Radio Receivers

How to Make and Operate

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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, 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.
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Simple Explanation of Radio Reception

"What Is This They Call Radio?"—Chapter 1

By P. E. Edelman

A RADIOCAST listener was showing his new set to a friend. "You see that light in the detector?" he said, "that shows the receiver is working properly." The friend, who was familiar with the operation of a phonograph, asked, "How can you tell the difference?"

Everybody knows that Radio is essentially a means of communication or carrying intelligence, and that Radio stations are simply a means of collecting and sending out information, entertainment, music, sports, lectures, and all the other things that are conveyed in conversations. Many of these conversations are conveyed in conversations that are conveyed by means of sound waves which are in turn conveyed to the air. There is no reason why any reasonably small expense can install a receiving outfit to hear what is daily Radio cast.

The next lesson in the radio class, was a talk on the small radio sets. "This is the largest set," said one of the students. "This is the latest model."

The professor, who was the largest set, said, "This is the latest model."

"The best way to understand the radio receiver is to understand the fundamentals of the science."

"What Is This They Call Radio?"

LOGICAL question for every new fan in the abstract, but not within the new fan, not the Radiocast listener who has been interested in this for years. One of three years, much more of Radio, and I wonder, who programs are "on" and who programs are "off" radio, to hear these programs.

One of the features of radio broadcasting is the ability of the radio to carry and broadcast the speech of the people. The radio is able to carry and broadcast the speech of the people, and this is why the radio is called a "radio." The radio is able to carry and broadcast the speech of the people, and this is why the radio is called a "radio." The radio is able to carry and broadcast the speech of the people, and this is why the radio is called a "radio.

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(Continued from preceding page)

be used. Radio energy is a wave motion which can be considered as extreme light or radio 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 cycles, 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 wavelengths; 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 red, 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 conveyer. 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 cause the waves of air to vibrate.

Now, vibrations are regular series of waves, and are sometimes called oscillations. Instead of speaking from a blacksmith's forge, Figure 8, in cooling down from dull red goes through a range in which the particles of length and weight, in it is the only wave that cannot be seen. It is an extremely high frequency.

In Figure 7, there are illustrated three widely 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 386-meter wave length this amount is closely 386,000,000 cycles per second. In Radio, high frequency energy or vibrations as used in Radiocasting are variously expressed as 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 Radiations of suitable apparatus, the way this is done is important. The common range of radio 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 horseshoen taken string near the other end. The string can be arranged at the other end, and 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.

In Figure 11 a diaphragm is shown in circumstances 1 to 2. A voice puts air against one side of the diaphragm as shown by 2 and air on the other side is pulled 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 Pulsaions

Electrically this is done in much the same way. The diaphragm is arranged to distort 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 constant 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 ex-

The Radiocast listener may regard the term "ether" as meaning space. In such sense, ether exists everywhere in and around the earth, in it, and in everything in it. Material things which have sound vibrations contains ether or space voids. Consider two bushel of air placed next to each other and the ether between them. Obviously there are air spaces in the basket containing carrots. Though apparently full there are certainly voids or spaces and pockets of air which contain air, an ether. Go farther, one can regard any idea or any piece of an idea, for example, as containing more or less ether or space. Dense materials have less ether voids in such a volume. It suffices here to regard ether or space as containing everywhere.

What Is Meant by Electrons

Explanations of Radio are based on the theory of electrons. The term electrons can be understood as
moving rapidly laterally and comprise Radio currents. The enormous number of electrons in even a single piece of rough-faded teeth. If there was an instrument so that one could look into a piece of copper wire and recognize what was there, a crowd of matter. The Radio molecules were found mingled with electrons. If more electrons were poured into 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 move so fast that 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 are formed by tiny dots 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 this is an electric current. Another thing is that the action of vacuum tubes depends on a certain type of electron flow.

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, 500,000 cycles. At it 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. The point in the voice envelope 3-4, the radiation is too much, as shown by 1-2. Many Radiocasting 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.

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

This aerial consists of a span of wires insulated at the earth. When the aerial is charged and discharged, it becomes charged and discharged at the rate of the current being thrown up and down the waves. The aerial in use is a 50 cycle alternating wave. The aerial is charged, then at 50 cycles a second.
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 that a magnet is used for tuning. Inductance coils are also used in amplifier transformers, heads, and loudspeakers. Inductances 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. Magnets, as is known, attract iron or can pick up pieces of iron. One end of the magnet is called the north pole and the other the south. Invisible lines of force pass from the south to the north pole. Figure 15

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

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

Now if a current of electricity through a coil makes a current of like nature, 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 apparatus is often in the form of transformers or coupled, variocouplers, etc. In Figure 17, transformer

action is shown. Suppose a second coil 2 is brought near coil 1, as is shown in Figure 16. Then if 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 2 in the opposite direction, a similar change of direction of the current set up or

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

The magnetic coupling means in a sense the connection between two coils by a magnetic field of force. Though the two coils or inductances is 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 18, two coils at right angles to each other have very small coupling so that only

a small compass needle.

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

Figure 20

Figure 21

Inductance so far has been mentioned as in a coil. But a straight wire also has inductance. The longer the wire the greater is the inductance. 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 farther.

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 assumed as an aerial, this part of the field will be thrown off as waves. Inductance is practically never found without a condenser effect term 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 little 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.

Now act on the other.

Looking at Figure 25, the effects of two coils on each other is shown.

If act on each other.

When the effect of the current in one coil is sent out from one coil and interferes with the current in the other, it is called an alternating current. An alternating 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 isRadio current, the output from the second coil will be Radio current of the second frequency. If voice current is sent through one coil, the second coil couples to it, the result is that 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.

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 increase in the capacity effect. Capacity effects are usually not wanted in Radio inductances so various special forms are

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, curvilinear, etc. designed to minimize capacity effects. Figure 31, a honeycomb coil. A similar coil called D. L. or duo-lateral, alternates the spacing of

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 increase in the capacity effect. Capacity effects are usually not wanted in Radio inductances so various special forms are

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successive layers. An easily constructed coil is the spiderweb, Figure 32. It is wound on a disc with an

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

Varactor and Variocoupler

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

(Continued on next page)
A condenser is a capacity or device for temporarily holding electricity. A large condenser holds a big quantity of electrons much as a gasoline jar holds water. A tiny condenser can only hold a small amount of electrons, corresponding, for example, to a thimble full of water.

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 un-equally 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 electricity 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 reverses itself. Following an un-equally 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 electricity on each plate. This is then accomplished externally by connecting a suitable circuit around the condenser plates.

Receiving Sets and Condensers

Every receiving set contains at least two condensers.

1. **The two wires in a telephone cord such as is used in Radio receiving sets are considered as a condenser.** As illustrated in Figure 46. So do two close parallel bus-bar connecting wires as form a tiny Radio condenser, as in Figure 47. Sometimes such tiny condensers can pass considerable Radio frequency current.

2. **Another small condenser is usually 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 variable or adjustable condensers to vary the 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 capacity. Thus for the same dimensions mica can hold a greater dielectric strain than air. Some materials, as paper, are not good dielectric because they absorb and dissipate energy. Figure 49 diagrams the popular type of plate variable condenser. Figure 50 shows one of the smallest.

- **Combinations of two or more condensers** 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 capacity of the one and coil combination may be more finely adjusted.

- **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) with it. The hand insulated from the receiving set makes a tiny condenser, number 2, with it. The hand and its batteries will usually make a condenser, number 3, with the ground. This has an interfering effect in tuning some sets and can be avoided by grounding the... (Continued on next page)
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 of 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—21-plate, 43-plate, etc., but this is less precise than to say .0005 microfarad, .001, etc. Many fixed 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 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 at one 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 hard 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 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.

There is a fundamental relation of resistance to current and voltage, called Ohm's Law. This is illustrated in Figure 70. When a battery having 6 volts of 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.

**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 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 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 flows 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.

**Heads used in Radio are often designated as 2000 ohms, 4000 ohms, etc. This is the usual measure of the merit of the phones, but expresses the direct current resistance offered by the windings thereof.**
much the same principle and is really not dry but moist, with the electrolyte in the form of a gelatinous like mass. The usual forms of dry cells have the zinc plate outside, as a case or container, and also comprise certain auxiliary chemical agents or depolarizers to assist the desired action.

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 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 to 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. A battery can be charged, that is to say, a new peroxide coated can be applied to one lead plate by passing electricity from an outside source through the battery, thus changing the condition of the entire cell to a charged condition. A storage battery really stores chemical energy rather than electricity. When fresh a dry cell usually affords slightly better than 1 3/4 volts at the terminals but cannot supply a steady current for long running down.

When freshly charged a storage cell, affords close to 22 volts and can give a heavy steady current for considerable time. Batteries also have what is called internal resistance. In the case of B batteries, the A battery is the one that is called internal resistance. 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 battery are run down oftener than do B battery cells because they furnish a heavier current then they should.

Series and Parallel Connections

Figure 72 shows 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 for 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 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 the weakest cell, but it then sets 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 microammeter operates; that is to say, by this variable battery resistance. The diaphragm is bumped and results in a so-called noisy B battery because a rumbling is heard in the headsets from the fluctuating plate voltage. Dry cells used in this way are not to be expected of being used to dry 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 being used in a single line connection, Figure 73. When connected to a coil of many turns as in Figure 73, a magnet is formed 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 this principle.

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, then it is reversed back and forth. This can be fixed in mind by analogy to two different kinds of saws. A hand 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 to a positive resistance or whatever the capacity and inductance are in proper relation. If alternating current is applied to a circuit containing both resistance and inductive reactance, then shown in 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 inductive 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 tuning Radio sets, a condenser is often combined in certain size with a coil for this effect, which is called "resonance." I. e., for a certain frequency the condenser effect and coil effect is balanced.

Another form of electronic 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 bears 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 to, after filling up the inside of the bulb and particles fly back into part of the filament, they form a so-called space charge in the 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 nothing but a large quantity of metal which can pass to the positively charged plate. The plate battery can then send a current through the electron flow, this current being 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 wire pipe, representing a condenser in the wire circuit. A direct water flow will stretch this condenser in one direction and then the water 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 a paddle wheel. In the same way, alternating current is made to work sufficient construction in the motor changes the alternating motor source into a condenser in current through it.

There are other devices which can change an alternating current effect into an equivalent direct current.
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 diagrams when the essential circuits are known. A circuit is a complete path for a flow of electrons carrying an electric current. A Radio circuit is usually made up of several individual and cooperating circuits.

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 grounded connection. When the intercepted waves act on this aerial they set up in it a high frequency or Radio current.

There is placed a convenient and proper sized plate for this Radio frequency current. This is termed the tuning circuit, 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 Radio station 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 insurmountable 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 waves are usually 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 82, only tiny and feeble Radio waves can be built up into a form strong enough to operate the detector satisfactorily.

If one combines 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 regenerating. By proper design of the circuit the two greatly differents frequencies, Radio and audio, do not interfere. 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 employed much used is termed regenerative. Referring to Figure 88, a portion of the Radio frequency current from the tuning device number 1 will not be received by the receiving 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 used. A single circuit may thus have several circuits, but the tuning is accomplished by one circuit, as illustrated in Figure 89. Such a circuit really has a tuned aerial circuit, a grid input circuit and a plate output circuit. In Figure 90 the addition of a 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 rectifying path for the Radio energy is provided. This might be further complicated with four circuit tuning, etc., but the increasing number of adjustments makes each multiple circuit tuning complicated. In Figure 93, the tuned plate circuit is 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. Returning 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.

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 musky and whistling sounds along with reproduced Radiocasting, or the use of less coupling, or the em... (Continued on next page)
RADIO RECEIVERS—How to Make and Operate

(type and thousands are in the bands of people who more or less innocently Radiocast a swarm of interfering Radio waves from varying 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 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, those not in technical and Fourthly, the dictionary.

Without attempting to print a Radio dictionary, one can point out that all of terms in common use.

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

ANTENNA. This term is usually written A. C. It is a current that goes in one direction, stops, and reverses in recurring cycles. Pulses, which are currents that go in one direction but vary from time to time in magnitude, are sometimes called 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.

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

ANTENNA. Means the overhead aerial wire, lead in for a broadcasting station; the antenna circuit.

ANODE. Means a point or region of the circuit where the electron stream is required.

CATHODE. Means an electrode which in a vacuum tube, is charged negatively and acts as a source of electron stream.

CIRCUIT. A. A flow of electrical units. It occurs substantially instantaneous.

CIRCUIT. May be considered as electrical elements which are connected.

ELECTRAL. A frequency of, or used for direct current.

ELECTRON. A unit of electric charge, or a group of electrons.

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

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

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

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

HARMONIC. The overtone of the fundamental vibration and can occur at Radio frequencies also. There are an infinite frequency of any wave made up of 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 condenser. It is caused by the reversed E. M. F. set up by the magnetic force of the wire collapsing back through the coil or wire. At Radio frequencies large quantities of impedance can be expected and this action is sometimes referred to as choke coil action.

INDUCTANCE. Usually describes the action of a coil.

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

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

LOOP. A coil or inductance used to intercept Radio waves and usually comprises ten to twenty turns of wire wound on a former. It is directional.

LOUD SPEAKER. Device for reproducing electric oscillations 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 action.

PHONES. The ear pieces or head set used in reproduction.

POTentiometer. A resistance device for obtaining gradual differences in F. or potential.

REED. A long, narrow plate of metal or other material used to deflect a stream of particles, such as electrons, and to pass it through a certain area.

RADIOCAST. Intelligence in form of sound waves transmitted by a carrier wave in such a direction.

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

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

RECTIFIER. Aside from its meaning in detectors refers to a device for changing alternating current into direct current. For storing charge, batteries, rectifiers are of magnetic, or electron bulb variety.

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 to the flow of current.

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

REFRAIN. An adjustable resistance for controlling current.

SQUEAL. Howl or WHISTLE. Undesired audio frequency current sets up in certain sets.

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

SUPER-CIRCUITS. Non-heterodyne, non-regenerative, as far as the design is concerned.

TAPES. The portion of a coil lead off for adjusting purposes.

TIGHT COUPLING. Two coils close together. When the inductance of the 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 the usual 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 accompanying.
(Continued from preceding page)ing figures. Sometimes diagrams are shown with pictures of 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, home to be drilled, dimensions of cabin, etc.

Figure 93

Figure 94a

Figure 94b

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 vacuum 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.

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 metallic tungsten filiated 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 the same diameter which requires more current for heating. The type of filament of Figure 97 comprises a platinum ribbon coated with oxides, baked thereon. Electrodes are better able to escape from such an oxide coat than from the surface of the platinum alone. The heating pushes the electrons out from the surface of the wire.

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 when the action is in a receiving set. Figure 98 shows the grid negatively charged and returning or pushing electrons back to the filament. Figure 99 illustrates grid without charge from the 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 emissions of electrons from the filament is increased or vice versa. This plate current will also be increased by a smaller or larger charge either negative or positive to the grid, because this will then control the electron flow.

A simple way to put potential on the grid is to let the thermostat controlling the filament heat be included in the grid circuit. A so-called IR drop or potential, set up by the current flowing through the thermostat, can then reach the grid. Such a potential is used as a control for the action of the vacuum tube. It could be obtained by using as grid as resistance, and then heats up, as from a potentiometer or a separate battery. This is shown in Figures 100, 101, 102.

Figure 102 shows 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, which is used to allow such a charge to discharge 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 on the grid will cause the plate current to vary in direct proportion to the frequency. The plate current, however, gets energy from the local battery and will remain greater energy at this same frequency than was applied. This is an 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 regenerative up oscillations. Power can be radiated back to such a circuit combination. This is shown in Figure 106.

The circuit of Figure 107 illustrates detector action. The radio frequency current from the detector 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. Detectors mean detecting power. 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 alternating frequency finds 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 amplification only, for signal circuits, etc. Figure 109 shows a tube with plate and no grid. It can act as a rectifier.

Figure 110 illustrates a tube with two grids, so that all three actions, detection, audio amplification, and radio amplification occur together in one tube.

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

Practical Points 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 out. 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, prices are characteristic. Some vacuum tubes changing tubes around in a set will improve the operation. Some vacuum tubes may not work when 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 any other method.

