in the socket, turning the tube until the pin in the base drops into the slot, and then turning slightly to the right. Swing the panel back in place and lock it, using the latch T.

Operation

Pull out the filament switch E. Turn the "battery setting" knob K clockwise from "off" toward "100." With new batteries, the pointer should be set approximately 40 to 50 on the dial. As the batteries grow older, this setting must be gradually advanced toward "100." Turn the "volume control" knob U clockwise from "soft" to "100." Push in the jack switch S, which puts the output of the second stage amplifier into the loud speaker.

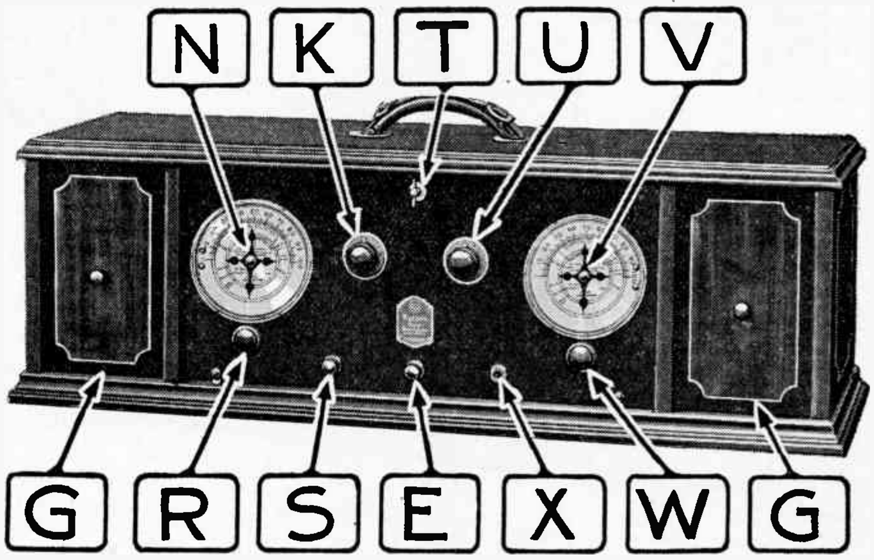
The tuning of Radiola super-heterodyne involves only the manipulation of the two "station selector" knobs R and W—a simple operation if the principle described as follows becomes throroughly understood.

The two gold-tipped pointers have approximately the same settings, i.e. if one is set at 10 or 30, etc., the other is at or near 10 or 30, etc.

When searching for stations, the settings of which are not known, proceed as follows: Set "station selector I" gold-tipped pointer N at, say, 10 (referring to the metal dial scale under the paper scale). Move "station selector II" gold-tippel pointer V slowly over the scale near 10, say from 5 to 15. If no signals are heard, there is no station working on that wave length. Then set "station selector I" pointer at say 12, and slowly move "station selector II" from about 7 to 17. If again no signals are heard, set "station selector I" gold-tipped pointer at, say, 14, and move "station selector II" slowly from about 9 to 19. If still no signals, repeat this process increasing the setting of "station selector II" in small steps until the whole scale has been covered. It will be noted after the first few trials that when "station selectors I and II" are in resonance, a slight breathing sound is heard, indicating that the set is working properly and in resonance.

This Radiola uses the second harmonic principle and has only two controls. All parts are enclosed in one cabinet including batteries and loop aerial, making it self contained. This is a highly selective and sensitive receiving set for a broad wave band.

After hearing a signal, carefully adjust both "station selectors I and II" to get the best results. If no stations are heard, the set should be turned on the table 90 degrees from where it was during the preceding adjustments, and the tuning process just described should be repeated.



As Radiola super-heterodyne is a very sensitive receiver, it is often found advisable to reduce the loud speaker volume. This may be accomplished by employing one or all of the following methods:

Turn the "volume control" knob U away from "100" toward "soft"; pull out the jack switch S; shift the set on the table, until best position is found.

Eliminating Interference

Signals from an interfering Radio station may be eliminated or at least minimized by either of the following methods:

Turn "station selector II" pointer V, either to the right or left, by approximately ¾ to 1 inch, to find another position of this control, where the desired station will be again heard. The setting of "station selector II" nearer the left end of the scale is technically called the "lower wave length peak," and the other the "upper wave length peak." Two settings of this nature will be found for all broadcast stations, and the separation between them becomes greater and greater for the higher end of the scale, i.e., nearer the right hand end. It is recommended that "station selector II" be consistently set on the "lower peak" in the usual manipulation of the set. When interference is encountered, shift to the "upper peak," and use whichever one at which minimum interference occurs.

Rotate the receiver on the table. For every transmitting station, there are two positions at which the signal strength will rise to a maximum, and two others at right angles at which it is at a minimum. Place the Radiola super where the best results are secured, trying to locate the position where the interference does not come in, but the desired signals do.

Four paper dials for each of the "station selectors" will be found with the set, three each in the envelope for the instruction book, and one each in place on the panel. To put another "station selector I" dial in place, grasp pointer N with the left hand, turn and remove the knurled nut which holds it in place. Grasp the two knobs on the end of the clamp wire, pinch the knobs together, and pull the clamp wire free from its retaining ring. Remove the old dial and place a "station selector I" dial on the panel, taking care to properly line up the central hole and the notch on the left side. Replace clamp wire, pointer N, and knurled nut in the order mentioned. Follow the same process for "station selector II."

The paper dials provide a means of recording the settings of the "selectors" for the various stations. Once recorded, the pointers may be reset at any later time to these positions, and if the station is broadcasting, it will be heard. After a station is tuned in as above, mark the positions of one of the tips of each of the "station selectors" as well as the call letters of the station. It is suggested that only the "lower peak" of "station selector II" be recorded.

General Information

Each of the "station selectors" is provided with four pointers, in order that stations of nearly the same setting may be recorded on the dials without crowding the markings. It is suggested that the gold-tipped pointers be reserved for wave length or frequency markings, and that the station settings be recorded on the three remaining pointers in the following order: Long black pointer, right short pointer, and left short pointer. Mark as many stations as possible on the long black pointer. When a new station is tuned in, quite close to one already recorded, then use the short pointers for the markings.

The only precaution to be observed when making these markings is to see that the set is not located near any large metal objects, such as a steam radiator, or that it is not near any aerials or electric wiring. Such positions may cause changes in the setting of "station selector I."

The "battery setting" knob K should be kept as near the "off" position as possible, without decreasing the signal strength or destroying the quality of reception. The six tubes should be used at all times. It is inadvisable to remove the sixth tube when only five are used, to reduce volume. Rather reduce volume by dimming all filaments or by turning the set than to employ this method. Both these precautions make for economical use of the batteries and tubes.

Very little maintenance is required on this superheterodyne, outside of an occasional oiling of a few of the parts. The oiling operation is important, and should be done about once every six months. To oil the moving parts, turn both "station selector" pointers as far right as possible, and open the panel of the set half way. Then place one drop of good grade oil, such as typewriter oil, on each of the following parts of both "station selectors":

On the front and rear bearings of the shafts, where the shafts pass through the black moulded sub panels; on the bushings in the panel which hold the "selector" knobs; on the universal or ball joint just back of the "selector" knob shaft; on the spring bearing of the slanting knob shaft (which spring bearing presses against the black insulation collar).

Possible Difficulties

Should any trouble develop in the use of Radiola super-heterodyne, it will in all probability be due to loss of life of the tubes or to the exhaustion of the batteries. As the batteries grow old, they decrease in voltage, and increase in resistance. After the tubes have been used for a long time, their filaments tend to lose emission. If the difficulty appears to be elsewhere, it is recommended that the services of the dealer from whom the set was purchased, be enlisted.

If the set becomes inoperative, try interchanging the tubes. The second tube from the right is the important one and it is well to replace it before looking elsewhere for tube trouble. Try substituting this tube for either the third, fourth or fifth one. It is of advantage to keep a spare UV-199 on hand, to meet emergencies.

There are several indications by which the user may determine that the filament or A batteries are becoming exhausted. These are low filament brilliancy, weak signals, and distortion, the signals becoming less and less recognizable. When it is found necessary to turn the "battery setting" knob up to "100," and the operation of the set is still unsatisfactory, it is a definite indication that the filament batteries are exhausted.

When fresh batteries are installed for the first time, listen to the loud speaker, while pushing the jack switch in and out. Sharp "clicks" will be heard in the loud speaker. Do this sufficiently to learn just how loud the click should be. If the B batteries have become fairly well exhausted, these clicks will become practically imperceptible—an indication that they need replenishing.

An indication of exhausted C batteries may be had by listening to the loud speaker with no station tuned in. If the loud speaker gives forth a continuous noise, the battery needs renewal. The noise may be either a high pitched whistle, a high cackling sound or a low gurgling murmur. Frequently the whistle is so high as to be above the range of audibility for some, but in any case the noise becomes more audible as the batteries age.

To restore activity in 199 tubes, apply six volts for 38 seconds, then drop suddenly to 4½ volts for eight seconds. For 201A tubes, use 8 volts 30 seconds, then eight volts 10 seconds. Cool in the ice box.

If your ground wire runs under the carpet, you soon will notice extra wear where the wire raises the carpet. To avoid this substitute brass ribbon for round wire.

How to Operate

The Crosley Three Tube Trirdyn Special

The Crosley Trirdyn is a three tube receiver using radio frequency amplification, a regenerative detector, reflexing and audio amplification

THE Crosley Trirdyn is one of the most widely distributed, popular priced receivers now on the market. A front view of this set is shown in figure 1, and it will be noted that there are two large dials and three knobs which appear on the face of the panel. The tuning from station to station is done by means of the two dials, while the center knob is the sensitivity control. The other two knobs are rheostats, which control the brilliancy of the filaments of the three vacuum tubes employed and they do not enter into the tuning.

Crosley Trirdyne is unique in the fact that it employs radio frequency amplification, a regenerative detector, reflexing and audio frequency amplification. To make these terms clearer it might be explained that radio frequency amplification means strengthening of the very feeble current received, while they are still changing their direction at the very high rate of 500,000 to 1,500,000 times per second, which frequencies are known as radio frequencies. A regenerative detector is one in which part of the current which has passed through the vacuum tube is returned to the input circuit of the tube and sent through the tube a second time for further strengthening. By reflexing, the Radio man means that one of the tubes is used to amplify or strengthen the energy both at the high radio frequencies and at the lower audio frequencies of 16,000 to 20,000 per second.

Figure 2 shows the path of the current through the three tubes utilized in this receiver. From the antenna and ground the current enters tube I and is strengthened at radio frequencies. You will note that the radio frequency current leaving this tube is shaded, denoting that it has been amplified in passing through the tube. The energy then enters tube II, which is the regenerative detector, leaving it as an audio frequency current. This current doubles back and passes again through tube II to be amplified by regeneration. The upper path, between tube I and tube II shows the current going back into tube I, which gives the reflex action and in tube I it is amplified or strengthened at audible frequencies. From tube I it goes by the upper, heavily shaded path to tube III, and it is further amplified at audible frequencies in tube III.

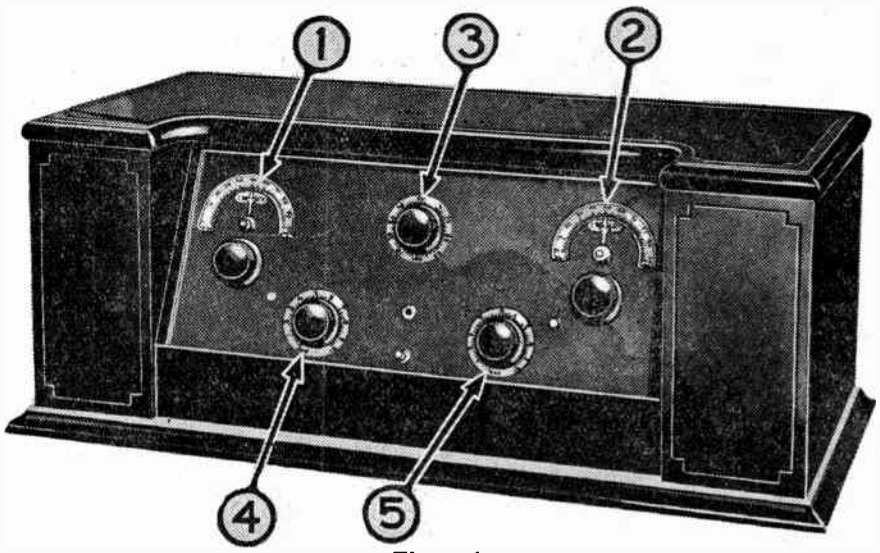


Figure 1

Figure 3 shows the rear view of this receiver, and tube socket 13 is to take the tube which has been referred to above as tube I, socket 14 takes the tube referred to as tube II, while socket 15 is to receive the tube referred to as tube III. Figure 4 shows the usual schematic diagram to which the more experienced Radio man is accustomed. The numbers by which the various pieces of apparatus are keyed, are the same in figures 3 and 4. The directions which accompany this receiver are very clear as to the antenna, ground, battery and loud speaker connections, so they will not be taken up here.

Let us presume that we wish to receive a station using a wave length of 375 meters. The frequency of alternation of the incoming current is determined by dividing 300,000,000 by the known wave length and, if this figure is divided by 375, the frequency is 800,000. Referring to figure 4 the signals are entering the antenna-ground circuit which includes the coil 8, known as the primary, at a frequency of 800,000. We wish the tuned circuit which is composed of coil 9 and the variable condenser number 1, to absorb signals from this antenna circuit and, in order that it will do so, this circuit must be adjusted or tuned so that it responds to, and will absorb, signals alternating at 800,000 per second. Turning the left-hand dial on the front panel, which controls condenser 1, will accomplish this purpose. This circuit is connected at one end to the grid of the tube in socket 13 and signals which this tuned circuit absorbs will be passed into that tube.

Having been amplified, we wish them to go to the detector in tube socket 14. The flat disc of wire, which is really a coil or inductance, and which has been labeled 3A in the drawings, includes two separate windings, one of which, known as the primary, is connected to the output or plate of the first tube, and signals which have passed through tube 13 must go into part of this coil 3A. The rest of this coil, and variable condenser 2, form another tuned circuit, which must be adjusted to absorb frequencies of 800,000. This is done by turning the right hand dial, and signals which this tuned circuit absorbs will pass to the grid of the detector tube.

In the output or plate circuit of this detector tube is the coil which has been labeled 3, and which is controlled in its relation to 3A by the center knob on the panel. If this coil is too close to 3A a condition known as oscillation will be produced which prevents signals from being heard, while if this coil is too far away from 3A the valuable benefits of regeneration are not gained. It is desirable, therefore, to so adjust the relationship between these coils that regeneration will be increased to a point just before the point of oscillation is reached. This point can be recognized if the two dials are correctly adjusted, as the signals will increase in volume as the center knob is pulled out and will suddenly begin to be distorted or "mushy." This knob should, therefore, be pulled out until this point is reached and then pushed back slightly so that the volume is still present, but the distortion is not noticed.

One end of coil 3 is connected to what is known as an audio transformer and labeled 6 in the diagrams. In figure 3 it will be found under the right end of the shelf. This transformer contains a large iron core and many thousand turns of wire, which are the features that distinguish it as an audio frequency transformer. It contains two windings, one of which is known as the primary, and is connected to coil 3 at one end, and, at the other end, to the binding post 17, to which is also connected the 22½-volt plus lead from the B battery. The secondary winding of this transformer, while it does not need to be tuned, as was the case with radio frequency transformers, will absorb energy from the primary. The secondary of this transformer is connected to the grid circuit of the first tube by being connected to the center of the secondary coil 9 as shown in figure 4. The current passes through tube 13 a second time, but now at audible frequencies and passes to the jack which is shown in figure 4, below the coil 3A. A pair of head receivers can be plugged into this jack and signals heard. If the receivers are not plugged in, the energy goes to audio transformer 7, shown at the left end of the shelf in figure 3, and into the primary, as shown in figure 4. The secondary of this transformer absorbs energy from this primary and passes it to the grid of the tube in socket 15, which is shown in figure 3 at the left end, in figure 4 in the upper right corner. Tube 15, which was tube III in the original explanation, amplifies or strengthens the energy, and from this tube it goes to the two binding posts labeled "output," to which a loud speaker is to be connected.

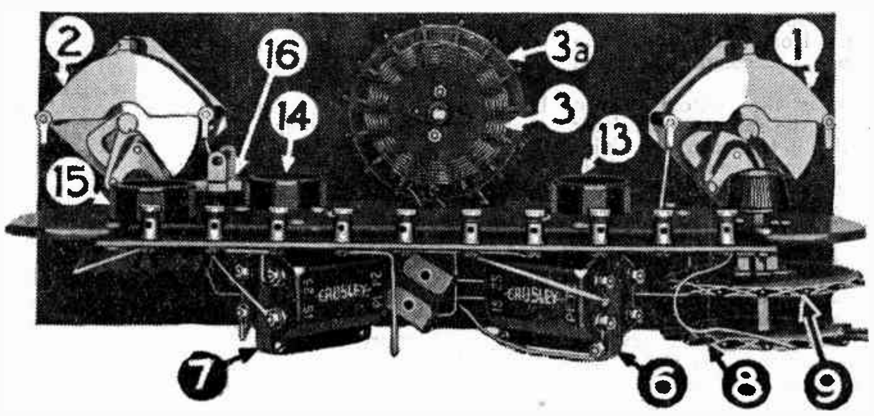


Figure 2

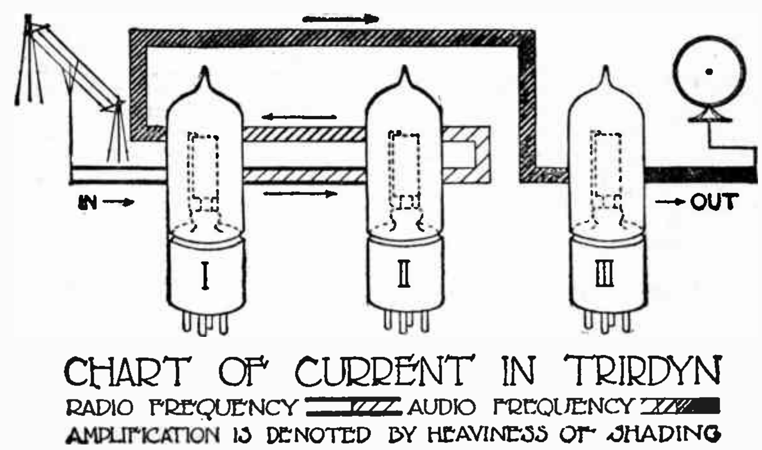


Figure 3

The adjustment of the two rheostats 4 and 5 will not be found particularly critical, but once signals have been brought in, as outlined above, these rheostats should be adjusted for maximum volume and clearness. The piece of apparatus which has been labeled 16 in figures 3 and 4 comprises two units, one of which is known as the grid condenser and the other as the grid leak. The grid condenser is permanently connected in place and there would be no advantage in changing it to any other capacity than that supplied in the set. The grid leak, however, which is the small glass tube held in two clips, will be found worthy of some attention in the way of changing it. Grid leak cartridges, as they are called, come in various values, such as 2 megohms, 3 megohms, etc., up to 7 megohms. Since the tubes on the market vary considerably in their characteristics, no definite value can be given for this unit and it would be a good idea to purchase one of each value from 3 to 7 megohms. One of these will be found to give considerably better results, both in volume and clearness, than any of the others, and it should be left in the clips.

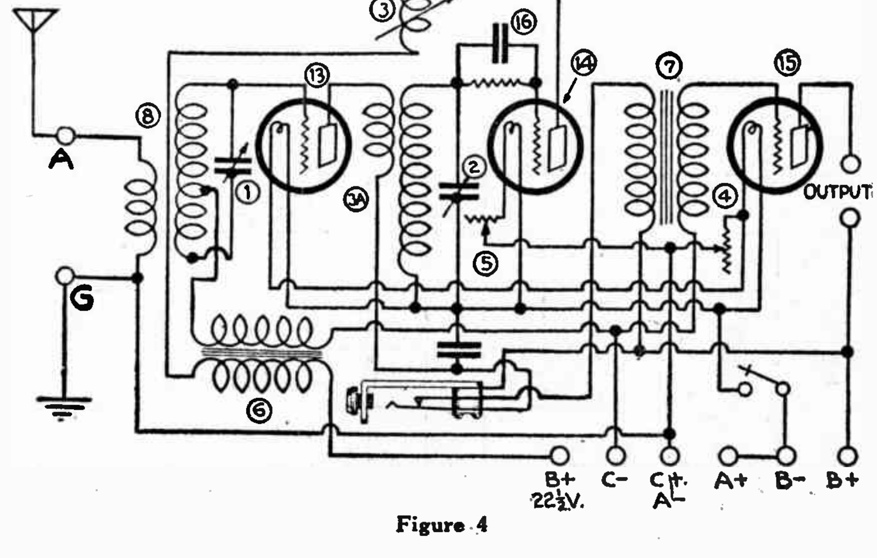


Figure 4

To Hear Stations

Push in the filament switch (6). Turn the amplifier rheostat control (4) and the detector rheostat control (5) to the "off" position. Put the tubes in their sockets (if a 200 type tube is used as a detector, it should be placed in the center socket) and the grid leak in its holder inside the set. If you have headphones, plug them into the jack (7). Inside the cabinet at the left-hand end, you will find a knob attached to a movable coil. Push

(Continued on page 94)

How to Operate

Jewett Five Tube Radio Receiver

The Jewett is a five tube receiver in which is incorporated all of the latest refinements known to a set of this type

THE Jewett is a 5-tube receiver of exceptionally handsome appearance and embodying all the latest refinements known to a set of this type. Two of the dials customarily found on a 5-tube receiver have been combined by ingenious arrangement exclusive with the Jewett, so that on the front of the panel there are only two tuning dials, the meter, the filament switch and a volume control. The control which regulates the brilliancy of the filaments in the tubes has been placed inside the cabinet, and once it is set at the voltage specified by the Jewett company it may be left alone. There are two methods incorporated to improve the selectivity in a congested territory where difficulties might be experienced in separating a number of powerful locals or eliminating a single powerful local.

The Jewett company has taken exceptional care that the beautiful finish on the cabinet of this receiver shall not be damaged in transit, and when you come to unpack this set, a suggestion may not be amiss. The writer found that the best way to get this set out of its container was to place the container on its side and remove the heavy, corrugated board pads at both top and bottom. You can then push the set through from one side or the other and remove the protecting layer of paper.

The receiver should be placed as close to the point where the aerial and ground enter the room as is possible, so that these leads may be kept short. The loud speaker may be placed on the same table with the set, or, if the speaker is provided with a felt base, it can be placed on top of the receiver cabinet. The batteries are presumably going to be placed on the lower shelf of the table or within some sort of a cabinet below the set, but they cannot be placed beyond the length of the cord provided with this receiver. The cable tips are clearly marked for connection to the batteries, and little difficulty should be experienced in hooking up this set. The Crowe cable marker labeled "A+" is to go to the positive terminal of a 6-volt storage battery, and this terminal can be identified on the battery either by the letters POS, or a touch of red paint on the terminal itself. The wire identified with "A—" is to go to the other terminal of the storage battery.

The B battery should consist of two 45-volt units, either dry cell or storage battery. The wire from the set, identified as "B—," should go to the negative terminal on one of the 45-volt units, and the plus terminal of the same unit should be connected to the negative terminal of the second unit. The positive terminal on the second unit is to be connected to the remaining wire from the receiver, contained within the cable, and identified as "B+."

The antenna lead-in is to be brought into the rear of the cabinet through the hole nearest the left end, and the binding post for its connection will be found at the left end of the shelf. The ground connection is brought in through the second hole from the left for connection to the large nickel binding post about midway of the rear edge of the shelf, close to which there is the letter "G" engraved on the shelf. The cord from the speaker is brought in through the third hole and the tips are inserted in the two little nickeled jacks right close to the ground binding post. It makes no difference which speaker tip goes in which jack, as the Jewett circuit makes this of no consequence.

Five tubes of the "A" type are required in this receiver, and they can now be inserted in the sockets by pushing each one down gently and then giving it a slight twist to the right. The small control knob near the bottom and to the left of set should now be turned to the right, and the five tubes should light up. The pilot light provided in the exact center of the set should also light. The rheostat for regulating filament brilliancy is found at the left end of the shelf inside the receiver and, if all tubes do not light up when the filament switch on the panel is turned, rotate the rheostat knob with a right, that is, a clockwise motion. This should cause the tubes to light, presuming the storage battery is charged.

At the bottom of the meter, and included as part of it, there is, a small switch which can be pushed to the left or right. You should now turn this small handle to the left. This will enable you to read on the scale the voltage being supplied the tubes, and the rheostat should be adjusted until the scale shows 4.8 volts. The receiver is now ready for operation, but before going further it might be a good idea to test the B batteries, which can be done by turning the meter switch to the right. The upper scale on the meter should indicate between 88 and 100 volts. The two dials should be turned together, with a hand on each, so that the numbers can be kept approximately together.

With as many stations as there are now, there should be no difficulty in finding a station, but if you have difficulty at first you will find a selectivity control within the set in the front left-hand corner. This is marked "broad" and "sharp," and it may be that this control happens to be in the sharp position, which will make our preliminary tuning a little difficult. Turn this selectivity control into either of the positions identified as "broad," and rotate the dials slowly over the scale once more, keeping the dial readings approximately the same, and a station will be heard; you will probably hear several. If you are close to a number of high-power stations you mave have trouble separating them.

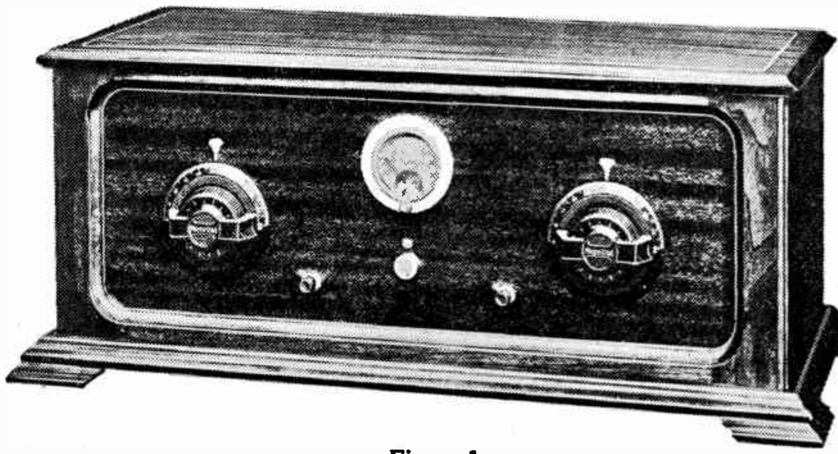


Figure 1

If this proves to be the case, open the link connector at the left end of the set, inside, which automatically places a small fixed condenser in series with the antenna lead. It will have the effect of shortening your antenna and increasing selectivity. Should you still have trouble, the selectivity control should be moved over toward the "sharp" position, which will probably eliminate this difficulty. It will, however, also have the tendency to decrease the volume, and a compromise position should be found where sufficient volume is still heard from out-of-town stations yet you are able to go through the local broadcasters.

The small control knob near the bottom of the front panel and to the right of the set is a sensitivity and volume control. When this is turned to the right, both the range and volume are increased, but, if it is turned too far, distortion will creep in. The best operating point for this control can quickly be found.

If your antenna and lead-in combined have a length of more than one hundred feet, it will certainly be necessary to leave open the link referred to above. Probably the better antenna for use with this set would be one in which the antenna proper, and the lead-in, have a combined length of about seventy feet, which would permit operation with the selectivity control on the broad position and the link either open or closed, depending on the proximity of powerful stations.

Once you have a distant station tuned in to maximum strength and clearness it would be a good idea to try switching the tubes around in their sockets to find those which function best as amplifiers and detector. This will require slight readjustment of the sensitivity control on the front of the panel, and a combination of tube positions will be found which gives the maximum in volume and tone quality.

The Digest laboratory in which this receiver was tested is exceptionally close to three powerful broadcasters, and is considered a difficult location. With an antenna and lead-in of a combined length of eighty-five feet the receiver was operated with the link open and the selectivity control on the line dividing "broad" and "sharp." The tubes, which were not new, were operated on a meter reading of 5.1 volts, and the B battery showed a voltage of 87. The chart which is included with this article as figure 2 shows the points at which a number of stations were found on the dials, and may make tuning somewhat easier for the reader when first looking for stations. The relation of dial number 1 to dial number 2 will vary with each antenna installation, and it will be noted that, with the conditions stated above, dial number 1 ran about eight points below dial number 2 throughout the scale.

There are a number of suggestions which the writer should like to give the newcomer in Radio to keep this set functioning at its best. A storage battery is tested with a device called a hydrometer, which can be purchased for about $1.50 at any Radio or automobile supply store. One of the caps on the storage battery should be removed for testing, and the small tip of the hydrometer is inserted through the hole into the liquid. The rubber bulb is pressed and then released, which will draw liquid up into the large glass portion of the hydrometer. Within this glass cylinder there is a small float with a scale reading from 1100 to 1400. The battery is fully charged when the surface of the liquid within the hydrometer is at 1300 to 1325 on the scale, and the battery is considered discharged when the reading is 1100 to 1125. It is better practice to charge the storage battery often, and keep it close to the fully charged point, than to try letting the battery go too long at a time and compensating for this weakness by increase of the rheostat within the set. The meter can be made to show 4.8 even if the battery is low by turning the rheostat, but, as just stated, it is much better practice to charge the battery oftener and change the rheostat less.

It is advisable to make a practice of setting a specified time each week for charging the battery and adhering strictly to this schedule.

The B batteries, if of the dry cell type, need not be changed until the meter on the panel shows that they cannot supply better than 70 volts. If your B batteries are of the storage type they should be recharged when the meter shows that they have run down to 80 volts.

Among other things, we tried this receiver on B battery eliminators and found that it could be used successfully with the Philco, the Balkite, the Cooper, the R.C.A. and the Freshman.

If the above suggestions as to battery care are kept in mind, and you will learn to tune carefully, you should have little trouble with this receiver; but if anything goes wrong, do not try to have it fixed by any local "expert." You will have much more satisfaction in the long run if you take this up with your dealer and, if he can make no suggestions, have him send it back to the factory for examination, and, if necessary, repair.

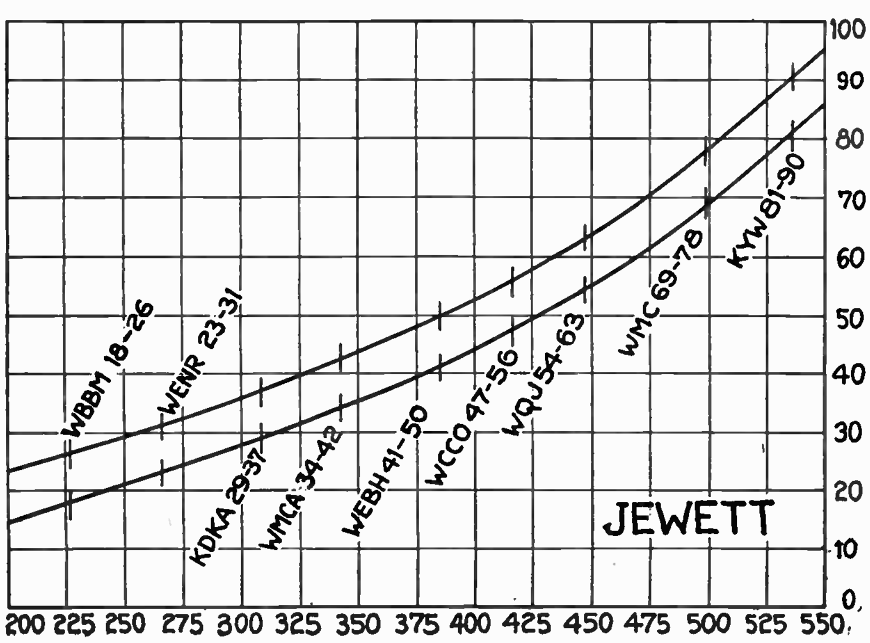


Figure 2

Crosley Three Tube Trirdyn

(Continued from page 93)

this knob down as far as it will go. Set the tickler control (3) at 0°. Pull out the filament switch (6). Set the rheostat knobs (4) and (5) according to the following table:

Tubes Used	Setting Dial 4	Setting Dial 5
3—199	2.5	1
2—199 and 1—120	3	1
3—WD-12	8	5.5
3—201-A	5.5	4.5
3—UX-112	7	5.5
2—201-A, 1—200	5.5	8

Now turn dials (1) and (2) very slowly, at the same time, keeping them both at approximately the same readings, until a station is heard. Set the right-hand dial for maximum signal. Then carefully adjust the left-hand dial until the station is as loud and clear as possible. Finally turn the tickler control (3) to the right (clockwise) until the signal is of the desired volume. Slightly readjust both rheostat (4) and (5) for best results. For greater volume on stations above 400 meters, pull up the knob at the left inside the cabinet about half way and readjust the left-hand tuning dial (1). After you have become accustomed to the set, you may tune it with the tickler control turned on part way. It will then be more sensitive in responding to stations.

The Crosley Trirdyn is a very simple set to operate and you should have no trouble. If you do have any trouble, confer with your dealer.

How to Operate
Freshman Five Tube Masterpiece Set

The Freshman line of Masterpiece receivers are all five tube sets employing two stages of radio frequency amplification, detector and two stages of audio frequency amplification. The simplicity of operation and the attractive appearance of the various models make this line the pioneer in the field of low-priced tuned radio frequency receivers

THE Freshman receiver is presented here as the pioneer in the new field of low-priced tuned radio frequency receivers that are simple to operate and require no delicate adjusting or balancing for proper operation. Practically any type of antenna except a loop may be used with this receiver and excellent results have been secured with an antenna plug, a wire around the picture moulding and with outdoor aerials from 40 to 125 feet in length. Operation should not be attempted with tubes other than the six-volt type such as UV-201A or C-301A. While the set will function with the dry cell tubes, the efficiency will be somewhat below that which a five-tube set should give.

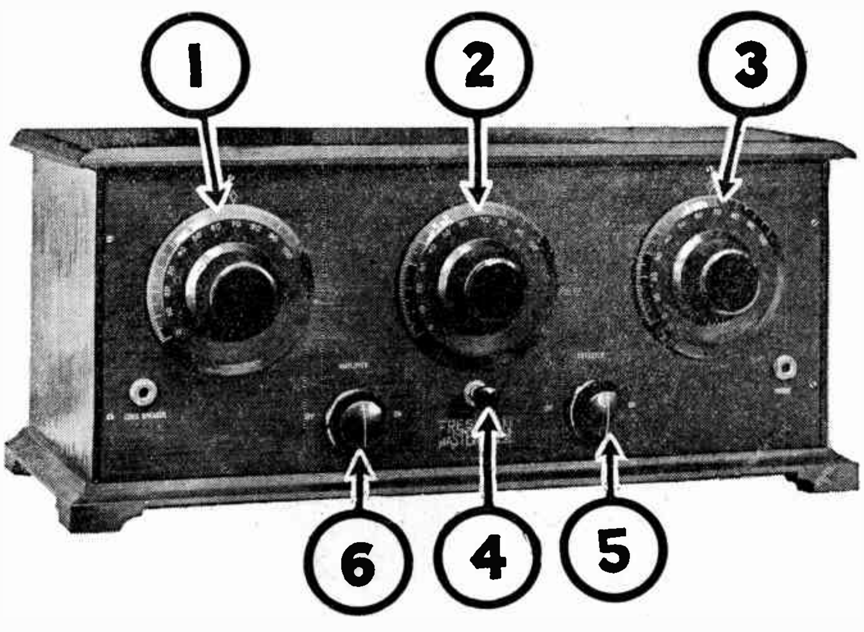
A front view of this receiver is shown in figure 1 and it will be noted that there are three large dials which are the tuning controls, two small knobs that turn rheostats which regulate tube brilliancy, and a switch in the center which turns the tubes on and off. Two jacks are employed, one at the extreme right and another at the extreme left into which a plug, connected to the loud speaker, may be inserted. The rear of the panel is shown in figure 2 together with the various parts mounted on the sub base. The three condensers are numbered to correspond with the numbers given the dials in figure 1. The schematic wiring diagram is shown in figure 3 and here again the various parts are numbered to correspond with the same parts in the first two figures.

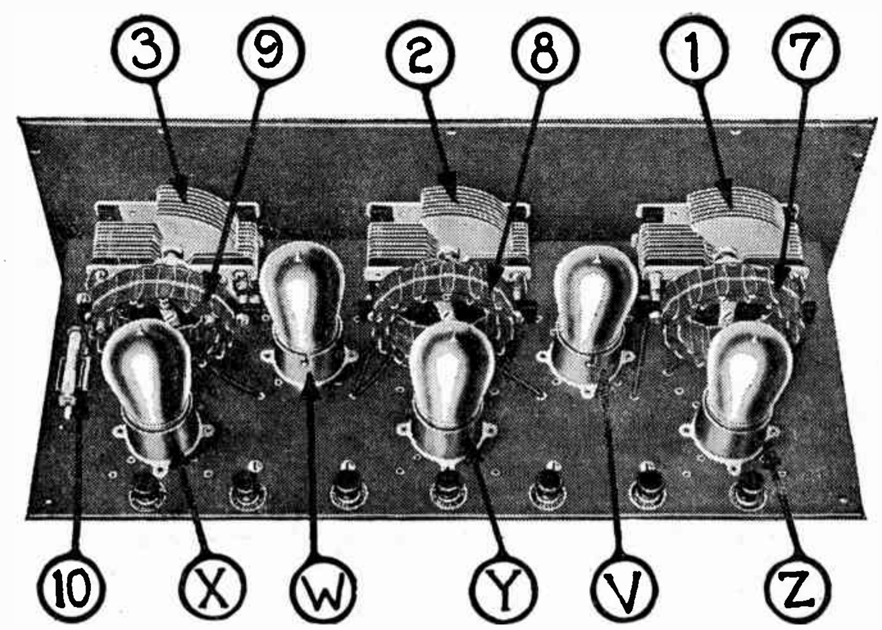
Now let us see what happens and where the energy goes when we have this set connected up in accordance with the instructions provided by the manufacturer, and are ready to tune. Each of the coils shown and numbered as 7, 8, and 9 consists in reality of two separate unconnected coils of wire, the center turns of which are known as the primary, and may be identified by the color of the insulation, while the turns on each side, which are the same color, are known as the secondary. When Radio waves strike the antenna and come in through the ground connection, they traverse the center turns of coil 7 which, as mentioned above, are known as the primary. Because of the proximity of the secondary coil, energy is passed into this secondary and condenser 1. These two units form a tunable circuit and this circuit must be adjusted, by variation of condenser 1, so that the wave length to which it responds best is the wave length of the station it is desired to receive.

Presuming that this condenser has been set at the correct point, the desired program will now pass into the first tube identified by the letter V and, after being strengthened, can go into the circuit consisting of the wires in the center of the coil 8. It is intended that this energy flowing in this primary will pass from it into the secondary turns of coil 8 but at this point the energy runs into an obstacle in the form of another tunable circuit. This circuit consists of the secondary of coil 8 and the variable condenser 2.

When this circuit is adjusted by varying condenser 2 so that its natural wave length is that of the desired program it is just as though one opened a gate, or removed the obstacle, and the desired signals can enter this circuit to the exclusion of all others. They now pass into tube W and are further strengthened, and from this tube they pass into the inner turns of the coil 9. These inner turns are, of course, the primary and currents are induced in the secondary, which secondary, with condenser 3, forms the third tunable circuit of this receiver. Until this circuit is adjusted to the desired wave length the signals cannot pass and enter tube X. Thus, you see, stations have to pass three gates, each of which opens only when set at the proper point on the dial. Tube X is known as the detector tube because its function is to change the form of the program, from energy which changes its direction of flow several hundred thousand times a second, into direct current which flows in one direction only and varies in strength in accordance with the voice or music sent out from the broadcasting station.

A pair of head receivers could be connected into the output circuit of this tube and the programs could be heard clearly but provision has been made for loud speaker operation by the insertion of two tubes, and transformers to couple them, so that the program is strengthened or amplified at this voice frequency. A loud speaker connected into the set, after signals have passed through these last two tubes, will function with good volume and clearness. These last two tubes mentioned are tubes Y and Z in figures 2 and 3.





Tuning

The dials on the front of this set have been so adjusted that the three tuned circuits are at about the same wave length when the three dials read alike, and while there may be a slight variation of a degree or two in these settings, they will be found to run pretty close together. Start in by setting dials two and three at 10 and then rotate dial 1 slowly between 5 and 15. If station is not heard set dials 2 and 3 at 12 and rotate dial 1 between 7 and 17. This procedure should be followed up the scale until a station is heard, then readjust each dial separately for greatest volume. Attention can now be directed to adjustment of knobs 5 and 6, which adjustments need be made but once each evening and will not have to be changed. Theoretically these need never be changed after the first setting, but since the voltage of the A battery drops a little as the storage battery discharges, and the voltage of the B batteries gets less and less each evening as the dry cells wear out, it is found in actual practice that nightly adjustment is desirable.

When you are looking for local stations, no great care in turning the dials is necessary as they will be heard several degrees on each side of the maximum setting but when looking for distant stations the dials should be turned very slowly and carefully, keeping the relation between the dial settings about the same. Thus, if you find that dial 1 reads 68, dial 2 reads 70 and dial 3 reads 67, and farther down on the scale the readings are 34, 36 and 33, the settings should read about the same in relation to each other on any part of the scale. After some practice in tuning this set you will find that you can tell pretty nearly where a certain station should come in on the dials and, if you are looking for a station whose wave length you know will come in at about 55 on the dials, naturally you should set the dials at 54, 56 and 53. A little maneuvering around these points should bring in the station desired if it is within range and on the air.

Trouble Shooting

If the set fails to function, the following procedure may be followed in an attempt to find the difficulty. First, examine all connections at the batteries and at the set, also the connections of the aerial and ground to the set. The wires, where they are attached to binding posts, should be bright and shining, and binding post caps should be screwed down tightly on the wires. Next test the storage A battery with an instrument known as a hydrometer. This is used by inserting the small end into one of the cells and, by squeezing and then releasing the rubber ball at the top, drawing some of the liquid up into the instrument itself. A small glass tube within the instrument will float and numbers on this float will indicate the condition of the battery. Fully charged, the battery liquid will give a reading of 1250 to 1300 and this reading will decrease as the charge in the battery grows less until down at 1150 the battery is so discharged that it should be connected to a charger for a fresh supply of energy.

Presuming that the battery reads 1200 or better, the next step is to test the B batteries with a voltmeter. B batteries come in two sizes, the smaller of which should produce 22½ volts when new, and the larger 45 volts. If the batteries have become reduced in efficiency to the point where a smaller unit shows less than 17 volts they should be discarded and new ones supplied. The larger batteries are useful until the voltmeter reads below 34. If none of these tests have brought the difficulty to light, the batteries should be disconnected from the receiver, the tubes removed from the sockets and the springs in the bottom of the sockets pulled up to insure contact with the prongs at the bottom of each tube. This can be done either with a button hook, a screw driver or any other thin but strong instrument that will enable you to bend up these springs slightly.

It will frequently be found that better results will be secured by switching the tubes around in the various sockets, since some tubes work better as tubes V or W than they do as tubes X, Y and Z. Supposedly, the tube X works best as a detector with 45 volts of B battery pressure, but frequently it will be found that none of the five tubes function very well with this voltage. It is a good idea therefore to try other voltages such as 55, 67, 85 and even 90 of these terminals.