Probably the best form of aerial for Radiocast reception is an insulated wire, set up about 100 feet or more. The wire is twisted about 20 to 30 feet, or more, and then connected to some nearby object, as indicated by Figure 111. This can be done as in Figures 112, 113 or 114. Rectified Radio Frequency Alternations

To convert radio waves to audible sound, a set with an oscillator is usually used. The oscillator idea is one of the most ingenious of all electrical devices. Instead of converting the radio waves onto an aerial, we can catch them in the ground and make use of them in another way. This is done by connecting the aerial to a tuned circuit, and then sending the waves through the circuit. This circuit can be made in a number of different ways, but the most common is to use a resonant circuit, which is a circuit that is designed to resonate at a certain frequency. This circuit is usually made up of a coil and a capacitor, and the resonant frequency is determined by the values of these components. The circuit is then connected to the aerial, and the waves are allowed to pass through it. The result is that the circuit will resonate at the frequency of the incoming waves, and the resulting oscillations will be large enough to be heard as sound. This is the basic idea behind radio receivers.
(Continued from preceding page)

In many localities a so-called antenna plug gives good results. It consists of two small miniature condensers to insulate the line from the receiving set, but allow Radio frequency to pass. When an antenna plug or a 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 interconnections in the lighting circuits, 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 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 to the dimension B becomes less than that from station Number 1, but less than if it was pointed towards station Number 3.

Loop sets usually employ Radio frequency amplifying condenser of 0.01 mdh maximum size, is made by supporting 100 feet of wire spaced as turns 1/8 inch apart on a framework 3/4 inch 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 the waves cut the wire of the aerial so a Radio frequency electric current is caused in the wire and flows rapidly back and forth. Basically the process of catching waves thus comprises the step of changing them from fluctuated waves to electric waves in the input circuit.

**Detectors**

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 very small, about 3 milliamperes, 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.

Detectors are of various types but the kinds in most use today are the crystal rectifier and electron tube type. An ordinary crystal detector consists of a metal wire or metal, or a metal and metal, or metal and metal, with the proper frequency flow much easier in one direction than in the other.

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 amount of energy which can rectify as well as its ability to rectify all the Radio energy supplied to it. When two crystals, such as nickel and boron, 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 first serial circuit can flow through the detector crystal, and, 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.

(Continued on next page)
action is accomplished by a boost in energy value, or amplification.

The same siren or vacuum tube circuit in which the incoming Radio frequency energy is partially rectified and partially amplified by a beating into the plate circuit.

There are two general types of vacuum tubes, one newly ignited (hard) and the other containing some residual gas (soft). The latter are the more sensitive because they can be operated at critical potentials 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 not without an disadvantage. 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 maker specifies 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, the grid condenser return should be to the negative side of the A battery.

The detector shown in Figure 126 is 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 least 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 results 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.

**Figure 125**

**Figure 126**

**Figure 127**

**ILLUSTRATING COUPLING ILLUSTRATE**

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 input.

**Proper Procedure for Tuning**

Tuning, while at first difficult to comprehend, is a simple principle. Two different sending stations can tune well within 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 load 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 received 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 128**

**Figure 129**

**Figure 130**

**Figure 131**

**Figure 132**

**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 hang 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 in motion, only the corresponding string at the other end will build up a similar motion, while the others dangle around. If two strings pendulums are used with the same dimensions, the principle of tuned coupling is shown, as energy will be transferred by the swinging 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 electrical tuning, increasing the capacity of the coil may be required. To decrease that frequency at which an electric 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 tuned to that frequency, otherwise not. Thus the appreciation length of the aerial circuit may be adjusted to pick up certain radio frequency and reject others. In receiving apparatus, this is further extended by additional circuit tuning, and it is possible to select each individual circuit through the receiving set.

Figure 129 illustrates how a dial setting on a single circuit receiver set can be used to select detector subject only to Radio frequency of the range tuned to. Suppose to 800 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 by a powerful Radio wave front, the aerial circuit can act like a bell hit by hammer and ringing for a moment by forced vibration. A local Radiocasting station may be improved by natural pulses called static can act in such manner.

That is why secondary tuning is often resorted to. Refer to Figure 130. Dial 1, 2 and 3 can adjust the condenser of the grid circuit so that the frequencies ac-

**RADIO RECEIVERS—How to Make and Operate**

13
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 interfering signals, such as those used by Radiocasting; spark transmitters; retransmission 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. The use of a strayed signal, in its amplitude, can usually be heard whenever tuning the receiving set so that it can operate on at least local stations regularly, and get programs clearly.

Nearby transmitting stations of the old spark type (non-continuous wave) are difficult to tune out by the usual methods of tuning. Usually such fixed transmitters are built into cabinets or other buildings using oscillating receiving sets. Such sets set up interference heard as whistling swatches.

Figure 136

Figure 137

loop, because of its directional effect, is also less affected by strays. Various circuits improve the signal-to-noise ratio in a receiver. The average listener cannot place the loop in a well in the earth to get a better signal ratio against static, as shown in Figure 136. It is only in certain localities and for limited times during the day that static prevents full enjoyment of Radiocasting, as the majority of us can operate on at least local stations regularly, and get programs clearly.

The Power Voice of Radio

Amplification may be employed in a Radiocast receiver to amplify 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 outlets is on electrical amplification, and more particularly on the vacuum tube tube. As illustrated in Figure 143, the initial grid voltage on the input is adjusted to a maximum of a straight portion of the characteristic operating curve of the tube. This requires that the grid be maintained negative in certain amplifiers in order that the tube may be capable of operating 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 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 more than another adjacent range. A few curves are shown in Figure 144 by way of example. Curve A is for an amplifier which is nearly uniform in amplification over the usual audio range of frequencies, whereas curves B, C, and D are for amplifiers which approximately the same amplification change with frequency. The following are two examples, high notes in the orchestra are produced and transmitted faintly and out of proportion to others.

Radio Frequency Range

Similar coupling of a receiving to a distant station announcer, one can hear a swarm of tuning whistles transmitted by other city stations. These whistles are various decades of the broad frequency range of a distant station which is more than one frequency or higher harmonics. Figure 145, number 1, indicates the conditions in which a large number of stations occur at one time. The usual broadcast band of radio frequencies is for such a number of stations to occur at the same time. The usual broadcast band of radio frequencies is for such a number of stations to occur at the same time. The usual broadcast band of radio frequencies is for such a number of stations to occur at the same time.
Radio Receivers—How to Make and Operate

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Figure 149 shows transformer input to 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.

Uses and Benefits of C Batteries

A so-called "C" battery keeps the grid at negative potential to secure a favorable initial operating condition for 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" amplification is not much more than from one tube alone, as such will operate with one transformer, but the reproduction is clearer. When using two stages of amplification the operation is kept the same, 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 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 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 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 milliampere 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 head unit will sometimes break down when too much output 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 loud reproducer such as a loud speaker.

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 headphones 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 at a much nearer station from which an entire program can be heard without interruption.

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

(Continued on next page)
The ears of the listener. A simple arrangement is indicated in Figure 161. A number of turns of fine wire are wound around a permanent magnet to form a coil. A thin iron diaphragm is clamped against the casing so that the magnet and window 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 horn window. 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 call without putting the receiver back at all. In such case your local receiver heterodynes whatever oscillations it indicates with the incoming feeble frequency received, but the incoming frequency is not carrying enough energy to properly activate your detector or rectifier.

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

One form of loud speaker unit employs a moving coil and a cone 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.

### 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 "dyne," "dyne-m," etc., circuits hardly recognize their third cousins of the tubes, so the average listener soon decides the names as just that—other than the point.

Another flock of so-called "hero" circuits are named after their inventor, to publish a circuit. Some writers make sarcastic remarks about such circuits, etc., as they are much press agitated or trade advertised, but this is hardly police. They will effect of concentrating and focusing the sound waves in nature so that an apparent amplification results. A horn is indicated in Figure 163. The mouth A is sometimes used as a bell and the length B should be carefully curved and tapered to get good acoustical 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, as to get more uniform frequency reproduction. Any diaphragm tends to respond to certain frequencies much better than others, so that the best reproducer is one which minimizes this effect. The natural vibration of a diaphragm can be employed to the detriment of reception if a tinny horn with its own natural vibration period is used.

In Figure 165 there is a diagram of the sources of distortion and noise in a typical receiving outfit. One or more of all of these can practically 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 earphone, do not of course wear away the form in form and value. This value is either built up by supplying local energy via amplifiers but the form loss repeats.

Hearing depends on the introduction of a range of frequencies within auditory which 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 ear 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 or long periods.

The tendency of the tube to self oscillate is stopped. The neutralizing circuit can be built 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 response 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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(Continued from preceding page) Link circuits are often used in Radiocast reception but the principle is shown in Figure 179. This will lessen tendency of oscillating receivers to radiate energy and also afford 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.

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.

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

2. Amplification. audio.
3. Self oscillation.
4. Heterodyning.
5. Detecting.
6. Refracting. Radio or regeneration.
7. Refracting. audio.
8. Refracting of heterodyned frequency output.
10. Super-regeneration.

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 tube by means of small neutralizing capacities, which connect opposing windings of coupled coils. If for example the primary coil has fifteen turns of wire the secondary may have sixty (Continued on next page).
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 or if detrimental effect. The third frequency is then amplified through transformer or resistance or inductance 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 199 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 or 2000. 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 with other 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.

Radio amplification and regeneration, reflex and super-regeneration, as well as the 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 largest tubes used are limited 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 overheats, when its limit is passed. The choice of complicated circuits thus depends on various factors and simple 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 sound. Usually these two aims must be adjusted.

Dry cell filament operated tubes such as UV-199 are not recommended for Radio-cast sets. However, storage battery filament tubes such as C-301, but are often more satisfactory. For radio-cast sets, as all batteries may be enclosed in the receiving cabinet. The current required for a set of five tubes at 199, is less than for two or three tubes such as C-301. In circuits using UV-199, tubes will usually at least one or two tubes will usually be selected due to the fact that these tubes have a much cleaner sound. The tubes 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 which is usually the coldest period. Daytime which are not heard during the day will be clearly heard at night. The day's temperature affects Radio reception. Many factors influence the signal strength, such as distance from the transmitter, general weather conditions, whether the weather is wet or dry, etc. There are seasonal variations in reception. The winter months and the times of drought conditions than 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 round and why conservative claims should be made for average range at all times rather than occasional records which may sometimes be repeated for many days when factors are favorable. Reliable range means how far an ordinary Radio-cast program can be heard distinctly with tolerable minimum of interference, at any time.

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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 direction for certain general 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 "disturbance 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 Radio reception, especially in gardens, 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 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

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 capacitance. For the same reason, an antenna series variable condenser is used in the primary circuit and connected in the ground lead of the coiler, it is advisable to use the movable plates to the ground and the fixed plates to the coiler.

Disturbances of Litz Wire

Litzendraht, usually called "litz," is recommended for winding coils, but only if the strands are perfect. The high resistivity 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 either 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 new tubes produce instant 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.

Next 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 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.
Using some single stage aerials, it is easily disposed of in a single aerial, the best distance range can be had with less equipment, but subject to interference disturbances, particularly during the summer season. A place which is aerial is out of the question. The landlord will have you do it. If you do put up an aerial or have one installed, be sure that it is done substan- 

The choice of Radio outlets is divided into two types, single stage aerial and multi stage aerial set. Making your own set is not so much with the idea of saving expense as with the object of exercising your hobby that the average homemake Radio outfit is started. Others make one that has to be 3-4 weeks before the operators takers get production started. There are some who will stop a circular and put together a passably good outfit for less than $50.00 and $1000 to $5000 to make the outfit. Assembly today is a different proposition than in the old days. Well designed parts are available in finished form and often come with blue prints or layouts showing exact manner of assembly or drawing or sketch. The usual radio outfit is a cylinder and a screwdriver, a rule, and a pair of dividers, or compass. When assembled, the beginning of the work is hard. The method, the parts and the patience or assembly skill are all that is required.

In selecting a radio circuit, one should understand how to read blue prints or layouts, a few pointers will help others, who do not. All that a mechanical radio operator understands is how to read a cylinder and a screwdriver. The cylinder and a screwdriver is all that is called for.

One Tube Set

From $15 to $40, there are available completely equipped audio and detector, and dry cell operation is preferable. A tube such as WJ-12 or UV-196 can be used. The non-regenerative form may be clearer out most outfits of this kind use the non-regenerative. 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 in the reflex principle without Radio feedback is to be preferred.

Data that may be said, numbers of one tube single circuit sets using regeneration will continue in use as long as such a set has had for the same result at about the same cost, i.e., until tubes are cheaper. The beginner is certain to get a better outfit of this kind use some kind of a non-regenerative one tube single circuit regenerative type of one tube machine in an area. The beginner will not thin that it is inferior for the hobbyist in which there are no batteries or tubes to buy. The beam 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 detector.

Two Tube Sets

Two tube outfits of the reflex type will afford best results. A simple outfit, one stage Radio, audio and detector can be obtained from two tubes. Using two stages of one tube single circuit stage of Audio and stages of Audio can be had from two tubes. Two tubes permit use of one stage Radio and a regenera- 

tive 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 tube outfits can be arranged reflex fashion with Radio and two audio with detector or two Radio and three audio detector, detector and microphone. For outdoor reception, employing outside aerial, or intermediate distance reception with powerful loud speaker volume. The best use of three tubes is made in reflex combinations. Two or three tube com- binations will work at any frequency and will permit satisfactory operation with indoor loop.

Feedback can also offer stage tuning circuit, audio 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 the unrefined cabinets any of the hoi polloi might purchase on time payments. Sums may be spent on elaborate cabinets or hand made hand. They made by a very elaborate setup might be made to order to fit desire or whim. But it is possible to buy an outfit which is never going to exceed $1,000 for one installation, there is any further induc- 

Figure 205

Reading a Radio Panel Layout

Figure 206 indicates how a panel layout is dimen- 

sioned. The straight edges of the panel are taken as a line. An outline layout is made before construction, and the panel is painted 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 mechani- 
cal picture, as every important feature can be dimen- 
sioned.

Making Your Own Set

The choice of Radio circuits is not so much with the idea of saving expense as with the object of exercising your hobby that the average home made Radio outfit is started. Others make one that has to be 3-4 weeks before the operators takers get production started. There are some who will stop a circular and put together a passably good outfit for the same money.
(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 damp cloth when the flux, when the joint is completed. In soldering condenser terminals, be sure the terminals are clean, as the tinfoil may melt away in the condenser. A good way to wire is to follow the methods of the best makes of commercial and amateur sets. In following a printed instruction sheet, the exact specifications may not be available, but it is well to note variations therefrom before marking drill holes.

Assemblies are sometimes made on wood bases, or table boards but most outlets are carried on of bases. Table sizes vary in size from 5 x 7 inches to 7 x 12 inches, which can be easily assembled into a complete cabinet. Two principle materials are hard rubber and bakelite fiber, and care must be taken in drilling to "split through" as the hole is near the end of the bore.

Keep Tube Socket Clear

The tube socket should be mounted so that no connections are made which would be broken when inserting the vacuum tube. Induction coils should not be mounted too close to other parts of the set. The inner terminal connections should be so as to keep separate circuits apart and insulated from each other. If you are building an assembly for the first time, it is advisable to tackle one for which the layout and instructions are readily available. It is always well to attempt following just a circuit diagram. One reason why so many homemade sets fail is that they are built as copies of others which have never been worked

Figures 207, 208, 209, 210 show ways of using poor conductors which now be clear, another, "Try to build a two tube reflex set.

Regardless of the kind of a set, Radio outfitting is a bit tricky, as it 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 concerning tubes, this precaution is due to run down batteries and other causes.

Even manufactured sets are not free from this. When a tube comes loose 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 any condenser position so that the station Radio set fails to come in.

As a condenser fails to tune a circuit, it may be short circuited. This can be tested with wires in series with the fixed and movable plates and a small battery. If the condenser fails to tune, there may be something wrong and the small battery may be incorrect to reach the wave length desired with the condenser used. Too long an aerial may slightly affect tuned circuits. A pointer for condenser testing is also likely to occur due to faulty construction of the socket or a broken socket contact. To test this point by trying a new tube in the same socket.

Best Way to Test Batteries

The best way to test a battery is to use a voltmeter. If this instrument is not available, a five volt 110 volt lamp can be briefly connected across each 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 should 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 to insert the tube in the socket of an operating set and compare its performance to the tube removed to permit the test. This test should be repeated. In such a test, one tube may require different rheostat adjustment than another do same test. Sometimes tubes have bases with contacts which do not make good connection with all the gold of the socket, but otherwise the load is O.K. It is not advisable to pull up a tube socket contact prone to accommodate but with a little effort it can be lifted 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 set should be able to light a 1 watt 110 volt lamp to a dull red, when from mains and filament of your tubes appear to be lighted O.K. but the tube itself will soon drop out, it is time to test the set.

Failure of the B battery will usually show by the filaments lighting faintly if at all. If you are using dry cells, it is time for new cells. 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. These battery cells run dry cells down faster than dry batteries. If the sockets set run dry cells down faster than dry batteries, and if performance is not satisfactory, use new batteries. It is not good to let a storage battery run down too far as the plates may be damaged. If you use a charger, always leave in place for an overnight charge once or twice a week, with an occasional cup of distilled water to cells to make up for water loss. To keep the battery O.K. at all times. Storage batteries are now little used for filament lighting on one tube sets, but are used for multi-plate or circuits of certain types. 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.

A dry cell on short circuit test with ammeters across a circuit against a thin gut, etc. If you use some form of ground clamp, it should be taken off, the contact resistance is reduced, and it is easy to oxidize and take on resistance by contact. There is another class of changes which are in the nature of improvements. If you have a single circuit regeneration set, a set that is used. Radio amplification can be added to cut out reradiation and increase operating power. An audio amplifier can be added to any set. A third stage audio amplifier can sometimes be attached to a set where extra loud reproduction is desired.

Repairing Phones and Loud Speakers

It is not advisable to attempt any repairs on phones or loud speakers. The connecting cord or connecting cord may break at or near one of the tips, and can be soldered together once or twice, but it never harm the floor, some of the permanent magnets may be bent. Sensitivity will also be lost if the diaphragm are bent. Careless handling can break a diaphragm, and there are always cause caps to come loose or break. A safe rule is to leave repairs on headsets to loud speakers to expert repairmen. Do not connect a headset to the output of a power amplifier as this may ruin the parts loose. A headset is designed to operate on weak currents, not powerful current changes.

Condensers, Colls and Other Apparatus

Fixed condensers may become short circuited. In some of condensers which are used for short circuiting, a fixed condenser will sometimes become insulated or partially insulated by the charging of the leakage path, and cause noise. If replacement of Irish B battery and cleaning of tube makes does not improve the condition, cells which should only 10 to 15 amperes on such test are likely to have short operating life. They don't accept old dry cells.

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

Leasing Short Circuits

Another trouble found in some sets is caused by one or more bus wires loosely touching others or coming loose. One bus wire being loose, the other not being, to bond the short circuit, a fixed condenser will sometimes become insulated or partially insulated by the charging of the leakage path, and cause noise.

In changing over from storage battery operation to dry cell operation, there is a little trouble, unless you do it, a few seconds. It is important to use the right value of rheostat resistance. Another point in changing to dry cell use is that a C battery may be used, and if it is neither cleaned, nor dry, it may be used, and if it is neither cleaned, nor dry, it may be used, and if it is neither cleaned, nor dry, it may be used, and if it is neither cleaned, nor dry, it may be used. It is important to use the right value of rheostat resistance.

Maintaining Aerial and Ground

It is also advisable to give the aerial and ground the "once over" as contacts may become poor, wires may be worn away, or there may be short cir-
Simple Explanation of Radio Reception

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

By P. E. Edelman

Why do they use antenntant at all? Why do they use transmitters? Why do they transmit sound waves? All these questions are important to anyone who wants to understand the basic principles of radio communication.

Radio sets are a combination of many different components, each playing a specific role in the process of transmitting and receiving information. In this section, we will explore the fundamental concepts behind radio reception, including the role of the antenna, the transmitter, and the receiver.

The Antenna

The antenna is the part of the radio that receives or sends electromagnetic waves. It works by converting the electrical energy of the wave into a usable form for the radio. Antennas come in many shapes and sizes, depending on the frequency of the waves they are designed to receive or transmit.

The Transmitter

The transmitter takes the electrical signal, generated by the microphone or other source, and converts it into a radio wave. This wave is then broadcast into the air, where it can be picked up by another antenna.

The Receiver

The receiver takes the incoming radio wave and converts it back into an electrical signal, which can then be amplified and played through a speaker or other device.

Types of Receivers

There are two main types of radio receivers: AM and FM. AM receivers are used for broadcasts that use amplitude modulation, while FM receivers are used for broadcasts that use frequency modulation. Each type of receiver has its own unique specifications and requirements.

Final Thoughts

Radio reception is a complex process that involves many different components and technologies. By understanding the basic principles behind these components, we can gain a deeper appreciation for the role that radio plays in our daily lives.

For more information on radio reception and other topics, please visit our website or contact us directly. We are always happy to help answer any questions you may have.
Figure 217 shows how audio output wiring can be 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 filament on or off is also possible as shown.

The new lister getting a special program of interest to a neighbor will often invite others in to hear. Figure 218 shows several sets of phones can be connected in series when a loud speaker is not available or the signal is 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 licensed 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 party giving 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 clear volume. It is well to have someone at the tuner to omit undesired announcements, broadcasts, etc., if the station heard uses such small talk between announcers. Also it is desirable to have a supplementary source of music such as a phonograph, player piano, or small orchestra, for variety ahead of the announcer, station is Radiocasting and to estimate the air distance. A prize can be given for the best list of answers. The thing about this is to have a wide variety and keep changing stunts so that interest does not lag.

In sections where the ancient Chinese time killer "Fish and Chips" game draws much attention, a Radio novelty can be tried out by using "Radio Fishing" in place of dice, to determine position of plaits, 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 L.C.U."

A transmitter can be arranged in any room on figure 218, to take a fun Radiocast through the loud speaker of the set, and possibly some of the guests can be inducted to entertain with specialties on "tunes," 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 shared with the loud speaker set the operator can cut off the speaker during the Radiocast. For members to take up own lot of stunts along this line, and keep them "snappy," as the announcer. You can put your phone receiver 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 two miles clearly in this manner. The loud speaker may also be conciliated from view, or back of a ventilating grate, 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 receive two 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 phones to hear programs they want while others hear popular programs. If you have a phonograph with recording attachment, you can record certain portions of an incoming Radio program. Doing this commercially would infringe copyright but it is proper as an experimental stunt for private amusement. A member of the family can record a list of programs of certain special interest recorded in his home, and put in his records. 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 listener of a phonograph is giving good vocal illustrations of pronunciations, a record might be made by using such a phonograph.

Figure 217 indicates how a talking newspaper can be used for news of the day. To make a talking table is to plate from tinfoil. Ordinary phones can be supplied with this "condenser" 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 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 relay 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 good choice. A flexible aerial can be thrown over any convenient tree or pole, but no pole carrying power currents, should be approached. 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 everything; when properly handled in tuning it does not whistle, buzz, squeal or howl. I can listen to programs Radiocast from Dallas, Texas, quite nicely. With two honeycomb coils of 50 and 25 feet range in meters it is wide enough to cover all Radiocasting stations up to 600 meters.

"I use 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 in "No. 12 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 5 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 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 they are really nothing new, but simply the phenomena first seen in previous chapters that a tube can be made to oscillate at a given frequency. Since amplification in both cases is accomplished in the same 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

Fortunately this is readily done; the simple reason is that they differ so greatly in their frequency. To handle both of these frequencies is made of two other principles that should be familiar to the reader. The first is that of the condenser which will permit a high frequency current to flow through it; the other is that a large inductance will choke a high frequency current to a negligible degree.

These are the two principles that we have to deal with in the case of the radio frequency, and the audio frequency currents. The inductance of the circuit will prevent any of the audio frequency signal from reaching the grid and therefore the audio frequency will be chopped out of the modulated signal. The audio frequency will then be chopped out of the modulated signal and there will be no possibility of any of it reaching the detector.

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. This is the principle of a super-regenerative receiver. The detector then reacts by the operation of the condenser in the circuit and the signal is then removed for detection and the signals audible.

There are, however, numerous little details that make or mar a circuit of this type. Take, for instance, the condensers. They must be of the mica variety if they are to work at all. It is said that the small condensers, usually 0.002 mfd., will not pass audio frequency currents under any conditions. This is due to the fact that the plate current of the tube is limited to some extent by the condenser. If the condenser is now fed back into the grid circuit only as high as 120 volts without harming the tube. The condensers will be varied in accordance with the signals across the plate, but the audio frequency currents will be chopped out of the modulated signal.

No definite can be said about the transformers, as the majority of them give little or no result. They should be of the highest quality and should be well tuned. Often a plate voltage too low will cause reflex effects to work improperly; a high plate voltage should be used to obtain good results. A large number of tubes are used in these circuits exclusively, the voltage may be as high as 200 volts without harming the tube. Too much voltage on the plate will be indicate 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 is due to the fact that the inductance and capacitance of the tube are in intimate contact curve and thus give the greatest amplification.

A Better Way to Bar Oscillation

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. The best results will be obtained when the filament is operated at 100 volts, but a filament of 500 to 600 volts should give better results.

In Figure 221 is shown a circuit embodying the refinements mentioned above. It will give very good results when the tube is of the hard type. A battery potentialmeter serves to vary the grid bias and condenser being connected from the contact arm of the rheostat. It is found advisable to prevent change of tuning when the arm is moved. The rectifier is also shown in the plate circuit to prevent oscillations.

A useful property of the circuit is that it will oscillate only when other tubes are used. The resistances are arranged to ensure no oscillation of the circuit at a low resistance.

In Figure 222 is shown the circuit for a three-tube radio receiver. This circuit is used in connection with two audio transformers and two at audio. In this circuit two radio transformers are used to couple the tube and detector are shown in the diagram. As in the one-tube circuit, the waves are picked up on the first tube and passed on to the second for which it must be modified so as to prevent being detected. During this operation the transformers and tubes are practically short-circuited out of the circuit by the condensers across them.

After the radio currents have been detected and amplified at the frequency the condenser no longer act as by-passes on causes of the frequency of lower frequency. The audible signals are now impressed on the second tube and amplified by both tubes in the usual manner. The audio frequency currents of the first tube is shown in the audio frequency transformers but due to the few turns on the tube and due to the little resistance in the transformer coupled in parallel with the phase inductance is a reason that is more suited to two 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 is advisable to use tuned impedances as it is more efficient than using transformer coupling. A circuit using tuned circuits coupled with tuned coupling between the first stage and the reflex tube is shown in Figure 223. It will be seen that the use of a Radio frequency coupling makes it difficult to feed the audio currents back into the grid of the second tube.

Two Tube Reflex Circuit

The coupling circuit used in the second stage is a fixed inductance of about 50 turns shunted by a large condenser. This circuit is coupled to the grid of the second tube through a small fixed inductance of 0.002 mfd. capacitance to prevent the direct coupling. This is found to be the most practical way of coupling the tube because it will drain off the grid of the second stage and render the tube inactive.

In order to overcome this, use is made of another tuned circuit consisting of a variometer and fixed condenser connected between the grid and filament. This condenser is used to make contact with the device. It gives freedom from static, and it is utilized the ability to utilize the directional effects of this form of aerial. These are greater when used with an indoor aerial, it will be necessary to use a variometer to obtain condenser circuits to obtain close tuning and selectivity.

Having mastered the principle of reflex circuits it is possible 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 and for this reason it is necessary to apply the simple circuit to all audio frequencies and it is practically the only circuit in which the full reflex action is obtained in all tubes.

(Continued on next page)
Radio Receivers—How to Make and Operate

(Continued from preceding page)

Three Steps of Radio Frequency

The circuit is identical in principle with the others described, except for the theory that Radio amplification is employed three times and audio but twice. This circuit is not coupled to any of the others, as it is desired to eliminate the maximum effect of reflex operation. It will be found very selective even when used with an outdoor aerial provided a loose coupled tuner is used. This is due to the tuned coupling used for the plate circuits of the second and third tuned tubes which are tuned to obtain full signal strength.

It is well to remember that if the second and third stages are coupled to a single tuned circuit frequency, the tuning arrangement their use is advised, for then one can receive more from the set. Selectivity in sets of this type for the amplification is so marked that any interferences never becomes a great annoyance.

Reflex sets may be built employing four or even five tubes, but in this instance the extra tubes are used as Radio frequency amplifiers, the inductance and capacitance of the crystal detector. The latter arrangement eliminates one of the features of the reflex operation, which is that of flexibility and clearness when properly operating. A poor reflex set is made worse when a tube is used as a detector.

Grimes Reflex Inverse

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 oscillation stages in the grid circuit. It is very apparent with this arrangement that the late tubes will be carrying the greater values of both audio and audio currents, and 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 the straight reflex in that the audio 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 low grid currents are broken. This results in further amplification of the audio 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 audio currents are fed into the third grid of the circuit, the second grid of the circuit and the first grid of the circuit. The amplifier audio currents in the plate of the second stage are fed back by a audio transformer to the grid of the second tube to be amplified again.

The plates are in the plate circuit of the second tube; so the signals are made audible after the second stage of radio 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 the feedback 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 varying tubes and 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 booster are not very critical and users 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 by using different varieties of bypass condensers and the inspection of resistances in the plate circuits of this sort will help to steady their operation.

The results are well worth the effort, for with 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 of operation. The set to be described is intended particularly for use with a loop aerial and will be 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 similar construction to that used for amateurs' work 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.

Grimes Reflex Inverse

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 0.002 variable condenser, preferably fitted with vernier, and to the right side of the panel is mounted a variometer which serves to tune the plate circuits of the receiver. The filament rheostat is mounted in the center of the panel. On the base, attached to the back of the panel, we shown in Figure 226, which gives the actual layout of the wiring. Binding posts are provided at the back of the board for connecting the 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 the filament will give the best results. The small tubes used 15/2 volts on the filament plate currents possible with the larger tubes give louder signals.

Operation of the Set

As to the operation of the set—after checking the reception of the station and tuning 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. The unit is then turned up to the station and getting it as loud as possible by the adjustment of the plate variometer and the honeycomb coil, the instrument may again be adjusted to obtain the cleanest 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 base strip. If this method of mounting is used, or wedge the two amounts so that the coil and base 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 both smooth and maximum signal strength is obtained.

Experience properly adjusted this little receiver will be found very efficient, suitable for any 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 proven itself a very simple device. Many descriptions have been offered but it has been published as a new way to construct the sets, so we will confine ourselves to a discussion of the method of obtaining this circuit; 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 for the circuits for the purpose of checking over regeneration. The method of obtaining this circuit is not only simple but also remarkable in its simplicity.

Considering the circuit without the tickler feed-back as shown in A in Figure 227, we find the original all forest ultra audion circuit using a condenser in the lead to the audion grid, which is also in the plate circuit of the audion, which is under regeneration, a condenser so situated will lead to a regeneration effect; thus the tube in such a circuit will be set into oscillation. The frequency of these oscilations 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...
(Continued from preceding page)
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 filament. By proper adjust-
ing the grid leak the tube blocks and frees itself
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 suc-
cessfully for many experimenters. It consists of a
step-up transformer, the primary being connected
to the A. C. mains, the secondary having the rated
voltage output needed for the tube filament. A
chart in series serves to con-
trol the filament brilliance.
Now were we to connect one side of the secondary
circuit to the filament term-
inal the polarity of this terminal
would be rapidly changing from
negative to positive; with each change
a variation in the grid potentiometer
result. The plate circuit would then be
affected, and the hum would
result. To offset this effect
we made a potenti-
ometer connected across
the secondary of the trans-
tformer. 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. When the potentials at the end of
the potentiometer are constant it seems apparent
that at some point on the resistance there would be
no change in potential as to the center of the filament.