Tube Gauged by Sound

DO NOT attempt to obtain signals by seeing how brightly you can make the vacuum tubes of your set burn.

This advice can hardly be repeated often enough. While it is true that turning on tubes of maximum brilliancy may mean, in some instances maximum signals, the test of the correct amount of voltage to be used in making the tubes light is not the degree of brilliance of the light, but the quality of the sounds produced in the head phones.

The light is given off by the heated filament of the tubes. It is the amount of heat produced in the filament by the resistance offered to the flow of the electric current through it that controls the operation of the tube.

That is, the more current that flows through the filament the hotter the filament becomes. If too great a current is passed through the filament it will burn out. When the filament becomes hot, electrons, which are negative charges of electricity, fly out of the filament. If they did not, the tube would not operate.

The higher the filament is heated the greater the number of electrons that fly from the filament, up to a certain limit determined by the construction of it and the material of which it is made.

As the filament is heated it becomes incandescent; that is, it gives off light. The more it is heated the stronger the light it gives. But it isn't the light that causes the electrons to fly from the filament. It is the heat. If the filament became heated but did not give off a single ray of light, the electrons would fly out of it just the same, but the lack of light would not affect the operation of the tube at all.

How to Operate
Fada Five Tube Neutrola Neutrodyne

THESE instructions cover the use of the following receivers when storage battery tubes are used: Neutroceiver, Neutrola, Neutroceiver Grand and Neutrola Grand. These four sets contain the same neutrodyne receiver panel unit, which is a five-tube unit containing two radio frequency amplifying tubes, a detector and two audio frequency amplifying tubes. These tubes and their accessory tuning circuits have been mounted compactly on a slanting bakelite panel which can be readily fitted into the cabinets of any of the receivers listed above. That pictured is Neutrola.

Connections

Connect 6-volt storage battery and 22½ and 90 volts of B batteries to the proper terminals as indicated on the tags on the leads. The leads for the C battery are short circuited when the receiver leaves the factory. The C battery if used (3 to 4.5 volts) will not necessarily improve the quality, but will lengthen the life of the B batteries. B batteries are made in both 22½ and 45-volt units. If 22½-volt units are used, it is necessary to use four units instead of two. The negative (—) and positive (+) terminals of the B batteries will be found marked in the insulating wax on the top of the batteries.

To make the proper battery connections, connect a wire from the positive terminal of one battery to the negative of the second, continuing the same series connections if four 22½-volt batteries are used. This will leave a positive and a negative B battery terminal unconnected. These are connected to the receiver as follows: The lead tagged —B from the set is to be attached to this —B terminal of the batteries while the +B90 lead on the set is to be connected to the +B terminal left on the battery. The last wire to be connected is the detector plate wire. The first B battery figured from the negative end has a positive 22½-volt terminal connected to the negative of the next battery. The lead from the set tagged +B22 is to be connected to this, in addition to the wire leading to the next battery.

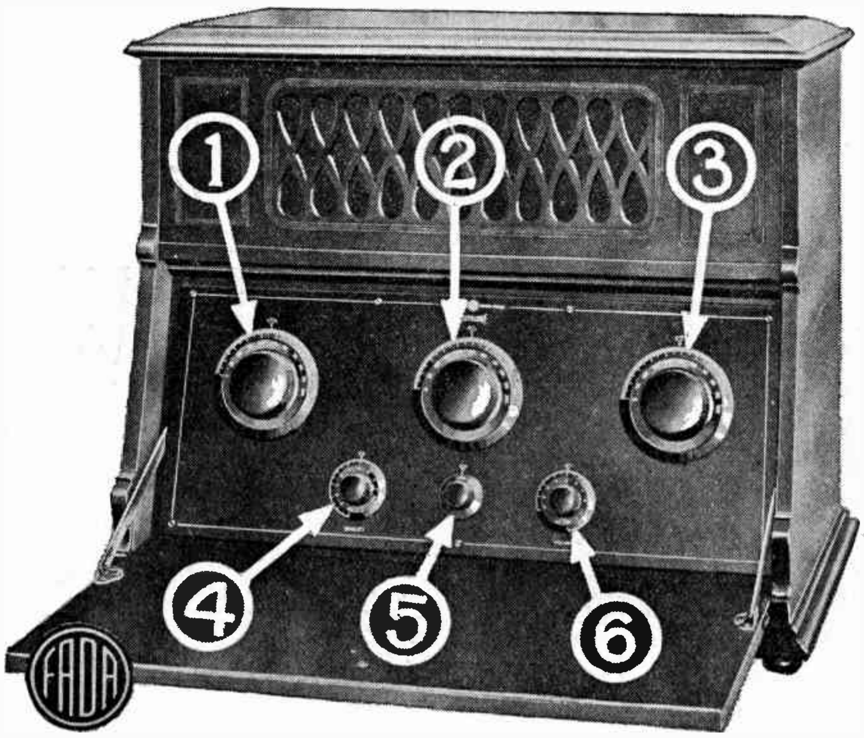
In order to get at the connections within the set, it is necessary for the user to remove the battery shelf. This is done by removing the two small blocks on each side of the receiver cabinet wall which hold this battery shelf in position. (A single nail holds each in position.) These two blocks are used to hold the shelf in place and prevent its knocking around inside in shipment.

Antenna, ground and loud speaker connections should be made before the shelf is put back into position. If one desires to place B batteries within the receiver the connecting leads should be pulled back through the holes in the cabinet, so that they are entirely within the receiver. Then replace the B battery shelf and make connections to the B batteries when in position. In the Neutrola it is important to keep the B batteries toward the antenna end of the receiver, and away from the center of the shelf. Use the vertical types or place horizontal types vertical.

Antenna should be a single wire from 60 to 125 feet long, either inside or outdoor, outdoor preferred. Ground connection should be preferably made to cold water pipe, and to "GND" binding post only; not to any other part of receiver or batteries. If external loud speaker is to be used connect to "HORN" binding posts. Keep the antenna and ground wires away from the set; do not bring them back along the length of the receiver.

Operation

Insert five "hard" amplifier tubes (type UV 201-A's or C301-A's) in the five tube sockets of the set. The two tubes on the front sub panel are the radio frequency tubes and the three in the rear, detector and two audio frequency amplifying tubes. The tube to the extreme right is the detector.



The Fada Neutrola Receiver is a five tube neutrodyne set incorporated in a beautiful cabinet with built-in loud speaker

Turn "QUALITY" number 4 and "VOLUME" number 6 adjustments to right to about "7" each. The number 4 control adjusts the intensity of the two radio frequency amplifying tubes and the number 6 control adjusts the intensity of the detector and two audio frequency amplifying tubes. Light the tubes by turning Selector Switch number 5 around to "LOUD" position. In the "OFF" position the receiver is absolutely dead. In the "MED" position, the filaments of four tubes are lit, and the receiver functions as a two Radio, detector and one audio, or four tube receiver. In the "LOUD" position the second audio amplifying tube is put into circuit, its filament lit, and the loud speaker or phones transferred to its output circuit.

Tuning

Let us assume that it is desired to receive Station WEAF, New York, N. Y., which transmits on a wave length of 492 meters. On examining the dial calibrated in station call letters and wave lengths, shown in figure 2, it is seen that this station corresponds to a dial setting of 67 degrees. Set dials 2 and 3 of the receiver at this setting and rotate dial 1 very slowly from 45 to 80. Signals will be obtained either at a setting identical with dials 2 and 3, or more probably a few degrees lower. Then rotate dials 2 and 3 independently very slowly until the maximum signal is obtained. In any particular neutrodyne receiver, dials 2 and 3 may read identically, but in no cases will they differ by more than a degree or two. The first or antenna dial may also read identically with 2 and 3, but in general it is several degrees lower than the other two. A record should now be made of the settings for this station on a log sheet.

WEAF 492 Meters 63 66 67

After adjusting the dials for maximum signal strength, turn the number 6 control until the maximum volume is obtained. Then adjust number 4 control for clarity and quality of the program desired. At no time turn these controls beyond the point at which the maximum signals are obtained, as this will cause the filaments of the tubes to burn too brightly and reduce the lives of the tubes considerably.

If it is desired to receive any station located at a wave length not listed in figure 2 the procedure is as follows. If you desire to locate a station transmitting at a wave length of 259 meters, note that the arrows show a station at 254 meters at 13 degrees, and one at 263 meters at about 14½ degrees, therefore the station broadcasting at 259 meters will be approximately half way between these.

Calibration Curves

As a further aid in locating stations, the wave lengths of which are not listed in figure 2, the calibration curve shown in figure 3 can be used. These two tuning aids were determined from representative receivers, but in practice, due to commercial variation, the specific receiver calibration may vary a degree or so from those indicated.

In all cases when tuning a neutrodyne receiver it is best to keep dials 2 and 3 always within one or two degrees of each other and to move them at a slow rate, about a degree a second. Very often a weak broadcasting station is passed over by moving the dials too fast. One can tell if the receiver is "tuned in" when the broadcasting station cannot be heard by listening to the intensity of the static noises that are usually present. Variations in the size of the antenna used only affects the tuning position in the first dial on a neutrodyne. Dials 2 and 3 are not affected by the type, length and kind of antenna. When a short antenna under 75 feet is used, dial 1 will read almost identical with dial 2 for any particular wave length. As the length of the antenna is increased the reading of dial 1 will gradually draw away from dials 2 and 3, reading in the case of longer antenas, several degrees below the other two dials. At the short wave lengths, with the long antenna, it may be necessary to insert in series with it a fixed condenser of .00025 mfd. capacity in order that tuning can be accomplished on dial 1.

Tubes

For the five-tube receivers of the Neutrola and Neutroreceiver type, the use of a "soft" tube is to be discouraged. In all cases a hard tube should be used as a detector. Superior results will always be obtained with hard tubes. At times the five-tube receiver will suddenly howl with an intense note, irrespective whether the receiver is tuned to a particular station or not. It can be remedied by substituting a new tube in place of the one which is defective or by interchanging the tubes among themselves. Generally the detector tube will be found faulty.

If no spare amplifier tubes are available for the determination of a possible defective tube, the user of one of the sets under discussion can, by turning the Selector Switch No. 5 to "MED," release his second audio amplifier tube for substitution with the two radio frequency amplifier tubes. Interchanging tubes will usually enable the broadcast listener to find a defective tube.

Locating Trouble

Be sure a Broadcasting station is operating within the range of the receiver.

Be sure the right A battery is being used and that it is in good electrical condition.

Check antenna and ground connections carefully; the antenna must be carefully insulated from any grounded object.

Test headphones by using them on a set known to be operating properly; if this is not possible, place phone tips on the terminals of the A battery, one on the negative and one on the positive. A decided click should be heard when this is done. Connect only momentarily.

Test vacuum tubes in a properly operating set if possible.

Remember that it requires no little skill to tune a set with which you are not acquainted.

Range of Reception

The range of transmitting and receiving Radio messages depends upon the nature of the territory lying between the transmitting and the receiving stations, the greatest range for a given power being obtained over water. Any metal, particularly iron and steel, lying between the stations, will cause loss of signal strength. Such metal may either be in the form of artificial structures such as building frameworks or tin roof, or may be in the form of ore deposits. Some regions of the country are noted for their poor location for Radio reception. In many places it is possible to receive effectively from all directions but one, and it is usually found that in this direction a metallic structure or metal deposit is responsible for the lack of reception.

Sometimes, a metal deposit will prevent Radio waves from reaching out in one direction, but does not affect those coming from the opposite direction.

Cause for Trouble

Many Radio fans have searched for hours trying to locate the trouble that is preventing them from hearing long-distance stations. Sets have been torn to pieces. Batteries have been tested until they have been worn out. But there is one item that is generally overlooked—the lightning arrester.

The arrester sometimes becomes short-circuited to a certain degree and permits a great loss of energy. Constant exposure to the weather may cause corrosion and a breakdown of the insulation.

The best way to test the arrester is to connect a B battery and voltmeter in series with the arrester. If the voltmeter shows a reading the arrester is faulty and should be removed from the aerial.

Each fall, the arrester should be taken down and thoroughly cleaned to remove the corrosion and dust which has settled on it. Also see that the wire leading to the ground has not become broken.

Storage Battery Aids

When using a storage battery, damage from spilling acid on floor or carpets can be avoided by getting or making a small box, about 3 inches larger all around than the battery. Paint or stain the outside to match the furniture. Paint the inside with several coats of heavy paint, or asphaltum paint, if possible. Leave no open cracks. Put casters on the bottom of the box. It will keep the battery safe, acid off the floor and afford a place to keep a receptacle for the hydrometer and a small bottle of distilled water, all together and safe.

This makes it very easy to move the box to one side in order to clean the floor.

Don't take a reading of your B batteries with an ammeter. Use a voltmeter. One test with an ammeter will draw as much current from the battery as you would in a month of regular service.

How to Operate

Grebe Five Tube Synchrophase Receiver

THIS receiver possesses several unusual features both as to appearance and construction which make it materially different from any other receiver on the market. While it would come under the general classification of tuned radio frequency, the transformers used to couple the tubes are radically different from the others and there is an unique volume control provided in the audio frequency part of the set. As can be seen from the illustration there are no dials on the face of the cabinet as is the usual practice but instead A. H. Grebe & company have utilized their well-known method of rheostat control and adapted it to tuning. The shafts of the condensers are vertical instead of horizontal and only the edges of the dials protrude through openings in the panel while, at the bottom of the panel, three kurled discs protrude which can be easily moved with the thumb. There is a vernier action, between the bottom controls and the dials, of about five to one. In the illustration, 1, 2 and 3 are the graduated dials while 4 is the volume control and 5 is the rheostat.

Connecting Accessories

The equipment required with this set consists of five 201A tubes, one 6-volt storage battery, 96 volts of B battery, one 4½-volt C battery and one loud speaker. This receiver was tested on a 60-foot vertical aerial with a ground that was known to be good, connected to the radiator. If four 22½-volt dry cell B batteries are used they should be connected in series, that is, the positive of one to the negative of the next. This will leave a negative terminal open at one end and a positive terminal at the other. Wires sufficiently long to reach from the batteries to the set should be connected to these open terminals and a third should be connected to the positive terminal of the second battery from the negative end; there should be two B battery units between the negative terminal and this third wire. In our tests 45-volt storage B units were used of which there were two; thus there was only one jumper wire between units and our third wire was attached to this jumper. Two more wires will be required that will reach from the storage A battery to the set. For this purpose it will be found very convenient to use the five-wire cables which have recently made their appearance on the market. The connections for the accessories will be found on the bottom of this set and it will be necessary to tip the receiver back on its rear edge to connect the wires mentioned above. Before connecting any wires, the rheostat knob 5 should be turned to the extreme left.

The antenna binding post will be found as a Fahnstock clip at the left end of the row, the ground is next, the third is for a loop if used, the unmarked loud speaker wire connects to the fourth, the plus speaker cord goes to the fifth, the B battery plus is next, then the wire from the center of the series of B units and the minus C connects to the eighth. Plus C and minus A should be attached to the ninth clip while minus B and plus A go to the last one to the right. The C battery should be placed close up behind the cabinet and as it is small it cannot be seen.

The Grebe Synchrophase is a five tube set incorporating two stages of tuned radio frequency, detector and two stages of audio frequency amplification. The coils are of the new fieldless binocular type and the volume is controlled by a special "Colortone" dial

Tuning

Now, with volume control knob 4 at maximum to the right and the rheostat knob 5 turned so the pointer is under the letter A in the word increase, one is ready to tune for stations. It will be found that dials 2 and 3 run practically identical throughout the scale while dial 1 will not vary from their settings by more than one or two dial divisions.

We first tried for Station WEAF with a wave length of 492 and found it at dial settings of 84.5, 83, 83. Going down the scale, WCAP, at Washington, D. C., on 469 was heard with maximum volume at 75, 74, 73 and just why the last dial deviated from the setting of number 2 is hard to say. The selectivity was well demonstrated on WCAP and KFI of Los Angeles, both of which were supposedly on 469 meters, and probably were not more than two meters apart. A turn of all three dials, one-fourth of a division to the left from the WCAP setting, brought in KFI and the Hotel Alexandria orchestra.

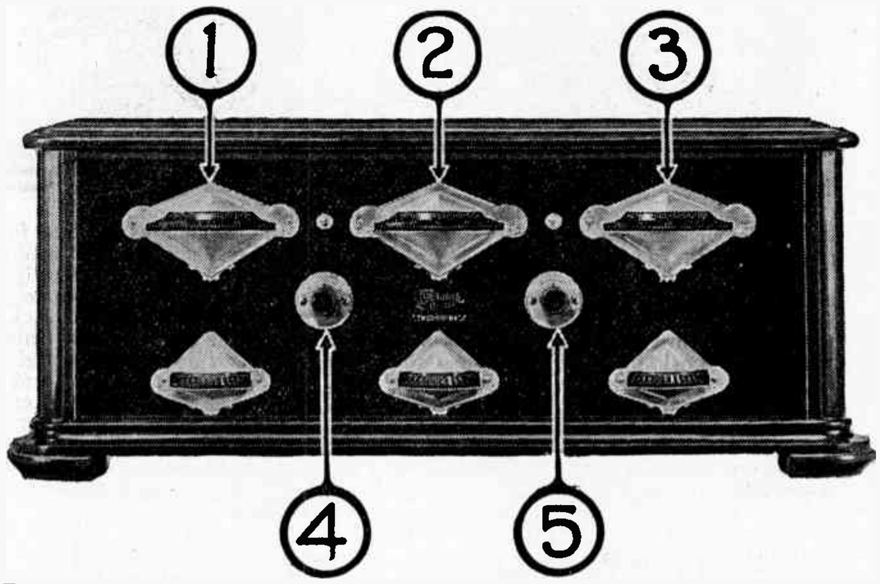
Dials 2 and 3 were moved together, one division at a time to the right and dial 1 was kept slightly above them. At settings of 62, 62, 62 we found WDAF of Kansas City on 411 meters. Going further down to 59, 58, 58 the east was heard from through WDAR of Philadelphia on 395 meters.

All this time we were, of course, going through local stations and it was at these points that the volume control came in handy. The energy put into the loud speaker by this set is terrific and, without reduction, is apt to cause distortion due to the inability of the last tube and the speaker to handle it. Once the program from a moderately strong station is tuned in, the volume control can be set at the point where volume and clearness balance for enjoyable reception.

Provision is made for the many types of antennas which purchasers can put up and the various lengths are taken care of by a link connecting two binding posts on the rear left corner of the baseboard. If the antenna is very long, or one is located unusually close to a high-power broadcast station, this link is to be released from one of the posts. If a short antenna is in use, or the owner is located out in the country, the link should be closed and greater volume will result.

Due to the use of binocular coils, operation on a loop was very successful. There is no external field around these coils and the use of a loop, usually impractical in tuned radio frequency sets, because of feedback between coils and loop, is permitted. Another movable link enables the owner of Synchrophase to use either loop or outside antenna. Thrown to the right, the former functions while, to the left, the latter is utilized.

After trying out various combinations of antennas and link positions, we resumed our tuning and, at 41.5, 41, 41.5, found WCAL of Northfield, Minn., with a wave length of 360 meters. WHK of Cleveland uses 283 meters so we swung to them and found their settings to be 23.5, 23, 24. It was plain from the curve we were drawing that this set would go down below the broadcast range so tuning further was unnecessary.



Front view of Grebe Synchrophase showing the attractive appearance of this set

Trouble

The construction of this receiver is exceptionally good and it is extremely unlikely that anything will go wrong inside. Should howls or whistles develop, the accessories and connections should be examined carefully before complaint is made to the dealer. High class tubes were found essential to clearness in our tests, and seven were juggled around from one socket to another before two were eliminated and we were satisfied that the full possibilities in this set were being realized.

Be sure that corrosion or jar has not produced a poor connection at one of the Fahnstock clips as anything but a perfect electrical contact in any of them will manifest itself as whistles or scratchy sounds in the speaker. Test the A, B and C batteries frequently and recharge or replace before any of them get too low.

Antenna and ground should be examined at frequent intervals, especially if they were not soldered. If they were not, the connections should be scraped and remade at least every three months.

Overcoming Interference

THOSE of us who have sensitive Radio receiving sets know how sharply a distant Radiocasting station tunes in—we know from experience how carefully we must adjust our dials to get any particular station. A few divisions off on the scale and we are lost.

Now, I have been asked a great number of times "Why cannot the local stations be tuned just as sharply?" I will attempt to explain the reason and also give detailed information, which I trust will assist the great army of listeners in overcoming a factor considered by many to be a very important one now.

"Forced Oscillations" Root of Evil

When a receiving set is located near a powerful Radiocasting station, you are able to hear that nearby station over a considerable range of the dial because of what is known as "forced oscillations." This can best be described by referring to that analogy so often used of a pond of water after a pebble has been thrown into it.

Waves radiate from the center of disturbance. At some little distance from this center the waves are regular and travel smoothly but right near where the stone struck the water, and particularly if it was a large one, you will notice a large number of irregular splashes. Any device designed to be affected by the regular waves would also be troubled by these irregular splashes or waves as you may call them. It is the same thing in Radio and the problem is to so arrange matters that these irregular splashes can be deflected or so handled as not to interfere.

Wave Trap Will Turn the Trick

In your Radio set you desire to pick up the tune or, as before named, the regular wave and weed out the irregular or forced oscillations. This may be done in several ways by devices called traps or filters. I will describe here a very simple one—something you can easily construct for yourself in a few minutes with simple apparatus usually used in Radio.

Wave Trap Connections

This filter that I am about to describe is so arranged and connected that it tends to offer a very low resistance path to the wave that is not wanted, while the tuner dial is set to offer an easy path for the desired wave which, therefore, passes through your receiver and is registered. Therefore, this circuit must be connected in such a manner that it can be tuned to the undesired wave and also so that the energy so picked up by-passes the receiving apparatus.

Need Coil and Variable Condenser

The circuit consists of an inductance (coil of wire) and capacity (condenser) either of which may be variable. It is probably simpler to use a variable capacity, or condenser as it is more usually called. This variable condenser may be of the 23 plate type and can be purchased for a few cents in any store handling Radio equipment if you should not happen to have one.

Next obtain a small inductance of about 25 or 30 turns of small wire, any size in the neighborhood of 24 or 26 B. and S. gauge, or if you have a so-called honeycomb or spider web coil, so much the better. This inductance can, however, easily be made by winding about 25 or 30 turns of wire on a cardboard tube 2 or 3 inches in diameter. CAUTION—do not wind on a metal tube! Now connect this inductance in series with the variable condenser and connect this combination across your receiving set between the aerial binding post and the ground binding post.

This is so that energy from the aerial can also flow through our filter circuit (or as we have described, "inductance and capacity in series") to the ground, as well as enter the receiving set. Make sure that there is no coupling between the set and the filter circuits. To prevent this keep the filter circuit several feet away from the receiving apparatus.

How to Try Out Wave Traps

After having done all this, we are now ready to try it out. Wait until a local station begins operating and then try to tune in another station. That means you have set your dial at the point where the desired station can be heard, but it is being interfered with by the local station. Now adjust the variable condenser of the filter circuit until the interference has been reduced to a minimum, at the same time readjusting your receiving set so that the desired station comes in as strong as it is possible to make it. A little practice will soon enable you to obtain sharp tuning.

Low Losses Aid Trap

Now this filter circuit is not one hundred per cent perfect but it is believed that for the amount of money invested and the simplicity of this arrangement, the results are worthwhile. This device depends upon low losses in the filter, particularly in the condenser. Great care should be taken to make sure the variable condenser used is a "low loss" condenser. There are several good types on the market.

This device will drain unwanted frequencies off the aerial, but it will not weed out unwanted frequencies from the receiving circuit itself. The receiver should be well shielded in order to prevent it from picking up any considerable amount of energy without aerial connection.

In place of flowers and fruits, small Radio sets are becoming the popular gifts to patients in hospitals. This is particularly true with regard to open air camps for tuberculosis patients, located in the vicinity of Radiocast stations.

How to Operate
The Erla Circloid Five Tube Receiver

The Erla Circloid Five receiver combines beautiful artistry of cabinet design with the latest toroid style of coil winding

RADIO receivers of the present season portray in a marked degree manufacturers' realization that artistry in cabinet design is of equal importance with that of Radio reception efficiency as a grace and appropriate fitting for the home beautiful. A most worthy example of such forethought is the cabinet housing of the ERLA Circloid 5 receiver.

There could not be any division of opinion regarding this point as the outstanding feature of this receiver, with its tow-tone mahogany finish, ornamental carved panels and top, were it not that a glimpse of its interior reveals a striking example of the application of the now popular balloon type Circloid coils, as the media for radio frequency amplification. This type of inductance has found favor with several manufacturers, not only because of their efficiency as radio frequency amplifiers, but primarily because they require no balancing for the elimination of coil interaction, and are practically immune toward the influence of nearby broadcast stations.

The Panel

One's attention is at once directed to the symmetry and balance of the sloping front panel of etched bronze on an antique background, upon which is mounted the operating dials, together with the loud speaker and filament controls.

Many detail conveniences are provided within the cabinet to insure not only the avoidance of error in connecting the receiver, but to also insure its most efficient operation upon a variety of lengths of antenna. A commendable part of the interior assembly is the provision of a cable of wires connected to the proper binding posts, together with a blue print drawing which indicates the exact connection location to the operating batteries.

Laboratory Test

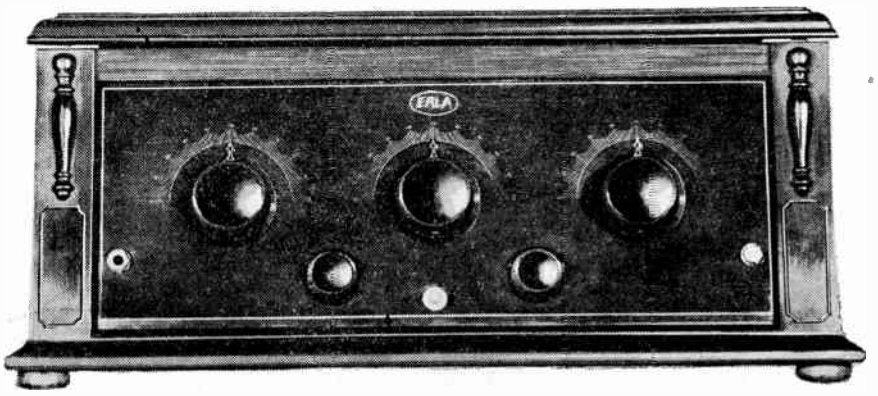
Our laboratory test upon this receiver consisted of a careful inspection of the total assembly, the quality of the materials used, and whether the workmanship indicated that repeated inspection tests had been made. In addition to the above, the usual tests for selectivity and quality of reproduction over the broadcast wave band were made. In each instance the high average which we expected, because of the well known reputation of the manufacturer, was well maintained, as evidence of the apparent "team-work" idea in design, through building each part to work in harmony with the whole.

Antenna and Ground

As this receiver is provided with antenna posts for both short and long aerials, our experience indicated that a single copper wire not exceeding 80 feet in length should be used, and connected through its lead in wire to either the post marked L-Ant or S-Ant, according to the degree of selectivity one desired. This antenna should be well insulated from the ground and surrounding objects, and placed as high above the earth as possible within the limits of 45 feet. The ground connecting wire should run as direct as in convenient and be fastened by a ground clamp to a cold water pipe, which has been thoroughly scraped. If this is not possible, a like connection to a six-foot length of galvanized pipe which has been driven in moist earth should be made. Both the antenna and ground wire used should be No. 14 copper wire, while the lead in to the receiver from the antenna may be made with a smaller guage wire which is well insulated.

Tuning

Three dials are provided for tuning, the smaller knobs, just below, acting as radio frequency control and rheostat control for the detector filament. After connecting the batteries and placing the tubes in their respective sockets (five 201-a or 301-a being



recommended) the battery switch at the bottom of the panel should be pushed in to light the filaments of the tubes. Set the lower right hand knob with the arrow in a vertical poistion if the A battery is new or a little beyond this point if not fully charged. Turn the three large operating dials to their zero position. Turn the detector rheostat, which is the small knob on the right, until a slight hissing noise is heard, then retard it just below this point, or until the hiss disappears. The receiver will then be ready for operation.

To tune in a station, first turn the lower left knob to the right until a rushing sound is heard, being careful not to turn this knob too far or this sound will stop and the dial will have to be retarded. Next, rotate each of the larger dials forward from their zero reading slowly and with each in step, or at approximately equal setting. When a station is heard, each dial should then be individually adjusted for volume. Very often one will find that after a station is tuned in, a slight readjustment of the lower left dial will be of benefit. It doubtless is not necessary to caution the operator to shut off the receiver, by pulling the filament switch out when through operating. Failure to do this means but an added expenditure of battery current and shortening of the tube life.

In connection with the maintenance of the A wet battery in a clean condition, one will often find that the contact terminals become corroded with a white and green substance resembling verdigrae, which refuses to respond to the usual treatment of being removed through wiping with a cloth. As each home is usually supplied with a box of ordinary baking soda, it is then well to remember that a teaspoonful of this soda dissolved in two ounces of water, makes an excellent neutralizing agent for this accunumlation, it only being necessary to apply the solution with a cloth dampened in it to the parts which require cleaning. Bubbles which make a frying noise will at once be evident, as proof that the cleaning process is taking place. After such cleaning the terminals should be wiped dry and then smeared with a light coating of vaseline, which will in most cases prevent the reoccurance of the formation. This treatment is equally effective for the cleaning of the terminals or clamps to which the battery wires are attached.

Trouble Shooting

Naturally, each reputable manufacturer of a Radio receiver, devotes much time and thought toward so assembling the total apparatus contained within the receiver as to insure uninterrupted pleasure to the purchaser, without annoying troubles occurring, which would invent cause for dissatisfaction. This is particularly true of the ERLA Circloid 5, as our inspection indicated that only through rough or careless handling was it possible to create a condition whereby their receiver would not function, because of inherent defects.

Yet with all of these safeguards, such accidents will occur, in any device which has to rely upon the human element, which is the reason for dependable guarantees being given by such manufacturers.

Most of the troubles which do occur are those outside of the manufacturers province, and lie in the deterioration of batteries, tubes and other accessories, caused from improper or careless connections, and the obvious fact that they possess only a replacement life. By this we mean that each of the accessories has a useful life, and when they have served for this period, it is then essential that they be replaced.

Multiplicity of the minor troubles which do occur in the operation of a receiver, can be generally traced to a lack of knowledge relative to the periodic attention which such accessories require, including, regular recharging of the A wet battery, seeing that its surface and contacts are kept clean, the replacement of B batteries when they have served their useful life, together with a regular inspection of the antenna, and the condition of its insulation, not forgetting the importance of likewise ever maintaining a secure ground connection

If Set Does Not Function

Have you closed the battery switch? Are the connections to your A an l B battery secure? Are these connections made correctly—that is not reversed? Do all of the tubes light? If not, remove the offending one and bend up the socket springs slightly. If the receiver gives a sharp click in the head phones or loud speaker when the attachment plug is inserted in the jack, this indicates the B battery connections are correct. If not, their connections may be reversed, or one of the wires broken.

Noisy Reception

A continuous low-toned hum is usually due to your antenna running parallel rather than at right angles to a power line or electric light wire. Leaky transformers also will create this effect. After changing direction of antenna, if this hum still obtains, report your trouble to the lighting company.

If this hum is high pitched, the grid connection has become loose or the grid leak is not in its position. Also look for loose connections. In place of a high pitched note, this trouble is sometimes noted as a knocking or tapping sound.

A scraping sound when the large dials are turned indicates as a rule dust between the condenser plates, which may be removed with a pipe cleaner.

Howling and shrieking is usually caused because the rheostats are turned too high, while scratchy, rasping noises indicate a run down B battery, accumulation of dirt or moisture upon the surface of the batteries, or loose connections.

Why Signals Fade in Radio Reception

By Dr. M. T. Zellers

MANY attempts have been made and many theories have been advanced to explain the fading of Radio signals but without success. The United States government conducted experiments on an extensive scale to ascertain the cause or causes of the fading but failed. The only thing discovered was the fact that there was less fading of signals transmitted by powerful stations using a long wave than of signals transmitted by weaker stations using a short wave.

This makes it appear a very complex problem. Yet, I feel that my experience with fading Radio signals and the conclusions I have reached therefrom, should be published so that others may verify my finding or satisfactorily disprove my theory. Anyone who owns a receiver with which he can bring in stations from 1,500 to 2,000 miles distant can make the experiments.

Air Currents and Radio Currents

The wind blows in every direction, not at the same time but in course of time. In the morning it may be from the south, but before the sun sets it may have veered around and comes from the north. At noon, there may be a gale from the east and in less than an hour it may blow with as great velocity from the west.

These air currents may be compared to the gulf stream, which is a stream of water flowing through a body of water at rest. The air currents move through a body of ether at rest. These facts are all well known. Equally well established is the fact that sound can be conveyed through this ether at rest on electromagnetic currents. Now, these currents also move and reverse themselves exactly as the wind or air currents move and reverse themselves, but their motion is infinitely faster than the motion of the air currents, and they reverse themselves at very much shorter intervals.

These conclusions are borne out by the fact that a person situated approximately equidistant from two stations located on opposite sides of him, may hear both stations on the same setting of his receiver, provided the wave lengths of the respective stations are the same, or nearly the same. He may hear both stations at the same time, but the signals are not very strong from either station. This condition does not continue very long. The signals from one of the stations begin to fade while those from the other station become stronger. This movement of the electromagnetic current may continue until the fading signals are lost entirely and the stronger ones increase in volume to a point where it may be necessary to reduce the voltage on the filaments in the tubes. I have had that experience a number of times.

Specific Examples

My first experience was with stations WSB, Atlanta, Ga., which is located about 900 miles east of me, and KPO, San Francisco, which is located about 1,400 miles west from me. The wave length of the former station is 429 meters, and of the latter 423 meters. Although there is a difference of 6 meters in the wave lengths of the two stations, the slight difference did not affect the volume of the signals as they came to me, now from one station, now from the other.

My next experience was with station WDAF, Kansas City, Mo., south of me, and WLAG, Minneapolis, north of me. The wave length of the former is 411 meters, that of the latter 417 meters. Here, too, is a difference of 6 meters in the wave lengths, but as in the former case, the signals were heard distinctly and with equal loudness from both stations on the same setting of the receiver. As the signals from one station faded those from the other became louder.

Several nights later while listening to WLW, Cincinnati, 700 miles east, I was surprised to hear someone say, "This is Radio Station KGO, Oakland, Cal." I had never heard of the Oakland station before and hence was not looking for it. I had dropped into it accidentally. The to-and-fro surging of the Radio current between these stations was the same as I had experienced on previous occasions.

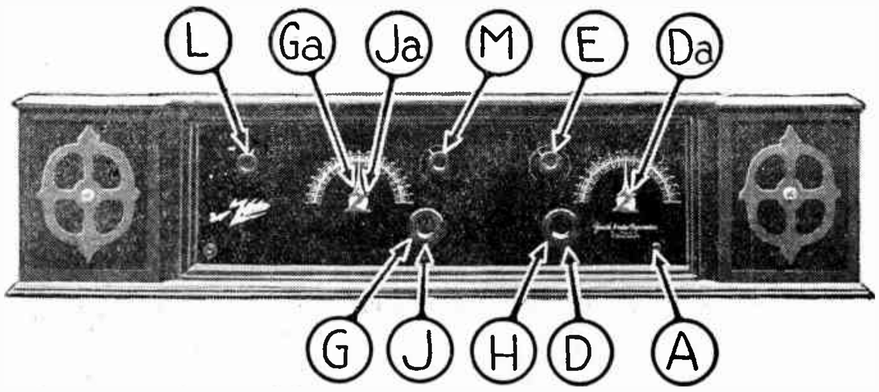
To make these experiments the stations must be on opposite sides of the operator.

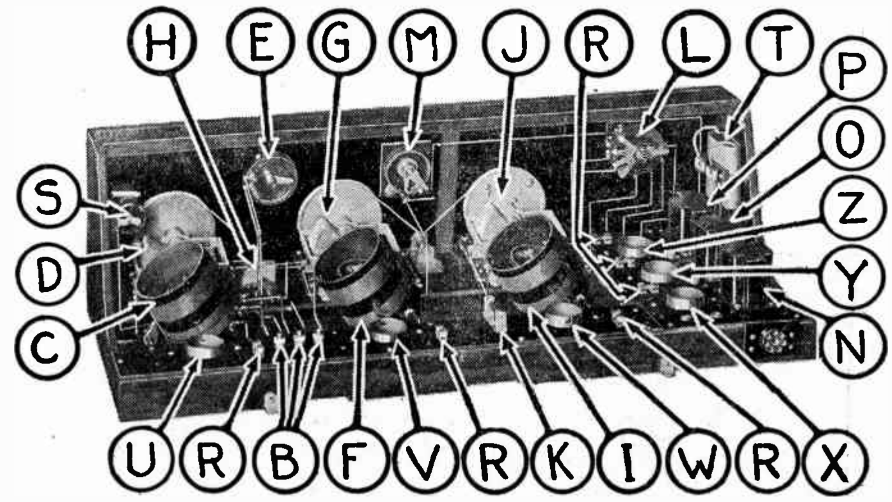
How to Operate
Super-Zenith Models VII, VIII, IX and X

THE panel and apparatus of Super-Zenith VII form the basis around which the other three models in the Zenith line are built so the following data on this set will be found of equal value to the owner of the larger models.

Super-Zenith VII is probably the largest cabinet receiver on the market, as the apparatus has not been crowded together and there are large compartments at each end for the batteries. This set is a tuned radio frequency receiver, incorporating two stages of radio frequency amplification, a detector and three stages of amplification at audio frequencies. Much interest has been aroused in Radio circles in this set as it is the first time that a receiver has appeared for use by the Radio public in which variable coupling in the radio frequency transformers has been tried.

All of the Super-Zenith models are six tube sets employing two stages radio frequency amplification, detector and three stages of audio frequency amplification. The difference between the various models is in the cabinets





The above photo shows the front view of Model VII. Note the neat and attractive appearance of the panel and the battery compartments at each end. The view at the right, shows the arrangement of the instruments back of the panel. These are numbered for your convenience in following the operating instructions

The unique and different factors are not all within the cabinet as inspection of figure 1 will show. At the right end of the panel there is an engraved scale which indicates the settings of the pointer Da, which settings are controlled by the knob identified by the letter D. The usual construction is to have a large dial which can be turned by means of a smaller vernier knob, but in this case all control of Da is done through the knob D. The other tuning control is the indicator Ga and Ja, the setting of which is varied by the knob GJ.

The rear view of this panel is shown in figure 2, and study of this illustration will show the reason for the peculiar identification lettering of the controls. The variable condenser D is on the shaft of the pointer Da which is adjusted through knob D. Behind knob D on the front of the panel will be found a knurled disc which is the control H, by which the capacity of the small condenser H as shown in the rear view, may be varied. The two condensers G and J in figure 2 are controlled through cords by the knob GJ, the settings for which are shown by the pointer Ga-Ja; thus two condensers are controlled simultaneously by means of a single knob.

Figure 3 is presented for those who are familiar with schematic wiring diagrams, and the various parts used and shown in figure 1 and 2 may be readily found in figure 3. For control of efficiency of the first tube, a variable high resistance unit is inserted in the plate circuit of the first tube and identified by the letter E M is the rheostat by which the brilliancy of the detector tube can be varied while L is a stage control switch which permits of ready change from one to two or three stages of audio frequency amplification. Considering now figure 3 it will be noted that signals come into the primary of the fixed coupler C and the turns in use in the primary can be varied by means of the different connections to binding post B.

A small loading coil is shown at A, which may be cut in or out by the switch identified as A. The secondary of coupler C is tuned by condenser D and from this tuned circuit signals pass to tube U. Tube U is coupled to tube V by means of the tuned radio frequency transformer F. The primary of transformer F is attached to the shaft of condenser G and is rotated with respect to the secondary simultaneously with condenser C. Tighter coupling between primary and secondary is possible at higher wave lengths than can be used at lower wave lengths, and this primary is adjusted so that its position approaches a right angle with respect to the secondary as the rotor plates of condenser G are tuned out of the stator plates. Signals then go to tube V and then to transformer I in which the same feature of variable coupling is found as is used in transformer F. Transformer I feeds into the detector tube W. The grid leak for this detector tube may be identified in figures 2 and 3 by the letter K.

There are no rheostats in this set for any of the amplifier tubes as fixed ballast resistances are employed to keep the voltage supplied the filaments of the amplifier tubes at the correct value. The three stages of audio frequency amplification appear at the right end of figure 2, the tube sockets X, Y and Z being the first, second and third stages respectively, while transformers N. O and P are used in that order.

A jack, not shown in figure 3, is furnished, allowing the use of head phones for tuning. The method of changing from phones to loud speaker is entirely automatic, merely removing the phone plug puts the loud speaker into operation, plugging in the phones puts them into operation and disconnects the loud speaker. Switch L is used to increase and decrease the amplification as desired. This is an improvement over the old plug and jack system employed in the majority of other Radio receivers. Until one has become thoroughly accustomed to the set it is suggested that head phones be used in tuning the receiver. After the operator has had sufficient experience in tuning, the majority of stations may be tuned in directly on the loud speaker.

Knobs D and GJ are the two tuning controls. By their use the desired station is tuned in. Low wave stations transmitting on 200 to 300 meter waves will be found on the lower left hand side of the scale, stations of higher wave lengths will be found as the pointers are advanced to the right. It will also be noticed that controls D and GJ will have practically the same setting when tuning in a station. For example, if a station is being received with pointer Da at 65 on the scale, Ga-Da will likewise be at approximately 65.

Control E, the resistance, will necessitate a little practice before its use is thoroughly understood. It should be turned to the right until a hissing sound is heard, at which point it should be turned back until the sound just disappears. In other words, it should be kept as far to the right as possible without causing distorted signals. The operator can readily recognize this point when a station is tuned in, by turning the control E completely to the right and then bringing it back until a point is reached where the signal is perfectly clear.

To tune, start with D and GJ at zero on their respective scales and the vernier H midway between its left and right hand stopping points. Move GJ slowly to the right and simultaneously swing D pendulumwise to the right, that is, swing it back and forth slowly over a range of three degrees on either side of the position maintained by GJ. The proximity of a station broadcasting at the time, will be indicated by a hissing or rushing sound as D passes a particular point. Adjust GJ and D to the loudest point of the sound, then release D and operate GJ and the vernier knob H simultaneously as follows: Move vernier H slowly back and forth, at the same time moving GJ slowly back and forth over a range about one division on either side of the point where the loudest signals are heard. This should clear up the reception. In the event that it does not, controls GJ and D should be slightly readjusted and the venier H operated as before. This will bring in the station clearly, and the readings on the scale may be marked down on a log card for future reference. Should it be desired to retune a station at a future time, it is only necessary to place the pointers at the positions on the scales indicated by the log card and then adjust the vernier H.

To get the utmost out of the receiver the following readjustments may be made after the station has been tuned in as outlined above. Turn control E completely to the right and then gradually bring it back to the point where the voice of music clears up. The best suggestion for using this control is to keep it as far as possible to the right without impairing the quality of the program being received.

After a station is tuned in, remove the headphone plug from the jack in the lower left hand corner of the panel, whereupon the signal will be heard in the loud speaker which has been connected to two posts marked "loud speaker" at the rear left-hand corner of the sub base, inside the set. Should more volume be desired, turn switch L to position 2, while turning it to point 3 will further increase the volume.

Considering now, the analysis of the set which formed the first part of this article, and considering also, the tuning procedure just concluded, it should be clear that one is endeavoring to bring three tuned circuits to resonance on a single wave length so that the program being broadcast on that wave length will be heard with maximum volume and clearness, to the complete exclusion of all other signals. The tuned circuits consisting of condenser D and the secondary of transformer C is adjusted to maximum response to the desired wave length by knob D. The two tuned circuits, one of which consists of condenser G and the secondary of transformer F, the other consisting of condenser J and the secondary of transformer I, are brought to resonance simultaneously by the use of knob GJ.

Due to slight differences which are bound to occur in the values of the four instruments included in these two tuned circuits, the vernier condenser H is provided and connected across the larger variable condenser G. The tuning procedure outlined first brings the circuit including D into reasonance with the circuit including J and, of course, into reasonance with the program it is desired to receive. Adjustment of the small condenser H then brings the circuit which includes condenser G into exact reasonance with the other two just mentioned. The control E enables to operator to keep the first tube U at maximum efficiency and, while there may seem to be a great many controls and that a person has only two hands with which to manipulate them all, one quickly finds that two are used for preliminary coarse adjustment, two are then used for fine adjustment and only one is used for the final setting to maximum efficiency.

Making Tests of Various Instruments

HERE are some hints for the Radio fan who wants to go over his set, testing his coils, connections, transformers and condensers and making sure there are no breaks in the circuit. An ordinary dry or storage battery is all the equipment necessary to make sure the circuit is all right.

From one terminal of the battery run a wire of convenient length to one terminal of the head set. Then fasten another wire to the other terminal of the battery and leave the other end open. Put the phones to the ears.

You will now find that you have two open terminals, one from the battery, the other being the open phone tip. Touch these together and a click in the telephones will be heard. This shows that the circuit in the receivers is right, and the test on the coils can now be made.

Touch one of the open terminals to one end of the coil and the other open end to the other end of the coil. If the click sounds in the receiver, the coil is all right.

In testing the transformers, the phones click when the two terminals of the primary or the two terminals of the secondary are touched. The click, however, should not be heard when one of the testing wires is touched to one of the terminals of the primary and the other wire to a terminal of the secondary. In other words, there should be no circuit between the primary and the secondary of a transformer.

When the testing wires are touched to the terminals of a condenser there should be no click. If a click occurs, the condenser is defective. If a variable condenser, it is probable that the plates are touching. If a fixed condenser, it is defective and may as well be thrown away.

With the phones and the battery hooked up in this fashion, short circuits and all manner of troubles can be detected.

How to Operate
Freed-Eisemann NR-20 Neutrodyne

The Freed-Eisemann NR-20 Neutrodyne is a five tube set employing two stages of radio frequency, detector and two stages of audio frequency amplification. This model is housed in a very beautiful cabinet with a hinged front panel

FIVE vacuum tubes are used with the Freed-Eisemann NR-20 receiver. It is best to use either five 201A or 301A tubes. Do not use any other kind of tube for the detector except those mentioned above, regardless of advice to the contrary. The NR-20 receiver is provided with rheostats designed for the above tubes, and best results will be obtained from the receiver with them.

Accessories

A storage battery is required to light the filaments of the vacuum tubes used in the NR-20, which is sometimes known as the A battery. In addition to the storage battery to light the filaments, a B battery is needed to supply energy to the plate circuits of the vacuum tubes, and it is this energy which operates the loud speaker and produces a large volume of sound. B batteries are usually made up in 22½ and 45-volt units. For the NR-20 receiver, a total of 90 volts is required, and either four 22½-volt or two 45-volt units may be used; the latter choice is recommended.

A telephone headset should be used, preferably for tuning in distant stations, because telephones are more sensitive to a weak signal than a loud speaker. Once the distant station is tuned in the horn can be connected in as desired. A telephone plug should be attached to the end of the receiver cords.

When connecting up the loud speaker for the first time, try reversing the leads from the horn to the two binding posts provided. Better reproduction may be had with the connections to the loud speaker made so that the current flows through the loud speaker in the right direction. Once the proper method of connection is determined, it need not be changed.

Antennas

For best results with NR-20 an outdoor antenna should be used. This should be a single wire from 70 to 100 feet long, as high as possible, and well insulated from surrounding objects. The lead-in wire should be securely attached to the antenna wire, preferably by soldering.

An indoor antenna very often gives excellent results with this set. A good indoor antenna consists of a long length of insulated wire running through the length of several rooms, or a hallway. The indoor antenna may be concealed behind the picture frame moulding of the room, although it is preferable to keep the antenna at least one foot away from the wall. Always run the antenna lead, both indoor and outdoor, away from the receiver. Never let the antenna or ground lead run on top, or under, or alongside the receiver. Do not loop the indoor antenna wire around the room in which the receiver is placed.

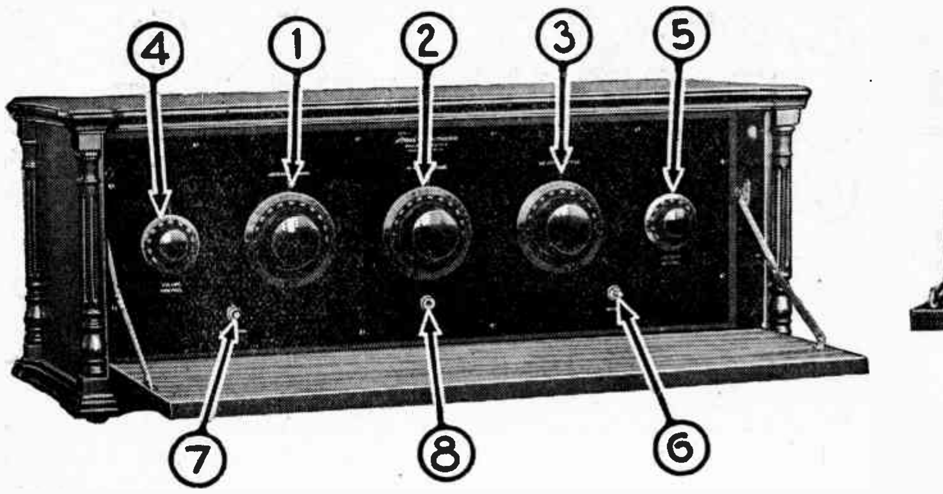
The ground connection is very important and a good tight connection should be made by first scraping the paint off the pipe at the place of connection, until the bare metal shows. The ground clamp and ground wire should be securely fastened and preferably soldered in place.

From the ground binding post, on the rear of the receiver, a wire should run directly to the rear and away from the receiver to the ground connection. In the home, a good ground connection can be made to a radiator pipe, water pipe or gas pipe.

Two antenna binding posts are provided, one for a short antenna, say 40 feet, more or less, in length and one for a long antenna 100 feet or longer. It is best to connect the antenna first on one binding post and then on the other when the set is first installed, to determine which connection results in the sharpest tuning. When this is determined, the connection should be left permanently and should not be adjusted back and forth. It will usually be found that when the antenna is connected to the upper antenna terminal marked "long antenna," tuning will be sharper. This is because a small condenser is then connected in series with the antenna.

Within the Set

In order that the user may understand something of what goes on in this set, figures 1 and 2 have been numbered and lettered so that reference can be made to them in the following explanation. The three units behind the panel, and adjusted by the three large dials, are known as variable condensers. These condensers might be compared to the combination locks put on large safes. The dials on the combination locks must be set at certain numbers or the door will not open and in this receiver, as in all neutrodynes, each dial must be set at a certain number or the signals cannot pass through. Each of these three condensers which have been lettered 1a, 2a and 3a is used in conjunction with one of the three coils and these coils have been numbered 9, 10 and 11.



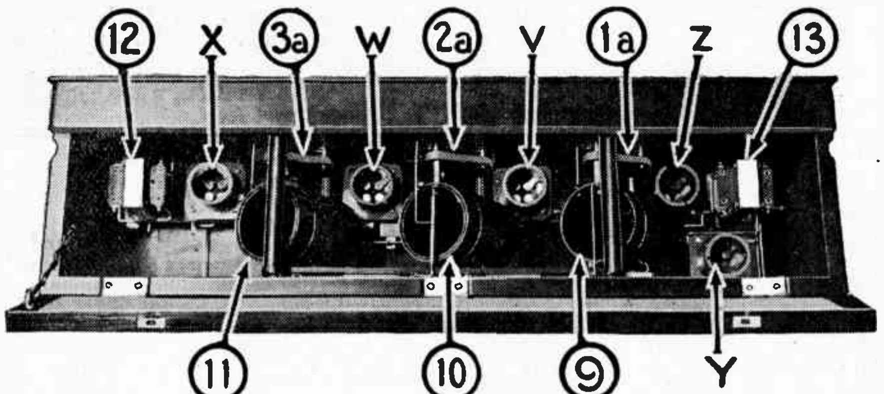


Figure 1, at the left shows the front view of this receiver with the hinged front panel lowered. Figure 2, gives an idea of how the set looks on the inside. Both figures are numbered for you to follow the directions more carefully

The signals come in from the aerial and ground and must first pass the obstacle presented by coil 9 and condenser 1a. When dial 1 has been set at the proper position signals can enter the V; from this tube they enter the circuit composed of condenser 2a and coil 10 and they can pass this circuit only when dial 2 has been set at the proper position. Tube W is the next piece of apparatus into which the energy must go, and from this tube signals enter the third critical circuit composed of 3a and 11. When dial 3 is set at a number approximately the same as dial 2 the energy goes to tube X, which is known as the detector tube.

It is the purpose of the other four tubes in the set to strengthen or amplify the incoming energy but it is the purpose of tube X to alter the form of the energy so that it can be heard. Having passed from the left end of the set almost to the right end, the converted energy leaving tube X enters the piece of apparatus identified by the number 12. It is the purpose of this unit to pass the signals from tube X into tube Y and it will be noted that the energy must travel, at this stage of the operation, from the right end of the receiver clear back to the left end, at which point we find socket Y. Another piece of apparatus similar to 12 will be found between sockets Y and Z and identified by the number 13. It is the purpose of this unit to pass the energy into tube Z, from which it goes to the loud speaker.

The push pull switch located at the lower left corner of the panel, and number 7, enables the user to connect the loud speaker after either tube Y or tube Z. This may be found desirable when local programs are too loud for the use of the speaker after tube Z. On the other hand, when distant programs are being heard it is better to connect the speaker after the last tube. The small dial, identified by the number 4, acts as a control of volume as it regulates the brilliancy of the first two tubes. The small dial identified as 5 controls the brilliancy of the remaining three tubes, namely the detector V and two audio amplifiers. Head receivers may be connected to this set by inserting a plug into the jack identified by the number 8.

Operating

Turn dial number 5, till the index mark points to about 75 degrees on the dial. Then turn dial number 4, till its index mark also points to about 75 degrees on the dial.

Set the "2nd neutrostage" dial, number 3, at, say 70 degrees, and the "1st neutrostage" dial, number 2, at 70 degrees. (This setting is approximately correct for receiving broadcasting on 492 meters.) Move "antenna tuning" dial, number 1, slowly from about 0 degrees to 90 degrees. If there is any broadcasting on 492 meters, it will be heard at some setting of the "antenna tuning" dial.

If no broadcasting is heard, set each of the "neutrostage" dials at 68 degrees, and readjust "antenna tuning" dial, number 1. Continue this tuning operation, always commencing by setting the two "neutrostage" dials at the same setting and then rotating the "antenna tuning" dial. Because of the sharpness of tuning of this receiver, and the complete absence of "beat notes," new settings of the "neutrostage" dials should be only about 2 degrees apart, when picking up a station. Thus, if no broadcasting is heard with the "neutrostage" dials at 68 degrees, reset these dials to 66 degrees, then 64 degrees, then 62 degrees, etc., until a station is received. Then move each dial separately either up or down the scale, slightly, until the broadcast music or speech is loudest.

Dials 4 and 5 should be readjusted till broadcast reception sounds clearest and loudest. This adjustment need only be made once during the receiving period.

The settings are always the same for a given station and can be received and tuned in again by merely setting the dials as shown by the log. When finished with this set, be sure to push in the filament switch 6.

Possible Troubles

Broad tuning with considerable amplification is caused by the set picking up too much energy and is usually due to an antenna that is too large. This phenomenon, in most cases, can be entirely obviated by cutting down the length of the aerial to, say one-half its length, which will have the result of sharp tuning; if a given station is heard within ten degrees on either side of its loudest point on the dial settings, shortening the aerial will cause it to be heard say within two or three degrees of its loudest point. Thus, broadcasting stations can be effectively separated from one another.

Loss of amplification and selectivity is usually due to a run-down storage battery or run-down B batteries, or to a reversed storage battery. Cracking noises on local stations is usually due to a noisy or defective dry battery or to a noisy or defective vacuum tube. There is absolutely nothing in this receiver which can possibly produce noise. All soldering is done with rosin core solder and all condensers and transformers are tested.

If there is any noise, it is caused by something external to the receiver, such as B battery, tubes, local induction that is picked up from leaky telephone lines, or lighting circuits in the house, etc., etc.

Distortion in the loud speaker may be due to overloading the detector tube, and this overloading can be eliminated by detuning the detector and antenna circuits as explained in the instruction booklet under "Tuning."

If there is any mushiness, it is undoubtedly due to the fact that the two stages of radio frequency are so powerful on nearby broadcasting that you are overloading your detector tube. This may happen on stations even 250 miles away. If so, get all three dials in tune and then turn the right hand dial, number 3, slightly, to decrease the input into the detector tube.

If each circuit of your receiver tunes, and there is gain in amplification as you switch from one to two stages of amplification, the set is positively capable of receiving distant stations. When the dry batteries are run down and need replacement, a howl may sometimes be heard when the switch connects the 2nd audio stage and all tubes are lighted. To overcome this condition, use new B batteries.

Eliminate Hazards in Radio

Do not permit wires to trail into thoroughfares or across high-power electric lines.

Support the aerial mast with guy wires to prevent its falling during a storm.

Lead-in and ground wires should be kept at least 5 inches away from the building. All joints should be soldered or made with approved types of clamps or splicing devices.

If fuses are used in circuits, they should be of approved types and not make-shift devices, such as copper wire or copper pennies. Small fuses should be placed on a storage battery and connected in the storage battery leads to prevent short circuits. Keep fires and sparks away from storage batteries, especially after the batteries have been freshly charged, as the highly explosive hydrogen gas is expelled. Be careful no liquid is spilled out of the battery onto anything of value, as this fluid will ruin almost anything it touches.

How to Operate

Thorola Islodyne Five Tube Receiver

The Thorola Islodyne is a five tube radio frequency receiver making use of the new doughnut type of coils

THIS set is most unusual in many ways. In appearance, the front panel differs radically from any other receiver available, due to the attractive wood covering over most of the front panel. In efficiency, the effect of the doughnut coils used is most noticeable in that this set really tunes sharp and confines local stations to a very few degrees on the dials. Operation is easily mastered and the controls have been reduced to the lowest possible minimum in a set of this type.

Islodyne comes sturdily packed against breakage and marring of the cabinet and is best removed from the container by placing carton on its side, opening the flaps at top and bottom and pushing through. Attempts to lift it out or drop it out were not very successful. The lint from the corrugated board may be removed with a soft cloth and at the same time the whole cabinet might well be gone over to restore the polish. There is no compartment for the batteries and space should be provided in the cabinet or table on which the set is placed. for them. A Belden battery cable affords a convenient means of making connections and was used by the writer when testing this set.

While there is an excellent diagram provided which shows clearly the proper battery connections, it may be a good idea to go over these for the benefit of those who may purchase an Islodyne from someone else from which diagram card has been removed. There are three possible antenna connection posts; beginning at the left they are antenna long, antenna medium and antenna short. The choosing of the proper one for your installation is a matter of selectivity. If the antenna proper and the lead-in have a combined length of 105 to 125 feet, the "Antenna Long" binding post should give best results. Total lengths between 75 and 105 feet will probably call for the "Antenna Medium" post, while overall lengths of 40 to 75 feet should work better on the "Antenna Short" terminal.

Aerial and Ground Connections

Try connecting your antenna on first one and then the other of these until adjustment is reached that gives you the desired compromise between selectivity and volume on distant stations. This is a compromise on any receiver which may or may not have been settled by the maker before shipping the set. This choice, as provided in the Islodyne, seems like the better way as all locations differ. No matter what the characteristics of your antenna, the "Long Antenna" connection will give the greatest selectivity, with "Medium" next and the "Short" connection the least. On the other hand, the "Short" connection will give greater volume on long distance.

The fourth terminal from the left is for the ground wire which can be attached to either the cold water pipe or, in rural districts, a long rod driven into the ground from 4 to 10 feet. This should, if possible, be placed in a spot where the earth is always moist. If attaching to a water pipe, carefully scrape, file or sandpaper the nearest portion of the pipe, for a length of about three inches. A ground clamp, as carried by Radio and electrical stores, is much to be preferred and costs but little. Otherwise, remove the insulation from the last two feet of the wire and scrape it bright, then wrap this portion around the pipe pushing the turns loosely together. Over this wrap a layer or two of tinfoil and then cover well with what is called "electrician's" or "bicycle" tape.

Connections for the speaker come next and are in the form of small cord tip jacks. It will be noted that, on most speakers, the cord terminates in two leads one of which is marked with a red tracer thread. The unmarked cord tip is to be plugged into the first of the two jacks while the marked one goes into the second. This makes quite a lot of difference in most speakers and if improperly done the speaker will sound badly choked and will rattle. If cord tips are not marked with tracer thread, some reversing will be necessary to determine which way sounds best.

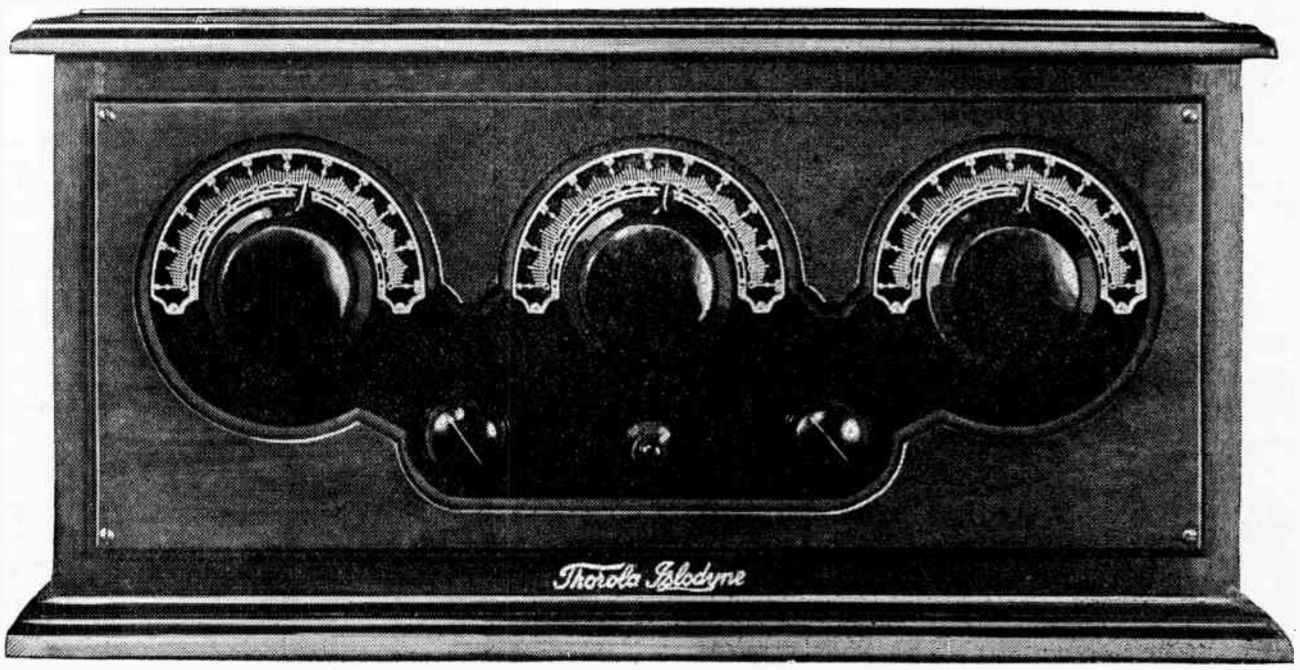


Figure 1

Connecting the Batteries

Before connecting the batteries be sure that the storage battery is fully charged as indicated on a hydrometer. One of the caps on the battery must be unscrewed and the tip of the hydrometer inserted in the liquid. The bulb is then squeezed and released which will draw up electrolyte into the large glass portion of this device. Within the hydrometer is a float on which there is a scale reading from 1,100 to 1,400. This float is read by noting the point on the scale opposite the surface of the liquid. The scale reading should be 1,210 or better; when between 1,280 and 1,310 battery is fully charged.

The first three terminals for batteries are for the B battery supply and are labelled B+90, B+45 and B—. This B power supply may take the form of dry cell B units as made by Eveready, may be of the storage battery type as constructed by Prest-O-Lite, World or Hawley, or may be one of the B eliminators on the market which supply direct current in the correct voltages when connected to the electric light socket. If a B eliminator is used, the binding posts will be found to carry practically the same identifications as those on the set although they may read B+100, B+50 and B—.

If batteries are used, either dry or wet, it will be found they come in 45-volt units and two will be required. The minus terminal on one of them is to be connected to the third from the last post in the set which is labelled B—. The other terminal on this battery is then to be connected to the B+45 post in the set and to the minus terminal of the second B battery. The remaining plus terminal on the second battery goes to the B+90 binding post in the set.

The last two posts in the set are for connection to the storage battery, usually called the A battery. One terminal of this battery will be found marked POS., + or painted red. This must be connected to the next to the last binding post while the second terminal of the storage battery connects to the last post on the set.

Tuning Controls

The three large knobs provided with pointers, which revolve over engraved scales, are the actual tuning controls. The center one, and that to the right, which we will call numbers 2 and 3, will be found to read practically the same on any station. Dial number 1 will probably read somewhat lower due to the effect of the antenna. Since every antenna installation varies, it would be impossible for any manufacturer to alter this point. Below the dials there are two knobs and one switch. The switch is used to turn the current on and off and one must get in the habit of snapping this to the left when through with the set. If a B eliminator is used instead of B batteries, the switch at the light socket should also be turned off.

The knob to the left controls the brilliancy of the first three tubes, the two which amplify the signals while still at radio frequencies, and the detector. This knob must be turned to the right to light the tubes and is used as a volume control on local stations or exceptionally loud distant programs. It also permits control over any tendency toward oscillation on the lower wave lengths, 0 to 30 on the dials, which would evidence itself by squeals, howls and distortion. Turning it to the left clarifies the program.

The other knob is called a "distance amplifier control" and adjustment is necessary only on distant stations. By turning it to the right, the volume on weak or far-away stations can be built up. When receiving local and nearby programs, and also distant stations found between 0 and 30 on the dials, this knob should be kept turned to the left. Much of the really exceptional volume on out-of-town stations possible with this set is due to proper use of this knob to the right, and this innovation is both new and exclusive with the Islodyne.

Method of Tuning

It is suggested, to start, that the first dial be placed at 28 and then a hand placed on each of the other two so they can be revolved together. Revolve them slowly, and together, between 30 and 40. If no program is heard, turn the left knob slightly toward the right and try it again. If again there is no result, reset dial 1 at 30 and revolve the other two between 30 and 42. This should be tried several times, moving dial 1 two degrees each time. At some setting of the left knob and dial 1, a program will be encountered when revolving dials 2 and 3. Slight readjustment of all three dials and the knob will quickly bring the station in with maximum volume and clearness.

It is good practice to jot down the settings of the three dials for about seven stations, well distributed over the dials, and then make a chart, such as that reproduced here. Wave lengths are evenly spaced along one edge and dial settings from 1 to 100 along an adjacent edge. The little crosses for the settings of dial 3 can then be connected and will make a curve as shown. Do the same with the crosses for dial 2 settings and those of dial 1. If dials 2 and 3 run exactly together throughout the scale, only one curve for both of them is necessary.

As in any receiver of the tuned radio frequency type, it is a good policy to switch tubes around in their sockets when tuned in on a distant station, as nearly always there is one that makes a better detector than the rest and two that are superior as radio frequency amplifiers.

In case of trouble always check over all of the connections, including the aerial and ground wires; test both the A and B batteries; and see that the tubes light before blaming it on the set.

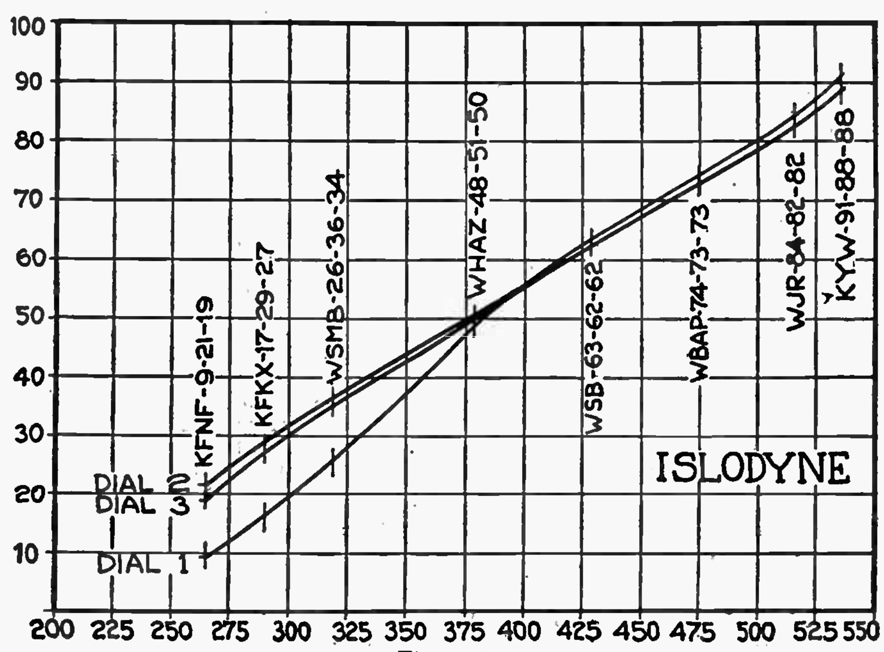


Figure 2

How to Operate
Howard Five Tube Neutrodyne Set

The Howard five tube Neutrodyne receiver incorporates two stages of Radio frequency amplification, detector and two stages of audio frequency amplification. The selectivity of this type of circuit is exceptionally good, making it an ideal receiver for long distance reception with loud speaker volume.

THE Howard receiver is a neutrodyne of the latest and most approved design and construction. Its operation is simple and its performance as to quality for the local stations and extreme sensitivity for distant stations is such as to put it in the front rank of modern Radio receivers.

To obtain the best results with the Howard it is necessary that it be carefully installed according to the following instructions.

Aerial and Ground

The first items to be considered in setting up a Radio receiver are the aerial and ground. If it is desired to hear only the local stations and the more powerful stations within a radius of 500 miles, a small indoor aerial is not only sufficient but is most desirable, since less interference due to static and spark stations will be picked up on this than on any outdoor type. This aerial may consist of twenty or thirty feet of insulated wire strung clear of the walls in a hallway or attic.

Use of the electric lighting system as an aerial by means of a well insulated plug frequently gives good results even on distant stations. This scheme at times provides the best type of aerial, especially in steel framed buildings, as they shield the Radio waves from other types of indoor aerials.

If it is desired to receive stations a long distance away, an outdoor aerial about sixty feet in length will usually give the best results. It should, of course, be well insulated and protected against lighting with a grounding switch or lightning arrester as specified by the fire underwriters. Even if one has an outdoor aerial at his disposal he should also provide an indoor aerial for use in receiving local stations.

The ground connection in all cases should be as short and direct as possible. Connection to the radiator system or water piping system is generally satisfactory.

A 6-volt storage battery of 50 or more ampere-hour capacity and B batteries totaling 90 volts should be provided.

The Howard receiver is designed for five UV-201A or C301A tubes.

A good loud speaker or phonograph attachment should be provided. This should include a cord and plug. If desired, a pair of telephone receivers with headstrap, cord and plug may be used. They are sometimes helpful in tuning in distant stations.

Installation of Receiver

The receiver should be so placed that when viewed from the front the aerial lead-in is at the left of the receiver. Connect this lead-in to the binding post marked A, being careful to run it in such a way as not to come close to the right-hand side of set. The safest procedure is to run it straight back from the receiver and thence to the aerial. The lead from the ground should be connected to the terminal marked "G."

The batteries should be placed as shown behind the set, or, better still, on a shelf or on the floor, beneath the set. It is a wise precaution to connect the A battery first and to insert all five tubes with the rheostats (the five small dials along the bottom of the panel) tunrned up to about fifty divisions. The tubes should then all light up. If they do not, some error has been made which should be corrected before connecting the B batteries.

After these connections have been made turn up the rheostat dials 4, 5, 6, 7, and 8 to about fifty divisions so that all tubes are lighted and insert the loud speaker plug in the jack at the extreme right of the panel. (If head phones are used they should be plugged in the other or left-hand jack.)

Tap the detector tube (the middle one) lightly with the finger and a metallic clang will be heard in horn. This is due to vibration of the elements of the tube. The tubes should then be interchanged until the one giving the least drawn-out ring or clamp is obtained. This tube should be left in the middle socket while the other four may be placed at random in the other four sockets.

Instructions for Tuning In

The receiver is now ready for use. Turn all three of the larger tuning dials 1, 2, and 3 to the same points of their scales (90 divisions, for instance), and then make small readjustments to dials 1 and 2 until a slight crackling or roaring noise which is due to the carrier wave of the station sending. A loud, unsteady noise is due to static and other atmospheric disturbances and is more noticeable when using an outdoor aerial. The receiver is now tuned to a wave-length of approximately 536 meters, which corresponds to a frequency of 560 kilocycles per second. If a Radiocasting station within range is transmitting on this wave length it will, of course, also be heard. If no music or speech is heard, turn all three dials downward a division or two at a time until a station is picked up. As the dials are moved downward the receiver is tuned to lower and lower wave lengths.

After a station has once been heard the settings of the three tuning dials should be recorded on the log sheet provided. To receive signals from it at any future time, it is only necessary to reset the dials to the points recorded on the log.

The signals from powerful local stations are likely to be too loud and perhaps distorted. This may be remedied by either using a small aerial or by turning down the dials of the first two rheostats until good, clear and sufficiently loud signals are heard.

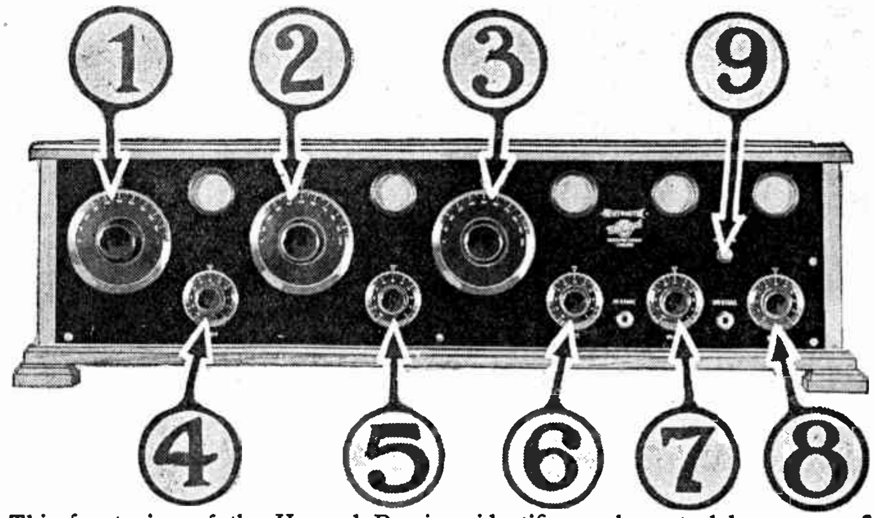
Kinds of Interference Experienced

Interference experienced by Radio listeners is chiefly of three kinds. These are: Interference between Radiocasting stations; interference from static, atmospheric disturbances and spark stations; and interference from reradiating oscillating receivers.

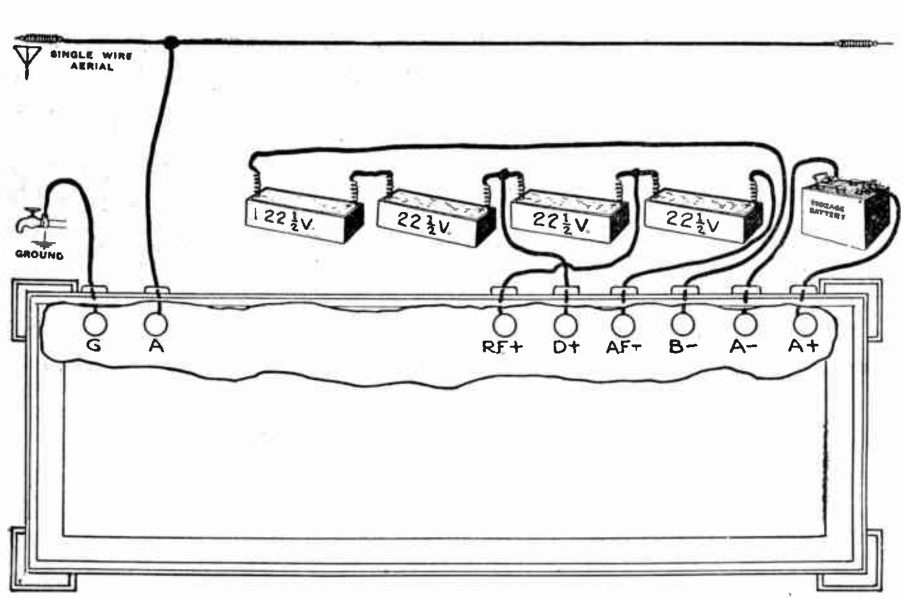
The Howard receiver is sufficiently selective to largely exclude interference between Radiocasting stations, especially when a small or indoor aerial is used. If, however, the Radiocasting stations transmit on incorrect wave-lengths interference in the nature of a steady squeal or howl of almost unvarying pitch results, which, of course, is impossible to eliminate.

The second types of interference—that due to static, etc., can be minimized, if objectionable, only by the use of a small outside antenna or an indoor antenna.

The third type—that due to re-radiation from oscillating receivers—is characterized by squeals and chirps which vary in pitch. Very little can be done to eliminate them until the re-radiating type of receiver is eliminted. The Howard neutrodyne does not oscillate nor re-radiate, and therefore does not produce this very objectionable interference, which is causing annoyance to the listeners in.



This front view of the Howard Receiver identifies each control by means of numerals. The article explains the function and operation of each one.



This plan view of the set illustrates the correct method of correcting the A and B batteries, aerial and ground.

Poor Tube Bases Cause Current Loss

ONE OF the indications of the progress of the Radio art is the increased attention which is being paid to the design of the individual parts which are used in Radio receiving sets. Until quite recently most of this care was focused on the design of the coils and condensers alone. However, it is now realized that there are mile-wasting losses in poorly designed tube bases, tube sockets and other parts, as well.

A modern fairly efficient Radio receiver will receive signals which have as low a pressure as .001 volts. Even in a very good antenna this will not produce an energy of more than .0000001 watts. It is hard to imagine such a small quantity of energy, but forty million receiving sets would produce just about power enough to light one ordinary 40-watt tungsten light.

New Tube Construction

The oldest manufacturer of vacuum tubes has recently greatly improved its product by eliminating the traditional metal shell which surrounds the base of their tube. This change reduces the internal capacity of the tube and at the same time eliminates the losses from eddy currents in the metal shell itself. While the saving of power thus accomplished is quite small when expressed in figures, it becomes of importance when compared with the minute currents received on the antenna.

Importance of Vacuum Tube Socket

Second only in importance to the vacuum tube itself, is the tube socket, for all the energy must pass through the socket before it reaches the tube. Indications are that the metal shell socket will soon become obsolete as the single slide tuning coil. The best Radio engineering practice of today calls for the elimination of as much material as possible in the neighborhood of the parts of the Radio set which carry the Radio frequency current. This applies not only to metallic substances, but to insulating materials as well. The sockets of the future will undoubtedly consist merely of a comparatively thin shell of some high grade insulating material, and a base only sufficiently large to accommodate the necessary contact springs and connecting posts.

Some manufacturers are already marketing sockets of this type. The necessary strength and durability is being secured by the use of Bakelite or similar material of uniform cross-section which assures thorough curing of the material, giving it the highest possible di-electric properties, as well as making it mechanically strong.

No Noisy B Batteries

A further interesting fact that has been developed through research conducted by one of the largest battery manufacturers, is that the "hissing" and "frying" noises often attributed to B batteries are in reality cause by poor connections, usually between tube terminals and the socket contacts. Their research shows that there are no noisy B batteries.

To prevent such noises and the shortening of many otherwise good concerts there are manufacturers who have not only provided sockets with the high insulating properties, but have devised contacts that are of a wiping nature, with dependable tension for each and every type of tube.

How to Operate

Stewart-Warner Five Tube Receiver

THIS is a most handsome outfit with mahogany crackle finish panel, a solid attractive cabinet and gold finish dial scales. That was what first struck the writer when Model 325 was hauled out of its heavy corrugated board packing. So many sets that are exceptional in results present such a poor appearance that to the feminine mind they are impossible in the parlor. This one is a delight to the eye.

The antenna lead-in wire and the connection to ground should be as short as is reasonably possible and should not be run together at any point. Many Radio set users bring these leads together at some point say five to ten feet from the set and then twist them together for the rest of the way. Do not do this under any circumstances. The wire from the aerial is to be brought into the set through a hole provided in the rear of the cabinet near the left end, directly behind a binding post identified with the word "aerial." About three inches to the left is a similar hole and binding post for the ground wire.

Two small jacks are provided for the cord tips on the speaker cable and it should be noted, in particular, that one of these is marked "—" while the other is marked "+." The terminals of the speaker cord are identical except that in one there will be found a red or blue tracer woven into the covering. This means that the phone tip on this wire goes in the "+" jack on the set, while the unmarked tip goes in the other small jack. The battery connections are taken care of by a five wire cable, the coverings of each wire being of a different color scheme. Thus you cannot well make a mistake in connecting the batteries with the consequent chance of burning out a tube or two.

Accessories Required

For operation this receiver requires one 6-volt storage battery, or its equivalent in a way of an "A Battery Eliminator," and two 45-volt B battery units, either dry cell or storage, or their equivalent in a "B Battery Eliminator." One of the storage battery terminals will be found to be marked POS. or + or with a dash of red paint. This is called the positive terminal and the other is the negative. That wire of the battery cable which is pure yellow in the color of its covering must be attached to the positive post of the battery. That which is black with a yellow tracer thread woven in, goes to the negative. Should a Philco, Gould or Cooper power unit for "A" supply be used, it will have these same two terminals,+ and —.

We tried the set on both B batteries and B eliminators with equally good results, connections being as follows: One of the B batteries will be found to have a minus post to which you attach the black covered wire with red tracer thread. This B unit also has a plus 45 post to which the maroon covered lead is connected. The other B battery has a minus post and the short black wire soldered to the maroon lead by the manufacturer goes to this minus post on the second B battery. The bright red lead goes to the remaining plus 45 post of this second battery. In the case of the B eliminator, however, there will be found three binding posts, B—, B+45, and B+90. The black and red lead goes to B—, the maroon lead goes to B+45 and the short black connector is to be cut off. The bright red covered wire goes to B+90.

Aerial and Ground Connections

As to aerial, it may consist of a single wire between 50 and 100 feet in length, measured from the end furthest out, to the set. The writer would recommend the enamelled wire marketed by Belden for use as antenna, as it will not corrode and will never need replacing except in case of actual breakage. Use porcelain or Pyrex glass insulators at each end of the straightaway portion of the aerial and either extend the wire itself down to the set or use heavy rubber covered lead-in

This set has a very attractive crackle finished panel with gold finish dials and solid mahogany cabinet

wire which is soldered to the straightaway close to one end just inside an insulator. In either case the lead-in portion should be kept clear of the building by insulators and kept from swinging, which would cause

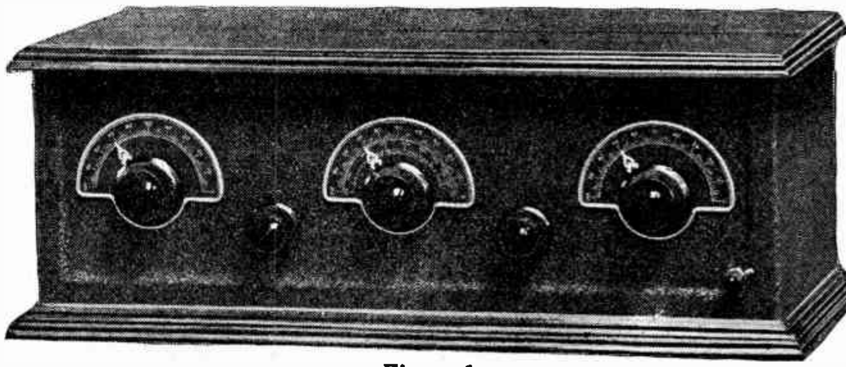


Figure 1

crackling noises and gradually tear off the insulation. Bring it into the room either through a porcelain tube or by one of the flat insulated strips on the market which go under the window sash.

The ground in most cases can be made to a cold water pipe. These instructions have been in print many hundreds of times before but for the benefit of the new owner of a set they will be briefly run over once more. Scrape the surface of the pipe for a length of about two inches, so you get through the corrosion, and the exposed metal is bright and shiny all the way around. Then put on a ground clamp such as can be purchased at any Radio or electrical store for this purpose and connect a wire from the ground post of the set, to this ground clamp. Remember, while it is not half as much trouble to install as the aerial, it is just as important and the set will not function properly without a good electrical connection to ground made in this way.

The country users of this, or any other set, can best get a ground by burying several large pieces of metal in a spot usually damp and soldering a connection from each one to the ground connection wire. Old wash boilers, pipe, edge-of-roof gutter, chicken wire and cylinder head shims are suggested. It is easier, if a pond or spring is close, to drive a length of rod into

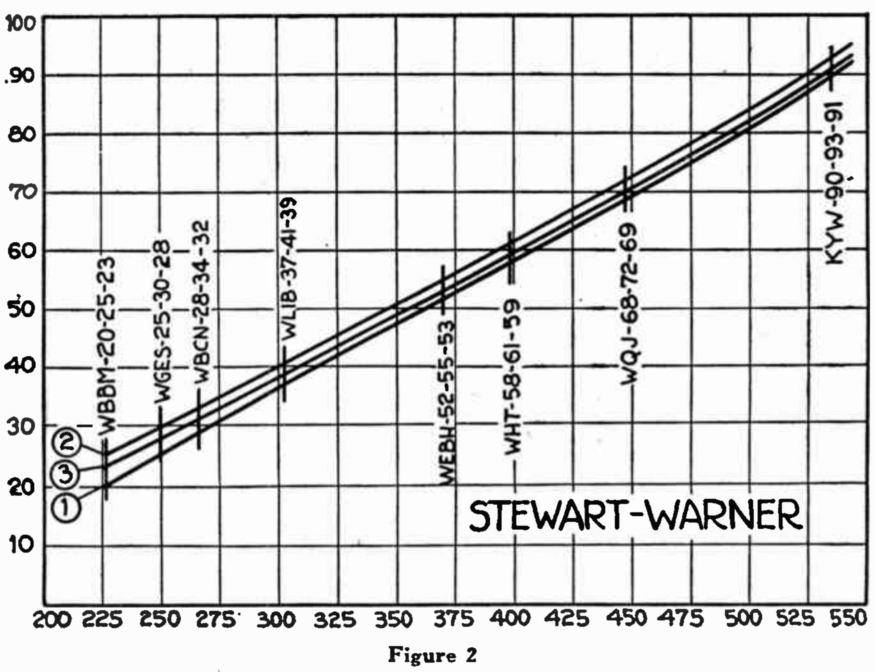


Figure 2

the ground in the wet soil and attach wire to this rod with a ground clamp.