Sources of the Hum
This circuit will work if it is possible to elimi-
nate 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,
the hum. For those transformers and storage bat-
teries this arrangement may prove very satisfactory for
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 15 watts for each UV-220-A
or C-301A. The allowance for other tubes can be
readily calculated by multiplying the p-e-t-a-
s of this rated filament current to the watts. The
potentiometer, of standard construction, may have
center of the secondary winding is employed.
The outer terminals of the secondary winding connect
to the plates of the two filament transformers. The filaments
of which may be lighted from a winding on the same core as the
primary. The secondary winding on the secondary forms the negative terminal, the
positive being the filaments of the tubes. The action
of the transformer is simply to step down the filament current
as flowing in one direction in the primary
principal. Fig. 1 shows 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 this winding, will have an instant
potential to permit current to flow to the filament, then
to the plate circuit, and back to the center tap. The other tube will not permit cur-
rent to flow. However, when the current reverses, the other plate permanently
a charged condition, then the first one checks it. In this manner the alternat-
ing currents is converted to a direct current; but it is
pulsating.

Direct Current Obtained
This action is shown in the diagram of the
A. C. A is shown
The ordinary
of the cycle is turned up, so to speak, giving a
voltage flow; but the
voltage with each half cycle. Before it is suitable for
use it must be smoothed; the
ripples must be removed.

Here again we have recourse to a well known effect
that is not to obtain a given result. We also learned that an in-
ductance acts to resist a change in the strength of cur-
rent flowing through it. Were inductances inserted in
the illustration, when the voltage tended to rise, the inductance would cause it to lag; when the
voltage falls, the inductance would
resist to keep it falling. The result then would be to "smooth" the wave form as in Fig.
C. This is not smooth enough for our purpose; so use is made of condensers.
As shown in the diagram the condenser consists of the plate circuit of the tube,
and the other plate permanently charged by the current from the transformer.
The condenser acts as a reservoir from which en-
ergy is drawn for the plate circuit, and is
constantly charged by the current from the transformer. The
voltage of the plate
The overall voltage of the condenser should be twice that required for the tube,
and the voltage of one half of the winding is used at one time. Its
rating should be very low; 15 to 20 watts is sufficient for an ef-
ficient transformer. The
condensers used in the
filter should be very high, 2 to 5 henries, and the coil of the condenser should be 4
mils.

The explanation here, covers the principles at
present used in applying alternating currents to vac-
um tubes. But they are not found in all laboratories
as yet. The art is still in the early stage of de-
velopment. The usefulness as to first cost and
efficiency for the use of radio sets in places of amusement,
stores and restaurants, the A. C. set is as sure
to be used as the alternating current as a source of power. The solution of the prob-
lem is the challenge to the entire experimental field for
it has gone many of the successes of the past.
At the present time there are quite a number of
radio sets introduced on the market, all designed for the purpose of eliminating both the A and B bat-
teries, and so making the equipment
portability of the batteries. The use of A and B
and the packing of Radio sets in places of amuse-
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lem is the challenge to the entire experimental field for
it has gone many of the successes of the past.
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 difficulty and expense, greater size and less utility in finding desired stations. In-
The first grid leak will probably be about 2 meehm 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: 120 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 much longer than three times as long as it would if used for three days, while each of the others perform far more than twice as long as it would if employed in the usual hook-up.

Radio Frequency and Regeneration

In Figure 241 is shown the first successful combination of audio 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 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 grid capacitor of 20 turns which acts as the primary of a frequency transformer and passes energy into the variometer, the stator serving as the secondary. With units of the proper constants, this set functions well on a single 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 arranged to be a grid condenser of five or six points, the "spill over". The amplification of regeneration is thus gained. With the first tube in circuit such a set and add two stages of audio amplification which will give surprising volume on distance.

The loop arrangement is that used by Grimes on the inverse duplex. There are three stages of transformer-coupled audio frequency amplification. Iron-cored transformers may be used, or one with iron core, 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; and C' are 0.090 mfd. each, as is C'. 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 single tube set is acquired that is marvellous in results. True, it has the condenser controls, two couplings and the loop switch, but since 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.

The series of circuits presented in this chapter give the experimenter all the range desired for the develop-

ment of any efficient simple or multisection 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 which will meet the demands of the most exacting and critical fan. The opportunity is hit, to work toward the goal he aspires to.

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

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 Ls consists of a tapped inductance, either 60 turns on a 4-inch tube, or 52 turns, or one of the new basket-weave type. Condenser C is .005-mfd. The variable Lw should cover the 200 to 600-meter band and be wound to contain air cells and of basket winding.

Condensers C2 are .001-mfd. mica insulated, while Cw is also mica, but only .005. 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 grid leaks have been adjusted so that oscillations do not occur at any setting of the dials, most station calls are heard in the 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 calfskin, this set should be surpassed only by a good superhet.

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 capacity between the plate and the grid, and each unit should be tuned. The small condensers between the tubes, and between each tube and the frequency controls must be small, little adjusting and are for neutralization of the inherent capacity of the tubes that is the cause of oscillations. This leaves but three adjustments to tuning, namely, the variable condenser and the transformers. It should be mentioned that these transformers are of a most unusual type, and the ordinary variocoupler or adapter 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 sensitivities, but 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. As far as the American equipment it would probably be necessary to insert neutralizing condensers across the grids and try several other well known methods of reducing regeneration and amplification. The maximum 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 0.001-mfd. capacity. Both of the fixed grid condensers shown are 0.0025-mfd.;
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, if not the oldest. All 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 circuit diagrams of a crystal re-ceiver, and ask them to say whether it 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 varidet condenser may be used in the aerial, and the ground circuit connected directly to the switch arm, as shown in the circuit diagram, for tuning.

Tapping the Inductance

In tapping off the inductance, instructions usually tell you to tap off the coil at regular intervals, as 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 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. The“square root” of 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 or one-tenth 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 box. In the case of an aerial coil, 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, the wave energy from the aerial would be just enough to make the one half of a cycle to pass through the crystal. But actually the conductivity of a crystal is not absolutely zero in one direction and practically zero in another. If, now, another crystal could utilize that half of the wave which the first crystal cannot use, then substantially the whole 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, a crystal detector 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.

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.

Location of Parts on Panel

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 as a simple crystal set for local reception—about three miles. Sounds came in strong enough to be heard over the radio 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 ability is not a KSD, the St. Louis clearing house," I then tuned in Louisville, Kentucky. My list of stations contains the following: KSD, KYW, WAB, WNW, WAJ, WTL, WGM, WGR, WY, WAB, WTA, WJAX, WLA, WLW, WLS, WMC, WOAW, WOG, WOR, WOD, WPL, WLA, WOQ, WQ, WEL, and KDKA.

List of Parts

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crystal detector</td>
<td>1</td>
<td>$2.00</td>
</tr>
<tr>
<td>1</td>
<td>Fixed mini condenser .005 mf</td>
<td>1</td>
<td>.50</td>
</tr>
<tr>
<td>1</td>
<td>Mini condenser .000 mf</td>
<td>1</td>
<td>.50</td>
</tr>
<tr>
<td></td>
<td>Materials for coils</td>
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<td>.50</td>
</tr>
<tr>
<td>1</td>
<td>Switch arm and base</td>
<td>1</td>
<td>.50</td>
</tr>
<tr>
<td>1</td>
<td>Binding posts, bus bar, screws</td>
<td>1</td>
<td>.60</td>
</tr>
</tbody>
</table>

Total cost $5.10

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 cost of $3.50. 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. I 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 toward the northeast, I had no directional difficulties.

I annealed the wire before putting it up and consider this important. Two lead-ins are too important. Aerial and lead-ins should be made of number 14 braided or stranded wire. The ground runs from the comb coil of my own make, a 0.025-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 difficulty may be experienced by the operator to find the proper position for the primary condenser, which will depend upon the length of antennae. It will be noted that the aerials are only two and four wavelengths. These need not be of the vernier type, as the value of the vernier only makes the condenser may be a helpful test. A buzzer will be of aid in finding a sensitive spot on the crystal unless a fixed detector is used. I do not recommend its use, as it seems to lose its sensitivity in a short time.

The hook-up diagrams show the simplicity of the set clearly. It can be mounted on any kind of a panel or in a grounded tin roof, the effective height would be 10 feet and not the 36 or 60 feet from the earth.

The aerial has a marked influence on the selectivity of the set and the possibilities in this direction must be taken into account. If the aerial were entered in an open space clear of any obstruction, the problem could be considered solved, as if 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 signals is termed its effective height. This does not mean the height from the ground to the topmost point, but is the height from the ground terminal to the center of its base area.

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 element that 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 tuning. Handling it at all will do more harm than good. Be very careful not to get any static on the set, as 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.
One Tube Long Distance Receiver

By Leon W. Bishop, IXP

One of the most interesting circuits for a single tube that is in regular use is that which combines the use of a triode and which may be used in car or at camp and requires little attention. The circuit is the adaptation of an Armstrong principle which really produces distance and clarity for a microammeter.

The success of any circuit depends upon the constant weight used, probably the best being a standard regenerative circuit but is completely changed by a few modifications and variable grid leaks. This circuit has been designed for the new wave bands of 2,000 to 550 kilocycles (150 to 545 meters) and includes a regenerative circuit on the shorter wave bands so it is possible to get the class A station efficiency which is much higher than the class B, which is not possible with other arrangements. To get full flexibility the circuit will work equally well on phone, CW, TV, and will insure you of all classes of service no matter where you are.

**Works Excellent on Short Aerial**

When using this one tube circuit to receive in a car, a flying boat or aerial it is equal to a three-stage Radio frequency amplifier and detector, and is to all intents and purposes a short aerial. It is to be recommended to all who have not been able to get reception on the highest frequencies. It is to be considered a must. The circuit can be used for transmission with a power tube and a B voltage with a little supervision. 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 points 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.

For operation in a car connect the point A to the frame of the car through the steering wheel and the tube A to the metal top of the car. A small aerial in the top of the car will almost cut 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.

This is a standard circuit and may be used as such with an aerial and ground by reducing the tickler coil resistance and switching the grid leak in parallel with the tickler. The tickler can be used for a B voltage with a little supervision. Results may be obtained which makes it an ideal vacation outfit.

**Mechanical Theory**

You have often turned the variable condenser of a standard regenerative set to the point of production of an awful howl in the phones and said that the tube was spooling over. However, the grid leak absorbs all the noise that usually accompanies this operation and the oscillations on the grid and leaks off in minute discharges through the tickler and the tickler, so that the phone is not clamped down as the usual circuit is. The grid leak is not necessary, but if these charges are negative so we can assume that the grid is negative with respect to the plate. From the above we see that the grid circuit would tend to build to infinity during the interval the grid was negative. This seems to prove that any form of hum is not harmful.

As the wave length is halved the amplification is doubled 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 IXP.

**Hints About Soldering of Radio Connections**

Three things must especially be remembered while soldering. It is always important to have the surface of the parts as clean as possible. A cloth or a fine file may be used in some cases. Uninsulated 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 soft solder on the surface to be soldered, 40/60 type of solder, and then applying a little tin. The tinning must be done while the solder is hot. The soldering iron is only the proper height and the work should neither be heated above the point where the solder was put. A little flux will prevent 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 a minimum amount of solder to flow; thus preventing an unsightly joint.
PORTABLE Radio receiver, representing a cash outlay of only $37, and so simple in structural details that a person with the slightest elementary 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 equipment 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. 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.

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 swaying away from electric circuits by visiting camps or in remote areas, will appreciate the possibility of building and assembling a set of such light weight that one person could easily carry cabinet, instruments, and batteries anywhere where he might go.

The materials necessary for building this simple form of regenerative circuit have been so clearly 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 possesses 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 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 sides of the variometers or coils. This obstacle may be avoided, however, by faithful adherence to the diagram or by hooking up illustrating one of the papers of this series of articles.

Materials Necessary

The materials required are the following: One 15 volt vacuum tube for detecting the Radiophone signals, type 21D3, being used by the Lighthouse Service; one vacuum tube receptacle; one pair of headphones; one 9 volt dry cell battery; one grid leak, or 43 plate variable condenser with vernier; one telephone condenser of 0.0025 mfd. capacity; one grid condenser of 0.0005 mfd. capacity; one grid leak, one piece of fiber or hard bristol board about 1/32 inch thick and 8 inches square; 1/4 pound of number 24 gage enamelled 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 1/4 inch diameter dowel stock, 8 1/2 inches long; three or four pieces of tinfoil for covering back of panel; four binding posts; four machine screws No. 6, about 1 1/2 inch long, with nuts; one piece of brass, about 1/16 inch thick, 5/8 inch wide, and 3 1/4 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, 3/4 inch wide and 3/8 inch deep, in each sidepiece near the top. The screw holes in the front board or panel is slotted. Any kind of wood, about 3/4 to 1 1/2 inch thick, will do. The panel should, preferably, be a piece of close grained wood 3/4 inch thick. The rheostat and condensers are put on the board, in order to be certain that the circuit is correct 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 in the panel be scorched. While the panel is still hot, a coating of thin shellac is applied on both sides, to the edges and

Lighthouse Keeper's Single Tube Radio Set

Compact and Popular Portable Kit

By S. R. Winters

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.

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 3/4 inch thick, 13 inches long, and 10 1/4 inches wide, for the front panel. Bakelite or other insulating material 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. The panels should be thouroughly dried, or they will not 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 this condition, any tinfoil that may be dangling through the holes of the panel is cut away, in order that no metal parts of the construction, rubbets, binding posts, or any of the wires 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 shell.

Making the connections of the two spider web variometers is likely to cause trouble in the wiring or painting. In this simple form of regenerative circuit, one of the apparent difficulties may be avoided by the use of transparent plastic paper, 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 the wire, the wire in each will be turning in the same direction. This is accomplished by 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 the (Continued on next page)
RADIO RECEIVERS—How to Make and Operate

(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 the center of the coil, making 20 wound magnet wire. Number 24 wire may be used for this purpose. Wood which is 1/4 inch in diameter. A piece of 1/4 inch dowel stock will meet the requirements. These shafts are passed through the center of the panel 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 your own, select a real homedone one, one-half of a common thread wood will suffice, the other half being inserted on the back beneath the wood and inside of the panel as a thrust collar to steady the shaft and support the coils. The other end of the shaft is sharpened to a flat coned-shaped point to fit into a hole drilled in the panel, as shown, as indicated in one of the diagrams. This bolt has a hole drilled to a size of 1/4 inch or possibly a bit more, so that the shaft will slip through easily. The brass sleeve is so located on the end of the shaft and caused the shaft thrust collar to force itself against the panel with sufficient fricition to hold the shaft in any position in which it may be placed by turning either knob on the receiving set.

Coil Mounting

The coils are held securely on the shaft by means of a wood strip, 1/2 inch square and 2 inches long, with a hole drilled in one end for the passing of the shaft. A pin through the strip and shaft will hold the former rigidly to the latter, provided that the pin is put through the hole snugly. The coil is fastened to the wood strip with a small flat head wood screw; the use of machine screws is not recommended by the Lighthouse Service, since they will eventually work loose.

List of Parts

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/4 inch dowel wood, vernier.</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>Vacuum tube 1/4 volt type.</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Muntz or malleable iron.</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>Variable grid leak with 10000 mfd. cond.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Tube volutes</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Rheostat</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Pair of head receivers</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Tube spring coupling of coils</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1/4 in. var. coils.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3/16 in. dry coils.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3/16 in. dry coils.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Test var. coils.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Cabinet</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Sheet, binding posts, screws.</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Total Cost: $30.88

The stationary coils are fastened to the sides of the cabinet by means of a flat head wood screw passing through the center of the coils. A tin block of wood, through which this screw passes, is stationed behind each stationary coil. Such insulating blocks are cut 3/4 inch from the side of the cabinet. The stationary coils are so located that they are 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 the importance of being lighted by the reed, the brass wire, and other wires would be kepters of lighthouses, rural dwellers, city dwellers, and others who might make use of this wiring diagrams, has outlined in the minute details the hook-up of this $37 Radio receiving apparatus. Reasonable heavy wire is specified for the various connections so that it will remain intact and be properly placed. At present regular radio wire may be heavy. Used heavy tinned copper wire furnished from electrical stores and other mercantile establishments. cements and adhesives. In the absence of this kind of wire, any rubber, or soft rubber, rubber, brass, copper, or copper-soldered to the ends of the wires, the bit of brass or copper being embedded 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 a terminal to a coil have a common meeting point at a wood block, provided with seven small round head brass screws, under which the terminals or ends of the wires are placed.