Operating Instructions

The accessories having been connected we are ready to put the Stewart-Warner into operation. This receiver requires five tubes or bulbs, known to the Radio fraternity as "A" tubes, because the manufacturers identify them as UV-201A or C-301A or M-401A, etc. The majority of dealers today have a tube testing device of some kind and you should insist on your tubes being tested, not only for filament lighting, but for amplification. If any one of the five tubes is inefficient the results will be most unsatisfactory even though all tubes light. Turn the small switch knob in lower right corner to the left which is the "Off" position and insert the tubes in the five sockets. Now set "Volume Control" knob and "Battery Control" knob so each points upward and slightly to the right, a "2 o'clock position." The switch in lower left corner may, for this first test, be turned to the right.

Now turn switch at right, to the right, the "On" position, and the tubes should all light up. This will not be bright, as you would expect from an electric light bulb, as these filaments are not of the type to get that bright in normal use and the inner surface of the glass bulb is coated with metallic magnesium which prevents anything but a slight glow from getting out around the lower edge.

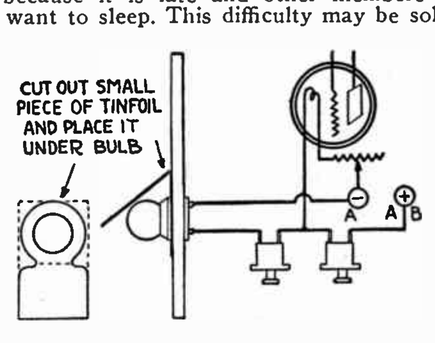
The dial numbers on the first and third pointers have no connection with the wave length on which a station may be transmitting but the center dial is provided with an auxiliary scale below the 0 to 100 scale, giving the approximate position of the pointer for settings by meters. The center pointer and that at the right (number 3) will run pretty close together in their settings for the various stations and the first pointer will not be far from them. It will, however, be somewhat different because the apparatus which it controls is influenced by the antenna and ground connections and these differ in every case.

As a starter, set all three dials at 39 which is in the section in which one finds such stations as KDKA, WLIB, WSMB and KTCL. Now place one hand on dial 1 and the other on dial 3 and move them slowly back and forth between 36 and 42 on their scales. If nothing is heard set dial 2 at 40 and repeat this operation. If no results, turn the "Volume Control" knob a little further to the right and try again. It may be that the "Battery Control" knob should be turned further to the right also. A combination of settings of these two knobs and the dials will be found that will bring in programs. Once a station is tuned in, bring it to maximum strength with the dials, very carefully, and then turn "Battery Control" knob to right to the point where further turning does not help, and leave it. Then turn "Volume Control" to right until signals become a little distorted and leave just to left of this point.

This "Volume Control" is the key to long distance and clear volume. Its position will have to be altered slightly with each new setting of the large dials and in each case it will be found that it can be turned to the right just so far and a maximum of range and volume will be had before distortion shows. When a powerful local is tuned in and the volume causes distortion, due either to overloading of the last tube or rattle in the loud speaker, turn the small swith at left, to the left, which will reduce the volume and clear up the program. When looking for long distance stations, though, this switch should be at the right or "Full Volume" position or otherwise the volume might not be great enough for you to hear the program at all. When through using set, always be sure that the little switch at the right is turned to "Off" position.

Panel Light for DX Hunters

Many fans have to turn in early or tune in without lights because it is late and other members of the family want to sleep. This difficulty may be solved by



making panel lights from parts out of the junk box. A piece of tin foil, a 6-volt flashlight bulb and a socket for same are required. You pull the switch and dials are illuminated. This is hardly any drain on your battery and light is independent of tubes.—John Mullikin, Washington, D. C.

Dust in Set Causes Loss

Dust in Radio sets is often the cause of a large loss in efficiency. This is especially true in wet weather, when the dust becomes damp, and allows the feeble currents to leak.

The worst places for dust to be allowed to collect is about binding posts and terminals and between the plates of rotary variable condensers. It may be removed from between wires and around terminals with a small brush, about two inches wide. Many Radio engineers use pipe cleaners, the same as are used for cleaning the stems of ordinary smoking pipes, for removing dust from between condenser plates and from numerous otherwise inaccessible places.

It would be good practice for the set owner to carefully dust his set in this way, as often as once a month.

Radio Frequency Choke Coil

A good radio frequency choke for the plate circuits of a Weagant type regenerative receiver can be constructed with a three-inch piece of wood dowel rod one-half inch in diameter. On this wind as many turns of No. 30 or 32 dcc. wire as it will hold. One end connects to the plate of the detector tube and the other to the P terminal of the first audio frequency transformer. Another lead runs, of course, from the plate of the tube to the fixed tickler and then to the stator plates of the regeneration control condenser.

When boring holes in wood or bakelite, splitting on the underside can be avoided if the piece being drilled is clamped or kept firmly pressed against the top of the bench or another thick piece of plank. In effect, the bench surface or the plank is one with the panel being drilled and there is very little tendency for chips on the underside round the hole, to break away.

How to Operate

Apex Super Five Radio Frequency Set

The Apex Super Five is a five tube tuned radio frequency receiver of the better group of sets of this type and has many unique features

SUPER FIVE is a tuned radio frequency outfit that can well be classed with the "better" group of sets of this type. The designer was plainly both conscientious in his combining of symmetry and efficiency, and knew his business. Frankly, we liked this receiver exceptionally well. No attempt has been made to combine controls and tuning is done with three dials operating independently. The smaller dials are a sensitivity or regeneration control, and a rheostat for the two radio frequency tubes and the detector. This is not a particularly complicated arrangement and the user quickly learns the knack of tuning.

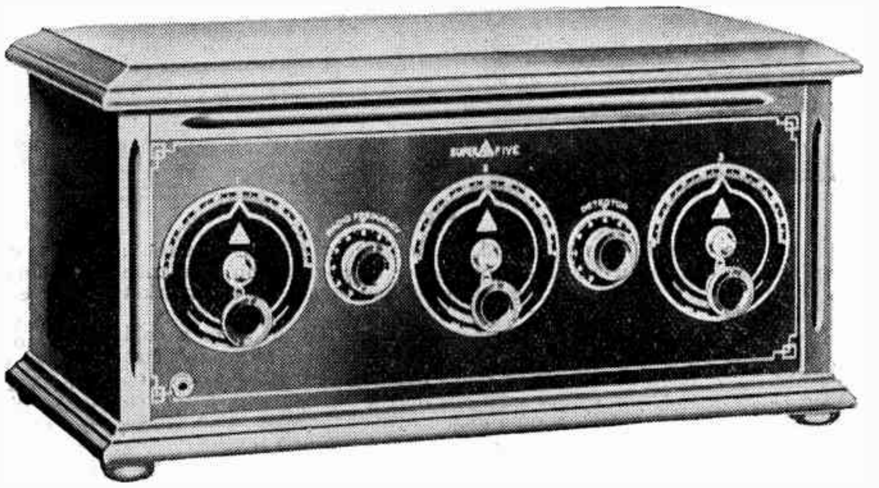
The antenna and ground system to be used with Super Five can be anywhere between 35 and 75 feet over all from actual ground connection to furthest end of straightaway wire. Since the average ground lead is about 10 feet, and the average lead-in is about 25 feet, it is recommended that the straightaway between insulators be 40 feet. This aerial installation should be well insulated, as high above surrounding buildings and trees as possible, and at right angles to street car lines, lighting and power lines, etc. The connection to ground should preferably be made to a water pipe with ground clamp. The surface of the pipe should be scraped clear of corrosion all around, for a length of about 2 inches and the clamp applied at this point. The wire from the ground binding post of the set is then secured to the clamp. Two binding posts are found at the rear left corner inside marked ANT. and GND.

A special means, exclusive to the Apex, is provided for making connections to the batteries. Within the set, just to the right of the ANT. and GND. binding posts is a peculiar looking little block with five springs secured around it. Through a large hole in the back of the cabinet you push a bakelite plug connected to a five wire cable and this plug fits down over the block to make all connections to the set simultaneously. This set was operated on both dry and wet B batteries, several B eliminators and two different A power units. There is nothing peculiar about its circuits that prevents it being used successfully with any of these devices.

If B batteries are used it will be found good policy to use two units of 45 volts each. Among the storage battery units, Prest-O-Lite, World and Hawley are suggested while of all the dry B types, the Eveready number 772 units will be most economical. To the negative terminal of one of the B batteries, connect the yellow covered wire in the cable. The plus terminal of this same B is to be connected by a short wire to the minus of the other B and also to the blue wire in the cable. The plus post of the second B gets the salmon colored covered lead.

The power supply to light the filaments of the tubes may be either a six volt storage battery or one of the A power units on the market. In either case there will be a plus and a minus terminal for the two remaining wires in the cable. The plus post of the battery will be identified by POS., a + sign or a daub of red paint. To this terminal connect the bright red wire of the cable. The second post of the storage battery is, of course, the negative and this gets the green covered wire. The terminals of an A power unit would be connected the same way. If storage batteries are used for both A and B supply, they can be charged without removing cable connections, provided plug is pulled from its pillar in the receiver, which can be done through the hole in the back.

This set may be operated without a C battery as



the two C battery binding posts are connected together at the factory. With B battery voltages of 90 or less, the C battery is not absolutely essential, although its use will improve the tone quality, noticeably. It will also decrease your B battery drain, which is equally important. The Eveready C unit is suggested with the "minus" and "plus 4½" posts connected to these corresponding posts within the set. Be sure to remove the wire conecting the C+ and C— binding posts before connecting the C battery. The use of this set without C battery is discouraged by the manufacturers.

The speaker binding posts are located on the base panel, inside, over toward the left and attention is called to the fact that one is plus and the other minus. The speaker terminals at the end of the twin conductor speaker cord are identical in appearance except that one has a red or green tracer thread woven into the insulation. This terminal must go to the + speaker binding post in the set.

Five tubes of the A type are to be used in Super Five. These can now be inserted in the sockets and, for first trial, no particular attention need be paid as to which goes in any particular socket. The filament switch is to be turned to the "On" position and the small dial marked "Detector" turned to the right. All tubes should light up and, with the "Detector" dial set at about 80 we are now ready to tune this set.

This set is provided with three vernier tuning dials and their settings will be rather close for any given station. Due to the influence of the antenna and ground, which varies with each installation, dial number 1 will be somewhat different throughout the scale, from the others, but dials 2 and 3 will be practically identical in their settings. There will be slight exceptions to this when adjusted for very maximum sensitivity and range but never more than 1 or 2 degrees difference.

The radio frequency control, located between dials 1 and 2, is the vitally important adjustment on this set, as its proper adjustment, in conjunction with the tuning dials, will increase both the volume and selectivity. Super Five is so designed and constructed that it can be made to oscillate at all wave lengths below 500 meters on the average aerial as any set of the tuned radio frequency type is most sensitive and selective when operated just below the oscillating point for any wave length. The radio frequency control can be left in such a position that set can be made to squeal at any point on the dial but this is to be avoided due to the disturbance caused in neighboring sets.

After a little practice in tuning, you will learn the approximately correct position of the radio frequency control, for different positions of the dials and it should be kept at a point just below that at which thumps are heard when the three dials are brought to correct settings and resonance. The lower the wave lengths being tuned, the farther back must the radio frequency control be set. On different antennas, the radio frequency control takes different settings in its relation to dial settings and, if the antenna has extremely high resistance, the control may not bring receiver up to regeneration on the higher wave lengths. The setting of this control will also change slightly for different B voltages on the pink lead of the cable. If regeneration or squeal cannot be obtained at higher tuning dial settings, increase the voltage between the pink or salmon colored lead and the minus B. Any B voltage up to 135 volts may be used and the higher the voltage the greater the volume and, occasionally, the greater the range. On voltages over 90, a C battery of six volts should be used.

When receiver is operating, and tuned exactly to an out-of-town station, vary the blue lead on your B battery as some A tubes require a rather critical B voltage for best results as a detector. Good reception was obtained with voltages down to 16 on this lead but trying several tubes in this socket showed the average best voltage was close to 45. Burn your radio frequency and detector tubes as low as possible, as controlled by the small dial between tuning dials 2 and 3, without loss of signal strength, and try slight readjustments with a distant station tuned in. Once you have determined the lowest (most economical) setting of this control, with full volume, you can leave it there.

The Apex line consists of three models, the Apex Super Five, the De Luxe with built-in loud speaker, and the Baby Grand Console.

Installation Instructions

WHILE the manufacturer has probably furnished a book of operating instructions with each set sold, the matter of installing an aerial and ground may be somewhat confusing.

The radio frequency type of receivers require an outside wire from 40 to 100 feet long, including the wire which comes down to the receiver itself. In localities where there are a great number of broadcasting stations, such as Chicago, New York or Los Angeles, the shorter antenna will give much more satisfactory results because of the increased selectivity or ability to separate stations, which the shorter aerial provides. The antenna proper is usually strung between two chimneys, in the case of the user living in an apartment house, while the Radio set owner who lives in the usual two-story house finds it more convenient to string the aerial between his roof and that of a neighbor. The best height for an antenna is 30 to 40 feet above the ground, as experiments have shown that at this height much less static is picked up.

The type of wire used for an antenna is not extremely important, except that it be made of copper, and it may be cotton covered, bare or coated with enamel. The Belden company has a very excellent wire for this purpose, covered with a heavy layer of enamel which is available all over the country, and the new Radio set owner will not go wrong if this wire is used.

Insulators Are Important

It is important that a small insulator be inserted at each end of the wire, between the wire actually used and that which is put in for the purpose of separating it from the chimney. The lead-in may very well be a continuation of the actual antenna itself or it may be a rubber covered wire soldered to the antenna, between the insulators and close to one of them. This lead-in wire should be kept clear of the building where it comes down from the antenna by means of more insulators and these insulators can be of porcelain, glass, or bakelite. Where the lead-in wire is brought in through the house, it should preferably be brought through a porcelain tube which can be had from any electrical or Radio supply store.

The ground connection is usually made to a cold water pipe, by scraping the corrosion and dirt from the pipe for a length of about two inches, and fastening a ground clamp (costing about 20c) on the pipe at this point. A wire is then connected to the ground clamp and carried to the receiver for connection to the binding post inserted for that purpose. In the case of the country resident it may be necessary to drive a long rod into the ground to a depth of four to six feet and fasten the ground wire to it either with a clamp or a machine screw inserted into the pipe by means of a drilled and tapped hole. The ground wire should be run as direct as possible so that it will not be too long, and it should, preferably, be insulated.

Batteries Necessary

All Radio receivers require what is known as an A battery, and also a set of B batteries; most of them also need a small unit known as a C battery. The A battery may be either a storage battery such as we usually find on automobiles, or it may be 3 dry cells such as are used on doorbells. The type of A battery necessary is determined by the type of vacuum tubes used. If the manufacturer's instructions state that the tubes are to be of the 201-A type, a storage battery giving six volts is needed. If the tubes are of the 199 class, they can be lighted from three dry cells such as the Columbia Ignitor, or the Eveready Special Radio A cell. Practically the only receiver now on the market which does not use one or the other of the above mentioned tubes, functions from dry cells but the cells are not connected in the same way that they would be to light the filaments of the 199's.

B batteries are the same for any type of receiver but they come in various sizes which determines the length of life, but not the voltage. It is good economy to purchase a large size B battery as the larger sizes have a length of life far greater than their proportionate cost to the smaller batteries. The Eveready number 486 is recommended for any installation and if the receiver is a single tube affair, it will require but one of these units, while, if it contains from 2 to 8 tubes, two or three of these units will be necessary. B batteries are also made in storage cell types and while these are rather expensive as to initial cost, they are probably somewhat cheaper over a long period of time. They can be readily recharged at low cost about once every three weeks, and with a little care should last for several years. Excellent storage B batteries are made by Prest-O-Lite, Willard, World and Philco.

There is only one method of testing the storage A battery, and that is with a device called a hydrometer which can be obtained at Radio and automobile supply stores. It consists of an outer glass tube, an inner glass float and a rubber bulb. The small tip on the end of the outer glass tube is inserted through one of the holes in the top of the battery. The rubber bulb is then squeezed and released, which will draw liquid up into the outer glass tube. The small glass float will then rise to the surface of the liquid in the hydrometer and the condition of the battery is determined by the number on the side of the float which is at the level of the liquid.

There is a scale in the float reading from 1100 to 1400, and if the surface of the liquid is between 1100 and 1150 the battery is pretty well discharged, while if it reads between 1250 and 1300 the battery is charged and ready for use.

How to Operate

Colin B. Kennedy Five Tube Model XV

The Kennedy Model XV receiving unit is a five tube set employing two stages of tuned radio frequency, detector and two stages audio frequency amplification. This is really a two handed set as it has but two tuning controls

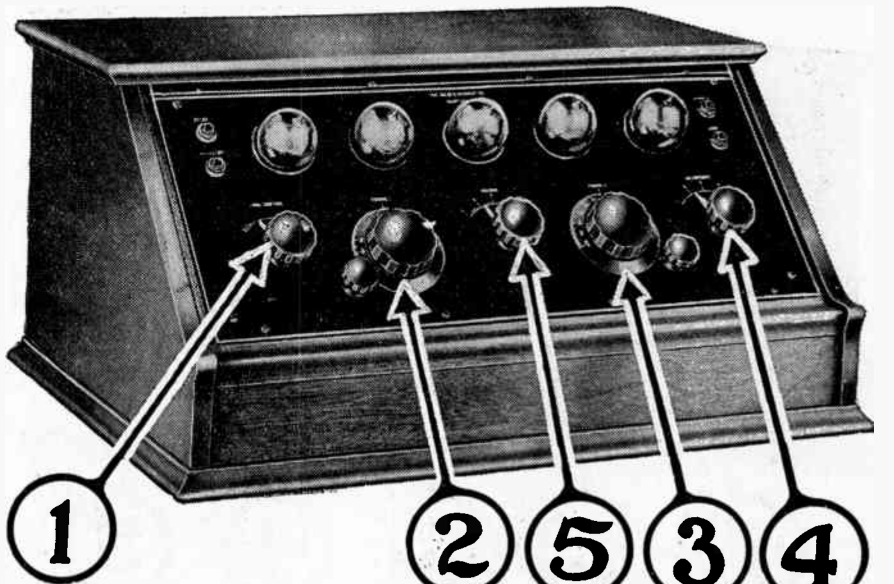
KENNEDY engineers have long known that tuned radio frequency amplification used in a Radio receiver would have two especially desirable advantages, namely, ability to pick up very weak signals and great selectivity. Many of the sets on the market today, embodying some variation of this system are, however, rather too complicated for the average person, as they require three principal controls for tuning-in stations. Long development and experimental work in the Kennedy factory finally produced in the Model XV a Radio receiver that anyone can operate regardless of whether he or she has ever operated a set of any kind before.

The controls necessary to tuning the Model XV have been reduced to a minimum and are so connected in the circuit that even though no previous instructions have been given or read anyone can tune in and receive different stations without one interfering with the other; something that can be done with few other five-tube tuned radio frequency receivers. The Model XV Kennedy set is truly a two-handed set; and uses but two tuning controls. These are already set about the same for any given stations; therefore, it is only necessary to log the settings for one dial in order to accurately record a definite station. This setting will always remain the same even though different antennas are used.

There are six principal features on the Model XV: the antenna is coupled to the first radio frequency tube and this coupling is variable, giving extreme selectivity when desired. Both stages of tuned radio frequency amplification are controlled by one dial; the new Kennedy method of utilizing tuned radio frequency enables the tubes to operate at maximum efficiency at all wave lengths and under all conditions. A jack is provided so that a loop antenna may be used; this makes the set a combination for either antenna and ground or loop. A control is provided so that volume may be regulated; this control is a coupling coil in the second step of radio frequency and uses no current as is the case in many sets where a potentiometer is used for volume control. This receiver cannot be made to howl or squeal regardless of the tubes used or how the controls are operated. Model XV functions equally well on either dry cell or storage battery tubes, requiring no readjustment other than the insertion of adapters.

The set is constructed on the rugged aluminum frame minimizing the chance of anything getting out of alignment and causing trouble. It has the familiar Kennedy sloping panel, that makes for easy tuning, of polished black formica and engraved. Controls are symmetrically placed and the unit is mounted in a solid mahogany cabinet with piano finish.

The controls of the Kennedy receiver are: (1) Tube control; this is a rheostat that regulates the current supply to the filaments of all the tubes. (3) Antenna tuning condenser; this tunes the secondary circuit when operating with antenna and ground and tunes the loop when the loop plug is inserted in loop jack. (2) Radio frequency control, which tunes two stages simultaneously. (4) Selectivity control, which makes it possible to adjust the set to fit local conditions and the antenna with which it is to be used. (5) Volume control that enables the user to bring the volume up to tremendous strength yet cannot cause the set to oscillate or radiate.



Space is provided within the cabinet for two forty-five-volt batteries or four twenty-two-volt units, and if dry cell tubes are used three additional one and one-half-volt cells can be housed inside without crowding. All binding posts are mounted on a bakelite strip inside the cabinet and to the rear of the apparatus making them convenient to get at, yet out of sight.

Connecting the Receiver

First connect the antenna and ground to their proper binding posts, connect the positive and negative leads of the A battery, then the negative B battery lead, the twenty-two and one-half-volt positive B lead and the ninety-volt positive B lead. Now insert the plug connected to the loud speaker in the jack marked stage 2 and insert the tubes in the sockets. The order of the tubes is as follows, looking at the set from the front: the first tube socket at the left is the detector, the next is the second radio frequency, the third is the first audio amplifier, the fourth is the first radio frequency amplifier and last is the second audio amplifier.

Operation of the Set

To operate the set first turn the knob 1 to the right about three-quarters of its possible rotation and, if connections have been rightly made, the filaments of the tubes will light. Now place the knobs 4 and 5 at 1 on their respective scales, the left hand on dial 2 and right hand on dial 3. Turn both over slowly, keeping them at approximately the same numbers on the dials. The better way to tune is to use the verniers; they are the little knobs at the right and left of the tuning dials 2 and 3. Just push them in lightly and turn. By accustoming oneself to using them instead of the larger dials one will develop and get a more sensitive "feel" and will not pass over distant stations while tuning.

The first thing to do when using the Model XV is to get familiar with the controls and practice tuning out local stations. After carrier wave of a station has been picked up adjust the selectivity control by moving it to the right; as this control is moved, the station will get weaker so that dial 3 will have to be readjusted slightly either to the right or left. The selectivity control 4 has no effect on control 2 so it is not necessary to retune this control after it is once adjusted to its correct position.

The degree of selectivity attained by the operator of the set depends upon the adjusting of control 4; this should be made with great care, especially in the metropolitan districts where four or more powerful stations may be operating at the same time. The Model XV will positively "go through" the locals and pick up distant stations, regardless of where the set may be.

Aerial Installation

To obtain best operation of this or any receiver, an outdoor antenna suspended well above the ground should be used, its length not less than 50 feet nor more than 150 feet, if a single wire is used. Several wires supported by wooden cross-pieces, may, of course, be substituted for a single wire antenna, in which case it may be somewhat shorter than the dimensions given. All wires must be carefully insulated at the points of support by means of the commonly available antenna insulators. The part of the antenna known as the lead-in, which runs from the antenna proper to the receiving set, should be no longer than is necessary. Where it passes through the walls of the house, use should be made of some form of insulating tube, and wherever supported along the sides of the building, insulating cleats are necessary. Where it is impractical to erect a good outdoor antenna, wires inside of the building can be substituted at but a slight loss of range. Such indoor antennas may be built by the use of wires strung around the room in which the receiver is located or in any space available, such as attics or hallways. It is recommended that such an antenna be located as far as possible above the set. In general it will be found that the indoor antenna will sacrifice something in the distance of reception as compared to that of an outdoor antenna. If no other type of antenna can be installed, the electric light or telephone wires may be found useful. In such cases, so-called socket antenna plugs are necessary.

The ground wire may be attached to a cold water pipe preferably, but a radiator or hot water pipe will do. Always remember to make sure you have a good ground, in order to get the best from your set.

Fading Caused by Stations

I HAVE read with much interest many articles of late in various magazines on the subject of fading. Many views have been expressed; but by checking up on these, we find certain stations will fade notwithstanding the conditions mentioned.

One writer claims he has solved the problem; that fading is caused by fluctuations in the potential on the mains of the central power stations supplying the transmitter of the Radiocasting station. We cannot say this will not cause fading, but how about WTAM, the Willard Storage Battery Co., of Cleveland? The entire power, I understand, is supplied by storage batteries. Does the potential fluctuate with this station? It fades just the same. We also find fading at night and not much in the daytime. Do the central power stations maintain a constant potential in the daytime and not at night? We must look for another cause.

Another writer claims atmospheric conditions, such as clouds, relative humidity, temperature, etc., are alone responsible. Why, then, is a certain station fading, while on tuning in another station in the same direction, but even more distant (the waves being subjected to the same atmospheric conditions as the fading station) we receive the latter's entire program without fading? A certain station, W——, is being received by a fan in a certain state and is fading. In another state, in some other direction, the same station is being received finely. It looks like a clear case of atmospheric conditions, but is the fan who is receiving the program satisfactorily bothered with carrier waves interfering as is he who is getting fading signals? The fan who is getting the fading signals may not hear the carriers, but nevertheless they are there, cutting down the efficiency of the signals tuned in.

Fading may be accounted for by the above causes, but the fading we get night after night—and which seems to be getting worse each week—is due to other Radiocasting stations, spark stations, amateur stations and reckless operators of receiving sets (within the immediate vicinity oscillating their tubes) on nearly the same waves. The number of kilocycles of the interfering stations is so nearly synchronized with those of the station tuned in that a counteracting or fading effect is produced.

Antenna Instead of Wave Trap

In the endeavors of the amateur—he who likes Radio for its own sake—to obtain selectivity so as to hear distant stations through the QRM of a local station, many couplings and wave trap devices have appeared; but few seem to have thought of solving the problem by a modification of the antenna system. In the following suggestions the ideal is described. Limitations in space, materials, etc., may prohibit some from erecting an ideal antenna system, but with the aid of the following suggestions a system may be erected as nearly ideal as possible.

Two aerials, somewhere near 150 feet in length (one wire each) are stretched parallel to each other and as far apart as possible. Parallel to one of these aerials, and about 6 feet away from it, is a third 100-foot single-wire aerial; while parallel to and about the same distance from the other is a fourth about 75 feet in length. Finally, a 125-foot wire is run either diagonally between the two long aerials or at right angles to them. The lead from each aerial unit is brought in separately, where each can be connected to a binding post on a panel provided for the purpose, or other convenient arrangement.

To obtain selectivity by this method, a number of combinations may be used with varying effects. If the QRM of a local station is troublesome when using one of the long aerials, the 125-foot aerial, which is diagonal to the two long ones (or at right angles to them) may be tried. If this does not prove satisfactory, one of the long aerials may be used as an antenna and the other as a counterpoise, or a long one as an aerial and a short one, near to it or farther away from it, as a counterpoise, and vice versa. Two aerials used in this way give greater selectivity with little or no decrease in volume.

Hint to Neutrodyne Builders

If you have trouble neutralizing your tubes and find that the tube is better neutralized with the neutrodon set either at minimum or very nearly so, try adding extra capacity across the grid and plate. This can be done by twisting two insulated wires together and soldering one to grid the other to plate. Be sure the bare wires of the free ends are not touching. You will then find that you have to increase the capacity of the neutrodon. This is especially valuable for those constructing neutrodyne sets using UV-199 tubes. I have built a set with these tubes and have had good results by this arrangement. I even found that this was necessary with one UV-201A in the first stage of radio frequency.

How to Operate
Stromberg-Carlson Five Tube Model 1-A

THE following list gives a number of antenna selections for this and other neutrodyne receivers, in the order of their distance and volume-getting value: An outdoor antenna composed of a single horizontal wire not over 60 feet long and between 20 and 40 feet above the earth. Indoor antenna of single horizontal wire 40 to 50 feet long, located in an open attic and with the receiving set in any room under one end of the horizontal wire. Indoor antenna of two or three horizontal wires, between 25 to 30 feet long, spaced above 2 feet apart and located under the roof in an attic. Indoor antenna, consisting of a single conductor lamp cord, supported on small insulators or on picture moulding and running the length of a hall or corridor, 30 feet or longer, with the receiving set located at one end. Indoor antenna, consisting of a single conductor lamp cord, running around the picture moulding in the room where the receiving set is installed.

Location of Loud Speaker

Usually the location of a loud speaker with respect to a neutrodyne receiver has no effect on the correct operation of the receiver or loud speaker. The loud speaker, however, should not be placed on the top of the cabinet and the loud speaker cord should not be carried behind the cabinet or draped over the cabinet top.

These locations of the loud speaker or cord may cause an electrical coupling in the receiving set circuits and result in oscillation noises. A correctly designed loud speaker will operate with no coupling noises when placed on a table or cabinet alongside this set.

It will be noted that the number 1-A neutrodyne receiver is provided with two antenna binding posts each marked "ANT" on the post proper, but one with the word "SHORT" and the other with the word "LONG" engraved above it on the panel. The "Short-Ant." post connects directly to the receiver circuit, gives the greatest sensitivity to the receiving set and should always be used when maximum distance is desired, regardless of antenna length.

The "Long-Ant." post connects through a small fixed condenser to the receiving set circuit and should be used when the reading of the large dial number 1 is more than 6 or 7 divisions lower than that of large dials number 2 and number 3. In other words, it equalizes the settings of the three large dials when an antenna of high fundamental wave length is employed.

Grid of C Battery

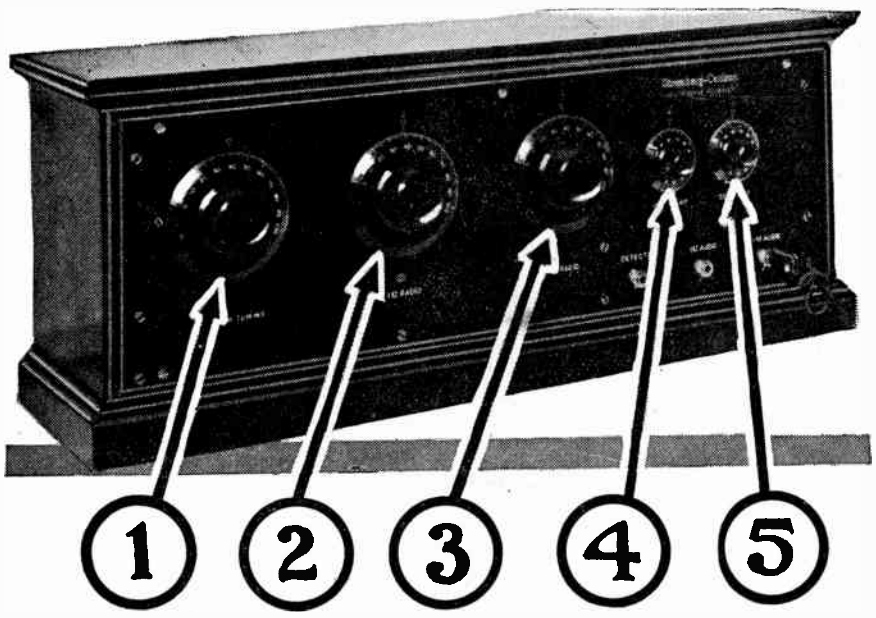
This battery may be a 4½-volt of any reliable make. It is located in a space provided under the base of the Radio cabinet and is held in place by a metal strap. Each number 1-A receiver comes with one of the C batteries correctly installed, unless otherwise specified on the packing case. The C battery should be replaced about every six months or at any other time that the loud speaker fails to give a good clear tone on the "2nd Audio" jack when the same setting of the tuning dials gives a clear signal with a head set plugged into the "Detector" jack.

Use of Storage B Battery

Storage type B batteries can be used in place of the dry cell B battery if electric light circuits and a suitable rectifier are available for charging. This battery should have 48 cells and give a normal voltage of 96. The B Bat + receiving set binding post connection for a "hard" type detector tube (UV-201A or C-301A) should be taken between the 24th and 25th cells so as to give 48 volts.

If a "soft" type detector tube is used (UV-200 or C-300) the connection from the receiving set binding post marked "B Det + should go to the + terminal of the 11th or 12th cell counting from the—end of the battery. The storage B battery has the advantage of uniform operating voltage, as it should never fall below 90 volts when discharged or run over 110 volts

The Stromberg-Carlson Model 1-A is a five tube neutrodyne receiver using two stages of radio frequency amplification, detector and two stages of audio frequency amplification. Both the tonal qualities and the volume are very good



when fully charged. This will maintain good, loud speaker volume at all times.

Some owners of this receiving set who use dry B batteries may wish to use a very sensitive "soft" type (low vacuum) tube, such as a UV-200 Radiotron or C-300 Cunningham. This type of tube can be used in the number 1-A neutrodyne receiver by merely connecting the receiving set binding post marked B Det. + to the + 22½-volt terminal of the particular B battery block that connects to the B Bat — binding post of the receiving set. This change in battery wiring gives the required 22½-plate voltage for the soft type detector tube, instead of 45 volts for the hard type detector tube.

Rheostat Settings

See that the rheostats are correctly set before plugging into the jacks. For UV-201A or C-301A tubes, all four rheostat dials on number 1-A receivers above serial number 500 can be set at the following markings at the time this receiver is installed and need not be disturbed unless the A battery voltage drops below the safe limit.

Rheostat	Location	Setting
"Radio Amp."	Front Panel	60
"Detector"	Front Panel	40
"1st Audio"	Rear Panel	30
"2nd Audio"	Rear Panel	30

It is not necessary to turn off or otherwise disturb the adjustment of these rheostats when shutting off this set. The act of removing the loud speaker or head set plug from the jacks disconnects the filament (A battery) current from the tubes.

Adjusting the Radio Amp. rheostat toward the 0 setting reduces the volume of the received signal without causing distortion, so this dial, number 4, can be used as a volume control. The Detector rheostat, number 5, serves as a control on the sensitiveness of the detector tube action but in no case should it be turned so close to the 0 setting as to make the receiving set unstable and allow self-oscillation of the audio amplifier.

The number 1-A neutrodyne receiver is provided with an accurate calibration curve which simplfies the locating of new stations. Take the published wave length of any desired station, say one of 380 meters and, by referring to the calibration curve attached inside the receiving set cover, find the dial settings as follows: (a) Follow the horizontal line from the left hand marking of the diagram corresponding to the desired station, say 380, to the point where this line intersects or meets the diagonal red line. (b) From this intersection point follow a vertical line downward until the marking at the bottom of the diagram is reached, say 36. (c) Now set dials, numbers 2 and 3, at this reading, say 36th division, and slowly rotate dial number 1 from a point about 10 below that of dials numbers 2 and 3, say 26th division, to a point a few divisions above the settings of dials numbers 2 and 3, to determine whether there is any broadcasting on the desired wave length. Rotate dial number 1 slowly so as not to pass by the point at which the distant station tunes. (d) When the signals from the broadcast station are heard it is advisable to readjust all three of these large dials, so as to increase the intensity of the signals to the maximum response (loudest signal) for each dial setting. The action of the large dials are independent of each other, so a change in one dial will not disturb the tuning of the other two large dials.

As soon as the station is tuned in at the most satisfactory setting of the three dials, maximum response, make a record of the dial marking on the station log sheet, putting the dial readings down in their correct column.

When observing the dial divisions, always face each dial in turn and thereby obtain an accurate reading, which would not be possible if these dials were viewed from either side. If the pointer comes half way between two markings on a dial it will be advisable to so record the reading on the station log sheet, say 24½, when the pointer comes half way between 24 and 25 on the dial.

When maximum response is obtained for each of the three large dials, it will be found that dials number 2 and 3 are at approximately the same markings and that dial number 1 is slightly below. The settings of dial number 1 are influenced by the antenna used, the longer the antenna the greater the separation between the setting of dial number 1 and the other two large dials. If no antenna is used, all three large dials should read approximately alike. The closer all three dials are set for the loudest signal from the desired station, the sharper the tuning and the less the interference from a loud local station.

Tuning With Headphones

When using a head set for tuning always plug into the "Detector" jack first, and if the desired station does not come in with sufficient volume after setting dials, numbers 1, 2 and 3, to positions of maximum response, then change the plug to the "1st Audio" jack. The head set should never be used in the "2nd Audio" jack unless you are sure that the signal is very weak.

Most loud speakers are so constructed that the best results are obtained only when they are connected to the Radio receiving set in a certain way, that is, so that the flow of B battery current through the windings of the loud speaker will assist, rather than weaken, the sound reproducing action.

For this receiver, the correct connection is made when the terminal of the loud speaker, marked + (usually designated by a solid red or by a red thread tracer in the braiding of one of the cord conductors), is connected to the body of the Radio plug and the other conductor to the tip or ball end of the plug.

When using a loud speaker for tuning or selecting a new station it is advisable to plug into the second audio jack as the signals will be amplified.

Electron Flow in Tube Operation

THE addition of a third electrode called the "grid," between filament and plate, in the vacuum tube makes it possible to increase or decrease the current between plate and filament over wide limits. It is obvious that the electrons traveling from filament to plate must pass through the wires forming the grid. If the grid is given a potential which is negative with respect to the filament, the grid will repel the electrons, but many of them will still pass through and reach the plate, because of their high velocity, inasmuch as the positive plate potential still affects them to some extent. If the grid potential is made still more negative, the plate current will diminish until finally it may be stopped entirely.

Positive Grid Absorption

If, however, the grid is given a positive potential instead of negative, electrons will be attracted to the grid as well as to the plate and more electrons will now be drawn toward the plate than would otherwise pass, so that the plate current increases. The charge on the grid partially neutralizes the effect of the space charge. A limit to the magnitude of the plate current will finally be reached, when the space charge caused by the large number of negative electrons in the tube fully counteracts the influence of the positive charges on the grid and the plate. The attainment of the limiting or saturation value of the plate current is assisted by the absorption of more electrons into the grid if its positive potential is increased. This absorption gives rise to a relatively small current in the grid circuit. The total electron flow is the sum of the plate current and the grid current. As the potential of the grid becomes more positive, more electrons will be absorbed by the grid.

Space Charge Effect

The current in the plate circuit depends very markedly upon the potential of the space between plate and filament. Electrons which have just left the filament and are moving away from it, give a "space charge," as it is called, to the vacuous space in the vicinity of the filament and will limit the flow of electrons between filament and plate. The influence of this space charge may be controlled by varying the potential of the grid. If the grid is made positive, it will tend to neutralize the effect of the electronic space charge which is negative and the result will be an increase in the flow of electrons from filament to plate. If the grid is made negative, it adds to the effect of the electrons in the space, and decreases the flow of electrons in the plate circuit. Thus, if the temperature of the filament is kept constant, and the potential applied to the plate is kept constant, the current in the plate circuit may be varied also by varying the potential of the grid.

In wiring A batteries, heavy insulated wires must be used to connect the cells together in order that there will be no voltage loss in the wires. Heavy leads should also connect the battery to set.

How to Operate
Atwater Kent Five Tube Model 20

EXTENSIVE tests with this set showed that it could be used, with excellent results, on almost any type of antenna. Naturally, the best results are secured with a high outside wire since more energy reaches this type. The length over-all, including the lead-in and ground, should, preferably, not exceed 100 to 150 feet. If the long straightaway wire is impossible and an aerial of two or more wires is used, the space between wires should be not less than three feet and greater separation would be to advantage.

Antenna and Ground

Between a loop antenna and an indoor wire, tryouts proved the indoor to be slightly better. A wire was strung straight down a hallway about forty feet in length and six inches below the ceiling, attached at each end to the top of a door frame with insulators. This worked very nearly as well as the outside wire. Since an antenna strung behind the picture moulding of two rooms was available this was also tried and, while the volume was not quite as great, the selectivity was increased to knife-like sharpness and the range differed not at all. Although it was not tried, there seems good reason to believe that an attic antenna would give even better results than the wire strung in the hall.

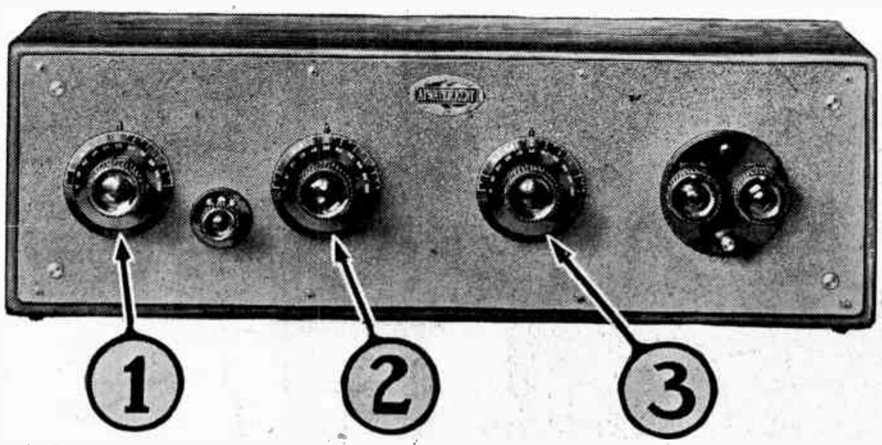
The ground, as usual, was made by scraping the water pipe and tightening a substantial ground clamp around the clean portion. In this case the connection was made in the basement near a window, the wire run out through a small hole in the basement window frame and up to the window through which the antenna lead from the outside wire was passed. Both wires are brought, in porcelain tubes, through a board under the sash.

Tubes and Batteries.

Following the manufacturers instructions, five "hard" tubes of the A type were used, instead of four A tubes and a soft detector. Although the set performed well on the first insertion of tubes, they were switched around while the set was left tuned to a station to ascertain whether any of them performed better as radio frequency amplifiers. Some improvement in both volume and clearness was perceptible when the first radio frequency tube and the detector tube were exchanged. The battery is a six-volt, 120 ampere hour unit and, while it may be used for several days, and then recharged for several hours at a high rate, it has been found better practice to charge it a little each evening while at dinner to make up what was used the evening before. A charging rate of two and one-half amperes for an hour seems to keep this one about right.

The Atwater Kent Model 20 is a five tube set employing two stages radio frequency, detector and two stages audio frequency amplification

Model 20 was used on both storage and dry cell B batteries. Performance over a period of six weeks is apt to be more consistent with the former, but no difference could be noted during the two nights' test of this set, though the dry cell blocks were 10 per cent gone and the storage cells freshly charged. When making connections to this receiver, or any other for that matter, make one complete connection from set to battery at a time, rather than making five connections to the batteries and then connecting all the loose wires to the set. Care should be observed when connecting the loud speaker that the cord with the red thread interwoven in it is connected to the post marked "Red Tracer Lead."



Check all battery, antenna, ground and speaker connections once before putting in any tubes; then insert one in any socket and pull the filament switch out. Turn the rheostat over slowly and, if tube lights dimly it will be alright to insert the other four tubes. Turn both rheostats to right nearly to the maximum position, and one is ready to tune in stations.

Operation

It will be found that the second and third dials will always be at very nearly the same setting for any given stations, while the first dial will be at some point slightly above or below them, depending on the position of the tap switch. This switch is provided to adjust the set to any antenna with which it may be used. A few trials will show on which tap it should be set for maximum results, after which it can be left there. In the case of our tests it was found that tap number 2 worked slightly better than the others. First of all set dials 2 and 3 on, let us say, 56. Then swing dial 1 slowly from 40 to 70. If no program is heard, even faintly, shift dials 2 and 3 to 54 and again swing dial 1 through the short arc. After two or three shifts, a station will be heard and all dials can quickly be set to maximum response. Then adjust the two rheostats to the point where both volume and clearness are at maximum, but do not turn them any further to the right as this would merely be burning up energy uselessly and will shorten the life of the tubes.

With a distant station tuned in, try shifting the switch located between dials 1 and 2 and reset the dials slightly. If any increased response is noted write down the dial settings and then tune in another station with the switch back on the point at which it was before. Then shift switch and reset dials as before. This procedure on different stations located in several directions will determine once and for all the switch setting and it should then be left alone. It will be found an excellent idea to keep a little red tag, or something else bright in color, attached to the filament switch for a few days, as otherwise if one leaves the set at a time when signals are not tuned in, it is very easy to go off and leave the tubes burning, possibly for many hours. The tag serves to attract one's attention and remind that the switch should be pushed in. After the fact that the switch is there and is to be used, has been sufficiently impressed on one's mind, the tag can be removed.

Dial Settings

The dial settings we found with the antenna compensating switch on point 2 are shown here and it seems reasonable to believe that other Model 20 sets will follow these setttings very closely.

Wave Length	Dial 1	Dial 2	Dial 3
278	18	22	22
309	24	28	28
337	30	34	34
380	41	45	45
429	52	56	56
469	64	68	68
492	70	74	74
517	78	82	82
536	84	88	88

Tuning Interference

INTERFERENCE, its causes and results, is now a most popular topic of conversation among Radio fans. Interference from one cause or another has been experienced by every Radio fan, but few of them know the real reason for this trouble and how to take measures that will assist in reducing it.

These interferences are caused by: Another Radiocast transmitting station so close or so powerful as to make it difficult to "tune out"; another transmitting station operating on a wave length so near to the one being received as to cause interfering beats at a beat frequency which is sufficiently low to bring it within the audible range; a nearby amateur transmitting station operating on a spark set, or an A. C. tube set; atmospheric disturbances, called "static" and particularly apt to be present during the summer months, and the interference caused by "birdies" so-called on account of their supposedly bird character of sound. While there are times when quick "tweet" sounds may be heard, I have always thought that the "howling of winter winds" or the "wail of lost souls" was more truly descriptive of the sensations produced by this type of interference.

Tuning Interference

As "birdies" is the interference produced by one listener with another I will direct your attention to it in order that you may better understand the cause of it and adopt a plan of tuning which will cause you to interfere with your neighbor as little as possible. Remember that a Radio listener tuning in late on a program can be just as much of an annoyance to those near him as can one arriving late at the theater in the middle of an act, carelessly stumbling over things and making a lot of unnecessary noises while finding his seat.

An antenna at a receiving station reradiates a certain part of what it picks up. This is true, in varying degrees, of all such antenna. When, however, one permits their detecting tube to oscillate, which is done by too much tickler, the radiating tendencies of their antenna are increased many fold. When the tube is oscillating the receiving station becomes a transmitting station, sending out waves of frequency at which the tube is oscillating.

Control of Tube Oscillation

As the tube oscillation frequency is controlled by the tuning of the set, it is apparent that when the tuning of the set is changed, the radiations sweep over that band of waves just like the note of a siren is changed as its speed is altered.

This sweeping across a wave to which someone else may be listening causes this kind of interference with them, if they are within about a mile of the offending party. In the majority of instances the operator of such a set is unaware that he or she is causing such disturbance.

It is hard to believe that anyone would knowingly drag across the various wave bands to find the beat of the carrier wave of the desired station any more than one would drag their arm over the heads of the occupants of seats in a theater in order to more easily find an empty one. Each act is equally rude, although the Radio tuner may for a time be excused on the score of ignorance.

The care that need be exercised in tuning to avoid annoying your neighbors depends upon where you live. If you are in the country where Radio receiving sets are miles apart, little or no thought need be given to this as a possible cause of interference with some one else. If, however, you are in a city where there are many Radio receiving sets near you, you should, as an act of courtesy and consideration, use every care against tuning while your tube is oscillating.

Two Things Necessary in Tuning

You will want to know two things in your efforts to carry out such a plan of tuning: How to know when your tube is oscillating and how to find the distant station. This whole practice is associated only with hunting such, without the tube oscillating.

You can always tell when your tube is oscillating by a peculiar change that takes place at the beginning of oscillations. There is a slight swish or rustle as the tickler reaches the oscillating position, and it should be backed slightly below this point.

Your search for the distant station should always be made with the tube near to, but always below, the oscillating point and the tuning can then be done with no inconvenience to anyone. You will recognize the distant station by the sounds of the music or speech, if in operation, or by a slight noise of the transmitter if you chance to hunt it during a quiet modulated going out.

Two-Circuit Sets Not Immune

There is a mistaken popular impression that the single-circuit sets are the real offenders in this trouble and that sets having two circuits are immune from it. Such is not the case, as repeated tests have shown. A two-circuit receiving set with the tube oscillating in the second circuit, when properly adjusted to receive the maximum strength of signals, will act as a radiator of signals to just the same extent as the single-circuit set.

That such a condition should be expected, is apparent when we remember that the largest and most powerful transmitting sets are constructed with two circuits arranged in exactly that manner.

The advantage of regeneration in the antenna is very great in attaining distance and, if kept below the oscillating point of the tube, causes no disadvantage to others.

The British Radiocasting service was started with a strict prohibition of regeneration, but it was soon found that this imposed a hardship that was unnecessary and at present regeneration below the oscillating point is permitted.

The particular point to be made is that the practice of hunting a distant station with the tube oscillating is impolite and that there is no difference in this respect, between a single and a two-circuit set.

How to Take Care of the Radio A Battery

See that the connections are clean and tight and scrape off the wire or terminal connections going out of the battery so that they are bright and will form a good contact.

See that there is no acid or water spilled upon the top of the battery which would cause voltage leakage between the cells. Keep the top of the battery dry.

Keep the plates covered with water at all times. The solution should come at least ¼ inch over the top of the plates. Use only distilled water.

Do not permit the battery to stand completely discharged for any length of time. It should be recharged when hydrometer reading shows under 1,200. When full charged hydrometer reading is between 1,280 and 1,300.

In using the hydrometer, see that the float does not cling to the side of the glass tube. When taking reading also see that the rubber bulb is fully expanded and not indented, as otherwise suction would permit incorrect reading.

How to Operate
The Day-Fan Five "Telephone Book" Set

MANY have tried, but few have succeeded, as have the designers of the Day-Fan 5, in producing a Radio receiver of such remarkable simplicity.

Its semi-sloping panel in black and gold, relieved by a housing of hand rubbed mahogany, in effect accentuates the one dial major tuning control, which is this receiver's outstanding feature. Through slowly turning this dial, and an occasional slight adjustment of the small vernier dials at either side of the major one, we were able to not only separate each of the Chicago stations, but receive satisfactory reception

Semi-sloping panel finished in gold and single control of five tube radio frequency receiver are its principal features

Figure 1

from outside stations, which speaks well for the selectivity of any make of receiver.

In addition to the controls mentioned, two additional controls are provided at the opposite lower corners of the panel, which function as aids for additional selectivity, and the regulation of volume. This completes the panel assembly with the exception of a centrally located battery switch of neat design, which is used to either turn on or off the set.

The interior assembly of parts, together with the evidence of careful workmanship, is in keeping with that which one expects from manufacturers of repute, the total receiver expressing the thought of keeping well abreast of Radio's rapid advancement.

Antenna and Ground

As the construction of an efficient antenna and ground are of vital importance, our experience with the Day-Fan indicated that the antenna should be No. 14 single strand copper wire, from 80 to 100 feet in length, and placed as high above ground as possible. Care should be taken to insure it being well insulated from, and not touching, any surrounding objects. The lead-in wire from the antenna to the receiver should be No. 18 rubber covered wire and securely soldered.

If this is impossible, your next choice may be an equal length of rubber covered No. 18 copper wire, strung along the picture moulding of an upstairs room, or located in an attic.

The ground connection should be as short as possible, the size of wire used to be the same as for the antenna, while it need not be insulated. Run this wire from the receiver as direct as possible to a cold water pipe, to which it should be fastened by means of a ground clamp, purchasable in all electric or Radio supply stores. If such a clamp is not available, it is then permissible to file or scrape a portion of the pipe and to wrap approximately two feet of the bare ground wire tightly around the cleaned portion of the pipe. When completed, cover this wrapping well with ordinary tin foil, and over it and the wire fastened to the pipe, place a wrapping of electrician's tape.

Should no cold water pipe be available, a galvanized iron pipe about six feet long, to which the ground wire has been secured, in the same manner as outlined for fastening to a cold water pipe, may be used. This should be driven its full length into moist earth.

As no receiver is any better than its weakest link, it is of importance that only proven accessories should be used. Look well then to the quality of the tubes, batteries and loud speaker which you purchase. Price is not a criterion of goodness, while reputation is.

Accessories

You will require five 201-A or 301-A type tubes, two 45-volt B dry batteries, the heavy duty type being preferred, and one 6-volt wet storage A battery, for this rec iver. In addition a suitable loud speaker will, no doubt, be required.

In purchasing the A wet battery, as well as the B dry batteries, secure your dealers assurance that they are fresh and fully charged. A fully charged wet storage battery should indicate a hydrometer reading between 1275 and 1300, while a 45-volt dry B battery should test with a reliable voltmeter 38 volts or better, in order to be of value.

Connecting the Receiver

Before attempting to connect the batteries and antenna and ground, carefully read the instructions which come with the receiver. The actual making of these connections has been made extremely easy as a 5-wire cable for making the connections to the batteries is furnished and properly connected with the terminals of the receiver. One then has but to place the set well away from radiators or metal objects, which have contacts with the earth, and attach the free ends of the cable to the batteries as indicated in figure 3. The plus, or positive terminal of the A battery is marked + or painted red.

Place the 6-volt storage battery as close to the receiver as is possible, yet convenient for charging if you have a battery charger. Rubber covered wire for the connecting of this battery to the receiver should not be smaller than No. 16 if the battery location does not exceed six feet from the receiver. If of greater distance, up to ten feet, then a No. 14 wire should be used.

It is also advisable to place the dry B batteries convenient to the receiver and at no greater distance than that of the A battery. The connecting wires from the B battery must also be well insulated, although the size may be smaller, though not less than No. 18 gauge.

A booklet is included with the Day-Fan 5, in which is a wave length calibration chart, which enables the operator to instantly locate the station desired. This is arranged so that the indicating numerals coincide with the dial reading, and presents a most helpful aid to the novice.

After connecting the receiver, insert the tubes in their sockets, and turn on the battery or loud speaker switch, then proceed as follows:

1. Set the pointers marked "Selectivity" and "Volume" so that they are vertical.
2. Turn the center dial all the way to the left and then all the way to the right, which will line up the tuning condensers.
3. Set the large center dial at the number shown on the wave length calibration chart, sent with the receiver, for the station which you desire to hear.
4. Turn the speaker switch to the loud position.
5. Turn the selectivity dial from right to left until maximum volume is secured.
6. Turn the volume control dial well over to the right and then slowly back to the left until the tone and volume is such as to please you.
7. If the volume is still too loud, turn the speaker switch from loud to soft.
8. Once a station is tuned in, slight adjustments of the dials to the right and left of the large dial will clear up the signal.
9. Slight adjustments of the "Selectivity" dial will materially assist in the tuning in of stations which are otherwise hard to separate from interfering ones.

Tuning Chart

As an additional assistance in operating this receiver, and also as indicating our method of checking the claim of the manufacturer relative to one being able to set the main control dial in accordance with their wave length calibration chart, we produce in figure 2 a graph chart of wave lengths against dial settings.

The check was made covering the reception of twelve typical stations which were broadcasting from 226 to 536 meters, and it is surprising to note from this chart how closely it adheres to the manufacturers claim.

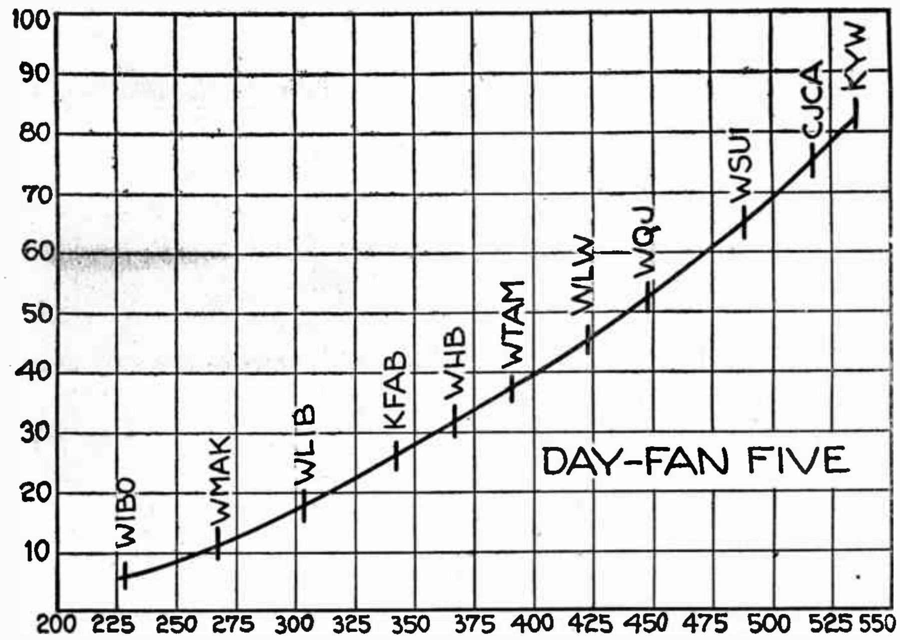


Figure 2

Trouble Shooting

Naturally, each reputable manufacturer of a Radio receiver devotes much time and thought toward so assembling the total apparatus contained within the receiver, as to insure uninterrupted pleasure to the purchaser, without annoying troubles occuring, which would invent cause for dissatisfaction. This is particularly true of the Dayton Five, as our inspection indicated that only through rough or careless handling was it possible to create a condition whereby their receiver would not function, because of inherent defects.

Yet with all of these safeguards, such accidents will occur in any device which has to rely upon the human element, which is the reason for dependable guarantees being given by such manufacturers.

Most of the troubles which do occur are those outside of the manufacturers province, and lie in the deterioration of batteries, tubes and other accessories, caused from improper or careless connections, and the obvious fact that they possess only a replacement life. By this we mean that each of the accessories has a useful life, and when they have served for this period, it is then essential that they be replaced.

A multiplicity of the minor troubles which do occur in the operation of a receiver can be generally traced to a lack of knowledge relative to the periodic attention which such accessories require, including regular recharging of the A wet battery, seeing that its surface and contacts are kept clean, and replacement of

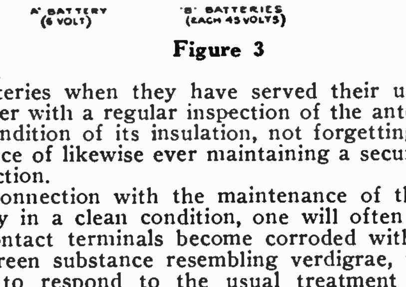


Figure 3

B batteries when they have served their useful life, together with a regular inspection of the antenna, and the condition of its insulation, not forgetting the importance of likewise ever maintaining a secure ground connection.

In connection with the maintenance of the A wet battery in a clean condition, one will often find that the contact terminals become corroded with a white and green substance resembling verdigrae, which refuses to respond to the usual treatment of being removed through wiping with a cloth. As each home is usually supplied with a box of ordinary baking soda, it is then well to remember that a teaspoonful of this soda dissolved in two ounces of water makes an excellent neutralizing agent for this accumulation, it only being necessary to apply the solution with a cloth dampened in it to the parts which require cleaning. Bubbles which make a frying noise will at once be evident, as proof that the cleaning process is taking place. After such cleaning the terminals should be wiped dry and then smeared with a light coating of vaseline, which will in most cases prevent the recurrence of the formation. This treatment is equally effective for the cleaning of the terminals or clamps to which the battery wires are attached.

Smoothing Out and Reducing Static

THE majority of static eliminators make their appearance in the winter season when there is little such interference to be overcome. When the real season of atmospherics arrives these so-called eliminators disappear. This is probably due to the fact that the inventor discovers to his chagrin that the eliminator is of no value when pitted against the terrific, hissing, crashing discharges of the summer season.

There is then nothing much left for the listener to do, since those devices which are of some value are, because of their cost and complexity of construction, beyond his resources.

Practically all listeners are willing and anxious to make any sort of experiment that offers any promise of success in this regard. For this reason only and not with any positive statements as to what may be expected, the writer ventures to offer the following to be of some possible use in reducing the static annoyance.

The methods outlined here will result in some diminution of the volume of reception and the head phones will in many cases be necessarily substituted for the loud speaker.

Receiver Silent in Operation

For the same reason—probable diminution of volume—it is essential that the receiver be absolutely silent in operation. In the winter season the Radiocast programs are received with considerable intensity, sufficient to mask slight receiver defects, which result in hissing and scratching sounds. Along with the increased intensity of static interference with coming summer, Radiocast reception seems to weaken. This is probably due to two causes: The conditions which give rise to atmospherics are also unfavorable to transmission; the heavy crashes of static in the receiver so irritate and numb the auditory nerves that they are temporarily insensitive to the intermittent snatches of music or speech. This latter view is corroborated by the fact that the listener usually finds that retreating some distance from the loud speaker or removing the 'phones a little distance from the ears serves to increase the ratio of Radiocast reception to static.

For these and other reasons it is exceedingly important that the receiver be silent in operation. When this has been accomplished and the receiver is at maximum efficiency, the listener is in a position to pick up with some satisfaction the diminished energy yielded by selective and smoothing devices.

It is well known that high capacities are used successfully in transmitting circuits to smooth out the generator interference and in the same manner capacities in the receiving circuit absorb some of the harshness of the static discharges.

Condenser and Coil in Aerial Circuit

To begin with, a very selective receiver is essential. Even with circuits ordinarily considered selective, the use of a separate antenna coil shunted by a condenser for tuning is quite useful. This coil should be connected directly between the antenna and ground, shunted by a variable condenser of capacity .00025 or .0005 mfd., the proper number of turns to the coil to be determined by experiment, probably about 40 to 50.

With a receiver silent in operation it is surprising the distance to which this separate coil may be moved from the receiver and still an appreciable amount of energy transferred to the receiver. The farther the coil is removed the more the static interference is reduced, but the Radiocast reception is likewise diminished. The crashes of static are, however, apparently less frequent. There is a limit to which this selectivity may be increased. At a certain point in the process the static is no longer perceptibly diminished—this is because the windings of the receiver, the transformers, tuning coils, etc., themselves pick up a certain amount of the static directly which is not affected by the coupling. Therefore shielding is useful, but in any event the coils should be a distance where improvement is no longer possible and probably in most instances returned about one-third the distance to the receiver tuning coil. At this point the quality of reception should be fairly good though considerable diminished in volume.

The static crashes should appear somewhat less frequent because of this increased selectivity, though still annoying and of a harsh, hissing character, extremely disagreeable.

Telephone By-Pass

The second consideration is a good telephone by-pass of not less than .001 mfd. capacity. If audio frequency transformers are used, this fixed condenser should by-pass the primary of the transformer.

Across the secondary of the first audio frequency transformer place a fixed condenser of capacity somewhere between .0005 mfd. and .005 mfd., this to be determined by experiment. Capacities at and above .005 mfd. may result in almost complete suppression of reception. Good fixed condensers should be used, there being little excuse for the paper wrapped fixed condensers, as good mica condensers are reasonable in price. The secondaries of the subsequent audio frequency transformers, if any, should also be shunted by fixed condensers.

It will be found that the higher the condenser capacity, the more completely will the extremely harsh and hissing sound of the static crash be eliminated.

Grid Leaks Required

Leaks across the terminals of the transformers, made with a soft lead pencil, may also improve reception. It is important in any circuit in the static season that sufficient grid leakage be provided from the grid to filament of each tube as this serves to carry off the static charge which may otherwise result in temporary choking of the grid circuit and result in ragged reception, another static annoyance which is thus partially eliminated.

The condensers across the transformers not only smooth out and absorb the static shock, like shock absorbers on an automobile, but they remove much of the shock and numbing effect upon the ear, thus leaving the nerves sensitive to the intermission in which music or speech is being received.

This method of attack has several advantages. In the automobile analogy, we do not attempt to remove the rough places from the road; we drive in such a way as to avoid the bumps and provide shock absorbers to make riding agreeable. Similarly, we use an extremely selective coupling to dodge the static bumps as much as possible and then provide leaks and capacities to absorb and remove the charges and render them less irritating to the nerves, thus leaving frequent intermissions in which the nerves are sensitive to the improved reception. A certain amount of atmospheric interference will inevitably reach the phones, but we drain it off and absorb it as quickly as possible, instead of leaving it to numb the nerves and choke the circuit until another shock makes it continuous. When we view a motion picture we are not aware that the interruptions are taking place as the separate images are impressed upon the screen. In the same manner, we may provide intermissions in the static interference so that their constant recurrence leaves upon the ear the impression of an almost continuous program.

These are by no means inteded as positve cure-alls. The reader may try these experiments and decide for himself whether there is improvement.

The Relation of Modulation to Tuning

THE wave in space which brings us the Radiocast music or voice is known as a modulated high frequency electromagnetic wave. Let us examine this rather imposing expression and see what it actually means.

The voice or music which we wish to transmit varies in frequency from about 30 cycles per second to about 400 cycles per second. An electromagnetic wave could be created at these frequencies. But it is found that it would travel only slightly further than the sound waves themselves. There would therefore be very little to be gained by changing the sound wave into an electromagnetic wave of the same frequencies.

Distances Traveled

It is found that a high frequency electromagnetic wave will travel to enormous distances. The term high frequency in this case means frequencies from about 30,000 cycles per second to about 3,000,000 cycles per second. It will be seen at once that these frequencies are of an entirely different order than the voice and music frequencies. Roughly, they are 1,000 times as great, or stating the fact in another way, 1,000 cycles of the high or Radio frequencies will occur during one cycle of the voice or audio frequency.

The modulated wave is a combination of the audio and the Radio frequency. The Radio frequency part of the wave is spoken of as the carrier because it is used to carry the audio frequency. The Radio frequency is modulated by the audio frequency, and we ordinarily think of the audio frequencies as existing in the complete wave as a change in amplitude or intensity of the Radio frequency. The successive cycles of the carrier frequency vary in intensity or strength in accordance with the audio frequency.

Wave Consists of Two Parts

When we say that the wave is electromagnetic, we mean that it consists of two parts. One part is a magnetic field, exactly like that given by the familiar horseshoe magnet. The other part is a static field, exactly like the one that can be obtained by rubbing a piece of glass with a cork, by which the glass will then pick up small bits of paper. In the wave, these two fields, static and magnetic, move through space together, at the velocity of light, or 186,000 miles per second.

The method by which Radio frequency is modulated at the audio frequency is relatively simple. A vacuum tube oscillator is used. As long as the plate voltage on this oscillating tube is held constant, the resulting wave has constant amplitude or intensity and is not modulated. In order to modulate the wave, the plate voltage is varied up and down in accordance with the audio frequency, and the amplitude of the resulting wave in space varies in the same way.

Components of Wave are Three

Now, it is found that this wave of changing intensity is exactly equal to the sum of three constant frequencies, that is, three frequencies whose amplitude does not change. One of these is, of course, the carrier frequency at which the transmitting tube is oscillating. The second frequency is the sum of the carrier and the voice frequency, and the third is the difference between them. These sum and difference frequencies are known as the side bands. With a receiver that is sufficiently selective, we can tune to any one of these three frequencies and detect it. Remember that each of these frequencies is constant, and that it is only their sum which varies in amplitude. It is easy to see why the sum does change in intensity, because, since the three frequencies are slightly different, they cannot stay in step with each other, or, as we say, in phase with each other, and will consequently tend to help each other at certain times, and at other times will act against each other, and reduce the amplitude or intensity of the combination.

Instantaneous Frequency Changes

No two successive cycles of the modulated wave are alike in amplitude. But are they alike in frequency? Before we can answer this question, we must say what we mean by frequency. When this word is applied to something that repeats itself exactly time after time, it has a very definite meaning. The frequency is the number of these exactly similar cycles that occur in one second. But when the cycles are constantly changing, we can only say that the frequency at any instant is the number of cycles which would occur in one second if all the succeeding cycles were exactly like the one occurring at that instant. In a modulated wave, therefore, we may think of the frequency as constantly changing in its instantaneous value.

The limits between which the frequency of a modulated wave changes are the sum and different frequencies which we have called the side bands. Let us take a numeric example now, and see how this all works out.

Number of Cycles Per Second

Let us say that the carrier or Radio frequency which we wish to use is 800,000 cycles per second. This corresponds roughly to a wave length of 380 meters, that is, the peaks of the wave as it travels through space will be 380 meters, or about a qquqarter of a mile apart.

Let us say that the voice frequency at the instant we are considering is 1000 cycles per second. This corresponds roughly to high C on the piano.

The modulated wave, then, has a nominal frequency of 800,000 and its amplitude varies up and down 1,000 times per second in accordance with the voice frequency.

The side bands would be the sum and the difference of these two frequencies, that is, 801,000 cycles per second and 799,000 cycles per second, the instantaneous value of the frequency of the modulated wave will vary between these two frequencies as limits. It is seen at once that if a receiver is to respond to this modulated wave, it must not tune so sharply as to give a different intensity to the different frequencies in this band. If it amplifies the 800,000 cycle part of the wave 100 times, when tuned to it, it must give practically the same amplification up to 801,000 cycles and down to 799,000 cycles.

Cutting Off Side Bands

Musical notes contain frequencies as high as 4,000 or 4,500 cycles per second. The receiver must therefore have a band of uniform response 8,000 or 9,000 cycles wide. It need not, however, have a band any wider than this. This is the limit to which the selectivity of a Radiocast receiver can be carried, and to which it should be carried, if we are to be able to choose between Radiocasting stations at will. Each station uses a different nominal frequency, and these nominal frequencies are 10,000 cycles apart, so that as the waves vary up and down 4,000 or 4,500 cycles each side of the nominal frequency, they will not overlap each other.

Until the advent of the super-heterodyne receiver, nothing even approaching the degree of selectivity just described could be obtained. Thus it was that we often heard two and three stations at the same time, and were unable to eliminate a powerful nearby station and listen to more distant ones. In the super-heterodyne receiver, however, we can obtain this remarkable degree of sharpness of tuning. We can separate stations that differ by less than one per cent in frequency and yet not distort the music by cutting off the side bands.

Resistance of Grid Leak

An important feature in securing proper operation of a detector tube is the resistance of the grid leak. A leak of the pencil mark type offers the advantage of being easily varied by increasing or decreasing the width of the mark and thus adjusting the resistance until maximum amplification is produced by the tube. Grid leak mountings which permit the interchange of resistances provide an easy method of experimentally determining the proper resistance for a particular tube, these resistances being obtained commercially in units varying from .05 megohm to 5 megohms.

Tips About Tubes

Certain types of vacuum tubes used as detectors will give rise to noises which sound very much like static unless the filament battery voltage is adjusted to the proper value. It is desirable with all tubes to examine the contact pins in their base occasionally, to make sure that these have not corroded. In cases where the tips have been tipped with solder, corrosion or oxidation may take place. Clean the pins with very fine sandpaper.

Radio Operators

Sea-going Radio operators are greatly in demand today. According to the U. S. Shipping Board officials a shortage of Radio operators to man both government and private vessels, exists and steps are being taken to make these positions attractive to licensed men. The shipping board is co-operating with the department of commerce to obtain the desired operators. The wages of government operators were recently raised 15 per cent.

Determining Rheostat Resistance Values

Ohm's Law Is the Secret

THERE has been created a decided confusion in the minds of the Radiophans in regard to the proper resistance in rheostats to be used for the various tubes now on the market.

The immediate result has been the flooding of the market with a series of rheostats of a resistance range running from one ohm for a power rheostat (controlling two or more tubes) to 50 ohms for the UV-199 and C-299 tubes.

Fans are using dry cells connected in series and some in parallel, or storage batteries with single, double and three cells. Each change in current source, and also in tubes used necessitates a consideration of the proper rheostat required. Apparently this has been extremely puzzling to fans but can easily be remedied by an application of Ohm's Law.

Direct Current Circuit

This part of the vacuum tube circuit which pertains to the filament lighting, is a simple direct current circuit: As such, it follows Ohm's law:

$$I = \frac{E}{R}.$$

The proper application of this formula will solve all problems covering the proper selection of rheostats.

Function of the Rheostat

For example, the familiar UV-200 and C-300 operate at 5 volts' potential and draw approximately 1 ampere. The average source of current supply is the 6 volt storage battery. By introducing a variable resistance, such as a rheostat the voltage across the filament can be varied from about 3 volts to 6 volts. Then if the tube operates even better at 4.5 volts than at 5, this can be taken care of by means of the rheostat. Obviously, by increasing the rheostat resistance, the range of variation also can be increased, from even lower values to the maximum 6 volts of the battery.

Since the tube does not begin functioning until about 3 volts are applied to the filament, there is no gain in the surplus control range. In selecting the rheostat for any combination of tube and battery, the resistance should be such as to furnish a voltage range covering that of the operating range of the tube.

Filament Resistance

Going back to the tube mentioned, if the operating voltage is five and the current consumption at that potential 1 ampere, the filament resistance can be computed by applying Ohm's law.

$$R = \frac{E}{I} = \frac{5}{1} = 5 \text{ ohms.}$$

The tube begins operating at about 3 volts on the filament. In order to find the consumption at this voltage, Ohm's law is again applied.

$$I = \frac{E}{R} = \frac{3 \text{ volts}}{5 \text{ ohms}} = .6 \text{ amperes.}$$

The filament resistance varies slightly as the heat of the filament is changed, but this can be disregarded.

The source of current, however, has a potential of 6 volts. If only, .6 amperes is wanted, the required total of resistance, including filament and rheostat will be:

$$R = \frac{E}{I} = \frac{6 \text{ volts}}{.6 \text{ amperes}} = 10 \text{ ohms.}$$

The filament resistance is 5 ohms so only 5 ohms more are required in the rheostat. The average storage battery, when fully charged, is likely to have a slightly higher voltage, so the standard rheostat used was the 6 ohm type.

Power Rheostats

When rheostats are used to operate two or more tubes connected in parallel, conditions are a little less simple. The effective filament resistance is the result of the resistance of one divided by the number of tubes connected in parallel. The current consumption is that of one tube multiplied by the number of tubes. For example, where two tubes are operated by one rheostat, the required resistance becomes:

$$R = \frac{E}{I} = \frac{6 \text{ volts}}{.6 \text{ amperes} \times 2} = 5 \text{ ohms.}$$

The effective filament resistance is only half of one, or 2.5 ohms. The required resistance in the rheostat is therefore 2.5 ohms. The standard two tube power rheostat has a resistance of 3 ohms. The factor to be considered in power rheostats is whether the resistance wire has the carrying capacity for the current required; if not, the resistance wire will fuse. If an ordinary 6 ohm rheostat is used for more than one tube, this usually happens. The safe limit for the standard 6 ohm rheostat is 1.5 amperes.

Dry Cell Tubes

As previously explained, it was the development of the dry cell tube that started most of the trouble in respect to rheostats. In order to make this as clear as possible, it will be advisable to analyze the problem for the two popular types, under different battery conditions.

The UV-201A and C-301A tubes operate on a filament voltage of five, but only consume .25 amperes of current. The filament resistance then will be 20 ohms.

How to juggle Voltage, Resistance and Amperage by Ohm's Law to determine the correct rheostat for highest efficiency

Assuming that the tube begins functioning at 3 volts, the current consumption will be .15 amperes.

If a volt storage battery is used, the total resistance required is:

$$R = \frac{E}{I} = \frac{6}{.15} = 40 \text{ ohms.}$$

The resistance of the filament is 20 ohms, so the rheostat resistance should be 20 ohms. Naturally, a 25 or even 30 ohm rheostat simply increases the range slightly, and can be used. If three dry cells in series are used, the voltage of 4.5 is not sufficient, whereas four cells give 6 volts, making the condition parallel to that of the storage battery.

UV-199 and C-299

These tubes operate at 3 volts and draw .06 amperes, thus giving a filament resistance of 50 ohms. They do not start functioning until a filament voltage of about 2.7 is reached.

At this voltage, the current draw is:

$$I = \frac{E}{I} = \frac{2.7}{50} = .054 \text{ amperes.}$$

Now if three dry cells, connected in series (two cells leave no margin) are used, the potential at the source is 4.5 volts. The required total resistance will then be:

$$R = \frac{E}{I} = \frac{4.5}{.054} = 83.3 \text{ ohms.}$$

The rheostat resistance required will then be 33 ohms. Forty ohm rheostats are sometimes used.

If a two cell storage battery (4 volts) is used, the resistance of the rheostat should be about 35 ohms or more.

Suppose, however, that a 6 volt storage battery is used, the required total resistance will be:

$$R = \frac{E}{I} = \frac{6}{.054} = 110 \text{ ohms.}$$

This indicates that the rheostat resistance must be 60 ohms. Under these circumstances it is of particular importance that the voltage should not exceed 4.5 or even 4 volts. It is suggested, in this case, that a permanent resistance of 25 or 30 ohms be inserted in series, the rheostat requiring only 33 ohms. If, then, the rheostat is accidentally turned on full, there will always be the fixed resistance in series with less possibility of burning out the tubes.

The use of a fixed resistance is recommended only where the voltage at the source greatly exceeds that required for operation. A small margin over the operating voltage is always necessary, however, in order to compensate for deterioration of battery and variations in tubes.

WD-11 and 12 Tubes

When using, WD-11 or 12 tubes with a single dry cell, the required rheostat resistance will be found to equal 6 ohms.

TUBE—	Battery Voltage	Operating Voltage	Current Amperes	Filament Resistance Ohms	Total Resistance Necessary	Rheostat Resistance	Detector Plate Voltage	Amplifier Plate Voltage	Grid Bias Voltage	Grid Leak Megohms	Grid Condenser Microfarads
UV-200 C-300	6	5	1	5	10	5 to 6	22.5	....	....	1	.0005
C-301A UV-201A	6	5	.25	20	40	20 to 30	45	45 to 80	....	1 to 5	.00025
WD-11 WD-12	1½	1.1	.25	4.4	10	5 to 6	22.5	45 60 80 100	0 1.5 3 4	2	.00025
UV-199 C-299	4½-6	3	.06	50	80 or 110	30 or 60	22.5	40 60 80 100	0 3 4.5 6	1 to 5	.00025
UV-201 C-301	6	5	1	5	10	5 to 6	22.5	40 60 80 100	0 3 4.5 6	1	.0005

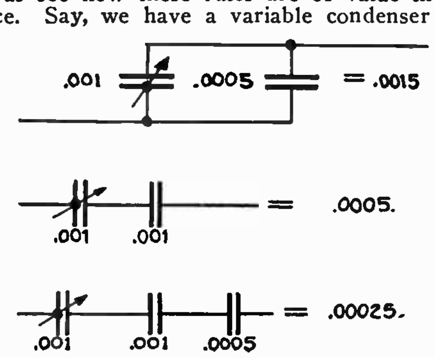
Data Chart for Tube Accessories

Grouping Capacities to Fit Your Need

HERE is a rule for the experimenter to remember as utilizing it frequently saves time and money. If condensers are connected in parallel, the effective capacity is equal to the sum of the capacities of the individual units. If equal capacities are connected in series, the effective capacity is equal to the capacity of one divided by the number so connected. If a number of capacities of various values are connected in series, this formula must be applied:

$$\frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

Let us see how these rules are of value in actual practice. Say, we have a variable condenser whose



Three ways of connecting condensers to obtain a capacity not provided by any individual unit

maximum is .001 mfd., a fixed condenser of .001 mfd. and a fixed condenser of .0005 mfd. The circuit with which we are experimenting requires a variable capacity of .0015 mfd. We merely connect the .001 variable and the .0005 fixed in parallel. Another circuit requires a variable capacity of .0005 mfd.—we connect the .001 variable in series with the .001 fixed, and the effective maximum capacity is .0005 mfd.

Should a circuit require .00025 mfd. capacity, we use all three in series. Using our formula, and changing .001, .001 and .0005 to micromicrofarads, we have

$$\frac{1}{\frac{1}{1000} + \frac{1}{1000} + \frac{1}{500}}$$

and this gives us:

$$\frac{1}{.001 + .001 + .002} = \frac{1}{.004} = 250$$

That is 250 micromicrofarads, or put in decimal form .00025 mfd. So, if at any time, you need a condenser of a particular value which you do not have in any one unit, see what you can do by grouping those you have.

Capacity of Condenser to Use

A condenser having .001 mfd. capacity is usually used in tuning low resistance antenna circuits, in a loop receiving circuit, in a wavemeter and in a Radio filter. The .0005 microfarad condenser works well as an antenna series condenser for reception of the Radiocasting stations and also across the secondary of the tuner.

A condenser in series with the antenna decreases the wave length and the smaller the capacity the greater will be the cut in wave length. If 600-meter commercial code stations interfere with reception of Radiocasting stations, the series condenser will help to eliminate the dots and dashes if the antenna is not too large. A condenser shunted across an inductance increases the wave length.

The plate or plates of a vernier condenser should not be as thick or rather, as closely spaced, as those of the ordinary variable condenser. The purpose of a vernier is to obtain fine adjustment and this cannot be secured if the capacity is too large.

Comparison of Transformer Efficiency

How to Make Comparative Tests

THE rapid development of the Radio industry has been the main factor in the collection of hap-hazard apparatus that is being sold over the counter. The prospect of getting rich quick has lured men from all fields into the making of Radio apparatus of all types and descriptions. Some were wise and employed designers that knew something of the subject; others copied the designs of established makes, while still another class just made up stuff to sell. As might be expected, the old line manufacturers in related industries that took up Radio as a side line, thought too highly of their reputation, and therefore placed the design of apparatus in the hands of competent engineers.

The ultimate results showed an assortment of all types, qualities and prices in apparatus. Naturally, the carefully designed apparatus was higher-priced than the others. The uneducated public, judging largely on the price basis, more often got the inefficient and poorly designed apparatus than the quality type.

With the inauguration of this season, the tendency toward discrimination has become more apparent. Not only is the question of cost losing much of the fan's consideration, but he is displaying a decided "show me" tendency. Even the high-priced apparatus must undergo sharp scrutiny and test before approval is vouchsafed.

The effect of all this is illustrated in the increasing demand for methods of testing and comparing of apparatus. This is especially true of any parts that the fan is not so likely to try to construct himself, making the question of proper selection of greater importance.

Transformer Problem

Tube analysis has been demanded and described—the next step has been the transformer problem. Few fans are anxious to sit down and make audio frequency transformers. The prospect of having to count the required number of turns in the primaries and secondaries, running from 10,000 to 60,000 and over, is not an attractive one, leaving alone consideration of the requirements of proper winding for minimum capacity reactions; and selection and construction of laminated steel for cores doesn't improve the situation.

For these reasons, fans buy their transformers but want to know which ones are the best. In order to try them out for comparison, they require a test that will not lead them into a series of calculations in advanced mathematics and a technical knowledge possessed only by electrical engineers. The test must be fair and give a comparative value of efficiency under operating conditions. It is not intended as a laboratory analysis, but a sufficient guide to give the fan an idea as to what results he may expect from various types.

Test Circuit

An effective circuit for a test outfit for transformers, is shown in Figure 1. It will be noticed that the circuit makes use of the transformer in a normal stage of audio frequency amplification. The test consists of impressing an oscillating current on the main circuit through a fixed condenser and a potentio-

No technical knowledge or use of higher mathematics is required to make these tests and the apparatus costs but little

meter. By means of a double pole, double throw switch this current is thrown into a pair of receivers direct or forced to pass throug the stage of amplification first. By increasing the resistance (500 ohm calibrated) the tone through the amplifier is reduced until it matches the tone direct. Under these conditions, the voltage amplification of the transformer and tube becomes approximately a factor of the ratio of the

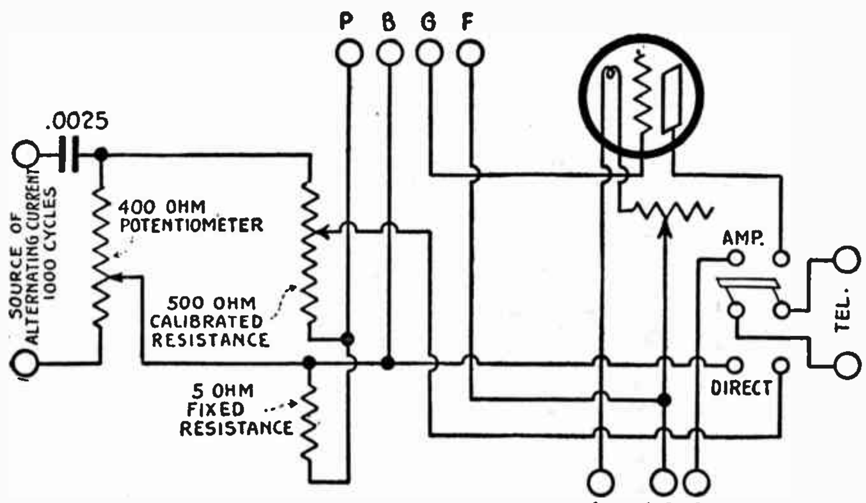


Figure 1

5-ohm resistance to the total amplifier resistance, which includes the 5-ohm fixed. For example, if the calibrated resistance, when the tone is balanced, reads 295 ohms, the voltage amplification is 295+5÷5=60.

The purpose of the potentiometer is to control the initial volume when connected directly to the phones. This direct tone must not be too loud, or adjustment is difficult. In comparing two transformers, the tubes must be taken in consideration as they will vary with different tubes.

The Source of Current

The oscillating current can be a buzzer circuit or, where more critical tests are desired, the frequency should be controlled and determined in order to make tests for values at various frequencies and thus determine whether the amplification factor remains constant. A variation for different frequencies indicates distortion will result in reception.

Parts Required

The parts required are all standard, with the exception of the calibrated 500-ohm variable resistance. The 5-ohm fixed resistance can be made by winding 1 foot of number 29 gauge Chromel "C" resistance wire on a small spool, taking care that adjacent turns do not touch. This wire has a resistance of 5 ohms per foot.

The Calibrated Resistance

The calibrated resistance can be constructed by any fan. A suggested plan is indicated in Figure 2. A hard rubber tube (bakelite or fiber may also be used), 2 inches in outside diameter, 1/8-inch wall, and 9 inches long. It is threaded in a lathe (24 threads to the inch) to within 3/8-inch from each end. A slot, 1/4-inch wide and 1/16-inch deep, is cut along the full length.

The wire is wound in the threads. The diameter at which the wire is wound will be about 1 15/16 inches. Each turn has a resistance of 2.536 ohms. Then 197 turns are required. Whether the turns required measure 8¼ inches in length, as shown, is not important, but the calibration guide should be made on the basis of the actual length of the winding from start to finish.

If chromel "C" 29 gauge resistance wire is used at 5 ohms per foot, 500 feet will be required. Don't use this wire for any other connections, however. In connecting from the end of the winding to any binding post copper wire should be used.

A slide and bar is then added. The slot in the tube permits contact with the resistance wire, which lies under the outside surface of the tube.

This calibrated resistance will come in very handy for other uses.