The wiring connections, as outlined by Mr. Tupper, are as follows: Starting at the antenna binding post on the front of the cabinet, to the right terminal of the grid condenser. Then connect the inside wire of the movable coils to the left terminal of the grid condenser. The movable coils a couple of turns around the wooden shaft, bringing in the correct position towards the coil. 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 to the outer wire of coil A and to connection 3. Be sure to get the outer wire of coil E.

Cross Section View

If the wires leading from the coils have been marked as suggested, as shown in the drawing, it is easy leading the wires to their proper places. Next, bring the wire of coil B to connection 1, 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, which last point run a wire to a connection F on the electron tube socket. Apparently this is a long wire but in reality it is quite short. Next bring the outside wire of coil C and the inside wire of coil D to connection 6; the outside wire of coil C 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 0.0025 mfd.) by short pieces of stiff wire and some small bolts and nuts between the telephone tube F 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 shaft and over to 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 through to the dialing a screw through a terminal on the end of the wire, near the left-hand notch in the edge of the shell. This wire is then fastened to the wire of condenser L by some screw connect another lamp cord, or a piece of brass piece wire having a terminal soldered to its end and fastened to one of the positive terminals on the B battery. Then, connect the D or the plate terminal of the 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 drawing, run a wire from terminals to the right terminal of the rheostat (to which one side of the telephone condenser has already been connected). Run a wire straight back, then drop down to the shelf about 1 inch from back edge, then across to a point midway between the connection on the B battery and the dry cell battery. The end of the terminal of the dry cell battery is brought to the ground terminal of the rheostat, and then back to each end, to the central or positive binding post of the dry cell battery.

When the final lap of wiring, connect one side of the grid condenser S to the G terminal of the electron tube socket with a metallic binding post, being sure to right angle, making the grid condenser S stand vertical, after which connect the top of the grid condenser by a stiffer wire to the aerial binding post N. The other side of the grid condenser is connected by a wire to the top of the grid condenser B battery and to the positive or outer side terminal of the dry cell battery. The next step is to connect the Fi terminal of the electron tube to the point on the dialing a screw which extends to each end, to the central or positive binding post of the dry cell battery.
**RADIO RECEIVERS—How to Make and Operate**

(Continued from preceding page)

If the signal is weaker, reverse the connections on coil C, reversing the connections of the wire as they were and reverse connections on coil C. To become even more successful, keep connections of coil C reverse to the connections of coil E. Do not change connections of coil A, but do not throw in the shorting wire to coil B. The exhausted combinations possible, and difficulties will double to be solved and remedied.

**Body Capacitors**

Body capacity effect is one obstacle encountered by the use of this one-tube receiver. This, however, may be overcome by using a heavy condenser at the back of the case and providing a non-metallic expansion or collapsing motion to the case or even the omission of a tiny wire for the trouble. Hence, a method is presented to remedy the difficulty is suggested:

- First, remove the vacuum tube, then disconnect the...
Circuit Using WD-11 and 12 Tubes

This unusual circuit, which is easily adapted for WD-11 or 12 tubes, was evolved and is copyrighted by John L. Reinartz. It is a revised form of the old circuit covering the whole range of wave lengths that are present as used by the Radiocasting stations. It will be noticed that three variable condensers are required, two of 0.005 mfd. capacity and the third of 0.001 mfd. capacity. The insertion of the 1,000-ohm resistance stabilizes the tube action and improves reception. Only 225 volts are required in the plate circuit.

List of Parts

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinartz, cell</td>
<td>$1.50</td>
</tr>
<tr>
<td>1,000-mfd. condenser</td>
<td>$1.50</td>
</tr>
<tr>
<td>Variable condenser, 0.005 mfd.</td>
<td>$0.90</td>
</tr>
<tr>
<td>1,000-ohm resistance unit</td>
<td>1.25</td>
</tr>
<tr>
<td>Tube socket</td>
<td>1.00</td>
</tr>
<tr>
<td>Resistors, ohms</td>
<td>1.25</td>
</tr>
<tr>
<td>Panel 7x14</td>
<td>1.75</td>
</tr>
<tr>
<td>Connectors</td>
<td>1.00</td>
</tr>
<tr>
<td>Multipoint switches</td>
<td>2.25</td>
</tr>
<tr>
<td>Molding posts, bus bar, screws, etc.</td>
<td>$23.50</td>
</tr>
</tbody>
</table>

Simplex Hook-up for Long Distance

HERE'S a Simplex that requires two variometers, two variable condensers and a grid leak. The wiring is simple, the circuit is regenerative and it is quite a 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 decoupling of 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 unstepped coupler with approximately the same distance value in both windings. The primary circuit is tuned by means of the 0.001 variable condenser.

List of Parts

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variometer</td>
<td>$6.00</td>
</tr>
<tr>
<td>Variable condenser, 0.005 mfd.</td>
<td>$0.90</td>
</tr>
<tr>
<td>Tube socket</td>
<td>1.00</td>
</tr>
<tr>
<td>Condenser, 0.0005 mfd.</td>
<td>1.00</td>
</tr>
<tr>
<td>Fixed mica condenser, 0.003 mfd.</td>
<td>0.00</td>
</tr>
<tr>
<td>Fixed mica condenser, 0.005 mfd.</td>
<td>0.00</td>
</tr>
<tr>
<td>Grid leak and mounting</td>
<td>1.00</td>
</tr>
<tr>
<td>Panel</td>
<td>1.25</td>
</tr>
<tr>
<td>Cabinet</td>
<td>2.50</td>
</tr>
<tr>
<td>Molding posts, bus bar, etc.</td>
<td>$15.50</td>
</tr>
</tbody>
</table>
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 type receiver, and the farmer.

List of Parts

<table>
<thead>
<tr>
<th>Part</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Variable condenser 100µfd. variable</td>
<td>$0.50</td>
</tr>
<tr>
<td>1 Variometer</td>
<td>5.00</td>
</tr>
<tr>
<td>1 Tube socket</td>
<td>1.00</td>
</tr>
<tr>
<td>1 Rheostat 6 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>1 Yoke grid leak with .0005 µfd. condenser</td>
<td>1.00</td>
</tr>
<tr>
<td>1 Panel 749</td>
<td>1.05</td>
</tr>
<tr>
<td>1 Caharet</td>
<td>7.00</td>
</tr>
<tr>
<td>Binding posts, bus bar, screws, etc.</td>
<td>1.00</td>
</tr>
</tbody>
</table>

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, 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.

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 system as it produces the original sounds striking the microphone at the broadcasting station and also the distant sounds miles away. When one considers that their function is to convert the changing electric currents, up and down with difficulty, into the musical currents of amplification, into audible sounds, their importance may be more easily recognized. The standard headset will cut down the range of set hundreds of miles; many DXers require one to hear the headsets.

The Theory of the Receiver

Briefly the theory of the telephone or Radio receiver is as follows: A thin metal diaphragm is tightly 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 of a certain value of the magnetic pull on the diaphragm will be strong enough to cause the diaphragm which is now made of thin metal to change its place slightly thus making the receiver sensitive to the variations of the windings once again. As the size of the pole pieces is increased the more sensitive the receiver is. In designing electromagnets the practice is to make the thickness of the winding twice the width of the pole pieces. The size of coil in the receiver is then 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 ampere 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 one way to get this is to increase the size of the receiver the manufacturers use very fine wire, for that reason the resistance of a Radio receiver is high.

However, another factor enters into the use of receivers with tubes. It is a well known law in electrical practice that the insulation of the diaphragm should equal the insulation of the device itself. Therefore the insulation of the receiver should equal the plate insulation of the tube. Impregnation as we have learned is the resistance offered to the flow of alternating currents by an insulating material 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 transformers with an impedance equal to the plate impedance of the tubes with which they are to be used.

Resistance Does Not Affect Sensitivity

Realizing then that resistance has little to do with sensitivity 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; it will not pay to pay a little more for the best. See that the cases are carefully soldered, or that the plates 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 that the permanent magnets will support the diaphragms on edges if they fail to hold the diaphragm in place; that the apex is weak and should not be accepted. The simple test for a Radio receiver is to place a picture of some material moistened with the tongue between a nickel and a penny and to touch the "phone" tips to the coin. The current generated by this simple battery should give a click in the phones. If no sound is heard they are useless for Radiophans.

The charcoal will draw the moisture and will always be wet and damp and will make a good connection. The ground rod need not be over 6 or 8 feet long. A 34-gallon galvanized steel pump rod such as we 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 simple circuitry and a re-radiating outlet from the word "go," has output that is not the squealing kind. It was the recent carry-off of a speech from the telephone transmitter, but is silent when it comes to the much talked of "squawker delight.

During the experiment I tried talking into the receiver of my headset and it, or heard at a distance, put the loud speaker in the jack and talked into the loud speaker, and that was it. A telephone transmitter which came over with Noah in the Arc was hooked in series with the ground and that worked 30 per cent better. The latter addition was a magnetic oscillator in the ground circuit and put the finishing touches to the output.

A neutralizing condenser made of three safety razor blades was shuffled across the plate and grid. This made the circuit an almost ready oscillator both for receiving and transmitting. The apparatus in general is composed of neutralizing matter, including cardboard tube, wood and such other junk contrary to Radio engineering. A dear friend of mine, Jack, who was as much interested in the more money, constructed a duplicate using the best material money could buy (his money), and from reports he is getting just as good as I am, so I figure if there are any "losses" they are goingvia 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.

Tuning as a Transmitter

In tuning the tube as a transmitter, rotate the dial in conjunction with the switch levers until a slight "hollow" 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 and you will 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 "hollow" is all but and sharp, and in all, it is an excellent receiver, which will not bother to the operator, yet it re-radiates energy, but not squeals or whistles. Queen it is. But it is much distance with a "bell-ringing" 110-volt to 12-volt transformer or a closed battery or positive they can with some other outlet. Yes, oh, I have tried that, too, and even used an audio frequency transformer as a modulator and that worked just as well, but it, or rather the modulator, was made of the make and brand kind. It can be made up in a short space of time, but should be well made, 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 supplied and high voltage cut in for the transmitting end of it.

Compact Regenerative Portable Outfit

For the fan who contemplates building a very compact portable set the hook-up 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 varistor and a .001 mfd. vernier condenser in series. These two controls of wave length will permit reception of any broadcast. The regenerative feature of the circuit guarantees plenty of volume in reception. The circuit and repertory of the Colpitts transmitting circuit named the "Gibbons." If desired, audio frequency amplification can be added. Any plate voltage need not be more than 45 and in fact 22/5 volts will do in most cases of this type of tube.

Maximum results are expected, good apparatus should be used and care taken in assembly and adjustment. The set should be properly made. Spaghetti insulation should be used in all com pact sets, thus reducing the possibility of short cir curts to a minimum.

A portent of the 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 45 volts). The tube sockets should be mounted on a rubber or heavy felt batting to eliminate vibrations that break the filament, and microscopic 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.

Lock on Tube Lighting

Two good ways to prevent children from lighting the tubes of a set. First a key switch (such as used in houses as flash switches) and insert it in the panel, or in the end of the cabinet, and attach the negative of a 12-volt battery to the 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 it looks like 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 used. In fact signals are about twice as loud as when one is used.

The main inductance L1 is wound on a bakelite tube, 3/4 by 41/2 inches, using number 24 wire. First tap to the grid, and then at 7, 10, 15, 30, 45 and 60 turns. A space 3/8 inch wide is left at turn 15 for the ticker shaft.

On the same tube and 3/4 inch below, L2, the primary is wound. This consists of from 5 to 10 turns of 20-gauge (.00025) mfd. wire, and turns up an old Ford coil and remove a good second secondary. This is about 35 to 30 turns. Drive two nails about 20 feet apart and string the wire from one nail to the other, making three turns and coil up each or 60 in all, which will be about right for the primary. Make a small hook of a piece of 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 little wire at about one-quarter inch long.

The tickler, L3, is a standard wood rotor, wound with 40 turns of number 24. The whole is mounted on a 6 by 8-inch bakelite panel so that it is really portable.

Using an old A-and-P detector tube which had almost burned out, 2000 hours and with 40 volts on the plate, no ground and 275 feet of wire held around the set, noise was receivable 60 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 a shown, a range of from 75 to 600 meters is covered, and the 2000-hour range is within easy reach. The selectivity is wonderful. 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 is almost nil, and set XDKA, 50 miles, is quite readable 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 coating of shellac varnish. Such a brush 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 is allowed to build up 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 keep that space is the best insulator for the high frequency currents used in Radio. Especially in a multiband 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.

List of Parts

1. Varistor...$6.00
2. Variable condenser .001 mfd. vernier...1.00
3. Aerial...1.00
4. Shield...1.00
5. Fixed mica condenser .0005 mfd. 4...1.25
6. Paint...1.75
7. Cabinet...$6.00
8. Rubber posts, bus bar, etc...1.00
Total cost...$18.00

List of Parts

1. Variable condenser 2000 mfd. vernier...8.50
2. Tube socket...1.00
3. Metal...1.00
4. Materials for winding coils...1.75
5. Sulfur mica condenser...1.00
6. Fixed mica condenser .001 mfd...1.00
7. Pickup...1.00
8. Chassis...1.00
9. A and B open circuit type...7.00
10. Binding posts, bus bar, screws, etc...1.00
Total cost...$15.45
Long Distance Reception on Single Tube

Split variometers have a habit of getting out of line with long distance work. Do you know why? Well, variable condenser tuning means a fixed load, while capacity tuning, when good variable condensers are used, undoubtedly gives real satisfaction for long distance results. Do you know that the neutropic is a capacity tuned circuit? Hence the results. Think it over.

This circuit uses two split variometers and a good .0001 variable condenser (not the 25-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 ft. of overhead or good ground connection, plus a good detector tube, and give it a fair chance. Then watch it grow you some real results.

But get used to the tuning, before you try the antenna changes that 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 varistor 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 4 inches from the bottom, the rheostat between the variable condenser and left hand varistor, the grid leak between the variable condenser and right hand varistor.

This arrangement will permit a neat job of wiring, and the parts are placed for short, direct leads with few cross-overs. The lead from the grid leak post on the tube socket should be split, one wire going to the grid leak on the panel, the other to the hand condenser and the variable condenser. Blinding posts, for both appearance and convenience, should be placed in the upper corners of the cabinet.

Centralizing all parts 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 mf. antenna tuning condenser should go midway vertically of the panel near the left edge; the .0002 mf. variable condenser is opposite on the right hand side of the panel. If the combination of a 50-turn coil with a .0002 mf. condenser is found to cover too low a range, another coil can be added to the variable condenser and the .0002 mf. 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 holder 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.

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.

<table>
<thead>
<tr>
<th>Size</th>
<th>Turns Per Linear Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>900</td>
</tr>
<tr>
<td>0.30</td>
<td>800</td>
</tr>
<tr>
<td>0.35</td>
<td>700</td>
</tr>
<tr>
<td>0.40</td>
<td>650</td>
</tr>
<tr>
<td>0.45</td>
<td>600</td>
</tr>
<tr>
<td>0.50</td>
<td>550</td>
</tr>
<tr>
<td>0.55</td>
<td>500</td>
</tr>
<tr>
<td>0.60</td>
<td>450</td>
</tr>
<tr>
<td>0.65</td>
<td>400</td>
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<tr>
<td>0.70</td>
<td>350</td>
</tr>
<tr>
<td>0.75</td>
<td>300</td>
</tr>
<tr>
<td>0.80</td>
<td>250</td>
</tr>
</tbody>
</table>

It is a rare thing indeed to see a properly tapped coil; the usual practice of dividing a coil into taps of an equal number of turns produces 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 the number of turns, and the constant for that particular increase.

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 any 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; this tube is oscillating it is impossible to get intelligible signals over the Radio-phone.