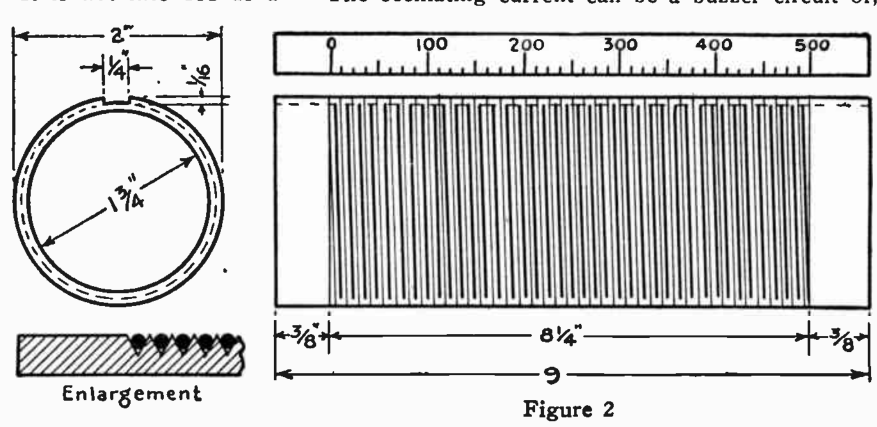


Figure 2

Wave Motion, Length and Frequency

THERE seems to be, among Radio beginners, considerable misunderstanding regarding the nature of wave motions and the relation existing between wave length and frequency. Some cannot understand what is meant by the wave motion produced by vibrating bodies or electrical discharges. Others cannot grasp the meaning of the terms wave length and frequency and the relation existing between them merely because they cannot form a mental picture of just exactly what takes place.

Suppose, for the sake of illustration, that you hold an ordinary type of cardboard fan in your hand and move it back and forth at a constant rate, much as you would in fanning yourself. As the fan moves to the right, it creates an area of compression by forcing the air in its path toward the right. As it reaches the end of its travel to the right and is brought back toward the left again, it tends to create, on its right side, a partial vacuum. Now, as it moves toward the right again it repeats the process of compressing the air on the right-hand side and on its return toward the left it again tends to create another area of low compression or partial vacuum. As the movement of the fan is transmitted toward the right, the air is made up of alternate portions of compressed and rarefied air. The portions vary from a point of highest compression to partial vacuum.

This condition is shown diagrammatically in Figure 1. The portions where the heavy lines are shown close together represent the compression areas formed when the fan is traveling on the right-hand side of the middle point and the pressure is therefore above normal. The light lines spaced farther apart represent those portions of low compression when the fan is traveling on the left-hand side of the normal or starting point of the fan.

What Is Meant by Cycle

Any round of events, movements or operations in which a body or condition passes through a series of movements and then comes to its initial starting point for a repetition of the operation is termed a "cycle." As the fan moves from its vertical position or starting point, goes toward the extreme right, then to the extreme left and back to its starting point to go through the movement again, this movement from starting pointed to starting point is termed its cycle.

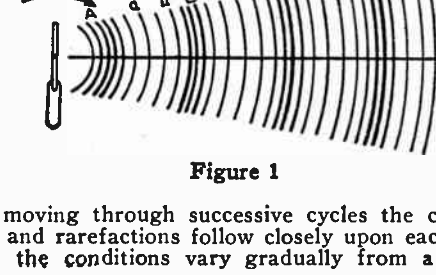


Figure 1

In moving through successive cycles the compressions and rarefactions follow closely upon each oth Since the conditions vary gradually from a normal point to a high compression point and then back to normal, down to the low compression point and up to normal again, the action can be represented diagrammatically as in Figure 2. The crests of the wave line, A, B, C, D, represent the points of high compression, A, B, C, D, in Figure 1; the points I, II, III, IV, in both diagrams, represent the normal points and the troughs of the wave line, a, b, c, d, represent the points of low compression, a, b, c, d, in Figure 1.

The compression and rarefaction action which takes place through movement of the fan can therefore be thought of in terms of the wave line shown in Figure 2. In the same way we can think of sound, electricity, magnetism and other such phenomena in terms of the effects produced as represented by a graph similar to that of Figure 2, so that we can speak of sound waves, electric waves, etc., in describing these actions. The wave length of the waves shown in Figure 2 is the distance from any point on one wave to a similar point on an adjacent wave. In this case the distance from A to B, or from B to C, or from a to b is the same and is called the wave length of the wave produced by the fan. Whether the fan is moved rapidly or slowly, the disturbance which it creates moves through the air at a constant speed. The frequency is the number of cycles which take the place in a unit of time. The unit of time is usually taken as one second so that the frequency of the wave produced

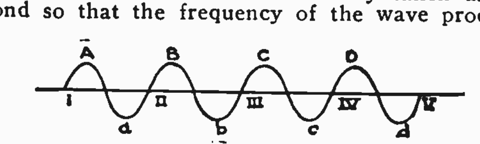


Figure 2

by the fan is the number of cycles through which the fan moves in one second. As the rate or frequency is increased, however, the waves follow each other more rapidly, so that a preceding wave does not move very far before it is followed by another wave. When the frequency is increased, therefore, the wave length is decreased.

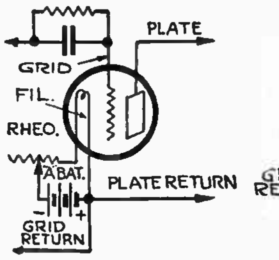
Applying this to Radio, we know that the speed of Radio wave motion through space is 300,000,000 meters per second. If the frequency used by a Radiocaster is 1,000,000, then 300,000,000 ÷ 1,000,000 is 300 or his wave length. Also, if his wave length is 300 then 300,000,000 ÷ 300 is his frequency—1,000,000. Frequency is oftentimes spoken of in kilocycles, a 1,000,000 being 1,000 kilocycles; an 800,000 frequency is 800.

Getting Results from Your Vacuum Tubes

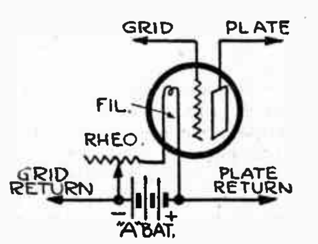
Correct Values Throughout Are Necessary

By Lieut. Harry F. Breckel

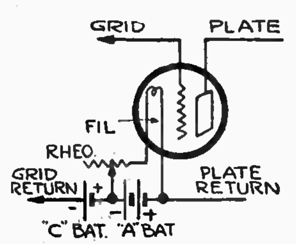
CORRECT CONNECTIONS FOR DETECTOR TUBE



CORRECT CONNECTIONS FOR AMPLIFIER TUBE USING RHEOSTAT RESISTANCE FOR BIAS



CORRECT CONNECTIONS FOR AMPLIFIER TUBE USING "C" BATTERY FOR BIASING



ONE of the most frequent sources of trouble encountered in Radiocast receivers which fail to function properly can be traced to the operator of the set failing to observe the necessity for operating the vacuum tubes on the correct filament and plate voltages and providing a grid leak and condenser of the right value in connection with the detector tube and further, in the failure to realize the advantage to be gained in using a grid biasing or C battery in the grid circuit of the audio frequency amplifier.

In order to get the most and best out of your tubes it is of paramount importance that the various voltage values for A (filament), B (plate) and C (grid biasing) batteries, be strictly observed (see tables on operating characteristics), and that connections of the grid and plate return leads be made as shown in the diagrams.

Another feature of importance often overlooked and which should be given careful attention is the grid leak, the value of which is usually expressed in megohms (one megohm is equal to one million ohms) and the value of the grid condenser generally expressed in microfarads, used in connection with the detector tube.

Changes in Value Noted

When vacuum tubes are used in amplifier circuits, very small changes in the voltage or potential of the signals, as applied to them between grid and filament, have the effect of causing large changes in the value of the plate current and in order to secure the best possible reproduction of the speech or music, the grids of the tubes should not draw any electron current. Should this happen, it would have the effect of changing the value of the plate current, which would be alternately normal and less than normal, which condition would result in the distortion of the voice or music.

To properly circumvent or avoid this possible condition, the grids of the amplifier tubes should at all times be kept at a negative value with respect to the filaments, this being accomplished by either one of two possible methods, i. e., by the insertion of a resistance, or the connection of a C battery in the grid return lead. The schematic diagram of connections for both methods are shown in the accompanying diagrams.

The selection of either method will depend on the particular type of vacuum tube used and on the value of the applied plate voltage (furnished by B battery). Where a negative grid bias of from ½ to one volt only is required (see table), the so-called resistance method of biasing is practical and efficient and can generally be used to advantage.

Another Method Required

Where tubes and plate voltages are used which require the application of higher grid biasing values (see tables), it becomes necessary to use the C battery method, the proper voltage values for which are set forth in the table and the connections for which are shown in the diagram.

Practically speaking, the voltage of the C battery should be varied in order to secure the best value to be used, as the characteristics of the individual tubes often vary, with the result that certain applied C battery potentials which provide best results with one tube, will not be satisfactory when used with another tube, even though both are of the same type.

Selecting a Grid Leak

The proper resistance value of the grid leak used will vary, depending also on the type of tube used and again on the individual tubes themselves, even though they are of the same type. For example, grid leaks of varying values of from two to nine megohms will be found to give best results with different individual tubes of the familiar UV-201A type and in order to arrive at the best value to be used, the operator should try several values while listening to some fairly distant station, selecting the one which gives best volume and clarity of reproduction. The accompanying table will show the best approximate values to be used with the different types of tubes, but these will vary, as before mentioned, with the individual tubes, even though of the same type.

"OPERATING CHARACTERISTICS OF VACUUM TUBES"

Type	Filament Battery Voltage	Filament Current	Filament Rheostat	Plate Voltage: Detector	Plate Voltage: Amplifier	Grid Leak Resistance	Grid Condenser Capacity
UV-200 C-300	6	.9 to 1. ampere	4 to 10 ohms	16 to 22½ volts	(Detector only)	½ to 2 megohms	.00025 to .0005 mfd.
UV-201A C-301A	6	0.25 ampere	10 to 25 ohms	18 to 45 volts	45 to 120 volts	2 to 9 megohms	.00025 to .0005 mfd.
UV-199 C-299	4.5	0.06 ampere	20 to 35 ohms	18 to 45 volts	45 to 100 volts	2 to 9 megohms	.00025 mfd.
WD-11 WD-12 C-11 C-12	1.5	0.25 ampere	10 to 30 ohms	18 to 45 volts	45 to 100 volts	2 to 3 megohms	.00025 mfd.

"PROPER VALUES OF "C" BATTERY TO USE FOR GRID BIASING"

Type	Plate Voltage	Grid Bias Voltage	Type	Plate Voltage	Grid Bias Voltage	Type	Plate Voltage	Grid Bias Voltage
UV-201A C-301A	45 65 90 110 130	0.5 to 1.0 1.0 to 3.0 3.0 to 4.5 4.5 to 6.0 6.0 to 9.0	UV-199 C-299	45 65 90 110	0.5 to 1.0 1.0 to 3.0 3.0 to 4.5 4.5 to 6.0	WD-11 WD-12 C-11 C-12	45 65 90 110	.... 0.1 to 1.5 1.5 to 3.0 3.0 to 4.5

Employ High Grade Grid Condenser

Practically speaking, the value of the grid condenser to be used with the detector tube is approximately .00025 microfarads capacity, although some individuals prefer the use of a slightly larger capacity, when a gaseous content tube such as the UV-200 or C-300, is used.

Generally however, the value of the grid condenser should not exceed .0005 microfarads capacity and it will amply repay the home constructor of a Radio receiver to make certain that a reliable and well designed grid condenser is used, for a faulty or cheaply constructed one has often been found to be the cause of objectionable noises in the set. And by all means, be sure to get one that is moisture-proof and which has been impregnated under pressure and further, which uses mica as the dielectric, as this type of grid condenser will entirely eliminate the possibility of the above-mentioned condition arising.

Detector Tube Plate Voltage

The plate voltage to be used in connection with the detector tube should also be varied, depending both on the type of tube and the individual tube used (see table) and it will be found advantageous to vary the value of this voltage while listening in to some fairly weak and distant station. The writer has repeatedly observed cases where the volume of reproduction was increased fully 50 per cent by carrying out this procedure.

In the case of the plate voltage to be used with the amplifier tubes, this value is not critical and varying potentials or voltages of from 45 to 120 volts can be employed, although, practically speaking, it will be found that best all-round results will be obtained with a voltage of from 60 to 90 volts for loud speaker work and from 45 to 60 volts when the head phones are used.

Adjusting Filament Control Rheostat

Too much stress cannot be laid on the necessity for careful adjustment of the tube filaments through the proper manipulation of the filament control rheostat, as not only the volume but also the clarity of reproduction is vitally dependent on this operation. And never, by all means, burn the filament any brighter than is necessary to reproduce the voice or music of the Radiocast you are listening to, with the best volume possible, consistent with good clarity, as the observance of this precaution will not only give you the best results, but it will greatly prolong the working life of your tubes. And further, be certain that you are using the proper applied filament voltage and the filament control rheostat of the correct resistance value in connection with particular type of tube you are using (see table).

Where possible, it's a good plan to incorporate a small voltmeter or ammeter in the tube filament circuit of the set, either being inexpensive and the use of which will enable the operator to operate the tube filaments at constant voltage or constant current values (the former preferable) to further safeguard their working life.

Remove Tubes When Making Connections

As a further precaution for the protection of the tubes from a burn out, caused by accidental application of the high voltage B battery leads to the filament circuit, it is recommended that all tubes be removed from their respective sockets until all connections are completed and in the case of a set which has just been completed by the layman, extreme care should be taken to trace out the plate and filament circuits, in order to make certain that they are correct before making any connections of the batteries thereto. This precaution if observed, will in many cases save the expense of a new set of vacuum tubes.

By proper observance of the foregoing simple precautions and the careful studying of the table of operating characteristics and accompanying diagrams, the broadcast listener is sure to get the most and best results out of his tubes, with a consequent greater satisfaction in the performance of the receiver used, for the factors—clarity, distance and volume—depend vitally on the correct functioning of the vacuum tubes in the various circuits wherein they might be employed.

The aerial system of a Radio installation is that part of the apparatus used to pick up the electromagnetic waves that radiate from the broadcast stations. Since the aerial system is really the collector of the energy that actuates the receiver the more efficient the aerial the greater the amount of energy reaching the receiver with a corresponding increase in range and volume of the set.

The Radio waves will induce a current or difference of potential in any conductor they pass and for that reason any metallic body insulated from the ground will serve as some sort of an aerial system.

What to Expect from a Set

Just what you can expect of any Radio set depends upon so many factors, some within and more beyond the control of the operator that the practice of rating sets in miles range is rapidly dying out. When one stops to consider that the range of a set depends upon the nature of the ground in the vicinity of the set; adjacent buildings, trees and other obstacles; the time and kind of day; the condition of the apparatus itself and the skill of the operator; the difficulty of rating any particular set as to its range is impractical.

The true rating of a set is its consistent range, that is, the distance it will receive day in and day out, winter and summer, day and night, and this figure rarely exceeds 10 per cent of the distance that can be covered under favorable conditions.

There are, of course, other elements entering into the question of range. There is the matter of power at the broadcaster, a set that will receive a 1,000-watt station 500 miles away will not receive a 500-watter as loud over the same distance under the same conditions. Furthermore, the range of a set is about doubled at night and is greater over water than over land. In addition we have the problem of selectivity. The range of a set that is not selective is naturally decreased by reason of local broadcast stations drowning out the weaker signals from distant stations.

As a general rule the selectivity and volume of a set vary in inverse proportion to each other. That is, in order to get selectivity some volume must be sacrificed and vice versa, by decreasing the selectivity greater volume is possible provided no locals are located within ten miles or so to cause excessive interference.

Use of Dry Cells

The A battery supplies the energy to heat the filaments of the vacuum tubes. Low consumption filaments such as those used in the UV-199, DV-3 and C-299 may be economically heated from a dry cell A battery. The current consumption of these tubes is .060 amperes, at a filament terminal potential of 3.0 volts. The detector tube rheostat and the rheostat for the amplifier tubes serve to reduce the voltage of the A battery before it is impressed across the filament terminals of the vacuum tubes.

Use three dry cell batteries. These may be the ordinary dry cells for ignition and door bell work, but are preferably those which are especially designed for Radio. Dry cells especially designed for Radio use will give about double the life of those designed for other purposes.

Difficult Tube Characteristics Explained

How to Analyze, Test and Estimate Them

Very important and not generally understood, tube characteristics may be adjusted to immeasurably improve the set's efficiency

THE usual articles on characteristics of vacuum tubes are forerunners of a more technical discussion and description of vacuum tube factors that are generally unknown and rarely understood or appreciated. Their importance will be appreciated when the statement is made that these factors are the best criteria of the relative efficiency and method of operation of the tubes.

The subject as handled in the few textbooks available is always accompanied by intricate and well-advanced mathematical analysis. In addition, the most important points are surrounded by lengthy details and descriptions, making it difficult for the ordinary layman to comprehend. In this series, the characteristics, such as plate resistance and impedance, amplification constants and mutual inductance, will first be described and analzed, then the method of testing them will be detailed. The values of the highly standardized tubes on the market will be given and sufficient instructions will be furnished so that the amateur may test or calculate the characteristics of his own tubes.

It is rare, however, that the amateur has available the necessary instruments to make these tests. If he has not, the knowledge of the method of testing and calculation of the values and their effect in operation will help to improve the operation of his Radio set and at the same time put him in a better position to discriminate in the selection of his vacuum tubes.

The characteristics are to be described separately. This will be followed by an analysis of the methods used in calculating and testing them.

Plate Resistance and Impedance

In all electrical circuits there is an action or condition that tends to resist the passage of current. Put in other words, it limits the amount of current that can pass through. It would correspond with the size of a water pipe. Naturally, the greater the pressure the greater the volume of water that passes through; likewise, the greater the voltage the greater the current which passes through. This factor is known as resistance.

Considering the vacuum tube—there is a plate circuit inside the tube. It consists of the movement of electrons from the filament to the plate. There is a direct current resistance to this flow, known as the dc. or plate resistance. When dealing with an alternating current, the direct current resistance no longer holds true; so another value is introduced, known as alternating current resistance or plate impedance. This impedance varies with the changes in frequency. For amateur purposes an approximation is possible; this is satisfactory for frequencies up to the order of several hundred thousand cycles per second. The value of this knowledge of impedance is in the fact that best operation for amplification is obtained when the transformer impedance is balanced against the plate resistance. This explains why some tubes will not operate satisfactorily with most transformers. It is only a question of time before all apparatus will be accompanied by accurate statements of characteristic values in order that circuits may be more carefully balanced for maximum results.

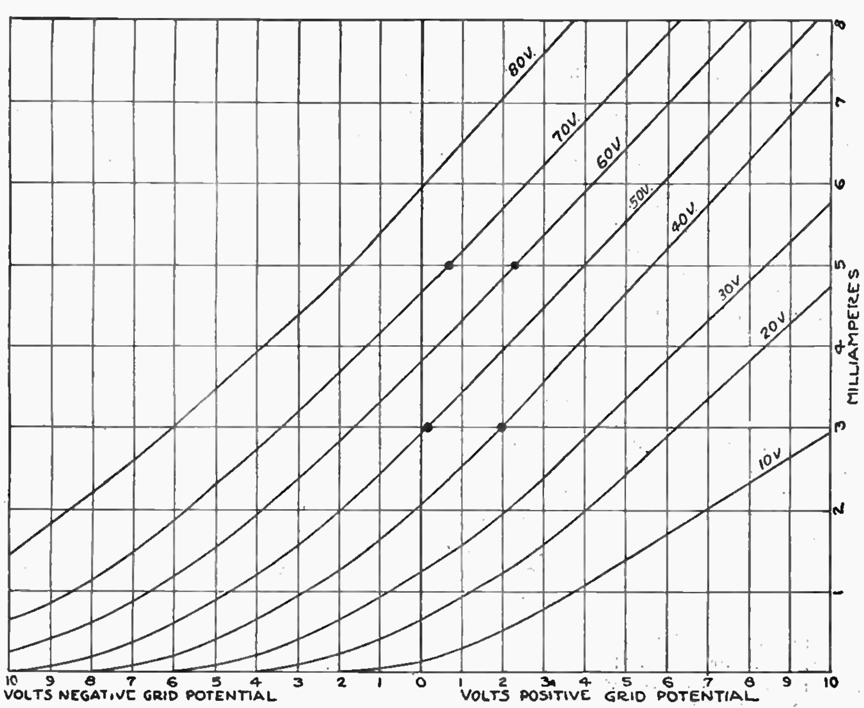


Figure 1

Amplification Constant

The amplification constant Mu is one of the most important constants of the audion or three-electrode vacuum tube. This constant represents the maximum voltage amplification obtainable from the tube and is also instrumental in determining the current and power amplification. It is a function of the construction of the tube, depending on the mesh of the grid, diameter of grid wire and distance between grid and plate. Its value varies slightly with changes in plate voltage, increasing as plate voltage is raised. Therefore, when operating as a detector, the amplication constant of a tube is not as high as when used as an amplifier. If the amplification constant is 5, it must not be assumed that the volume will be 5 times as great; there are a number of factors which must be considered; but it furnishes an index of the possibilities of the tube.

Mutual Conductance

Inasmuch as every circuit has a resistance, it is easily understood that the resistance and the voltage pressure determine the amount of current that the circuit will

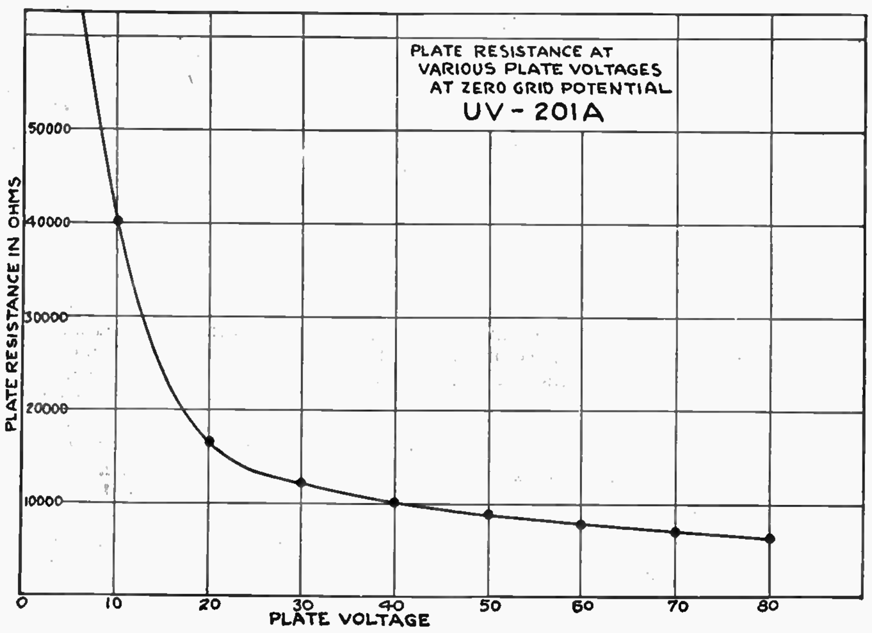


Figure 2

conduct or permit to flow. Therefore the conductance of a circuit may be considered as an expression of its efficiency. This is the dirivation of another tube characteristic known as mutual conductance, and it is a function of the amplification constant and plate resistance.

This is a very important characteristic and furnishes the degree of merit of the tube when functioning as amplifier, detector or oscillator. It is always desirable to have the mutual conductance as large as possible.

The mutual conductance is a measurement of the effect of the grid potential on the plate current.

Having described some of the more unusual and difficult characteristics of vacuum tubes, the next step is to find how these characteristics can be ascertained; later we shall analyze the possibilities of vacuum tubes by means of their characteristics. The UV-201A tube will be ued throughout in illustrating how the work is done.

It has been said that the amplification constant is the maximum voltage obtainable from a tube. Its value is determined by means of the grid and plate voltages. It expresses the ratio of a change of grid potential to a change in plate potential when the change in plate current is the same.

There are two ways of increasing the plate current flow outside of the filament control; one is to increase the plate battery voltage; the other is to increase the grid potential by making it more positive. Of these, the latter is the more important. Volume in reception is dependent on the amplitude of the pulsations in the plate current. In other words, the smaller the potential variation required for a given change in plate current, the more efficient will be the tube.

How to Derive Amplification Constant

In deriving the amplification constant, a given value of plate current is assumed; then taking a given reduction in plate voltage, the grid voltage increase necessary to bring the plate current back to its former value is ascertained. This plate voltage difference divided by the grid voltage increase gives us the amplification constant.

Expressed in a formula we have:

$$Mu = \frac{E'p - Ep}{Eg - E'g}$$

where Ep=plate voltage and Eg=grid voltage.

Figure 1 is a chart showing the plate current and grid potential values with plate voltages in steps of 10 running from 10 to 80.

Let the plate current values be taken as 3 milliamperes; then at a plate voltage of 50 the grid potential is .25 volts positive. Then if the plate voltage is reduced to 40, the grid must be increased to 2 volts positive in order to get the plate value back to 3 milliamperes. Substituting these values in the formula we get:

$$Mu = \frac{50-40}{2-.25}$$

or Mu = 5.7

Repeating this procedure at a plate current of 5 milliamperes, at 70 volts plate potential the grid is .75 volts positive; when the plate potential is reduced to 60 the grid must be increased to 2.4 positive to keep the plate current at 5. Substituting these values in the formula we get:

$$Mu = \frac{70-60}{2.4-.7}$$

Mu = 5.8

The amplification constant does not remain in a fixed value, as will be noticed. The value decreases somewhat at lower voltages. It is sometimes given in the form of a curve with its values plotted for variations in plate voltages. Due to inaccuracy of readings and outside factors in the circuit these values may have a possible 5 per cent error, but will be found sufficiently accurate for the purpose the amateur requires of them.

As to Plate Resistance

Making use of Ohms law, the direct current resistance of the plate circuit is equal to the plate voltage divided by the plate current. The alternating current resistance, however, depends on the slope of the curves; since the curves are not straight lines, it is not the same as the direct current resistance.

If the readings are taken at a zero grid potential the alternating plate current resistance equals $\frac{Ep}{2\ Ip}$ where Ip is the plate current in amperes. This will give a fair estimate of the plate resistance value. For convenience the values of the plate resistance are calculated on this basis at the zero grid potential and the plate resistance curve shown in Figure 2 is drawn. Then the resistance value at any specified plate voltage and grid potential other than zero can be found by applying the following formula:

$$E'p = Ep + Mu\ Eg$$

This formula gives the effective plate voltage; this value is used in reading off the proper resistance in the curve of Figure 2.

For example, let it be assumed that the plate resistance at 60 volts plate and 4 volts negative grid potential is desired, then

$$E'p = 60 + (5.8 \times [-4]) = 60 - 23.2$$

E'p=36.8 volts.

Therefore, reading from Figure 2:

Pr=10,400 ohms

The negative value of the grid potential changes the plus sign to subtraction.

It has been stated and shown that the amplification constant depends almost entirely on the structure of the grid and its position relative to the filament and plate. It is defined as the plate voltage increase divided by the grid voltage increase. The plate resistance has been described as depending on the same factors and in addition the surface of the plate and filament.

The mutual conductance depends on both of the two previous characteristics; it is a function of the slope of the grid voltage plate current characteristic curve. It is defined as the change in plate current divided by the change in grid voltage producing it. Inasmuch as this value changes considerably with different values of the grid potential, it should be taken at that point at which the tube is going to be worked. The grid potential values are taken with respect to the negative terminal of the filament. If the tube is to be used as an amplifier and the grid return is connected to the negative side of the filament, the values should be computed at zero grid potential. If a biasing battery is used the potential of the grid is determined by the biasing voltage.

(Continued on next page)

(Continued from preceding page)

Mutual Conductance Formula

The formula for the mutual conductance (Gm) is:

$$Gm = \frac{Mu}{Rp}$$

The amplification constant can be taken at 5.7 as previously calculated. The plate resistance value can be taken from the curve shown in Figure 2 of the latest article. For example, the average plate voltage used is 45; at this value, assuming a zero gird potential, the plate resistance is 9,400 ohms. Substituting in the formula:

$$Gm = \frac{5.7}{9400} = .000606 \text{ mhos}$$

Mutual conductance, however, is usually expressed in "micro-mhos." The term "micro-mho," a convenient value, is simply one millionth part of a mho. (A mho is the conductance of a circuit of one ohm resistance; the name derived by taking the reciprocal of the word ohm, that is, spelled backwards.)

This then gives a mutual conductance of about 600 micro-mhos.

If a biasing battery is used and the value is desired for a negative potential, the plate resistance value must be corrected, as previously stated by applying the formula:

$$E'p = Ep + Mu\ Eg$$

It must be remembered, however, that a biasing battery for the grid is usually used only in conjunction with fairly high plate voltages so that the mutual conductance will not drop off as would at first appear to be the case. The curves as given are drawn for a maximum plate voltage of 80 volts; with Radio frequency, reflex plate voltages are often used, so it would be advisable to carry curves to the maximum plate voltage permissible or recommended for the particular tube under test.

There is always a possibility of error when each characteristic is calculated from previous solutions. For this reason, and for convenience in direct solutions numerous test circuits have been designed for solving these characteristics. These are given as follows:

Test Circuit No. 1

Figure 3 shows a test circuit that will permit quick evaluation of the amplification factor of any tube. The three successive rheostats have graduated readings in stages of one-tenth the total resistance of each. In using this instrument the desired plate voltage is connected to the proper binding posts, likewise the filament battery required for the tube to be tested. The battery connected to the lower binding posts should have a voltage of about fifteen. The filament is then adjusted; when the switch 1 is closed the milliammeter will show a current flow in either direction (zero center reading recommended). The variable resistances R_1, R_2 and R_3 are then adjusted until no current flow is indicated.

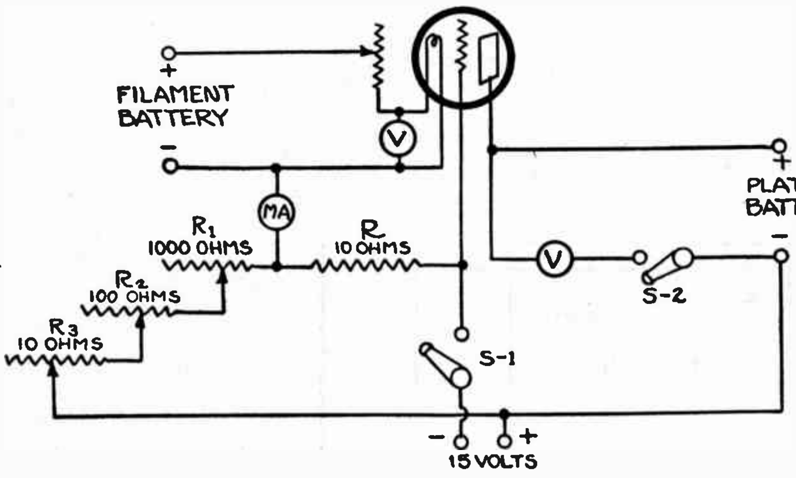


Figure 3—Test Circuit No. 1

Then

$$Mu = \frac{R_1+R_2+R_3}{R}$$

Test Circuit No. 2

In test circuit No. 2, Figure 4, the ammeter has been replaced with telephone receivers; a source of alternating current is necessary instead of the direct battery current.

Another set of variable resistances of 100,000 ohms, 10,000 ohms, 1,000 ohms and 100 ohms is added with a switch for obtaining the plate resistance values. Adjustments are made by listening to the tone of the receiver. The minimum tone in each case indicates the best adjustment.

With S-1 closed and S-2 open, adjust R_1, R_2 and R_3 for minimum tone, then

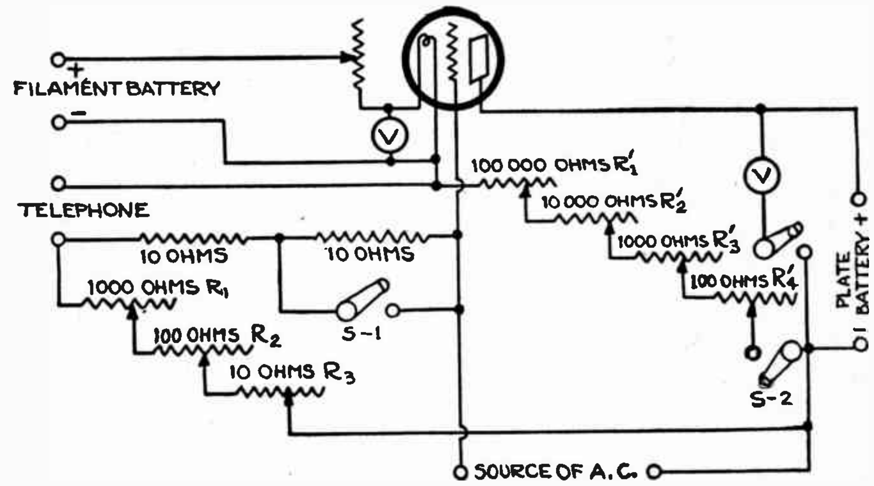


Figure 4—Test Circuit No. 2

$$Mu = \frac{R_1+R_2+R_3}{10}$$

Keep the adjustments as made; open S-1 and close S-2; adjust R'_1, R'_2, R'_3 and R'_4 for minimum tone in the receivers, then

$$Rp = R'_1+R'_2+R'_3+R'_4$$

Mutual conductance may be directly evaluated by test circuits but a special test setting is necessary. The circuit used is well equipped but complicated in relation to the obtainment of all three characteristics.

With the previous test circuits the amplification constant and plate resistance values can be obtained for a range of plate voltage; from these the mutual conductance can easily be obtained.

The Theory of Loop Aerials

THE loop antenna is a very interesting device. It is quite different in its method of operation from the outdoor antenna. The outdoor antenna is in effect nothing more nor less than a condenser. It is a very large condenser to be sure, so far as its physical dimensions are concerned, but electrically it is a relatively small one. The loop on the other hand is an inductance. This fundamental difference between the two is the reason why it is necessary to use different methods of tuning in the two cases.

Let us examine this special form of inductance, which we call a loop, and see why it serves as a pick-up device for Radio signals and how it should be made effective.

There is a very close parallel between the ordinary direct current generator or dynamo and the loop antenna exposed to passing Radio waves. In the dynamo a number of coils corresponding to the loop antenna are rotated in a powerful magnetic field. The purpose of rotating them is in order that they may move with respect to the field and thus have a voltage generated in them. The amount of this voltage depends, of course, upon the strength of the field and the speed at which the wires are swept through it.

In the Radio case, the coil stands still, but the field moves swiftly past the coil, thus accomplishing the same result. The speed at which the field moves cannot of course be varied and is always the speed of light, that is, 186,000 miles per second.

How Voltage Is Generated

Let us see now what form of loop would have the greatest voltage generated in it by a passing Radio wave. Let us think of this Radio wave as very much like great smooth waves on the ocean, which of course, also move forward with a very definite velocity. The turns of wire in our loop antenna are necessarily in series with each other, that is to say, they form a continuous winding. If the maximum voltage is to be generated in any one turn of the loop, then the voltage generated in the two sides of this turn should be in opposite direction so that they may add and not oppose each other. If the voltage generated in both sides of the loop were in the upward direction at any one instance, then these two voltages would cancel each other, but if the voltage on one side of the turn was up and on the other side of turn, it was down, then they would add and if the loop were connected to a receiver, a current would flow around the turns of the loop. This is, of course, exactly what we wish to have happen.

Now in order to have the voltage generated on one side of the loop in the opposite direction to that generated on the other side of the loop, the loop would have to be one-half a wave length long, that is to say, it would have to be long enough in the horizontal direction so that one side was in the crest of the wave when the other side was in the trough of the wave. Since the distance between the crests of the waves is the wave length itself, then the distance from the crest to the trough is one-half the wave length.

The higher the sides of the loop are, that is, the longer the vertical wires are, the greater will be the voltage generated, and of course the voltage generated in each turn is added to the voltage generated in all the other turns.

Wave Length of Loop

But a loop one-half a wave length long is quite out of the question. It would be as long as a steamship and almost as difficult to handle. The loops which we are using every day are of quite reasonable dimensions. They are only a few thousandths of a wave length long. How do they function? In order to answer this question let us ask ourselves how we would build a coil of wire in order that absolutely no voltage should be generated in it by the passing wave. The only way in which this could be accomplished would be to so build the coil that the same voltage would be generated in both sides of it and that the voltages generated in the two sides would be opposed to each other. This would give a complete cancellation and no voltage at all at the terminals of the loop or coil. It is obvious that the only way in which this could be done would be by so arranging the loop that it had no length at all. That is to say, arranging it so that the two sides were exactly in the same position in space. This would mean that the horizontal wires across the top and bottom of the loop would cease to exist and the loop would become nothing but a wire laced up and down between pegs on the plain surface of a board.

If there is any distances at all between the two sides of the loop, then there will be some difference not in the amount of voltage generated in the two sides, but in the time at which this voltage is generated and there will consequently be some voltage at the terminals of the loop since complete cancellation of voltages cannot occur.

Directional Properties and Inductance

If the loop is rotated so that its horizontal wires are at right angles to the direction in which the signal is coming, then the loop has no length so far as those signals are concerned. The passing wave strikes both sides of each turn in the loop at exactly the same instance and opposed the voltages generated are therefore, equal and opposed and there is no terminal voltage.

This is, of course, the fact which gives the loop antenna its very useful directional property. It is to be noted, however, that if the loop is turned ever so slightly from this zero position then the voltages no longer cancel and there is a voltage at the terminal. This means that the zero position of the loop is very sharp, but the maximum position is very broad.

In applying the loop antenna to an actual Radio receiver, it is necessary that provision be made to tune it to resonance with the desired signal. This is accomplished by means of a variable air condenser and since this condenser has a very definite maximum capacity, the amount of inductance which the loop can have is also limited. This maximum capacity of the variable condenser, must give resonance to the longest wave to be received.

The specification for the best loop antenna therefore, is that it shall have just as many turns as possible, each turn being just as long as possible and just as high as possible, and still have no more than the required maximum inductance. The higher the loop is, the greater will be the voltage generated in each side of each turn and the longer it is, the greater will be the difference in time at which these voltages are generated in the two sides of the loop and consequently the greater will be the voltage at the terminals, but it must not have an inductance value greater than that required for tuning.

Why Turns Are Spaced Apart

Now the inductance of a coil of wire increases very rapidly as the turns are wound closer together. The maximum inductance is obtained with the minimum number of turns when they are wound just as close to each other as possible. In order to get the maximum number of turns for a given inductance, which is what our loop requires, the turns should be wound just as far apart as possible.

Now it is found that this spacing is best accomplished by winding the loop on a frame which has the form of a vertical cylinder. The wire goes up one side of the cylinder across the top and down the other side and across the bottom, and turns are spaced around the circumference of the cylinder so that the complete winding covers an arc of about 120 degrees on each side of the cylinder.

Splicing Wires

When making a connection between two wires, do not merely twist the wire ends together. This will sooner or later cause trouble by producing weak signals and other bad effects. When two wires are to be joined, the insulation should be removed from each for a distance of 2 inches. The wire itself should then be scraped so that it shines brightly. A right-angled bend should then be made in each wire at a point about ¾ inch from the insulation, leaving about 1¼ inch of clean wire between the bend and the tip. By hooking these right-angled bend together, each may be wrapped around the other wire of the pair, care being used to wind each wire tightly on the other. A spliced joint of this kind will be strong mechanically and a good conductor.

Marking Condenser Dials in Wave Lengths

Reference Charts Are Best Solution

The construction of the condensers now available makes impractical the marking of dials in wave lengths. Charts are popular and easy to use

IT IS not unusual to receive a letter from some fan who wonders why the dials are not graduated in wave lengths. His idea is not unreasonable, and the time is not far off when sets will have wave length graduated dials instead of just the usual zero to 100 or the angular degree graduations. There are, however, a number of factors which affect this, of which the fan usually does not know; it is these factors that will be discussed in this article.

First, we need not define wave length, but it is generally known that wave length is dependent upon the inductance and capacity of the circuit. Expressed in a formula, we have:

$$W = 59570 \sqrt{(L \times C)}$$

where W = wave length in meters.
L = inductance in milhenries.
C = capacity in microfarads.

priced, so for the present only the rotating plate type will be considered.

This type can be divided into three different classes, namely:

The semi-circular plate construction.
The straight-line capacity type.
The square-law type.

length would run from 500 to 750 meters, or a total of 250 meters range. But the lower part of the scale, 0 to 42, would cover a wave length range from 0 to 500. In other words, the lower half of the graduations would cover over twice the range that the upper half does.

In order to remedy this difficulty, the third class of condensers, called the square law type, were developed. They are used mostly in wavemeter work and for laboratory testing.

The Square Law Condenser

The wave length formula can be changed around to read:

$$C = \frac{W^2}{3552000000\ L}$$

using the same unit values as before.

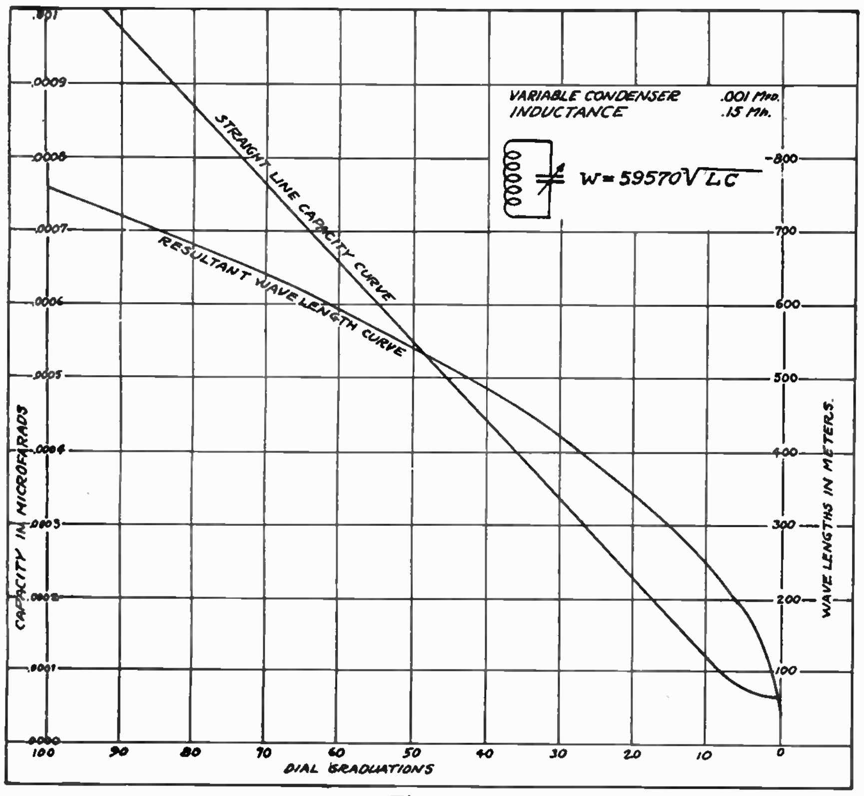


Figure 1

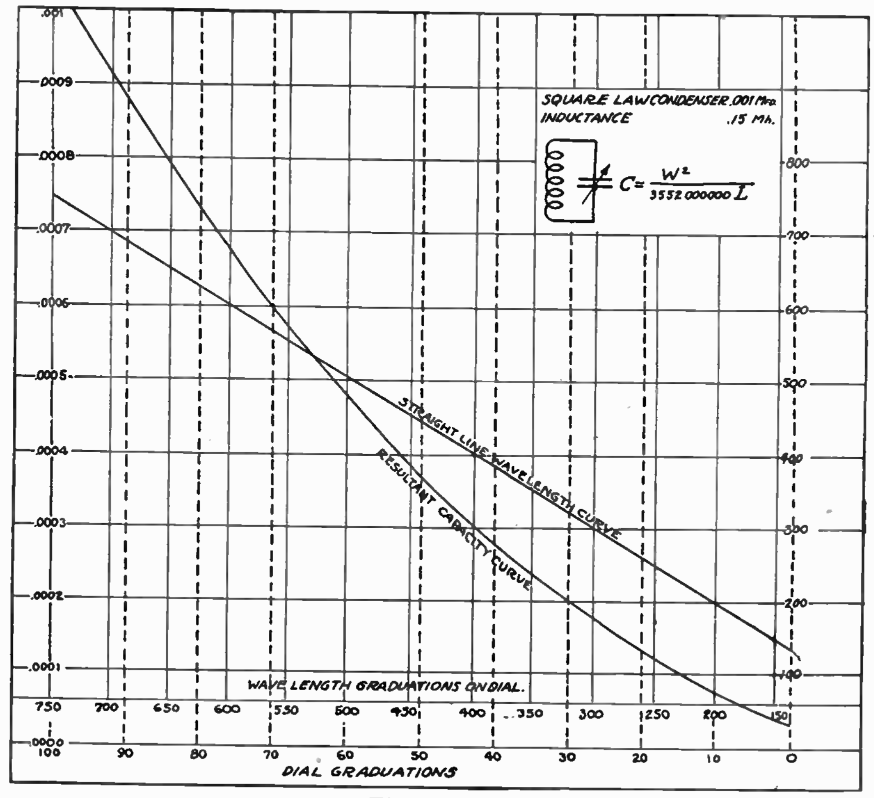


Figure 2

Antenna or Primary Circuit

The antenna circuit includes the aerial and ground, with its capacity and inductance in addition to the tuning units. The aerial inductance and capacity are not necessarily fixed values. Both vary to a limited extent, depending on a number of conditions; then, again, one fan has an aerial 100 feet long and 40 feet high, while another has one 60 feet long and 50 feet high. It is, therefore, impossible to graduate a dial for wave lengths in the primary circuit. If, however, a loop aerial is used and its inductance determined, the dial of the usual tuning condenser can be graduated for wave lengths, but this condition is parallel to what is taken up under secondary circuits, and will be more fully discussed under that heading. All circuits operating without an aerial, usually a fixed or variable inductance incorporated in the circuit, can also be handled the same way.

Secondary Tuning Circuit

In the secondary circuit there would be little trouble in having the dials graduated for wave length. The main condition imposed would be the necessity of a fixed inductance value. Naurally, if the inductance is variable, every change in the inductance would alter the condenser setting for the same wave length. This fixed inductance value is not unusual; for example, the rotor of a variocoupler has no taps, therefore, the inductance value is fixed. Similarly, the loop aerial, unless tapped, has a fixed inductance value.

Where a double or even triple honeycomb coil circuit is used, the secondary circuit is tuned by means of the variable condenser shunted across the secondary honeycomb coil.

If, then, the inductance value is fixed, the tuning control being centered in the variable condenser, it is the dial on this apparatus that can be used to indicate the wave length for its different positions. This naturally emphasizes the importance of accuracy and workmanship in its construction.

Variable Condenser

Up to this time there has been but limited development in condenser design. The present type of rotating plate condensers is seldom very accurate. Though spacing may be fairly uniform when manufactured, handling soon changes positions of plates. Many of the plates are stamped out with rough edges. Unless the metal is carefully treated, temperature changes will produce warping of the plates. The plates may not be shorted, but there is no uniform capacity change. Gradually development and improvements in design will help eliminate these uncertain factors. The other types of construction, if efficient, are usually too high

The average variable condenser that appears on the market falls in the first class. The second type are not so numerous, and as a rule are much larger in size, due to the contour and size of the plates. Of the third class, there are very few on the market.

The capacity curve of the condensers of the first class, based on the dial graduations, is very irregular; no two are alike. It is very difficult to graduate a dial in wave lengths because of the irregularity of such graduations. This will become more apparent when the other classes are analyzed.

The Straight Line Condenser

The illustration, Figure 1, shows the straight line graph by plotting the capacity against the usual dial

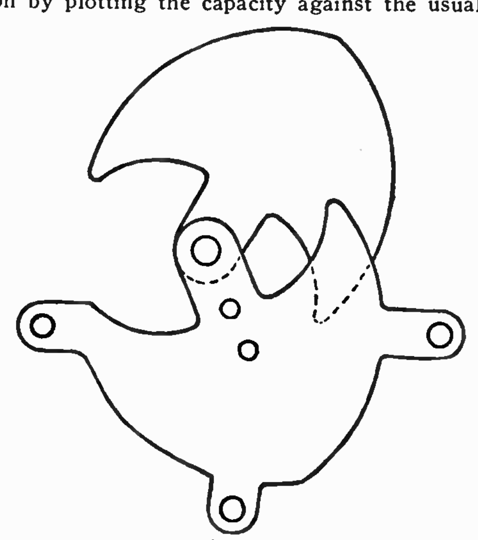


Figure 3

graduations. The markings on the dial are taken as zero to 100; some dials are graduated to 180; that would mean merely that the divisions on the bottom of the graph would cover 180 points in the same distance that the 100 are covered. Naturally, 180 degrees of rotation are assumed. Using the formula for wave length, the different wave lengths are calculated, assuming a 50-turn honeycomb coil (.15 milhenries) is used as the inductance. The illustration shows the resultant wave length curve. Since the curve is not a straight line, the dial graduations would be irregular.

For example, from graduations 42 to 100 the wave

This indicates that in a circuit with a fixed inductance value the capacity varies as the square of the wave length, divided by the product of a constant and the fixed inductance.

In Figure 2 the wave length is first plotted as a straight line, the necessary capacity values are calculated and the curve drawn in. The condenser is so designed that the plate areas required for the various dial settings check up with capacities as called for on the graph. The dial range in wave lengths would then run from about 150 to 750 meters. Naturally any change in the maximum capacity of the condenser or the inductance of the coil alters these dial values.

At the base of Figure 2 the wave length values at the different points of the dial graduations are marked in steps of 50 meters. This can be carried further and kept handy with a set, so that the dial graduations can readily be interpreted in terms of wave length.

The illustration Figure 3 shows the form of plate used in one of the square law type of condensers at present on the market.

Transformer Cores

The main objection to the iron core Radio frequency transformer lies in the inability to secure thin enough laminations for the core. Laminations such as are used in the audio frequency transformers have a tendency to "lag" and are therefore inefficient. This may be easily overcome by using soft, fine iron filings for the core.

The filings may be secured from most any machine shop or may be readily made if a grindstone is available. Place them on a sheet of iron, stove lid is suitable, and heat them to as high a degree as possible without melting them together, they are then allowed to cool evenly and naturally. This heating process is to anneal the filings so that they will not become polarized.

To make the core pour these filings into molten battery compound, paraffin, or better yet melt an old wax Edison cylinder phonograph record, stir the filing into the solution until it has taken all it will hold together and still be workable.

The filings are then poured into the form of the core.

The best way is to wind the secondary and primary coils, insulate the windings and leads to prevent possible shorts and grounds from the conductivity of the filings, pour the compound with the filings in it around and in the center of the transformer coils, in this way securing closed core construction.

Radio Inductances and Tuning Functions

Their Effect in Radio Circuits

By Thomas W. Benson

THE sole purpose of the tuning elements in a Radio receiving set is to separate the currents induced in the aerial by Radio waves from the various broadcast stations so that the impulses from any desired station may act upon the detector and amplifiers to the exclusion of all others. The selectivity of a tuner is a measure of its ability to completely eliminate all unwanted signals and to permit only desired impulses to be reproduced.

Since the Radio waves are transmitted at differing wave lengths the length of time elapsing between successive waves striking tne aerial will vary and consequently the frequency with which an impulse is given the aerial will differ with each broadcast station. A tuner is simply a sort of filter that will permit currents of a certain frequency to flow freely in the circuit, and damp out or offer high resistance to currents of a higher or lower frequency.

Tuning with Inductances and Capacities

Tuning is accomplished by means of inductances and capacities. Inductance is that property possessed by all conductors but more marked so when they are wound in the form of a coil, adding what might be termed electrical inertia to the circuit they are connected into.

The effect of the inductance is to oppose any change in the current flowing through the circuit. Thus when they are connected into a circuit carrying high frequency currents that are alternating in direc-

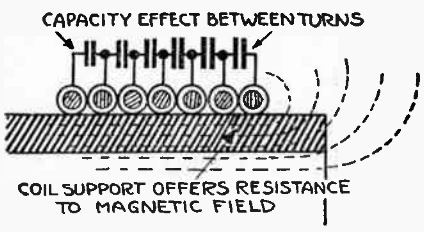


Figure 1—Detail of cross section of plain inductance showing source of losses

tion of flow, when the current tends to decrease, the lines of force around the coil collapse and induce a current in the coil in the same direction as the current in the coil, thus opposing the decrease in current.

When the current is increasing and the magnetic field of the coil building up the current induced in the coil is in opposition to that flowing in the coil and again opposes the increase of current. As the frequency of the currents in the circuit is increased the strength of the opposing currents becomes greater.

The effect of a condenser in a circuit is somewhat different. Whereas an inductance causes the current to lag behind the exciting voltage a capacity tends to make the current lead the voltage. Just how this effect is obtained has been described elsewhere in this book. The point to be considered here is that the two characteristics are so balanced against each other that a circuit containing both inductance and capacity will have a certain time period of oscillation. That is, the circuit will pass freely a current of a certain frequency and damp out those of a different frequency.

Forms of Inductances

Inductances take many forms, some good and some bad, but to obtain highest efficiency inductances must meet certain conditions. They must have a low ohmic resistance, have a low distributed capacity and also a low high frequency resistance.

To meet the first condition, fairly heavy wire must be used in winding them. Number 24 gauge is the smallest size that should be used while the larger sizes are to be preferred.

The distributed capacity depends upon the method of winding the insulation on the wire and the binder used to hold the turns together. Since a capacity always exists between two conductors each turn in a coil forms a tiny condenser with the turns adjacent to it. It is the capacity between the turns of an inductance that forms the distributed capacity in an inductance. It is reduced by spacing the turns in winding.

When the wire is wound on a plain coil the kind of insulation on the wire affects the distributed capacity, therefore enameled wire should not be employed for winding unspaced inductances, while the practice of painting the windings with shellac likewise increases the distributed capacity. The effect of distributed capacity is to broaden the tuning and materially reduce the selectivity.

The high frequency resistance of an inductance is affected by the method of supporting the winding and the substances within the magnetic field of the coil. Since an inductance carrying a Radio frequency current is surrounded by a magnetic field that is constantly changing in intensity the lines of force around the windings must have a free path for their flow.

Various materials used for supporting inductance offer resistance to the passage of these lines of force and cause hysteresis losses, which have the effect of increasing the resistance of the inductance at high frequency.

The importance of the above factors cannot be overlooked, for it is impossible to obtain sharp tuning and selectivity with inductances that have a high resistance due to the use of fine wire on supports of materials that absorb energy.

Winding Inductances

We shall now consider the various methods of winding inductances with their advantages and disadvantages. The simplest inductance is made by winding a single layer of wire on a tube. Even when large size wire is used in this type of winding there remain losses due to distributed capacity and the hysteresis loss in the tube supporting the wire. This form of inductance is the most common, but is being rapidly replaced by the other types which are more efficient.

For plain coils it has been found that well shellacked or paraffined cardboard tubes are better than bakelite or fiber. The former has a high hysteresis loss at all times, while the latter absorbs moisture and acts with the result that eddy current losses develop. Hard rubber is excellent, but the best form of inductance is one that has no solid support. The source of losses in a plain inductance are illustrated in Figure 1.

The honeycomb or duo-lateral coils were designed to reduce distributed capacity by separating the wires and still keep the inductance compact. The wind-

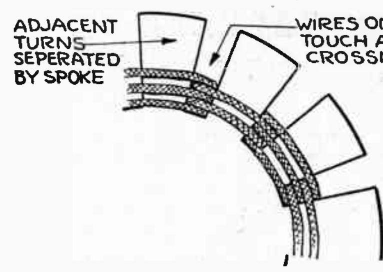


Figure 2—Detail of spider web showing how distributed capacity is reduced by increased spacing between wires

ing is therefore more efficient and gives good tuning qualities and makes a very convenient inductance for certain purposes. The practice of binding them with a fiber strip is very poor, simply tying them to the mounts is far better.

The spider web inductance was next introduced and met with popularity chiefly because of its ease of construction as compared to the honeycomb coils which invariably require a machine for their proper winding.

As shown in Figure 2, the distributed capacity is kept down by spacing the wires on opposite sides of the spokes of the web with a gain in tuning qualities, but the hysteresis losses were retained. They can be eliminated when heavy wire is used for the winding by cutting the spokes where they join the center piece and withdrawing them after the wires are bound together with cotton threads. This makes a very efficient winding when mounted clear of other apparatus.

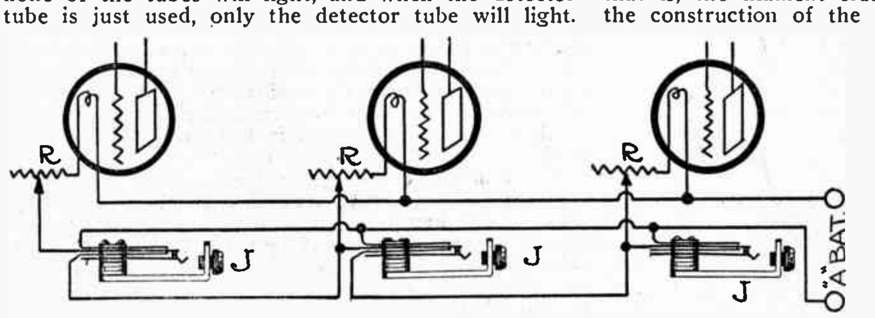
Low Loss Coil

The so-called low loss coil is really a tubular spider web made by setting a number of pegs, always an uneven number, in a circle and winding the wire in and out around the pegs. After winding, the coil is tied together and removed from the form. There are a number of ways the wire can be wound around the pegs, but the result from the viewpoint of efficiency is always the same. A practically perfect inductance, almost free from distributed capacity with no hysteresis losses. These advantages cannot be retained if the coil is mounted close to other masses, particularly if they are conductors, so all inductances should be kept in the open as much as possible and not mounted flat against the panel or base or placed around condensers.

Correct Connection for Filament Control Jacks

Do you know the correct way of connecting a filament control jack so that it will operate only one tube when the plug is in the first jack, and two tubes when the plug is in the second jack, etc.? As I have been asked this question I thought many others would be glad to know how to connect them.

This hook-up will work with the ordinary filament control jack and also with the special jack attachment. When the plug is pulled out of all the jacks none of the tubes will light, and when the detector tube is just used, only the detector tube will light.



This device is a great saving on batteries because sometimes a person desires to listen in on one or two tubes on a three tube set. Without a jack the third tube must burn and at the same time the listener does not get any use of it, it only draws power from the battery. The rheostats can be turned down but think how simple it is just to change the plug to another jack and not have to touch a control knob. The illustration is clear enough to be understood without further explanation.

Inductance switches of the type made up with lever and points in one assembly for panel mounting, are much to be preferred over the individual points inserted in the panel. They have the points exactly spaced and the electrical characteristics are good.

Condenser Across Secondary

When using a condenser across the secondary use as small a condenser as possible and as much inductance as possible. The reason for this is that in a circuit containing large inductance and small capacity the voltage induced in this circuit will be greater than if large capacity and small inductance were used.

Connect the condenser with the rotary plates to that part of the circuit that is at a ground potential; that is, the filament side of the secondary. Again, the construction of the condenser might cause one to use the stationary plates as the filament connection, but this must be tried in order to eliminate hand capacity. In the oscillator circuit of a super-heterodyne, if the condenser is connected across the grid coil, the rotor plates connect to the filament end; if the condenser connects to plate and grid, the rotor plates are connected to grid.

Filament Switches

Filament switches on each amplifier tube are well worth while Using the loud speaker, you will want both tubes. If you seek DX with the phones, two tubes are too noisy, so that one step is better. With filament switches you can turn off the last tube while hunting DX, and if you get a station you want, the second tube is ready, at proper rheostat setting, at the pull of a knob.

In wiring A batteries, heavy insulated wires must be used to connect the cells together in order that there will be no voltage loss in the wires. Heavy leads should also connect the battery to set.

Grounding Interference

A very annoying Radio interference problem arose in a small country town where the power company had installed a new 3,500-kilowatt multiple-stage turbine. Lead-covered, single-conductor cables run direct from the unit to the oil switches, a distance of about 75 feet. Since the interference had not existed before its origin was thought to lie in the new equipment. It became so distressing that even the newspapers took up the people's cry for relief.

To overcome this interference much time and effort was spent. It was at first thought that the trouble lay with the faulty insulation of the 75-foot cable, so it was subjected to a high voltage test. But this was successfully withstood, showing that no flaws existed in the cable insulation. Then a further analysis with an oscillograph showed what caused the trouble. On the peak of each voltage wave there appeared a small ripple of a higher harmonic. Investigation as to the cause of this higher harmonic then led to the complete solution.

Although lead-covered cables were used to transfer energy from the generator to the oil switch, it was found that the lead sheath had not been grounded. Capacity between the cable and the lead created this harmonic which was dissipated into the air and not to ground as it should have been if proper connections had been made. After grounding the sheath this trouble disappeared entirely.

Use Tinned Lugs in Set

It is surprising how many Radio set builders make the great mistake of soldering the various wires to the heads of screws. The majority will say this is all right, providing the heads of all screws are carefully sandpapered before attempting to solder a wire to them.

If you are desirous of saving yourself a lot of unnecessary work and trouble don't make connections in that way. If you want to make a neat job of the set you are building, use small "tinned lugs."

Common Electrical and Radio Terms

Simplifying Some of the Puzzles

SINCE Radio is a branch of electrical engineering and is merely the utilization of electricity in smaller quantities and with slightly different characteristics than electricity as used for power and light, it is but natural that Radio science should use electrical terms and similar symbols in the drawing of diagrams.

From electrical engineering, Radio has borrowed

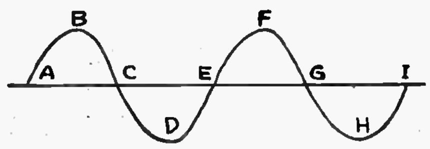


Figure 1—A diagrammatic representation of two cycles of alternating current.

four terms with which every fan and experimenter should be more or less familiar—volts, amperes, ohms and watts. To force any liquid or substance through an opening or tube, pressure is required and since "electrical pressure" is necessary to force current through wires we must have some unit of measurement of this pressure. This unit is termed a volt. Pressure must drive something—in this case, current—through something else, and to measure the quantity of current involved, we need another unit, the ampere. The pressure, or voltage, is necessary because the wires or other conducting mediums offer opposition to the passage of current, and we must have some means of measuring and expressing this opposition or resistance and we use the term ohm.

Ohm's Law

These three factors always have a definite relation to one another which is expressed by Ohm's law. To write this formula we designate the voltage by the letter E, the current by I and the resistance in ohms by R. Then we say that.

$$I = \frac{E}{R}.$$

To determine the amount of current that will flow in a circuit we must divide the voltage available by the

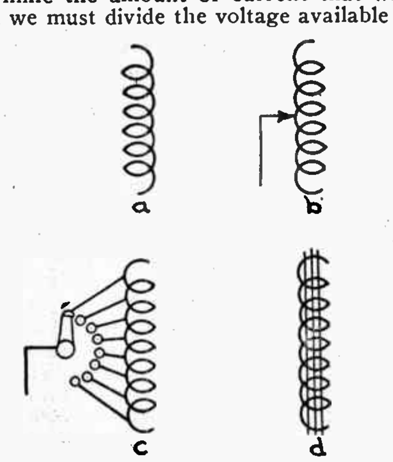


Figure 2—Four types of inductance used in Radio Circuits

resistance of the units in the circuit. If, on the other hand, we know the current flowing in a circuit and the voltage but wish to know the resistance, we consider the law in this form:

$$R = \frac{E}{I}.$$

Dividing the pressure in volts by the current as expressed in amperes we learn the resistance in ohms. The third variation of this formula is, of course, when it is used to determine the voltage, and the resistance and current are known—$E = I \times R$.

A UV-199 Radiotron should have 3 volts pressure at the pins leading to the filament; it is rated at .06 ampere; we would like to know the resistance of its filament. Using the second form of Ohm's law, we divide 3 by .06, and the result is 50. The resistance of the filament of a UV-199 Radiotron is 50 ohms.

The term watt is used to designate the unit of electrical power provided by one ampere of current with a pressure of one volt behind it, and the power in a circuit is always determined by multiplying volts by amperes. The filament of the UV-199 Radiotron, drawing .06 ampere with 3 volts' pressure, may be said to require .18 watt.

D. C., A. C. and Frequency

Let us now consider the three terms—direct current, alternating current and frequency. The term direct current designates the flow of current in a circuit when the pressure is always in one direction and the current flows into the circuit at one end and out of it at the other. Such a current is supplied by a dry cell, a storage battery, and frequently in power and electric light lines.

Alternating current differs in that the pressure alternates in direction and the current flows, momentarily, from the end we will call A to the end B, and then reverses and flows from B to A. Such a current cannot be obtained from a battery but is supplied in many power lines. Radio transmitters change direct current into alternating current to produce Radio waves in the ether.

We speak of the number of times the current changes its direction of flow per second as the frequency (see Figure 1). Here, we represent one second of time by the distance A to E and of another second by the distance E to I. At point A. the current begins to flow in one direction, reaches its greatest strength in one quarter of a second (point B), then begins to weaken until at the one-half second point C there is no current flowing. Then it begins to flow in the opposite direction until at point D it is as strong as when at B, then it weakens until the one second point E is reached and it is ready to flow again in the original direction. The current is said to have completed one cycle and the frequency is 1. This would be one-cycle alternating current. If, however, we take the distance A to I as one second and the current flows twice in each direction in that time, and completes two cycles we have two-cycle current. In power lines, the frequency is usually 60 cycles.

In Radio transmission, we use alternations or frequencies of from 15,000 to 4,000,000, and frequencies within this range, usually termed band, are spoken of as Radio frequencies to distinguish them from others. So, when you see Radio frequency (R. F.) transformers advertised, it means that these units are designed

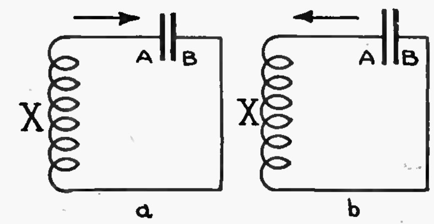


Figure 3—A diagrammatic presentation of oscillating circuit which explains condenser action

to handle small currents whose frequencies are within these limits.

There is one use of the term frequency in Radio, which does not meet the above definition, although perfectly correct. Before being put into the head telephone receivers, Radio signals are changed from their alternating current form into direct current which, while it flows in one direction only does so in pulsations and not steadily as does electricity from a battery. We then use the term frequency to give the number of the pulsations per second. Since these produce sounds in the head phones that are audible, we speak of this current as audio frequency current and the transformers which handle it as audio frequency transformers. Audio frequencies are those within the band 8 to 12,000, which are those commonly used in music, although the human ear can hear sounds consisting of as many as 30,000 vibrations per second.

Inductance and Capacity

We now come to the terms inductance and capacity. A straight piece of wire is said to have a certain amount of inductance, which is a property essential in a circuit to the reception of Radio signals. This property is greatly increased by winding the wire into a coil, either of several layers or of a single layer on a tube. It is not necessary for the average experimenter to fully understand inductance, the knowledge that it is the property of a coil of wire and is measured in henries and millihenries being sufficient. Another method of increasing the inductance of a piece of wire is to insert an iron core after winding the wire into a coil.

In Figure 2 are shown four ways of designating inductance in a diagram: 2a is an inductance which does not contain an iron core, but is of the "air-core" type; it is not variable and all of the turns of wire are always in use; 2b shows another coil, also air core, but variable. Such a drawing is used to show either a coil from which short leads are brought out at intervals to switch points or a coil which is varied by moving a metallic slider along a rod, the slider making contact with the wires of every turn, the insulation having been removed for a distance of about 3/16 inch on every turn. Figure 2c specifies that the coil be varied by taps and a switch. In 2d we have a coil wound on an iron core and non-variable.

Capacity is another property necessary in a circuit in which Radio frequency currents are to travel. Capacity is the result of having close together two metallic surfaces or wires in which alternating or pulsating direct current is flowing. For a better understanding of this let us consider Figure 3a. Here we have a circuit consisting of a coil of wire (X) and a device consisting of two flat plates about 2 inches square and 1/16 inch apart. In this circuit, Radio frequency current is flowing and we will consider it at a moment when the current is flowing in the direction indicated. The current spreads out over plate A until the plate is full. If the plate is of the correct capacity, it will become full at just the moment when the current reaches its greatest value and begins to weaken. As plate A is full and plate B contains no electricity we have an unbalanced, unstable condition and plate A discharges or unloads its current back through the coil X and into plate B, as shown in Figure 3b. Electrical current has momentum, just as does a swinging pendulum, and the flow does not stop when both plates are equally charged, but the current piles up in plate B and then must again flow as in Figure 3a. This action would continue indefinitely and we would have a perpetually oscillating circuit were it not for small losses which occur and the resistance of the circuit.

The symbols used for showing capacity in the form of an instrument known as a condenser, are shown in Figure 4; 4a designates a variable condenser, that is,

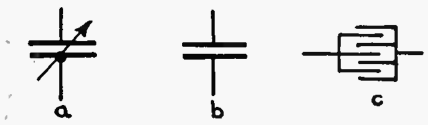


Figure 4—Three methods of showing condensers on diagrams, one variable and two fixed

a condenser whose capacity may be varied from maximum to very nearly zero. The unit of measurement of capacity is the farad and its subdivision, the microfarad (.000001 farad). Condensers used in Radio work have very small capacities and are usually measured in fractions of a microfarad; 6b is the usual designation of a fixed capacity, while 6c is another less used method of showing it.

As the capacity of condensers is usually written and spoken of in decimals such as .001, .0005 and .00025, Radio men have developed the following way of speaking of them. The Radio experimenter would say "double O one," "triple O five" or "triple O two five," meaning condensers of .001 of a microfarad, .0005 of a microfarad or .00025 microfarad.

Resistance

Resistance is, as was stated before, measured in ohms. Since we frequently use resistances of from 1,000,000 to 12,000,000 ohms, the Radio fraternity has come to use the word megohm for 1,000,000 ohms and to mention 8,000,000 ohms we would say "eight megohms."

Resistances are shown on diagrams by the symbols shown in Figure 5. A resistance which cannot be varied is shown as in 5a, while a resistance that is variable (such as a rheostat) may be specified by 5b; 5c shows a particular form of resistance known as a potentiometer, which is usually connected across the

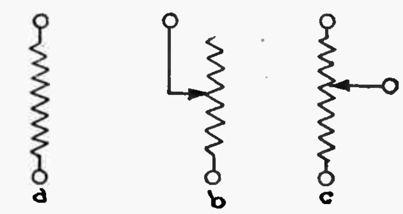


Figure 5—Resistances are shown in these drawings, one fixed, one variable, one of a special unit

filament battery of a vacuum tube. The sliding contact is connected to one of the other elements of the tube (grid or plate), and moving this contact varies the difference in pressure between the filament and the second element.

Wire-Table

Turns per Inch of Copper Wire with Various Insulations

B.&S. Gauge	Enm	Sngle Cot	Dbl Cot	Sngle Slk	Dbl Slk	Cot Enm	Silk Enm
18	23	21	19	23	22	20	22
19	26	24	21	26	24	23	24
20	29	26	23	29	27	25	27
21	32	29	25	32	30	27	30
22	37	33	29	36	33	31	34
23	41	37	32	40	37	34	37
24	46	40	34	44	41	38	42
25	51	44	37	49	45	42	46
26	57	48	41	54	50	46	51
27	64	54	44	60	55	50	57
28	74	59	47	67	60	55	63
29	80	64	50	74	66	60	69
30	90	70	54	82	71	65	76
31	101	75	57	90	77	71	84
32	112	82	60	99	83	77	92
33	127	88	64	108	90	83	101
34	141	95	67	119	97	89	110
35	158	101	71	129	104	95	120
36	178	108	74	140	111	102	131

FEET PER POUND OF COPPER WIRE HAVING VARIOUS INSTALLATIONS

B.& A. Gauge	Enamel	Single Cotton	Double Cotton	Single Silk	Double Silk	Cotton Enamel	Silk Enamel
18	200	196	189	201	199	196	202
19	253	246	237	255	252	242	248
20	320	311	298	324	319	307	315
21	404	387	370	400	389	380	394
22	509	488	401	501	493	479	497
23	642	612	584	632	631	600	622
24	810	763	745	799	779	750	781
25	1019	953	903	1008	966	933	982
26	1286	1201	1118	1263	1202	1166	1232
27	1620	1500	1422	1584	1543	1457	1548
28	2042	1860	1759	1988	1917	1824	1946
29	2570	2370	2207	2520	2485	2288	2433
30	3218	2860	2529	3165	3009	2810	3031
31	4082	3482	2768	3933	3683	3473	3793
32	5132	4234	3737	4913	4654	4267	4737
33	6445	5141	4697	6129	5689	5267	5956
34	8093	6317	6168	7646	7111	6461	7427
35	10197	7755	6737	9680	8856	7835	9207
36	12890	9511	7877	12162	10869	9437	11485

Secrets of Selectivity and Regeneration

Resonance and Fundamental Principles

By William W. Harper

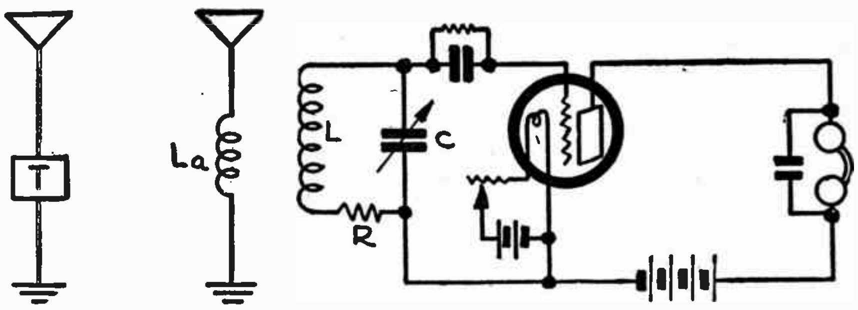


Figure 1

WITH the advent of increased broadcasting, the Radio world has been compelled to devote a great amount of consideration to the problem of selectivity. Although numerous methods for gaining a high degree of selectivity have been developed, the most desirable systems constitute the same general principles. It is the purpose of this series of articles to explain these basic principles and their application, so that benefit may be derived by those experimenters who desire to construct highly selective receivers.

As a starting point, we should thoroughly understand the prerequisities for a selective condition in a simple Radio tuning circuit.

Sharpness of Resonance

In a system such as shown in Figure 1 it is well known that the selectivity depends upon a factor which is called the "sharpness of resonance." The latter characteristic is often depicted graphically and is known as a "resonance curve." From this curve we may predict how sharply our receiver will tune and in that way estimate the selectivity or its ability to eliminate an interfering station. A resonance curve is shown in Figure 2 which may be applied to the tuning circuit of Figure 1, which comprises the coil L and the condenser C.

This curve, as will be noted from the diagram, is made by taking a series of observations of the intensity of a certain signal with the condenser C adjusted to various positions. It is obvious that as we rotate the condenser C we will find one particular point at which the signals from a certain transmitter, T (Figure 1), are of the greatest intensity in the head receivers. At this point our receiver is said to be "tuned" to the wave length of the transmitter T, or more technically, it is in resonance with T. This point is shown on the resonance curve of Figure 2 corresponding to a condenser setting of 60.

Interference between Stations

It is noted, however, that the signal is also received with diminishing intensities on each side of

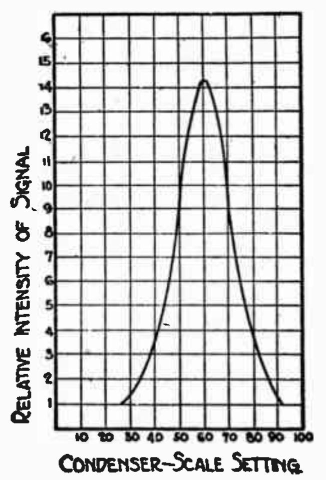


Figure 2

this point. If it happens that another transmitting station is broadcasting on a wave length which would necessitate rotating the condenser C to a setting of 70, in order to be in exact resonance, it is apparent from the curve that we will still hear the signals from T with an intensity equal to 9 and the result will be "overlapping" or interference between the two stations.

Therefore, we learn that in order to have high selectivity we must strive to make this resonance curve as sharp as possible, so that we are enabled to hear a given station at only one setting of the condenser and to either side the intensity of the station should decrease with the greatest possible rapidity. Then, by tuning to a second station operating on an adjacent wave length, no interference will exist due to the first station.

Cause of Broad Resonance Curve

It is essential, then, to know the cause for a broad resonance curve. We find that this broadening of the curve is due to the electrical resistance in the tuning circuit consisting of L and C, which is represented at R. From the study of circuits of this type with various amounts of resistance, it has been brought out that the less the resistance present, the sharper will be the resonance curve of the tuning circuit. To improve the selectivity we then reduce the resistance of the circuit as much as possible. This involves the reduction of the resistance of the coil L and the condenser C, which is effected by proper design.

Fortunately, due to the "low loss" campaign which has recently been waged, we have a fairly decent assortment of low resistance coils and condensers available on the market. For this reason no attempt will be made here to go into the merits of coil and condenser construction.

Further Reduction of Resistance

Having reduced the circuit resistance as much as possible by careful design, a further increase in the degree of selectivity will obtain through the utilization of regenerative action. In the past, regeneration has been used with the intent of increasing the volume of received signals, and little consideration was given its ability to better the selectivity by virtue of the reduction of the resistance which it effectively accomplishes.

In the application to a simple Radio receiver, we have two possible methods for securing regenerative action. The most popular method is based on electro-magnetc coupling between plate and grid circuits. Such an arrangement is shown in Figure 3. The second method is illustrated in Figure 4 and depends upon the electro-static coupling which exists by

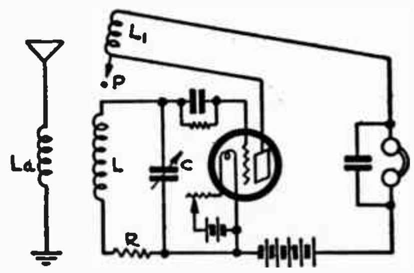


Figure 3

reason of the capacity in the vacuum tube from grid to plate. This capacity is represented by Cn.

With reference to Figure 3, the energy which is fed back from the plate circuit by means of the "tickler" coil, L1, is in phase with the signals induced into the LC circuit from the antenna coil and the result is intensified signals. This feedback of energy also effectively reduces the resistance, R, of the circuit LC. The extent of reduction depends upon the electromagnetic coupling between L1 and L. As L1 is moved in the direction of the arrow so as to approach L, the resistance R is gradually reduced, reaching a zero value at some point P.

At this point the set goes into a state of oscillation and the quality of a modulated signal is impaired, so it is necessary to adjust the electromagnetic coupling between L1 and L to a point just above P where the resistance R is greater than zero. This point, just above zero resistance, is termed "critical regeneration" and is the point at which maximum signal strength without distortion is attained. Since the resistance has been so noticeably reduced we obtain the maximum selectivity at this adjustment.

Tuned Plate Regeneration

In the circuit of Figure 4 the same end is attained, but in this case the feedback of energy occurs through the natural electrical capacity of the vacuum tube, as represented by Cn. The variometer L2 serves to tune the plate circuit to the wave length of the impressed signal. This impressed signal having been induced into the LC circuit, causes pulsations in the current of the plate circuit and when the latter is even partially tuned to the wave length of the incoming signal, energy in the plate circuit will be reflected back to the LC circuit through the tube capacity Cn. Fortunately, the natural phase relationship within the tube is such that this reflected energy reinforces the incoming signals and in that way gives rise to regeneration. The circuit resistance is also reduced as the wave length of the plate circuit approaches the wave length of the circuit LC; and zero resistance is reached even before these circuits are adjusted to resonance. By adjusting the variometer to a position just above this point of zero resistance, we have the same condition of critical regeneration mentioned in the preceding paragraph.

The use of critical coupling between the antenna coil La and the secondary coil L is also recommended for the best selectivity. This condition may be approximately realized by using a comparatively few number of turns for the antenna coil wound in close proximity to the secondary.

Conclusion

The data which has been given merely suggests the basic factors which are important in gaining desirable selectivity in a simple receiving system. It

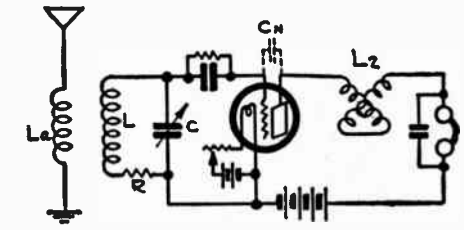


Figure 4

is to be understood that the degree of selectivity in such a receiver is insufficient under existing broadcasting conditions.

Useful Honeycomb Data

The following data has been compiled as an aid to the user of honeycomb coils. Table A gives the wave length range of the various size coils with standard capacity condensers, .001 (43-plate), .0005 (23-plate), and .00025 (11-plate).

The value .0001 is taken as the approximate capacity of a secondary circuit when the tuning condenser is set at minimum capacity (plates apart) and can be considered as the lowest wave length that may be reached.

It is possible to reach lower wave lengths than shown in table by using less turns on the coils; however, it is not advisable unless the primary and secondary and tickler values for the complete wave length range of the honeycomb coils. It will be noticed that the primary is smaller than the secondary due to the (antenna to ground) capacity which is in parallel with the primary coil.

Use of a smaller primary offers greater selectivity and gives an advantageous step are rewound with heavier wire (number 18 or larger).

Table B lists the correct primary, secondary and tickler coil combinations for various wave length ranges.

TABLE A
Wave Lengths in Meters with Following Capacities Connected in Parallel with Coils

Number of Turns in coil	.001mf.	.0005mf.	.00025mf.	.0001mf.
25	372	267	193	131
35	528	378	277	188
50	743	534	391	270
75	1007	770	560	379
100	1470	1055	771	532
150	2160	1546	1110	746
200	2870	2050	1470	980
250	3910	2800	2020	1355
300	4900	3490	2510	1670
400	6160	4400	3160	2095
500	8070	5750	4140	2740
600	11600	8300	5980	3980
750	13300	9500	6830	4540
1000	17600	12500	9000	5950
1250	20100	14300	10250	6780
1500	24200	17200	12350	8150

TABLE B
Proper Honeycomb Coils for Various Wave Lengths

Wave Length Meters	Primary Coil Turns	Secondary Coil Turns	Tickler Coil Turns
150- 250	25	25	35
200- 350	25	35	50
250- 500	35	50	75
300- 650	50	75	100
400- 850	75	100	150
800- 1850	100	150	150
1500- 2750	150	200	150
2500- 4200	200	300	200
4000- 6350	300	400	300
6200-42500	400	750	400
13000-20000	750	1250	400
18000-25000	1250	1500	500

When Phones Rattle

If there is a rattle in one of the phones, carefully remove the shell cap and the diaphram and see that there is no dust or filings between the magnet and the diaphram. Filings will stick to the magnet sometimes and, as the diaphram vibrates, will cause noise.

Aerial Must Be Taut

While the aerial is loose and sways in the wind you cannot expect to get good reception. The best way to keep it taut and yet prevent it from snapping is to hold it to the masts by a pulley and heavy weight arrangement.

A Tip Worth Knowing

Some circuits utilize a secondary coupling coil that is placed in inductive relation to the plate variometer. This coil should be wound in the same direction as the windings on the plate variometer.

Factors of Radio Frequency Amplification

Amplifying before Detection for Distance

By Thomas W. Benson

RADIO frequency amplification is a simple method of increasing the energy in the Radio receiving set before the signals are detected and the modulation wave made audible by a tube or crystal detector. Strictly speaking, an amplifier of this type amplifies the carrier waves but should be so designed as not to distort the modulation wave. The advantage of this form of amplification lies in the fact that it will not amplify currents at audible frequencies and can therefore be carried further than audio frequency amplification which is limited to two or, at best, three stages. The other features of Radio frequency amplification are that it makes the set more selective and enables one to take advantage of the square law of the detector.

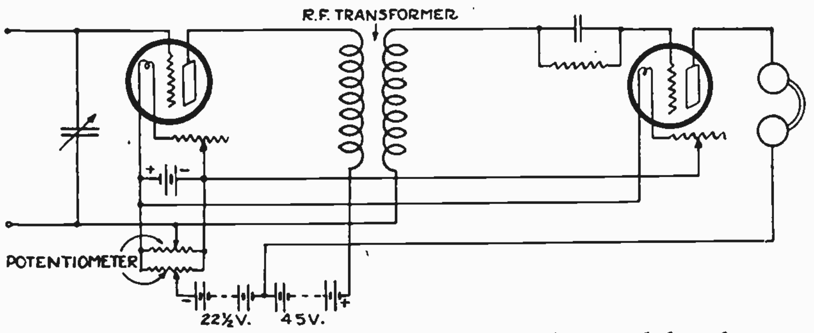


Figure 1—One stage of Radio frequency amplification coupled to detector

It is a well known fact that extremely minute Radio impulses will not cause a detector tube to function but after the impulses reach a certain intensity the response in the plate circuit varies approximately as the square of the grid potential change. Thus, when the grid charge is doubled the plate current change is four times as great. With Radio frequency amplification we can take an extremely weak signal and intensify it to a point where it will operate the detector tube at its highest efficiency. On the other hand audio frequency amplifiers can only amplify detected waves, and weak signals that do not affect the detector are not heard at all.

There are numerous stumbling blocks in the way of obtaining high amplification per stage at Radio frequencies and for that reason more stages are necessary to obtain a given increase in energy at Radio frequencies than are required at audio frequencies.

The chief obstacle is the high capacity existing between the elements in a tube itself. Actually this capacity is low but it is sufficiently high to cause trouble at Radio frequencies. This tube capacity can only be reduced by proper tube design so one has to get along the best way possible.

The use of several tubes in cascade implies the use of some means of coupling the plate circuit of one tube to the grid of the next and we have three methods in common use for accomplishing this, namely, by transformer coupling, resonance or impedance coupling and resistance coupling.

The first method makes use of small transformers either wound on a small finely laminated iron core or a nonmetallic form. The extremely high frequency of the current forbids the use of any kind of iron other than the softest, built up from very thin sheets. Iron core transformers are difficult to design for this purpose and those on the market are usually the result of cut and try methods.

Air core transformers are easier to build and are often described in the technical press. They usually consist of two coils of fine wire wound close together on a wood or fibre form. The disadvantage of transformer coupling lies in the fact that a transformer operates efficiently over but a short band of wave lengths and when a wide range of wave lengths are tuned some means are required to change the inductance values of the windings on the transformers. Thus a certain make of transformer is rated to cover a wave length range from 200 to 500 meters. As a matter of fact this transformer operates at its highest efficiency on a wave length midway between these limits and when waves either side of that value are tuned the increase of energy per step of amplification is reduced.