Cooper wire not larger than Number 26 gauge is ideal for cathodizers on crystal detectors. Phosphor bronze, silver and gold wire make good contact points. Brass and cooper 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 work at its sharp tuning capability. Besides doing all the sunts without ground and aerial, I recently brought in for PWX, Havana, Cuba, 250 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 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 the variometer, take for granted you are adjusting the rheostat, because the action on the set is much the same. Remember this.

The rotor should be set at nearly or at a distance from the variable that means cross-wise. From this position it should move slowly and slightly, not more than 10 or 15 degrees, 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 and spend a few more nights on the spot that brings in the lowest signals and it's 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. Yonder will, 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-plat e. A 3-plat e is nothing more and nothing less than a vernier on a condenser. And a 43-plat e with too long an aerial is so often the trouble when you can 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. I am now giving you such sharp tuning with condenser C 2 that I had so much for my local export 5 to 10 degrees will tune it out completely with proper adjustment of your other dials. Yes, you can tune out the other fellows, not only one Radiocasting station but two, 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 225 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 with out ground or aerial; 200 miles without ground, and from 500 to 1000 with aerial only. If you are a "do-it-yourselfer" you should try 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 circuit. Always remove the acid or water from the tops of the battery, as the moisture will sometimes cause unnecessary noises. Never put the battery near window curtains, as the fumes will ruin these. Never 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 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, and condition can sometimes be remedied by 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 the bucket of water slowly over the surface of the battery. The vent caps or battery covers 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 plates 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 droplet of alcohol 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 raut, 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 simpler diagram presents an extremely efficient circuit; it is not only simple to construct, but covers a wide range of wave lengths. The cost of the necessary apparatus is low; an assortment of honeycomb coils, including 35, 50, 75, 100 and 150, will supply even the unusual demands of the ordinary fan. The device resembles somewhat the well-known high-sonority; its operation is very familiar. Tuning in the rheostat can be varied by from 225 volts on the plate, but if an amplifier tube is used it probably would be advisable to increase the voltage. The rheostat used depends on the type of tube, like the voltage of the A circuit.

Mount the variable condenser in 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. It is sometimes advisable to connect the shield to the wire connecting the A with the grid lead.

If a 199-299 tube is used the cartridge in the grid lead will have to be of a higher value—3 to 5 meg ohms. The 50-ohm 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 25 and 30-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, audio frequency, the detector and one stage of audio frequency. It has only two tuning controls and is installed on a single set that any person can adjust. The stage of Radio frequency gives the long distant range, while the audio frequency builds up the local.

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 225 is sufficient. The amplifier plate voltage should be about 67 volts. As may be guessed by the maker, the standard form of neutro-
Regenerative Reflex Is Powerful Receiver

The first matter of importance is that all components of the circuit must be of very high quality; second, the values indicated in the diagram must not be altered, since a small change will, in many cases, cause the two frequencies to become intertwined, and result in a jumble of sounds, instead of music.

Two varicouplers are necessary. A first varicoupler 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 real that this circuit is very critical and sensitive; therefore care should be used in tuning.

**List of Parts**

1. Radio frequency transformer...
2. Audio frequency transformer...
3. Crystal detector...
4. Condenser...
5. Potentiometer...
6. Transformer...
7. Crystal detector...
8. Transformer...
9. Varicoupler...
10. Binding posts...

Total cost: $12.45

**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 very small changes are not split this time—one good variable condenser, a good variable leak, and a good audio transformer, some fixed condensers and the usual assortment of necessities.

One of our few friends sent it 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 it get you to and very select, 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 225 shown in the illustration. 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 on the panel on the back; the .005 mfd. variable condenser is placed close to the left edge, the grid circuit variometer close to the right=edge, and the plate circuit variometer close to the left edge.

The detector tube may be placed close up behind its rheostat, but the amplifier tube should be placed farther back on the backboard with the audio frequency transformer between it and its rheostat. Use the three selectivity not usually found in a "single circuit" receiver, will be had it efficient, low loss parts have been used.

The following layout is suggested for this receiver. Place the secondary tuning condenser in good position. It is well to use the condenser of the varicoupler on a circuit only a little above its maximum value; then cut in primary of coupler, beginning with a few turns and increasing them as a last resort, until a signal is heard, or when the tube starts to oscillate. In the latter case, the second varicoupler signal circuit up; then proceed tuning more sharply by adjusting rotor of coupler and secondary condenser. At this stage, if the signal is not strong enough, the variable condenser and then build up volume by means of varicoupler and condenser. This will result in doubling of Radio frequency transformer.

If volume is built too high, light will be reached at which the tube will burst from oscillating. 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 remember that the filament of the filament is rather critical, there being three different positions upon the rheostat which are very close, but only one, neither of which is evident, while each succeeding point renders the signal louder. Any change in the filament temperature will affect the grid potential, by means of the potentiometer.

**Hints**

If a cat whisker type crystal is used, first remove cat whisker. Low resistance of rheostat, which causes filament to burn at a very low temperature; then proceed from the speaker till signal is heard. The signal, in this case, is very strong, 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 tube to oscillate; then, by adjusting crystal properly, oscillation will cease and the signal will again be audible and of greater volume. Then proceed as before.

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 tuned in properly, and you will nearly always find the trouble is a fault in the coupling. 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 resultant 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. If so, all state that stations within 50 miles are very satisfactory; and with one added stage of audio frequen-

cy, stations at 1,000 miles can be heard on this speaker with plenty of volume. Voice and music are also exceptionally clear and free from interference.

Additional stages of audio frequency will modify the circuit in the usual way, being sure to shunt first audio primary with a fixed condenser.
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-21A tube is used with a 45-volt plate battery and the potentiometer has a resistance of 400 ohms. The coupling adjustment between the spider web coils is apt to be very critical and therefore some form of micro meter control is recommended. Vernier plates on the variable condensers are not necessary, although some form of their 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 4-5 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 floor baseboard directly in front of the potentiometer.

This hook-up, which will interest the experimenter, is a combination of the popular Miliplex and the ultra-audition with the addition of an "absorption circuit" that also aids in tuning. Audio frequency amplifica-

Ultra-Selective Long Distance Receiver

The circuit shown is another of the selected receivers, and it 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接收 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 0.005 md, one 0.0025 md, fixed condenser, one 0.005 md, fixed condenser, three tube sockets, three rheostats, two amplifiers, and two detector tube, two audio frequency transformers (ratio about 5 to 1), two double circuit 14, two single open circuit jack, one panel 9 by 14 by 3/16, one backboard 9 by 8 by 16, 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 are 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.

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 squeals. The same applies to a neutralizing condenser which is properly adjusted. In this latter type of the grid 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.

**List of Parts**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable condensers .0005 mfd.</td>
<td>@ $4.50</td>
</tr>
<tr>
<td>Single coil mounts @ 50c</td>
<td>1.50</td>
</tr>
<tr>
<td>Mica condenser 100 mfd.</td>
<td>@ $1.25</td>
</tr>
<tr>
<td>Mica condenser 250 mfd.</td>
<td>@ $1.75</td>
</tr>
<tr>
<td>Honeycomb coils 75 turns</td>
<td>@ $2.00</td>
</tr>
<tr>
<td>Mica condenser 350 mfd.</td>
<td>@ $3.00</td>
</tr>
<tr>
<td>Fixed mica condensers .0005 mfd.</td>
<td>@ $1.00</td>
</tr>
<tr>
<td>Tube sockets @ $1.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Rheostat 40 ohms</td>
<td>@ $2.00</td>
</tr>
<tr>
<td>Rheostat 20 ohms</td>
<td>@ $2.00</td>
</tr>
<tr>
<td>Rheostat 6 ohms</td>
<td>@ $1.00</td>
</tr>
<tr>
<td>Grid leak, ununa and 1 meghm res.</td>
<td>@ $2.00</td>
</tr>
<tr>
<td>Crystal</td>
<td>1.00</td>
</tr>
<tr>
<td>Capacitor</td>
<td>2.50</td>
</tr>
<tr>
<td>Binding posts, bus bar, screws,</td>
<td>1.00</td>
</tr>
<tr>
<td>Total cost</td>
<td>$86.95</td>
</tr>
</tbody>
</table>

**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 wood; some are spooler web windings; others have a lattice wound honey comb coil. These coils take the place of the old slide tuners.

The taps need not be more than four or five, since the flux density 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.

A 400 ohm potentiometer is connected across the battery as shown, and near close adjustment of plate potential is possible. This is important with the various detector tubes at present available. The plate or B battery should consist of one 225-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 1 megohm. This plate circuit is considerably simplified and made means of the varistor. This varistor can be made of nichrome wire .001 inches in diameter, which will have a resistance of about 1,000 megohms. Since the current through it is not more than 10 ma., it will have a capacity of about 0.03 uh. The potentiometer should be of the high resistance type.

**List of Parts**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable condenser .001 mfd.</td>
<td>@ $6.00</td>
</tr>
<tr>
<td>Tapped termination 4 or 5 taps</td>
<td>2.00</td>
</tr>
<tr>
<td>Variable</td>
<td>5.00</td>
</tr>
<tr>
<td>Rheostat 6 ohms</td>
<td>1.50</td>
</tr>
<tr>
<td>Rheostat 12 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>Rheostat 20 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>Rheostat 30 ohms</td>
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<tr>
<td>Rheostat 60 ohms</td>
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<tr>
<td>Rheostat 80 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>Rheostat 200 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>Rheostat 400 ohms</td>
<td>1.00</td>
</tr>
<tr>
<td>Potentiometer 500 mfd.</td>
<td>@ $3.50</td>
</tr>
<tr>
<td>Potentiometer 1000 mfd.</td>
<td>@ $4.50</td>
</tr>
<tr>
<td>Potentiometer 1500 mfd.</td>
<td>@ $5.50</td>
</tr>
<tr>
<td>Potentiometer 2000 mfd.</td>
<td>@ $6.50</td>
</tr>
<tr>
<td>Total cost</td>
<td>$20.75</td>
</tr>
</tbody>
</table>

**Two Element Tube Set**

EVERYONE who builds his own Radio outfit desires to get the maximum performance with a minimum expenditure. A receiver may be constructed which is far more sensitive than a commercial set, but is more economical and reliable in its operation. Nowadays everyone wants a receiver with a built-in receiver 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.

Audio frequency amplification can be added in the usual manner if more volume is desired.

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 No. 22 wire, then turn on 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 filament.

Efficent Variocouler

A good variocouler 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 variocouler, in order to cover the Radiocasting stations' wave lengths, should have about 60 turns of Number 24 wire for the primary, or stat, 36 inches in diameter. The rotor should have about 50 turns of Number 26 wire.

of the potentiometer can be assured that they will get good results well worth the trouble by using the other circuit.
Compact Three Tube Portable Receiver

**Suitable for Home or Field Use**

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

The following list is of apparatus used.

**List of Parts**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Varispec</td>
<td>$5.00</td>
</tr>
<tr>
<td>1</td>
<td>Variable condenser .0005 mfd</td>
<td>4.00</td>
</tr>
<tr>
<td>1</td>
<td>Variable vernier condenser, 2-plate</td>
<td>3.00</td>
</tr>
<tr>
<td>2</td>
<td>Audio frequency transformers @ $4.50</td>
<td>9.00</td>
</tr>
<tr>
<td>1</td>
<td>Variable grid leak with .0005 cond.</td>
<td>5.00</td>
</tr>
<tr>
<td>1</td>
<td>Fixed mica condenser 0005 mfd</td>
<td>4.00</td>
</tr>
<tr>
<td>1</td>
<td>Fixed mica condenser .001 mfd</td>
<td>2.50</td>
</tr>
<tr>
<td>1</td>
<td>Phone jack, single circuit</td>
<td>2.00</td>
</tr>
<tr>
<td>1</td>
<td>Phone jack, 15-point Rheostat</td>
<td>3.50</td>
</tr>
<tr>
<td>3</td>
<td>Phone sockets</td>
<td>3.00</td>
</tr>
<tr>
<td>1</td>
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</tr>
<tr>
<td>1</td>
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<td>1</td>
<td>Panel 7x12</td>
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</tr>
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<td>1</td>
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<tr>
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</tr>
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<tr>
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Compact Three Tube Portable Receiver

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<td>Audio frequency transformers @ $4.50</td>
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How to Make a Harkness Reflex Receiver

A Simple and Efficient Radio Set

Among that vast multitude of Radiophans there is no ever increasing number who are seeking a hook-up that 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.

The list prices of the apparatus used in the List of Parts. The cost of the parts required for this receiver 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 frequency, detector and two stages of audio frequency amplification. Only one jack is used for phone and

not connected in the series of voltage for the amplifier tubes, since it was found that this materially cuts down the volume. So the fan may attempt to use the same battery for lighting the two element tube as for the amplifiers, that the circuit will not destroy the volume that can be expected as 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 one illustrated did.

List of Parts

<table>
<thead>
<tr>
<th>Part Description</th>
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<td>Tube sockets @ $1.00</td>
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<tr>
<td>Socket for 0-element tube</td>
<td>$1.00</td>
</tr>
<tr>
<td>Audio frequency transformers @ $4.50</td>
<td>$2.25</td>
</tr>
<tr>
<td>Rheostat 20 ohms</td>
<td>$1.00</td>
</tr>
<tr>
<td>Parts for air-core transformers</td>
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</table>

Figure 2

Figure 3

Figure 4

from the two condensers and the coils is sufficient to take care of almost any type of variable condenser. Angle room is provided for the location of the two audio frequency transformers. Dimensions of standard tube sockets are fairly uni-

(Continued on next page)
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 single-minded amateur in a fit of brilliancy when none exist. On the contrary it is the account of a simple regenerative set which 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 and Wireless Communication," he described a circuit devised by Roy A. Weagant, then a student engineer of the Bell System, which one might account of its extreme simplicity was particularly recommended.

What is the secret of it? That Mr. Weagant had evolved the circuit as a means of circumventing the famous Armstrong patent in which it failed to operate properly, so, he nevertheless gave to the Radio world a substitute that is efficient, universal and performance can hardly be "beat."

A glance at Figure 1 will acquaint the Radio enthusiast with the circuit. A little energy suffices 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 coil of the coil II is the same as any standard regenerative set. It consists of a 50-turn coil with a 0.005 mfd. variable condenser. The secondary circuit is the typical inductance with capacity in parallel. The inductance value is 25-turn coil and the condenser in shunt of the order of 0.005 mfd. The tertiary, or tickler circuit as it is commonly known, is of a form of an inductance of 50 or 75 turns with a .0005 condenser in series, the whole placed in parallel or coincidence with the filament circuits. Any Armstrong circuit, by the addition of a variable condenser, may be revamped into a Weagant without the slightest thought for the score of efficiency.

On account of the great variation in phone wave lengths, the desire of many fans for the arc and spark length, and the blanketing of the listeners who have the desire going down to 100 meters, a honeycomb condenser mounting with three plugs is recommended to give the greatest versatility to this receiver.

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 Radiofan.

The lead-in, even though it is insulated, still acts as a part of the circuit, and if you happen to live near the ground floor of an apartment house and you are really the same number of turns and are only slightly affected by the inductively coupled primaries. Neither one of the two isochronic centers has a critical setting. On tuning, in both condensers should be turned together until the approximate resonant 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.

Keep Lead-in Free from Metal

Even though the lead-in wire is insulated, never let it touch anything. This means the corona around the edge of the roof, the metal window screens or weather strips. When anything comes in contact with the lead-in, there will be leakage here, and trouble will surely result. Leakage will be greater during storms or damp weather and the trouble 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 range as a multi-tube set, although it is much inferior in the number of tubes used. The amplifier only serves to increase the strength of signals brought in by the preceding receiver without addi- tion 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 many 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 study before plugging them, we perhaps would know much about them from the circuit they originated from and know what to expect. Almost all circuits in use are present based on the three general principles for regeneration, Radio frequency and super-heterodyne.

- In keeping abreast of the advance of Radio we are forgetting that the use of the regenerative circuit in itself possesses Radio frequency regeneration and heterodyne control to operate as well as parts in the construction. The writer is a neutral and heterodyne fan, but from the view point of the advance of circuits 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 indirectly related to the secondary. Such has been said about doing away with taps and tickler coil 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 KHz 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 lesser number of controls are the appealing features, and for those desiring to construct such a tuner and receiver the hook-up is both 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 taking 66 turns of No. 26 c.w. wire. Wind the second primary first by starting 34-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 34-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 14-inch space, and is tapped at the first 30th, 36th, 50th, and 70th turns.

In leaving space on a tube it is advisable to cut the wire past through a 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 34-inch hole through the tube in the center of the 44-inch space between the secondary windings and bolt a thin plate over each hole. The plate is to be drilled exactly through the center of a pipe that is 3/4 inches in diameter and 1/4 inches long. Wind 40 turns of number 26 d.c. wire on each side of the holes (connected across the space), beginning as close to the outside edge as you will have 32 turns of wire on the rotor. This rotor is placed inside of the tube where it revolves. For this use a 34-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 locate on 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 washers.

#### Addendum of Audio Frequency

The audio frequency for this circuit is standard. It can be made in a separate cabinet. Those who have cranking the tube and hooked up with a detector tube alone want to know how to add amplification. We are showing parts and stages of Radio frequency amplification. A U-V detector is used for the detector and U-20A's for the amplifier. There is no question but which the small dry cells can be used with equal advantage.

Radiophonists building their own sets desire a more selective and tuning control. The diagram illustrated comes pretty near to being perfect it makes the tuning of this tuner works especially well in the circuit shown, it can also be used as a standard varicoupler by using the secondary windings as a primary and this is not necessary for either as a secondary, or it may be used as an inductive coupling to add selectivity to a crystal or tuning 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. In any case, whichever method of making these is used, if and must use a cardboard tube sleeve, it is very carefully so that it will not get out of shape. Coat it with colloidin or paraffin before winding the wires on this. This core is not necessary. The windings may be coated also with the same manifold, this is not necessary. Never use shelf.

The rotor tube must be large in diameter and impossible, provided it rotate inside the rotor windings in the secret to Radio frequency with this tuning.

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 rotor. The rotor or shaft bearings on 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 in the construction of this tuner; correct design is behind its success.

### Changing 3-Circuit to R. F. Amplifier

I wish to mention for the benefit of those who build this circuit that it must be soldered, all wires well insulated and the instruments set well apart, especially variocoupler. Also keep the grid and plate circuits separated well or at right angles if it is necessary to do so. 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 the soil driven into the ground in a damp place in the soil, with all wires soldered.

The best working condition was found with 30 or 24, or 21 volts on the detector or plate. I might say that one set would not work with .0025 grid condenser but found .0025 and .0025 was the proper capacity. The grid leak can be set on the proper point and allowed to remain at this setting.

In regard to tuning, I wish to say that with a little experience both variocouplers and the rotor of the coupling box, but 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 circuit jack in place of the pickup receiver with the center leads connected to primary of the next transformer.

### How to Wind and Assemble Coils

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<td>Designed for three tubes</td>
<td>30-70</td>
</tr>
<tr>
<td>Grid coil</td>
<td>Designed for three tubes</td>
<td>30-70</td>
</tr>
<tr>
<td>Plate coil</td>
<td>Designed for three tubes</td>
<td>30-70</td>
</tr>
<tr>
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</table>
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 coils was an adaptation from four to eight wires, a ground, a carbon-borundum 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

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two slide tuning coil</td>
<td></td>
<td>$2.00</td>
</tr>
<tr>
<td>1</td>
<td>Variometer</td>
<td></td>
<td>$4.00</td>
</tr>
<tr>
<td>1</td>
<td>Tube socket</td>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td>1</td>
<td>Rheostat, 6 ohms</td>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td>1</td>
<td>Grid leak of 1 meg. with .0005 mfd. condenser</td>
<td></td>
<td>$1.25</td>
</tr>
<tr>
<td>1</td>
<td>Panel Tht.</td>
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<td>$0.50</td>
</tr>
<tr>
<td>1</td>
<td>Cabinet</td>
<td></td>
<td>$0.50</td>
</tr>
<tr>
<td></td>
<td>Binding posts, crewes, bus bar, etc.</td>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$14.00</td>
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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 an add-on set of essential accessories for a detector tube; that is, a 1-megohm grid leak, a .0005 mfd. condenser, transformer, 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 holder should not expect to get everything from ZLO, 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 circuit is taken 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 find 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 employed, using a hard tube, such as UV-20A, and amplification is obtained in a wavemeter circuit employing the principle of negative reaction.

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 30-turn spider coils, 4 inches in diameter and wound with number 24 sic. wire, and two 11-plat condensers. No grid leak condenser is required.

Panel Hole Filler

Good hole filler for blank panels may be made in the following manner: Melt some sealing wax compound and mix tar and paint 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.

List of Parts

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Variable condensers .0005 mfd. vernier</td>
<td></td>
<td>$4.00</td>
</tr>
<tr>
<td></td>
<td>@ 9.40</td>
<td></td>
<td>$9.00</td>
</tr>
<tr>
<td>1</td>
<td>Material for spider web</td>
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<td>$3.50</td>
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<tr>
<td></td>
<td>Transformer 2 to 4 by 1</td>
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<td>Fixed mica condensers, .0005 mfd.</td>
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<td></td>
<td>@ 460</td>
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<td>$.80</td>
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<td>1</td>
<td>Phone jack open circuit type</td>
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<td>1</td>
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<tr>
<td>1</td>
<td>Rheostats 30 ohms @ $1.00</td>
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<td>$.25</td>
</tr>
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<td>1</td>
<td>Panel 7 x 14</td>
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<tr>
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<td>Cabinet</td>
<td></td>
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<tr>
<td></td>
<td>Binding posts, screw, bus bar, etc.</td>
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<td>$.50</td>
</tr>
<tr>
<td></td>
<td>Total cost</td>
<td></td>
<td>$10.25</td>
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</tbody>
</table>

12 inches away from the wavemeter circuit, as coupling between these two parts of the circuit is detrimental. The two other spider coil are wound closely. In use, 60-volt plate current is employed, and tuning is accomplished with another condenser as usual, leaving condenser 3 unused. The wavemeter circuit at zero or 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, it operates, where loud speaker results are desired. The circuit is protected by patent rights and is distinguished from others in principle and performance.

One Tube Reflex

Reflex circuits offer the true experimenter, the man who does not mind a change (two adjustment here and there—is the key) passage through the relatively unexplored field. The circuit shown here is but a "single-tube," but it is the proper set to begin with before doubling-on tubes and is, in addition, a remarkable set for both volume and tone. It 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

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<tr>
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<th>Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Variable condenser .0005 mfd. vernier</td>
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</tr>
<tr>
<td></td>
<td>@ 9.40</td>
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<tr>
<td>1</td>
<td>Wire, mica</td>
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<tr>
<td></td>
<td>@ 460 ohm</td>
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<tr>
<td></td>
<td>Rheostats 50 ohms</td>
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<td></td>
<td>Tube sockets @ $1.00</td>
<td></td>
<td>$.25</td>
</tr>
<tr>
<td></td>
<td>Panel 7 x 14</td>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td></td>
<td>Cabinet</td>
<td></td>
<td>$.50</td>
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<tr>
<td></td>
<td>Binding posts, screw, bus bar, etc.</td>
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</tr>
<tr>
<td></td>
<td>Total cost</td>
<td></td>
<td>$4.20</td>
</tr>
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</table>

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 173 turns of number 36 sic. or enamelled 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. This audio frequency transformer is of a special type, but higher ratios than five to one are not recommendable. The tuning unit consists of a one-turn coupling with an 8-turn primary and 48-turn secondary, number 22 or 20 dic. Wire wound on a four-inch tube. Fixed coils which closely approximate these figures are readily obtainable on the market. The plate voltage should be varied between 85 and 90 volts until best results are secured. That a loop antenna may be employed in when desired, a four-spring plunger is slipped to the secondary circuit.

To lay 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.
Theory and Operation of Neodyne Circuits
Their Advantages and Difficulties

The latest development in Radio is the popular craze for new circuits. The rankest amateur plays with the apparatus, books it up in a slightly different way, hears a station and promptly advertises that they are going to feature another new wonder circuit. The question of the practicability of these new circuits can be decided through an actual set-up of the apparatus and a test of operation. Considering the number of these wonder circuits, the reader can readily conceive the fact that it is not an expensive proposition. In doing this, though, the reader must be careful of the previously mentioned difficulty or non-existence of a 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 Neodyne. The word "circuits" is used, but actually it is a moniker. The Hazeltine Neodyne is not a circuit unit, 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 of the headphones or the condenser capacitors between the windings of any tuning unit, should be kept as low as possible. Because of this, the popular method of winding honeycomb coils was developed and in like manner, a condenser capacitor, the same used on the market. This same condition holds true of transformers. A transformer is one of the three elements, because of the dielectric value of the vacuum in the bulb. Even the wiring of the set creates capacity reactions, if not closely spaced. The internal microfarad value of this capacity effect may be small, but the ultimate effect of the unneutralized coupling 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 .0001 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)

\[
\text{Capacity} = \frac{1}{1 + \frac{1}{C_1 + C_2 + C_3}}
\]

Because the low value necessary the adjustment becomes exceptionally difficult unless the proper equipment, methods and facilities are available.

The method used in manufacturing the Neodyne condensers is illustrated in the small inset. There are two condensers, one of the capacitors, and the other condenser, the tube. When the condenser is placed in the vacuum of the tube, the condenser is completely neutralized. The filament wire is connected with the grid of the detector, and the second condenser is made with the second tube. After the two tubes are completed these condensers are sealed and should not be further adjusted. The result is a complete elimination of the coupling apparatus.

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.

Do not immerse any acid or water spilled upon the top of the battery while it is dry. Keep the top of the battery dry.

Do not permit the battery to stand completely discharged for any length of time. It should be recharged where there is loss of energy by leakage on the surface of the plates. When full charged hydrometer reading is between 1.280 and 1.290 the detector is in proper condition. When taking reading also see that the rubber bulb is fully expanded and not indented, as otherwise suction would permit incorrect read.

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 when exhausted 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 a considerable amount of the energy lost in the aerial. The heat generated is particularly annoying during wet weather when the sap absorbs moisture.
How to Make Five Tube "Traveler"
Simple but Efficient R.F. Set

In designing this receiver the writer has not attempted to accomplish anything revolutionary nor to present civilization with anything that will "up-set" the present-day standard of radio design, attractive appearance, and some of the refinements in parts construction that are the result of research and development 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 Transistor receivers and that will be a good set when compared with this set.

Considering now the refinements which, when all is considered, are really the distinguishing feature of this receiver from others in any price line, one where one is within 30 to 25 miles of the superstation or 10 to 12 miles of a standard class B broadcaster, the ordinary type of coil will pick up signals, and the inferiority of entirely eliminating that situation at all, is out of the question. Whether the coils are wound on solid tubes or are self supporting, whether they are set in the magnetic angle of 37 degrees or are vertical, does not matter. This seems to have been well proven in Chicago, which is one of the finest testing grounds in the world. One has his choice of the type of coil, also known as the toroid. The writer has experimented with many coils—and it probably will to a slight extent—but it does this to a lesser degree than any other type of commercial 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. All coils are designed, and used with good condensers, give sharp tuning.

If the question natural that straight line frequency condensers be used. The department of commerce allocates the stations to wave bands 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 dial, 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. This is true, and the curve resulting from the use of Thorola coils has been placed in practical any relation to each other and what, used with good condensers, give sharp tuning.

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 significantly and helps to break through DX. Dial and index dials are chosen because they are just as convenient to operate as any other, show up handsomely and have little to do with cost. Their price is also a very pleasant surprise.

Wallbert sockets have several 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, while there is a metal flange around the top 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.

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.

![Figure 1](image1)

The audio frequency transformers were chosen largely on past performance in other sets and the fact that Thordardon transformers are the choice of many leading competitors. The ratio between the 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. The coils 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 change of the home builder upsetting these when putting C-I-I rheostats in place. The hole mounting also appears, as it eliminates the chance of not getting three holes correctly drilled. The Frost PantaLack journals have long had an enviable reputation for consistently reliably 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 that there is very little adjustment of the grid leak. A condenser is made by Allen-Bradley for this unit which just fits across the terminals. This is specified in the list of parts. The switch used is also made by Allen-Bradley and gives a clean, clean break of the circuit and compactness. There is no mention of any of these parts.

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, these are not critical, they even can be used in the event of your getting rid of another content. This is the circuit design which will keep the applied voltage at a low level and vary slightly, depending on the amount of charge in the box at any time. For this reason, when a few are enough. Erela fixed condensers are the writer's choice because their construction would seem to keep the capacity close to rating.

Meter is desirable in this receiver. The writer is sitting at a receiver when he wants to get "out of town" and there is no possible way of knowing when the Jewell meter specified is at, then, both accurate and compact. Rukh is an instrument to be had in all the meters suitable for panel mounting on receivers. You do not know in advance to get the best out of a flexible lead, clip the negative terminal to one of the points designated as X1 and X2 to learn if the first three tubes are getting a better or worse. If they are, it can be taken for granted that the last two are, through any possible error.

If you have not yet tried Walmart's binding posts, you have yet to see the convenience and practical desirability to both of these exerted on this set construction.

As to the panels, there is not much choice between the various bakelite types put out, but Formica has been introduced for the writer 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, and a high class knowledge of tube voltage and filament control on the last tube. When the speaker or phone is connected to the jack, only four tubes are lighted and drawing current. Connected to the second jack, the last tube auto-matically lights on. 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 out as to performance, Traveler will do what any other well designed, carefully built units will do, but for all around efficiency it surpasses others which the writer has seen. It is doubtful if it could be put within a couple of blocks of a 10,000 watt station and still maintain DX on wave lengths between 10 or 15 meters away. It will, however, cut through in any but the most extremely depressed locality, it has a splendid performance, it can be used on the air and is one that any owner of a DX station has to have.

If the parts are all at hand we are listing one will get the front and sub base and mount the various pieces of apparatus in the receiver as he goes. The receiver has two alternators, one for the front and sub base of construction; the other for the front and sub base of construction; the third, for the front and sub base of construction.

To lay out three full size drilling templates, or, he can write in to Department 5, Radio Digest, 50 N. Dearborn street, Chicago, Ill., and enclose 25c for full size blue print
templates. They will be sent promptly on receipt of this amount in stamps, silver or money order.

If the feature, 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 piece of paper to the size of a template and then, with ruler and pencil, make a small cross where you wish to have your hole. The cross shou-
d to be the sub base, with one long edge down and so that one surface is flat. Make the cut on the edge of the front panel that will later be the bottom. The

Bracket Hole

Brackets holes hole sizes 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 a flat surface and use a couple of tacks to be the sub base, with one long edge down and so that one surface is flat. Make the cut on 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 to the rear of the P and G terminals on the socket also go to the rear. It will be noted that mounting holes for the right hand trans-
formers 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 3/16 inch to the left of the rear left mounting hole of the left hand transformer. An-

upper surface of the sub base will then be 3/16 inch from the bottom as the panel is 3/16 inch thick. Now place the sub base just right over the cross, then marking half an inch off the sub base which amounts to 3/4 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 cut cross these points and all on holes in the panel template.

Now paste the template to the front of the front panel with four holes drilled in it and some paste or 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 in bringing them up to size.

Mounting the Meter

The meter hole may present some difficulty if you have not handled a meter on a panel before. There are two ways of doing this. You can either use the fly creen made for the purposes 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 Vanessa 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 deck should drop out. Now with a hair round file, smooth down the edges of the hole to the line of the bracket holes 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 fig-
ure 4 is a four-spring two-circuit jack; that in the lower left corner is the flat control jack. The one next to it is the through-the-screw control jack. It will be noted that the writer hung his baseboard on the back of the cabinet.