Radio Frequency Amplifiers

Just how a vacuum tube functions when acting as a Radio frequency amplifier may be explained by Figure 1. Here is shown one stage of Radio frequency amplification coupled to a detector tube. It will be remembered that variations in grid potential affect the plate current.

The curve of a tube, when used as a Radio frequency amplifier with a high voltage on the plate, will have the usual characteristic curve but will be further to the left of the zero line and higher. When the tube is connected into a circuit like the one shown in Figure 1, the grid potential is adjusted by means of the potentiometer to such a value that the plate current is halfway down the slope of the curve. Now when a current flows in the aerial tuning circuit it will alternately impress negative and positive potentials on the grid.

When a positive potential is impressed upon the grid it will increase the slight positive potential already there and the plate current will be increased. When a negative potential is applied it will reduce the positive potential and less current will flow in the plate circuit. The plate current will then rise and fall in exact reproduction of the current flowing in the aerial circuit, at Radio frequencies but of much greater values.

Function of the Transformer

The function of the transformer is then to transfer these currents to the second tube where they are detected and made audible. Obviously, the more effective this coupling can be made the more energy acts upon the grid of the detector tube and the louder will be the signals. When additional stages of amplification are used the same method of coupling is employed between them. We must be careful, however, to keep the grid potentials of such a value as not to push the plate current over the bends in the curve. Should this occur the plate current wave will not follow exactly the grid current wave and distortion will result.

As a rule transformer coupling is not as efficient as impedance or resonance coupling. In Figure 2 is shown a circuit employing resonance coupling or tuned Radio frequency amplification between the first and second tube with transformer coupling between the second tube and detector.

It will be remembered in regeneration, it was shown that an inductance in the plate circuit would transfer part of the energy back into the grid circuit through a condenser. In a resonance coupling we have practically the same thing except that the energy is transferred to the grid of a second tube. The inductance and condenser shown connected between the positive battery and the plate form a tuned circuit.

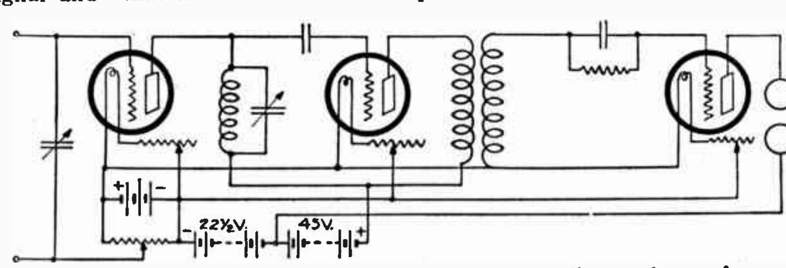


Figure 2—Two stage amplifier using tuned coupling and transformer

When the set is functioning and the plate current of the first tube varies in synchronism with the grid potentials the plate circuit is tuned to resonance by means of the variable condenser across the inductance. Due to the high impedance of this tuned circuit, the resultant reactive effect of the inductance is transferred through the condenser to the grid of the second amplifier tube. The energy from the second tube is then passed on by the transformer to the detector tube. When a fixed impedance is used in this circuit it is connected in place of the inductance and variable condenser but has the limitation of functioning only over a narrow band of wave lengths similar to a transformer.

Tuned Radio frequency makes the circuit extremely selective and, when used, the simplest form of tuning may be employed in the aerial circuit. It acts in all respects like a two circuit tuner with extremely loose coupling. Its use is not advised beyond one stage as it makes the selectivity of the set so fine that it is difficult to pick up a distant station.

Coupling Between Tubes

The use of resistance coupling between tubes for Radio frequency amplification has not the disadvantage of working only over a narrow band of wave lengths but is not usually used for the reason that it is very inefficient on waves below 1,000 meters. The principle on which this type of coupling works is similar to the others, utilizing a high resistance instead of a high impedance.

The transformer and tuned resonance amplifiers have a high impedance, that is, they offer a high resistance to the high frequency currents but have a low direct current resistance. This is, of course, due to the inductive action of the windings. The resistance coupling on the other hand offers a high resistance to both plate current and to the high frequency currents. A typical circuit using 2 megohm units as coupling between tubes is shown in Figure 3.

The operation of this circuit may be outlined thus: When put into operation there is a certain voltage drop across the coupling resistance and between the plate and filament of the tube.

Consider now that the grid of the first tube is made positive for half a cycle by the incoming waves. This draws more electrons out of the filament and reduces the resistance of the plate-to-filament part of the circuit.

The additional current flowing in the plate circuit increases the drop across the coupling resistance and this increase of voltage is impressed upon the grid of the second tube through the small fixed condenser. Thus the second tube further amplifies the wave, repeating the action through all the tubes.

This type of coupling is practically useless for short wave work by reason of tube capacities by-passing part of the current and reducing the potential applied to the grids of the tubes. Its advantage lies in the wide range of waves over which it will work but they must be above 1,000 meters. To overcome this, Armstrong devised the Super-Heterodyne circuit. The principle of operation of this circuit is rather complicated but the idea is beautiful in its simplicity.

Super-Heterodyne Circuit

The first tube in the series is connected like a simple detector tube but the grid circuit is loosely coupled to a tube that is kept oscillating. The oscillations impressed upon the grid of the first tube are of such a frequency that they form a beat current with the carrier wave of the incoming signals.

This beat current is due to the waves of the two currents coinciding and then opposing at fixed intervals giving rise to a current in the plate circuit of the first tube that is of a lower frequency than the carrier waves received. This beat current is still at a Radio frequency, having a wave length of about 3,000 meters. At this wave the current may be fed into a series of resistance coupled amplifier tubes, usually five stages, and finally detected and passed through one or two stages of audio frequency amplification. By this means the resistance coupling is made to operate efficiently and such a receiver is considered the best it is possible to build at the present stage of the art.

Some Radiophans have excellent results with Radio frequency amplifiers while others seems to fail entirely when they attempt to build this type of apparatus, as in one case, to the writer's knowledge, a fan installed a five stage amplifier and found his set worked better without it. Failure is usually the result of inattention to details and a little experimenting will often clear up the trouble.

General Rules Necessary

By following a few general rules good results are assured. Use only apparatus of known quality. Cheap instruments are usually worth just what they cost, if not less. Use only mica condensers, and tube sockets that have all metal current-carrying parts well spaced from each other.

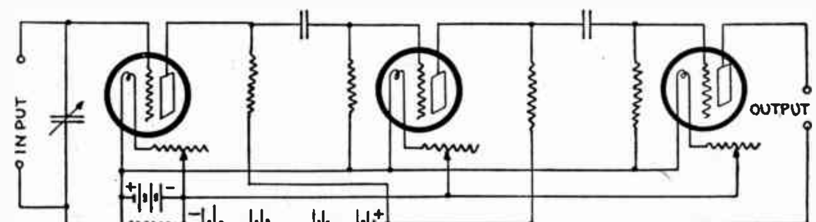


Figure 3—Resistance coupling employed with grid leaks to control grid potentials

Where but one stage of Radio frequency is desired it is best to use a tuned type of coupling thus obtaining good efficiency and selectivity for the set. More stages can be employed using transformers, if desired. Where one is willing to make the necessary adjustments two stages of tuned Radio frequency will prove highly satisfactory.

Tuned Radio frequency amplifiers have a tendency to self oscillation and this can be prevented by the use of potentiometers and by care in wiring. Keep the wires as far apart as possible, keep the leads short and make wires cross each other at right angles.

Some constructors shield their panels and instruments but from the writer's experience this is not always advisable. The use of a shield introduces capacity effects that sometimes render the amplifier useless.

The better method is to build the amplifier without shielding, mounting the tubes and other apparatus well back from the panel and lengthening the control shafts. If body capacity is then troublesome the panel can be shielded as a last resort.

Hard tubes are used exclusively for Radio frequency amplifiers with a high plate voltage, 60 to 90 volts being used. For local reception where there is plenty of energy received a hard tube can be employed as a detector with a high plate voltage to give louder signals. Where distance is the goal a soft tube in the detector stage with a lower B battery is advised.

Locating and Remedying Troubles in Sets

The Most Common Causes of Them

By Peter J. M. Clute

RECEIVING sets, like other apparatus, are subject to many ills, but a little patient search on the part of the listener in will generally lead to the root of the trouble. While it is difficult to definitely point out or cover every kind of trouble, it is the aim of this discussion to present sufficient information to enable the Radiophan to eliminate in part or entirely, some of the more common troubles. Most of these troubles manifest themselves in definite symptoms which result in some characteristic noises. Many of the faults which users of Radio equipment find are imaginary, and in a great many cases earnest endeavor to locate the fault in his method of operating his set rather than in the equipment itself, will remedy the situation.

Loose Connections

Perhaps the most disconcerting trouble is dead silence, inasmuch as it gives the operator no definite clue as to its location. In this case, it is advisable to first look over the external connections, such as those to the antenna, the ground, the telephone receivers, and the batteries, for poor contact. If after this preliminary inspection no indication of the trouble is found, the interior of the set should be examined to see if the vacuum tube is making good contact in the socket, the batteries run down, the phones defective, or the phone condenser, if one is used, is short circuited.

When the springs on the socket do not make good contact with the tube prongs, it is advisable either to bend the springs or sandpaper the prongs, as they may have become corroded. The breaking of the braided tinsel cord in the phone leads presents an unseen difficulty. This is due either to a sudden strain or to the continual twisting that the phone leads are subject to.

Weak Signals

If only weak signals are received so that the set is not working at its highest efficiency, it is probable that the A or B battery voltage may be below normal; the polarity of the plate battery reversed; the grid condenser short-circuited, the grid circuit open, or, if the set is of the regenerative type, the tickler coil connections may be reversed.

Weak signals in the detector circuit may also result from incorrect regulation of the tube filament temperature and plate potential, or the tube may be forced to work below its critical filament temperature, due to an excess of tickler coil inductance. In this case, reducing the tickler coil or cutting down the plate voltage may remedy the situation.

If the signals weaken considerably when switching on the amplifying stages, the trouble might be traced to too low battery potential to operate both amplifier and detector tubes. Poor tube contact in sockets, open-circuited or burnt-out amplifying transformers, or faulty jack contact might also be investigated.

Unusual Noises

When any scraping or scratching noises of unusual character are heard the operator should first look for loose connections. However, for the sake of convenience, such noises may be grouped into two classes, namely, those affected and those not affected by tuning. In the first group, such noises may result from too much feedback inductance, dust between condenser plates, excessive plate or filament potential, or too low an antenna capacity, thus causing the set to oscillate and make it hard to control. An excessive grid charge will cause howling and knocking, which may be eliminated by either decreasing the feedback coupling, cutting down the tickler inductance, or by lowering the value of grid leak resistance.

If tuning the set does not change or affect the character of the noise, the filament control rheostat may be defective or making poor contact; there may be loose connections on the apparatus; the grid leak resistance may be excessive, or the plate battery run down.

Unsteady operation, accompanied by crackling noises, might be traced to faulty filament circuit connections. Poor contact of the arm of the rheostat on the resistance wire can be remedied by loosening the arm and bending the contact spring. However, it is advisable, before working behind the panel, to remove the tubes to prevent any possible damage.

Crackling noises, heard when dialing the condenser, are generally caused by dust lodging in and bridging the space between the condenser plates. This accumulation may be either blown out or removed with a pipe cleaner. Adjustment of the plates will be imperative, if they touch each other as they are revolved.

Atmospheric Discharges

Atmospheric discharges cause crackling, scratching and rumbling sounds in the receivers. Such static noises are more pronounced in warm weather, but even in winter when a change of weather is about to take place, these discharges will occur and it is sometimes possible to hear them quite a distance away. No method of eliminating such disturbances has as yet been devised.

To distinguish between noises caused by trouble within the set and those external to it, disconnect the antenna and ground leads. If the noises continue, it is a positive indication that they are caused by internal trouble.

Some types of soft or gassy vacuum tubes produce noises similar to static, unless the filament battery potential is properly adjusted. The proper brilliancy to burn the filament of a vacuum tube is the lowest at which signals are distinctly heard. Increasing the filament current beyond that point does not increase the signal strength, but lessens the life of the tube considerably. A good rule to follow is to keep the filament at as low a temperature as possible, consistent with good reception. Certain varieties of vacuum tubes operate at very low filament temperatures and it is advisable to follow closely the directions furnished with each.

A steady whistling may be caused either by two stations operating on about the same wave length, or heterodyning, or the reradiating of a neighboring regenerative receiver. This sort of trouble differs from the whistling accompanying feedback effect within the set, because the latter may be varied by adjusting the tuning control. Howling and whistling within the set may be due to excessive regeneration caused by too much tickler inductance. Excessive plate battery potential; too high a value of grid leak resistance; excessive filanment potential, or too much grid charge can sometimes be blamed for noises of this character.

Trouble in Amplifying Circuits

A frequent source of trouble in audio-amplifying circuits is the magnetic interaction between the cores of the transformers, which manifests itself in the production of howls and in signal distortion. To reduce this effect to a minimum, mount the transformers with cores at right angles to each other and as far apart as possible. Transformers inclosed in a steel case should be grounded as a precautionary measure.

A high-pitched tone is often heard in amplifier circuits, in many cases high enough to blot out the signal. This is due to the voltage variations on the output side of a tube being fed back to the input side. This produces voltage variations on the grid, which are further amplified and fed back, resulting in serious disturbances.

Howling may be traced to grid and plate leads running closely parallel to each other. Separating these leads as much as possible will produce a marked improvement. The proper location of the various pieces of apparatus in the amplifier circuits will cut down the howling. All leads, especially those from transformers to the grid terminals of the vacuum tubes, should be made as short as possible.

Fading

Variation of signal strength without making any tuning adjustments may be attributed to fading effects. Such unsteady signals may be caused by the antenna or lead-in wire swaying to and from objects near it, or the lead-in and ground wires swinging toward and away from each other. Such conditions produce capacity variations in the antenna circuit, at times large enough to cause a fading signal, especially so when receiving from distant stations. Very often, during high wind storms, the antenna may swing and touch a conductor or partial conductor, and cause a cessation or partial interruption of signals.

Installation of Antenna

Receiver installation should be located away from electric lights or power wires, as they will induce humming or buzzing noises in the receiver. It is advisable to support the antenna system at right angles to any light or power wires nearby. Antennas should not be erected over or under such wires nor so located that a failure of either antenna or electric light and power lines can result in contact between them. Neither should the antenna be located as to allow accidental contact with light and power wires by sagging or swinging.

Besides trouble caused by improper adjustments or arrangement of parts, there also exists a multitude of outside disturbing factors, some of which can be eliminated by corrective measures and others which will have to be tolerated. Static or atmospheric discharges are perhaps the worst offenders of this type. Other disturbances practically beyond the control of the listeners in include trolley-line or third-rail flashings, electric generators or motors with high commutator bars or chattering brushes, electric arc welding apparatus, electric arc lamps, ex-ray equipment, vibrating types of battery charges and other similar electrical apparatus.

The flashing which occurs on trolley lines, due to the continual making and breaking of contacts, will produce steady crashes in the phones. To lessen these disturbances, the antenna should be located at right angles to the trolley lines.

In the case of electrical machines, with one or more high commutator bars or with chattering or sparking brushes, the disturbance generally assumes the form of a vigorous humming. While it may be difficult to locate the trouble exactly, it will well repay the operator to shift the position of the antenna system until the point of minimum disurbance is obtained. If the source of the trouble is too close to the receiver, the changing of the antenna will not remedy the situation. In this case, an indoor directional loop may be used to advantage, provided the set is powerful enough to operate with such an antenna.

Disturbances emanating from electric welding apparatus, electric arc lamps, and x-ray machines are very persistent offenders, which generally defy correction. Fortunately, welding apparatus and x-ray machines do not operate for any great length of time, and the harsh ripping sounds must be borne in patience while they last. Shielding and grounding may alleviate conditions somewhat in the case of x-ray machine disturbances.

Amplifying Frequencies

IT IS not so long ago—yes and even now—fans wondered what was the difference between Radio and audio frequency. Then we discovered that broadcasting covered a wave length range of about 200 to 600 meters. This is equivalent to a frequency range of 1,500,000 to 500,000 cycles, and is known as Radio frequency. Amplification of the wave at this frequency is known as Radio frequency amplification and takes places before the detector or rectification.

In passing through the detector the frequency is lowered to the range of audibility or becomes an audio frequency amplification after the detector and therefore is known as audio frequency amplification. The problems of audio frequency amplification were fairly simple in solution. Radio frequency amplifiers were not so easily worked out. For shorter wave lengths, it was found difficult to efficiently couple the various stages. Either the efficiency was too low or covered too narrow a wave length band.

Better efficiency in Radio frequency amplification was found in wave lengths of about 3,000 meters or more. This is equivalent to 100,000 cycles or less. That meant that maximum efficiency was not possible unless the wave length was raised to 3,000 meters, or ten times the present broadcasting wave length. But then transmitting stations had their wave lengths assigned to them by the government and the ideal range was assigned for other uses.

Obviously this held up matters for a while. Major Armstrong, however, conceived the idea of receiving the transmitted wave at its high frequency, and convert or change it to one of lower frequency, which would permit higher efficiency in the amplifying stages before detection.

This wave length range to which the original wave is raised runs from 3,000 to 10,000 meters, which is equal to 100,000 to 30,000 cycles. Because of the fact that it comes between what we know as Radio and audio frequencies, it has become known as intermediate or long wave amplification.

Special Transformers

The ordinary Radio frequency transformers cannot be used for this form of amplification, since they are not designed for operation at this low frequency. Special super-audible or long wave transformers are required. The transformers are designed to respond to some wave length between 3,000 and 10,000 meters. All the transformers used in one set must be designed for the same frequency.

In some cases the step-up ratios are changed or occasionally the last stage uses tuned transformer coupling.

Oscillator

This conversion to the higher wave length is accomplished by means of a separate circuit known as an oscillator. This oscillator circuit, through its tube, is a source of oscillating current the frequency of which is controlled. Its circuit is coupled to the main circuit so that the incoming wave combines with and modulates the oscillating circuit. The oscillator circuit control is then tuned so the resultant frequency is the same as that at which the super-audible transformers give maximum efficiency. The main circuit, of course, is tuned at its source for the transmitted wave or station desired.

After the last stage of super-audible amplification, detection takes place in the usual manner. Audio frequency amplification then can be applied as usual.

Insulate Lead-In

It is always good practice in bringing a lead-in into the house not to let it touch anything. If the lead-in touches any metal, some of the signal strength will be absorbed. In some cases where the lead-in touches wood there is not much difference in the signals; however, when it rains the wood has the same effect as a metal object.

Place for the Set

Many experimenters do not know that the lower the Radio set is placed with respect to the aerial the better will be the results. With an antenna 30 feet off the earth the best results are obtained if the receiver is located on the street floor instead of in the attic.

Wood Finishing for Radio Cabinets

Well Made Sets Deserve to Be Enclosed

By W. S. Standiford

LARGE numbers of Radio amateurs throughout the United States and Canada are constructing their own Radiophone sets to listen in to Radiocast music, etc., many of their outfits being very good working ones when used a few times, until the spaces between the leaves of their variable condensers and jacks clog with dust, then trouble occurs. In order to make their apparatus give the least amount of trouble, manufacturers of Radio sets enclose them in a wooden cabinet, which not only adds to their appearance, but efficiency in working.

In sharp contrast to this, many amateurs do not enclose their outfits in a case, but try to keep the dust away from the delicate parts by frequent cleaning, a process that not only wastes time, but is liable to press some wires too close together and out of shape, thus making other difficulties, such as buzzing sounds, during operation. As a general rule, most Radio novices can make neat looking cabinets but fall down in their finishing work, which is very crudely done and mars the appearance of the completed article. As this is due, in most cases, to a lack of knowledge of the processes and materials needed to do a good job of varnishing and polishing, rather than to any carelessness, there is no doubt but that the information given in this article will supply a long-felt want of Radio constructors.

Varnish for Finishing

Varnish is used as a base for many finishes, whether it is used for automobiles, furniture or Radio outfits. When learned, this work is very easy to do, but certain precautions have to be taken if a satisfactory and neat looking job is desired. It is of the utmost importance to have a clean, smooth surface in order to get a first-class finish. At the outset, it cannot be emphasized too strongly that a smooth exterior is necessary whether the wood is to be painted, enameled, oil-finished in natural woods or varnished.

The first thing to do is to decide upon what kind of wood the box is to be made of; whether it is open or close-grained and also if it contains any sap, as such conditions will cause different methods of working to be adopted. This is a matter of the utmost importance and should be looked into before proceeding with the finishing work. In order that the amateur finisher may not go astray, a list of open and close-grained woods is presented, the handling of each kind being described later on.

The open-grained woods are oak, ash, chestnut, walnut, mahogany and butternut. These woods require fillers. The close-grained woods are pine, cherry, maple, birch, cypress, whitewood, poplar, sycamore, redwood and beech. These, and others like them, do not need fillers, but can be finished in natural colors, or stained as preferred. Five operations in wood finishing are needed, although, in the case of close-grained woods, the filling process can be omitted. For varnished cabinets sandpapering, staining, filling, varnishing and the final polishing comprise the list. Directions for each process will be given in rotation as the work progresses.

Preparing the Surface

Plane the wood as smooth as possible, then tack a piece of 00 sandpaper on a smooth block and rub with the grain, using moderate pressure and taking care when working near the edges, not to round them. Wipe all dust from the surface with a cloth so none will remain to make rough spots.

Staining comes next, if pine or poplar are used, to imitate the appearance of the more costly woods. By using the former, Radio set containers can be made that will look as if an expensive natural colored wood was used. In wood finishing, much trouble in working will be avoided by the purchase of the best stains obtainable. There are two kinds of stains on the market, oil and water, each having their good points. Oil stains are those in which the coloring pigments are dissolved in linseed oil or turpentine, water being the solvent for the other. As pine wood, in some cases, has more or less sap, this wood after coloring with an oil or water stain, when the latter is dry, should have two coats of white shellac varnish put on, and each coat after drying is to be lightly sandpapered to smooth its grain down.

This shellac effectually keeps any sap from discoloring the finish. Varnishing, rubbing down and polishing are the things to do in the order named. The best way to use water or oil stains is to apply them with a brush and then rub them into the wood with a piece of cheesecloth. This distributes the color evenly and absorbs surplus moisture which in the case of water stains is apt to raise the grain of the wood, thus making more sandpapering necessary, and also makes a more uniform color tone. If the first application does not give as deep a color as desired, give it another one. If the amateur desires to use an open-grain wood such as mahogany or walnut, using stains to make them deeper in color, the pores will have to be filled after staining; otherwise, staining can be omitted, but not filling, which is necessary. Supposing that such a wood has been stained, get a paste filler of a color to match the stain as nearly as possible; put some of the filler on a piece of cloth and rub it on the wood. As soon as this filler has dried a little (don't let it get hard), continue to rub the surface until all pores are filled up, rubbing off any surplus, the main idea being to have nothing but the pores contain filler.

Applying the Varnish

After it is dry and smooth, give it a coat of white shellac varnish, which should be rather thin. If it is thick, dilute with alcohol. All surplus varnish must be wiped off the brush before applying to the surface; for if too thick a coating is applied it will not be clear and will allow the stain to show. The first coat of shellac should dry in about three hours, after which put on another coat. Rub the dried surface with the finest grained sandpaper until the wood is smooth. Don't rub too hard or the shellac varnish will be cut through. Varnishing comes next. Good brushes should be used. Cheap ones will not give good results as the bristles coming out will cause trouble. The varnish must not be too cold as this prevents it from flowing freely. Have enough varnish on the brush to just give a level coating when it is brushed across the grain. Finish off by rubbing lightly with the grain, letting it dry 30 hours or until hard.

Hand Rubbed Finish

Purchase some FF grade of pumice stone at a paint store, some linseed oil and a rubbing felt. Dip the latter into the oil, then in pumice stone which will now adhere to the felt. Rub your varnished surface lightly along the grain and continue this process until all small depressions have disappeared. This may be observed by looking diagonally over the wood's surface when it is held to the light. All hollow places will now show as dark spots. The surplus pumice stone is to be removed with a soft dry cloth. Give it another coating of varnish and repeat the operation with the pumice stone. The cabinet will now have a "dead" non-glossy finish.

Those who prefer a shining polish can easily obtain it by dipping a piece of felt into linseed oil and powdered rotten stone and going over the surface in the same manner as with the pumice stone. A higher polish can be obtained on the last coat by giving the rotten stone treatment and then rubbing the hard varnish with a soft cloth dipping into linseed oil, using plenty of pressure until a high polish is obtained. The surplus oil ought to be wiped off with a chamois skin. The foregoing gives a durable finish; one that will not scar easily.

If all the work has been done carefully the Radio will have a neat looking cabinet that will compare well with the purchased article. The work will also look good to one's friends who do not understand polishing work. Varnished and polished woodwork of all descriptions should not have any strong soap powders applied for cleaning purposes to remove finger marks as it will turn white in spots. Use nothing but a good furniture polish which will clean it very nicely and restore its finish at the same time.

Selectivity with Wave Trap

IN the ordinary receiving set, all signals picked up by the aerial are free to run through the primary coil of the receiver; some selectivity is obtained by tuning the set to respond to the particular wave length or frequency desired. However, if some particular signal is very strong, it will force the receiver to respond regardless of the tuning. Although there are receivers built that are selective enough to eliminate this troublesome interference, the simplest and most effective means of elimination is to stop these interfering signals before they reach the receiver. In order to do this, we cause all signals to first pass through a simple resonant circuit known as a wave trap; by tuning this circuit to the frequency of the interfering signal the troublesome energy is absorbed before it reaches the receiving set whereas all other signals will come through without losing their energy.

In construction, the wave trap is a very simple device, consisting of a coil and a condenser. The condenser should be of the variable type of 23 plates and preferably should have a vernier attachment for fine adjustments. If a larger condenser is available, such as the common 43-plate size, it may be used, but will be harder to adjust properly.

For making the coil procure a round tube of some insulating material such as bakelite, formica or even ordinary cardboard (a round oatmeal box will serve nicely); this tube should be about 3 inches long and from 3 to 5 inches in diameter. If a 3-inch tube is used, wind about 40 turns of number 24 or number 26 insulated wire on it, or if a 4-inch tube is used, wind on only 30 turns; in other words, the larger tube requires a less number of turns and the small tube requires a greater number of turns.

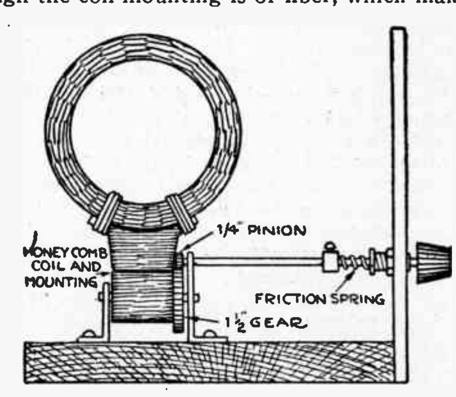
The next step is to connect one terminal of the coil to one terminal of the condenser and also to the antenna. The second terminal of the condenser and the remaining terminal of the coil should be connected together and also to the antenna binding post of the receiving set. Your wave trap is now completed and ready for operation.

Possibly you are skeptical regarding the ability of this simple device to eliminate the powerful signal of the nearby stations, but just try it. As you turn your set on, you will hear the nearby station as usual, but start turning the condenser of the wave trap and soon you will come to a point where the signals begin to grow fainter. Continuing carefully from here you will finally reach a point where the signal cannot be heard. Leaving the wave trap condenser at this setting and tuning your receiver as usual for distant stations, you will not be bothered by the local station until the position of the wave trap condenser is again changed.

Gear Attachment for Vernier Drive on Coil

The accompanying illustration shows a vernier tuning device I am using on my Flewelling set. I find with this arrangement that much more satisfactory results can be obtained from this set from the standpoint of volume and stableness of the set. The hand capacity effect on the coils is entirely eliminated with this arrangement, and the shortest possible leads can be had.

In referring to the sketch, the shaft that extends through the coil mounting is of fiber, which makes the



gearing and knob insulated from the circuit. A friction spring is used to hold the coil in any position that it is set. I use the gearing arrangement on the tickler coil in order to make the well-known grid circuit as short as is possible. The tickler coil has pigtail connections.

This arrangement can also be used to make the coils work like scissors by putting the large gear shaft through the width of the mounting instead of the length of the mounting as shown.

Care of Receivers

Having purchased 'phones let us take good care of them so they may give long and satisfactory service. Handle them carefully and do not knock or jar them excessively. Vibration will weaken the magnetism in the permanent magnets and reduce the sensitiveness of the receivers. Do not test the 'phones by connecting the cord tips with a B battery, for strong currents in the wrong direction tend to demagnetize the magnets. Since the pole pieces are kept magnetized, a current in one direction in the windings will assist the permanent magnets but a strong current in the opposite direction tends to reduce the magnetic effect and demagnetize the magnets. For this reason the receivers are fitted with marked cords, the cord with the red thread being connected to the positive "B" terminal. The current in the plate circuit will then tend to help the permanent magnets and the 'phones will retain their sensitiveness. With crystal detectors this is not important; the 'phones may be connected either way.

Should it be necessary to remove the diaphragm at any time do so by sliding it off carefully. Do not attempt to lift it with the finger nail for it will be bent and the efficiency of the instrument reduced. In replacing the diaphragm slide it into place to prevent bending it.

The 'phones should not be pulled around by the cords. The conductors are made from tinsel; excessive pulling or twisting causes the tinsel to break. In time loose contacts will develop that cause annoying sounds by reason of the circuit being made and broken with each movement of the cord.

Single 'Phones for Loud Speakers

Many fans make a practice of using a headset as a loud speaker by mounting it in a horn. The heavy currents they are called upon to handle will often render them unfit for DX work despite the ruggedness of the receiver under ordinary conditions. It is better practice to reserve the headset for long distance reception; for loud local reception, make use of a single receiver, similar to the Baldwin, mounted in a horn. To reduce the amount of current in the headset use is made of jacks but one should be careful in wiring in the jacks to see that the same spring in all the jacks is positive and that the cord with the red thread is so connected into the plug that it will make contact with the positive spring when the plug is inserted in the jack.

When putting the receivers away do not throw them into a box or drawer with other objects that may strike the diaphragm and dent it and then expect the 'phone to do good work.

Sockets and Rheostats

TOO often a socket is considered simply as an arrangement to mount a vacuum tube and make connection to the tube terminals. This would be very true were the tube an electrical device operating on low frequency currents but when a device must carry currents with frequencies ranging up to a million cycles per second there are many other factors that enter into the design than the method of making connection to the tube prongs.

The first requirement of a socket is that it should be a good insulator. For this service we have no better material than bakelite or the similar substances derived from phenol which means the socket should be of the moulded type. Porcelain is likewise excellent for the purpose, but the difficulty with this material is that it cannot be worked as accurately and the sockets are not uniform in size.

We learned previously that bakelite is a poor substance to have near conductors carrying high frequency currrents but a compromise must be made in this case to obtain its high insulating value. There are many sockets having the appearance of moulded bakelite but a simple test is to touch a hot soldering to the base on the underside and the odor of formaldehyde will be noticed. Anyone who has drilled a bakelite panel will recognize it instantly. Other materials used in moulded sockets usually make themselves apparent by their distinctive odor when heated.

Capacity Effects in Sockets

The next thing a socket should be examined for is capacity effect. As stated in previous chapters any two conductors placed close together will have capacity between them. Therefore every socket will have a capacity effect between the metal parts imbedded in it. Such capacity effects are not so important in sockets used in audio frequency stages because the currents dealt with have a comparatively low frequency but for Radio frequency amplification the capacities present are very important. The use of metal shells is to be condemned.

True the base of the tube is metal cased but the metal shell of the socket can be eliminated and thus reduce the capacity between the terminals of the socket. The interterminal capacity of a socket will depend upon the design of the contacts and their proximity. The terminals should be widely spaced to separate them as much as possible and the contact springs should preferably be flat. With this construction only the edge of the springs act as condenser plates and the capacity is kept down.

Mention might be made here of the practice of using adapters to mount the C-299 and UV-199 tubes in standard sockets. The fact that the contacts of the different types of tubes are arranged differently makes necessary the placing of the contact springs in the adapter in such a way that the capacities are greatly increased. This offsets entirely the real benefit of using the small tubes with their low inter element capacity. Always use the proper socket for the tube used.

Contact with Tube Prongs

That a socket must make good contact with the tube prongs is almost self evident. Many manufacturers have gone to an extreme in this direction and built sockets with high capacity values, although the contacting members are very efficient from the standpoint of current carrying ability.

The simplest arrangement is the best. Laminated flat springs are entirely satisfactory if certain points are observed. The tube prongs are usually rounded on the ends. If these are flattened on the bottom by rubbing the prongs with a fine file they make a good contact with flat springs and the connections offer no resistance to the flow of current. The springs of course should be of phosphor bronze which resists tarnish and retains its resiliency.

Sockets for dry battery tubes should be mounted so as to absorb vibration. While this is not so important with the larger tubes it often assists in eliminating disturbing noises due to tube vibration. Avoid the use of sockets that use the contact springs to form a resilent mount because they increase the capacity of the socket. Soft rubber pads under the sockets is the best and simplest means to give the proper resiliency to the socket.

Finally the socket should be mechanically strong. It should be reinforced where the pin on the tube shell latches in and have solid sections for the mounting screws to prevent breakage. These socket details may not seem important but the expert Radio man always keeps in mind that it's the elimination of the tiny losses in a set that makes it efficient and in the present day multitube sets socket losses play a large part in results.

Function of Rheostats

And so with rheostats. They function simply to control the filament brilliancy but the operation of the tube depends upon the electronic emission from the filament for its operation. There are two chief uses of the rheostat that determine the design. When used to control the detector it should permit of accurate control of the filament current, while with amplifiers the necessity for accurate control is not as great.

Of the two chief types of rheostats, namely, carbon and resistance wire rheostats, the former is preferable for detector tube control, the latter for amplifier tube. When the wire type is fitted with a vernier winding they can be used satisfactorily with detector tubes.

The advent of the dry cell tube requiring a high resistance rheostat has eliminated the necessity for vernier attachments because the fine wire gives a vernier control over the whole range. The fact that these tubes are all hard tubes makes the filament control less critical than with the soft detector tubes. In selecting a rheostat for a certain purpose these factors should all be considered. For soft detector tubes the carbon type is unquestionably the best. Where a hard detector tube is used or dry cell tubes are employed a wire wound rheostat is entirely satisfactory.

Calculating Wire Resistance

It is possible to calculate nicely the resistance of a rheostat to use with a given tube or given number of tubes but the writer believes the best method is to follow the tube manufacturer's instructions in this respect when a single tube is used. Where more than one tube is used on one rheostat the following rule will give the proper rheostat resistance. Divide the resistance of the rheostat recommended for one tube by the number of tubes to be controlled at once and the quotient is the resistance of the rheostat to use. If none of the exact resistance is obtainable take the next highest resistance that can be purchased. As a rule the detector tube should be on a separate rheostat and the amplifiers controlled separately, that is, all the Radio frequency tubes on one rheostat and the audio frequency on another.

To reduce the number of controls on the panel of a Radio set recourse is had to the so called automatic rheostats. These consist of a fine wire sealed in a vacuum which is connected in series with the tube filament. Their action depends on the fact that the resistance of certain alloys increases rapidly with a rise in temperature. Therefore, should the current through the tube exceed the proper amount the wire heats up and the increase in resistance reduces the current through the tube. As the storage battery falls off in voltage, the current is reduced and the wire cools slightly, passes more current, and keeps the current constant. Such control is entirely satisfactory for audio frequency, and Radio frequency amplification under certain conditions, but is not recommended for the latter purpose.

What to Expect of Your Radio Set

RADIOING has become America's greatest sport, not only indoors but in the open as well. Simplification and compact design has made all its pleasures available at the seashore, in camp, on ship board and while touring. It will continue to remain our greatest sport for years to come, for in no other pastime, if you wish to call it such, will be found such genuine entertainment, educational advantages, up-to-the-minute information with the elements of skill and chance intermingled.

What to Expect from a Set

Just what you can expect of any Radio set depends upon so many factors, some within and more beyond the control of the operator that the practice of rating sets in miles range is rapidly dying out. When one stops to consider that the range of a set depends upon the nature of the ground in the vicinity of the set; adjacent buildings, trees and other obstacles; the time and kind of day; the condition of the apparatus itself and the skill of the operator; the difficulty of rating any particular set as to its range is impractical.

The true rating of a set is its consistent range, that is, the distance it will receive day in and day out, winter and summer, day and night, and this figure rarely exceeds 10 per cent of the distance that can be covered under favorable conditions.

There are, of course, other elements entering into the question of range. There is the matter of power at the broadcaster, a set that will receive a 1,000-watt station 500 miles away will not receive a 500-watter as loud over the same distance under the same conditions. Furthermore, the range of a set is about doubled at night and is greater over water than over land. In addition we have the problem of selectivity. The range of a set that is not selective is naturally decreased by reason of local broadcast stations drowning out the weaker signals from distant stations.

Since the majority of the above range factors are beyond the control of the set owners it is advisable to spend a little time in improving every detail that will give increased efficiency and the greatest satisfaction to the Radiophan. The purpose of the following article is to point out methods and means for getting the highest efficiency from the receiver and help in the selection of the proper apparatus most suited to the particular needs of the purchaser.

Reliable Apparatus Necessary

Experience has taught many that good results are possible only when good reliable apparatus is used, properly installed and cared for and a little patience until the knack of handling the apparatus is mastered. Just what constitutes the best apparatus is often a problem to many and it can best be answered by advising one to buy apparatus that is backed by the old established manufacturers. Unless one is qualified to judge of quality of material and workmanship it is best to rely on a concern that has gained a reputation by its long existence in a given field.

The day will come, and it should not be far distant, when every Radio instrument will be so labeled that one can determine its characteristics at a glance just as all electrical apparatus is labeled in the commercial field. Thus condensers would have plainly marked their maximum and minimum capacities, re-displacement, inductances their inductance in millihenries and their resistance at certain Radio frequencies. Likewise a Radio set could be rated as to the damping in its tuning circuits to give an idea of its selectivity and some means devised for rating change of current in the output or phone circuit when a standard Radio impulse is impressed upon the input or aerial circuit. Then one could specify a receiving set to meet requirements just as one now specifies a motor for a given service.

Impossible to Give Actual Ranges

It would be impossible now to give actual ranges for any given type of receiver that would mean anything, so the best advice is to buy or build the very best set one can afford. Where one lives in a large city, with broadcast stations within a few miles, select a set that is designed for selectivity, otherwise it will be practically useless for DX work. When a receiver is desired for local work only selectivity is not so important and can be sacrificed for simplicity in control and reduction in the number of tubes. Where the set is to be installed ten miles or more from a broadcast station it need not be extremely selective with the result that the range will be increased.

As a general rule the selectivity and volume of a set vary in inverse proportion to each other. That is, in order to get selectivity some volume must be sacrificed and vice versa, by decreasing the selectivity greater volume is possible provided no locals are located within ten miles or so to cause excessive interference.

Use Tinned Lugs in Set

It is surprising how many Radio set builders make the great mistake of soldering the various wires to the heads of screws. The majority will say this is all right, providing the heads of all screws are carefully sandpapered before attempting to solder a wire to them.

If you are desirous of saving yourself a lot of unnecessary work and trouble don't make connections in that way. If you want to make a neat job of the set you are building, use small "tinned lugs."

Watch Your Jacks

Jacks frequently cause great trouble by reason of one of the contact leaves or springs failing to make contact, or being so closely spaced that a spark discharge takes place.

The contact points of the best jacks are made of silver. Atmosphere in a home where small amounts of gas fumes are present will corrode these contacts. Sea or salt air will cause corrosion very quickly during the summer time.

Headset Troubles

If there is a rattle in one of the phones, carefully remove the shell cap and the diaphragm, and see that there is no dust or filings between the magnet and the diaphragm. Filings will "stick" to the magnet sometimes, and as the diaphragm vibrates, will cause noise. In putting in the phones, see that the colored cord goes to the positive terminal of the B battery and the other to the plate of the last tube.

A Good Aerial and How it Should Be Erected

What kind of aerial do you use?

This is a highly important question and should be given careful consideration by every Radiophan.

The lead-in, even though it is insulated, still acts as a part of the aerial, and if you happen to live near the ground floor of an apartment house and find that it is necessary to use an extremly long lead-in to reach the aerial on the roof, you might better forget the aerial altogether and simply use the lead-in.

The ground wire also acts as an aerial, or rather counterpoise in this case, and if you have an extremely long one, just try disconnecting it from the cold water pipe and see if you do not get practically the same results.

A single straight wire is the best for all around receiving. There is no question about that, but there are different ways of taking off the lead-in. If you take this from the middle it means that you are really using only about half of the aerial. The effective length of the antenna has been cut in half, the capacity doubled.

It is possible to have the aerial and lead-in all in one length, if you can get a single piece of wire long enough. By running the aerial wire through the eye of the insulator at the "near end," it is possible to keep right on with this wire and drop it down to the outside of your window, where an insulated wire will have to be attached. By doing it this way, rather than attaching a separate piece of wire to the aerial, you will save one joint and make things just that much easier, for both yourself and the broadcasting.

Every joint in both aerial and ground lead should be carefully soldered.

Universal Log Sheet for Any Type of Set

Station Call Letters	Location	Wave Length in Meters	Frequency in Kilocycles	Dial 1 or Loop	Dial 2 or Lower Oscillator	Dial 3 or Upper Oscillator
WBBM	Chicago, Ill	226		2	9	
WENR	"	266		12	12	
WSBC	"	269.7		2	25	
WLS	"	344.6	500	25	25	
	"			23	58	
WQJ	"			55	58	
WJZ	New York N.Y.	454.3	1000	60	45	
WEAF				60	47	
WJB				60	60	
				78	83	

Station Call Letters	Location	Wave Length in Meters	Frequency in Kilocycles	Dial 1 or Loop	Dial 2 or Lower Oscillator	Dial 3 or Upper Oscillator
WLW	Cincinnati Ohio			49	51	
KOA	Denver Colorado	322.4	5000	23	27	
	" "					
WCAE	Pittsburg Pa			59	62	
WASI	Cincinnati Ohio			23	56	
	Canada			30	34	
KFKX	Hastings Neby			15	15	
WBAP	Fort Worth Tex			65	68	
WDOD	Chattanooga Tenn	256		10	63	
WOAI	San Antonio Tex	394.5		40	33	
WMBF	Miami Beach Florida	384.4		38	79	
WOC	Davenport Iowa	373.6		67+	674	
WGY	Schenectady N.Y.			36	31	
WSM	Nashville Tenn	282.8	1000	12	16	
WGHP	Detroit Mich	270	1500	13	14	
WPG	Atlantic City N.J.	299.8	500	19	18+	
WSB	Atlanta Ga	428.3	1000	7	8	
WJR	Detroit Mich	516.9	5000	70	11	
WOC	Davenport Iowa	483.6	5000	65	8	
WOOD	Grand Rapids			11	11	
KPRC	Houston Texas	296.9	500	18	17	
WDAF	Kansas City Mo			32	29	
WEAR	Cleveland O }			39	42	
WTAM	" O }					

Universal Log Sheet for Any Type of Set

Station Call Letters	Location	Wave Length in Meters	Frequency in Kilocycles	Dial 1 or Loop	Dial 2 or Lower Oscillator	Dial 3 or Upper Oscillator	Station Call Letters	Location	Wave Length in Meters	Frequency in Kilocycles	Dial 1 or Loop	Dial 2 or Lower Oscillator	Dial 3 or Upper Oscillator