The sub base panel should now be cut to 29 1/2 inches long by taking 3/4 inch off one end, and then painted. The wire is then inserted. Two diagrams are necessary to show the holes to be drilled in the sub base. You can either combine these on one template or make two templates as indicated in figure 6. The writer would suggest making a template per figure 5, punching a hole, center punching, and drilling the holes in this location. All holes shown there are for 6-32 screws and a No. 27 drill is correct. Then make the template as per figure 6, punch, center punch, and drill with as small a drill will pass the bus wire you have prepared. These will be about 1/32 inch in diameter. Mark the positions of the bracket holes, and presum-
ing the positions of the brackets, place the sub base under the brackets so that the rear edge is 9 inches from the front surface of the front panel. Now use a small drill and drill holes 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 be-
tween 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 the detector socket with P and G 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 instru-
maments previously mentioned and takes off can now be put on again. The Brandleyak is mounted be-
tween Thorola T-2 and the socket to its right; the Brandleyak terminals and condenser go to the rear. This will be necessary to use two 4-36 machine screws one inch long for this. The Ameritec 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 A, 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 as the flat base will have to do this not as he pleased. The writer shifted binding post nuts over the mounting screws on these sockets, be-
tween the socket and the first sub base to raise them and reduce any dielectric absorption of energy by the sub base from the large springs, and reduce the ten-
dency of dielectric placed close to them to cause

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 con-
struction. The sub base, when completed, will be moderately hard to get at, and the builder will have smooth sailing to the end of the job. Each operation which consists of putting in a wire, is given a number which applies, after that, to the wires. Two nuts are placed 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 1 to rear left post on socket 5 (above sub base).

9. Connect rear left posts on transformers 1 and 2 by wire nailing under sub base.

10. Connect rear left post on transformer 1 to minus C binding post of control C.


12. A short lead is put in connecting rear right post on socket 1 with P on Thorola T-2.

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 com-
pleted by connecting rear right post on socket 2 with P terminal on Thorola T-2.

15. Bend 4 wire so that it passes through sub base from B terminal on Thorola T-2 under the hole be-
neath 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 to P post on transformer 1 (front left corner) and over to plus 45 binding post.

These are all the wires that can be connected with-
out combining panel and sub base, so with the brack-
ets, carefully bolt these two assemblies together, tak-
ing care not to injure or bump any of the pieces of apparatus while doing so. With the two fastened to-
gether we can proceed with the wiring.

Connecting Panel to Sub Base

18. Considering the left corner of panel, connect the shorter of the two long springs to the front variable condenser and to rear left post on socket 1. This wire is to pass above the sub base. The stator terminal is almost directly above jack on upper end of condenser.

19. The spring next to that just con-
nected will be wired to G terminal on Thorola C by a wire passing below sub

20. Now bend a wire to pass from the remaining middle spring to the hole beneath the hole above GN on Thorola C, back to GN (ground) binding post. A short lead is now inserted from terminal CO through sub base to this wire just in-
serted.

21. A comparatively long wire is now bent from the jack on top of the sub base and across to the left end of the front Amperite.

22. A wire from the sub base from A terminal on Thorola T-1 to wire 21.

23. Bending the wire, this will go on, center punching, and drilling the holes in this location. All holes shown there for 6-32 screws and a No. 27 drill is correct. Then make the template as per figure 6, punch, center punch, and drill with as small a drill will pass the bus wire you have prepared. These will be about 1/32 inch in diameter. Mark the positions of the bracket holes, and presum-
ing the positions of the brackets, place the sub base under the brackets so that the rear edge is 9 inches from the front surface of the front panel. Now use a small drill and drill holes for 6-32 screws. The positions of the parts on the sub base are shown in the photograph 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 con-
struction. The sub base, when completed, will be moderately hard to get at, and the builder will have smooth sailing to the end of the job. Each operation which consists of putting in a wire, is given a number which applies, after that, to the wires. Two nuts are placed on the sub base before it is attached to the front panel. These will be described first.

24. Another wire is bent the same shape to con-
nect rotor of left post variable condenser to wire 21.

25. There are two rheostats; that to the left being B, the other being R+4. Connect the right terminal of R-2 to wire 21, and left terminals of R-3 to wire 21.

26. Insert a wire connecting the left terminal on R-2 with 4 wire that connects the front right terminals of sockets 1 and 2.

27. Run a wire straight back from wire 21 to the minus A binding post.
30. Connect plus C binding post with short one-inch wire to minus A binding post.
31. Now connect the right hand terminal on the filament control switch to the nearest point of wire 1, the first one put in.
32. This wire is now inserted diagonally from left terminal on switch to plus A binding post.
33. Going now to the jack in lower right corner of panel press the switch has been put on with frame to the right, the filament control springs are the two in the two left position of the instruments, and those two springs to the rear left terminal on socket 5.
34. The second jack from the right hand, is also unconnected. Connect the shorter of the two long springs to the right hand post of socket 4.
35. Connect the left terminal on transformer 2 to the right hand terminal under wire to sub base to the remaining short straight spring.
36. Where wire now, these two jacks in the lower short portion of panel, bend a wire to pass from the transformer 2 to the right terminal, and connect the remaining straight spring (terminal of the other jack), then across sub base, to both wires 1, until opposite plus 90 binding post then back to that post.
37. Remove one of the long two springs in left hand jack (referred to as the "remaining spring terminal" in operation 39) put a wire through sub base.
38. Drop a wire through sub base from left terminal on rear Amperite to wire 21.
39. Run a wire down and straight back, above sub base, to the right hand end of variable condenser to the wire connecting G of Throbula 7-2 with the front end of the condenser (wire 4).
40. The next wire, from the stator of variable condenser, drops straight down and then back, either above or below sub base to rear left terminal of sub base socket 2. If run below it will be necessary to drill small holes in the sub base or the left terminal of socket 2.
41. Bend and insert a wire to reach from right of rotor of variable condenser G (C-3), in front of, then back under sub base, to wire 1.
42. From this sub base, connect minus B binding post to plus A post with a short wire.
43. On underside of sub base it will be found that wire can be separated by a distance approximately the length of the A cord on the fixed condenser which can be connected across one to the other.
44. From the binding post of the A cord, fixed condenser is connected to the front right post of socket 4, with one loop side down resting on the base part of socket. In this position it will be found that the binding post is in the middle position of the "A" cord touches wire 6 while the binding post is directly above the front right post on socket 4. Bend a wire 6 and drop a short one to the connecting right terminal to the right terminal on socket 4.
48. A piece of flexible wire is now connected to the Antenna binding post, beneath sub base, and will be brought up through the holes beneath terminals A-1 and A-2 on the left side of Throbula C and reach either of them.
39. 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 subbase and to one wire which was number 1. To the other terminal, a flexible lead is attached terminating in either a spade connector or small clip. Preparing that there have been put in, we are ready to set up the Traveller.

Batteries Necessary

Three power units are needed, a six-volt storage battery of any amperage hour capacity between 60 and 120, two 45-volt B batteries such as the Eveready number 570, and a small 45/2-volt B battery.

Two small holes will be drilled either in the bottom of the cabinet near the rear edge or in the back close to the bottom, for the antenne 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 46 in diameter 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 phonos in the jack which should be pulled out, whereupon the two tubes at the right should light if the speaker jack is used or only number 4 if the phone jack is used.

Operation of Rheostat

The right rheostat should be turned clockwise until the arrow points horizontally to the left. This is pre

Reading from right to left, the three large tuning dials will be considered as numbers 1, 2 and 3. Now when the rheostat is turned to the left as far as will go and in the off position. The right rheostat is then turned clockwise until the indicator points horizontally to the left. This is pre

Tuning Dials 1, 2, and 3

In this connection, one is guided by the settings of dials 1, 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. This is done by the close coupling of the antenna system and will be found to run from 5 to 10 degrees below the center two.

With an on-off-type switch in, or just the variable grid leak (to the right of the T horola coil) for maximum sensitivity and then leave it alone. Turning this Bradfield, the slip in the increase the resistance and increases the sensitivity on distant stations until a point is reached where everything suddenly "pops out" and the grid leak must be turned back until the station again comes in. The right rheostat which controls the strength or sensitivity of the "b" variable can be varied by this method.

The voltimeter is employed as follows: The detector rheostat has, preferably the voltmeter to point X on the tuning dials. The flexible lead from the 45/2 unit at the right terminal of the dials the pointer may be a fraction of a volt above 90, while at 80 on the dials, the voltmeter may read around 6.
How to Make DX-Seven Super-Het
Full Construction and Assembly Details

W HEN any of us plan to build a new receiver, especially a superhet, we usually have in mind two chief points, namely, range and clearness of reproduction. 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 one who connected with selectivity and is willing to sacrifice something of this quality for range. However, the builer living in large cities where there is at least one powerful broadcaster, and possibly four or five others, may prefer clearness of reproduction at the expense of range. The choice between these two, or a compromise between them, is the problem discussed in the article which is about 75 per cent efficient in each of these parts, as compared with the ideal.

The Problem Overcome
The writer lives in Chicago where eight wave-
nels are divided among about fifteen stations and forms a barrier to distance that is a walking distance against which one
bends his receiver at sitting after setting
pling only to find a local station sparking and
strongly, over several positions. He may also
ny to construct a "good" but, when one lives within
the 50 per cent strength zone of five powerful
stations, that is not so easy. After trying combination of apparatus without set to be described was evolved, and is the most satisfactory solution of the problem, the writer now is not sacrificed for selectivity, nor has either quality been cut to get the other. It is called by the writer "DX-Seven" because it will do DX anywhere, and is a seven-tube instrument of a straight eight.

The sensitivity of a super-heterodyne is largely by the efficiency possible in the intermediate stages. If, due to feedbacks within these stages, the amplification per stage, within the tube, has to be cut down by the changes in the overdrive, the range is at once seriously impaired. While keeping the choice of intermediate frequency transformers. The Collo, we find, finally chosen by the writer, are constructed on the principal of two D's, each facing the other side, and register in a closed magnetic field which cannot be affected by currents from the tube to the other tube to the transformer by the preceding tube via the primary winding. An undesired current striking one of these transformers is an output 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 result that no output flows in the secondary and there is no difference between the ends of the transformer.

Only the desired output 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 to any relation to each other as regards angles, without fear of having to lower the selectivity by the potentiometer. High gain can be put on the grids of the intermediate stages, and the feedback to the oscillator, giving it a very great amplification and low B battery drain. Result, range and economy. This is, however, another benefit from the use of Collo 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 secondary de

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

Figure 1

1. Collo Super Kit $27.50
2. Benckendorff 7, type 8552 Cond. 10.50
3. Marco-Desuper Dualie, Nickel 11.00
4. Benckendorff Triple Gang Slant 5.00
5. Palz Magnetic 10,000a. Cond. 5.00
6. Glasgow Midget 1,600c. Cond. 3.50
7. Carter Inp. 2000a, 6 ohms 4.00
8. Carter Inp. 2000a, 10 ohms 4.50
9. Carter Inp. Potentiom., 200 ohms 5.00
10. Collo Indicating Switch 4.00
11. Vanly 4 spring Jack, No. 4 6.00
12. Vanly Open Circuit Jack, No. 1 3.25
13. Vanly Transformer, 40 to 1000 2.50
14. Vanly Transformer, 40 to 1000 Cond. 1.75
15. Dbllerlife 0.0005 with clips 1.75
16. Dbllerlife 0.0005 cond. 1.25
17. Aven Lens, 5 megohm 3.50
18. Aven Lens, 5 megohm potentiometer 3.00
19. W. & C. City Reel, 5 megohm 2.00
20. W. & C. City Reel, 5 megohm potentiometer 1.75
21. Aven Transformer, 0.5 ohm 2.50
22. Aven Transformer, 0.5 ohm potentiometer 2.00
23. Parts, 3 neg., 1 neg., 1 neg., A, 1 neg., B, 1 neg., C, 1 neg., D 1.50
24. Jewell Panel Voltmeter, 0.0 5.00
25. Jewell Milliameter, 0.0 5.00
26. Sears Crown Cable Markers 1.00
27. Hattie Bakesite 1761, 6/16 " 1.00
28. Oakmeal, 1/2ed 1.00
29. Round Slit Angle Brackets 7 1/2 x 7 1/2 0.25

Total cost...$104.00

Figure 2

Radio Receivers—How to Make and Operate

Mac-Dialo Discs
The problem of the dial manufacturer has been, to the writer, an interesting one. There must be a dial and a dial is a loud in a straight line.

Some of these points have been covered to perfection by the Martin-Coleman company in their new release. The first impression is to put it mildly, handsome in appearance. There is not a single part of any of the half-dozen workers. The ratio of parts to parts of this set is not too many turns of the knob to go from end to end, yet one can split a degree on the scale in setting the condenser. Station call letters can be long enough to accommodate the smallness of the dial scale.

In choosing the Benjamin gang socket for this set, the writer himself and incidentally, you, a lot of the seven sockets come all mounted, each on a small column, in a line in a 175 Hz by 45/45, shape. Connections can be made easily above or below this shell without drilling holes; the non-microphone qualities of the socket are unaffected by the use of still better. The non-microphone qualities 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 reaches the tube base is taken through the springs and does not reach the tube, thus ensuring of the filament and reducing of the noise in the speaker. So convenient to use in this apparatus, we can say that future sets presented by the writer will, many of them, take this feature.

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 modulator condenser. Many Después they use it, and all look pretty much alike. After examining several, the James, Jr., made of various condenser bodies, only that which some people like. A skeleton frame looked free from losses and there is a very small area of plates and plates dielectric. Construction is rugged though the unit is very small, and the contact spring giving connec-
tion of the plates is a good job. Few will den-
ied the amount of stage of audio fre-
que-
ncy, and I think added, brings with it very little. Therefore, if we can put off one of the usual visual devices that Carter rheostat and poten-
tiometer perfect examples of compact but dependable condensers, in this case units were added for their respective purposes; I do not doubt that their diameter of 0.24 in and projection behind panel of but 0.25 inch, nothing has been 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 part of the make-up before the one hole mounting feature saves worry and work.

Care was used by the writer in selecting the mis-
relep-

The Daven Lekandenser is a comparative unit on the market, and a unique one. There is no marginal condenser, as we usually expect to find it. The "common," others obtained, by the way of two wires. One is connected to the cap at one end, and the other connected to the other cap. The two are wound parallel to, but insulated from each other, forming the plate of a con-

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FRONT PANEL
ALL HOLES NOT MARKED, 9/64" DRILL - COUNTERSINK.

5/16" DRILL

3/8" DRILL

SUB-PANEL
ALL HOLES 9/64" DRILL

TRANSFORMER MOUNTING PANEL
ALL HOLES 9/64" DRILL

Drilling Templates "DX-7" Rece
- Designed by John G. Ryan -
Drilling the Sub Panel

In studying over the template, the writer noticed two distinct areas on the lower part of that drawing were omitted, which are essential to the placing of the transformers. Figure 5 shows that the layout of the transformer, as shown in the small, vertically placed panel on which the Celco intermediate transformers are mounted, and, across the top are 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 in the left and right top edge are also 5/16 inch from that edge.

With this lower limit, you would have to make four more holes in the panel, put four more holes on it, in addition to those, shown for the wire running across from the left, the first to be 4-3/8 inches from the left end, the second, 1 inch from the left, the third goes 6 inches further to the right, while the fourth goes 4-5/8 inches from the left. These will, when wired up, provide leads, connections, and grid leads. The fifth hole will be at the upper left corner and 1/2 inch from the left edge, and 3/4 inch from the top edge of the plate.

The sixth hole is also 1/2 inch down and 2 inches to the right of those holes.

Refering now to Figure 5, you will note in the lower right hand corner, there is a vacant space to the right of the last intermediate transformer. The Daven Leckan
denser is to be mounted on the back of the transformer stack so that it projects back into that space. The fifth and sixth holes mentioned in the preceding paragraph are spaced at 2 inches from the two clips with the Leckan
denser. The Duhiler 1.0 mil, 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 wire is connected to the transformer, and the other is slipped under the nut holding the third intermediate transformer from the left. The Duhiler grid condenser with clips is mounted on the short side of the tube, parallel to the Amperite on the upper side. This Amperite is just in front of the first tube section from the plate, running toward the set from the top, with panel toward you. This will put the grid condenser squarely behind the oscillator coupling.

1. 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 where the switch.

2. From upper terminal of switch proper, next wire parallels the first along under side of shelf but with terminals inverted. Remember, all directions as to right and left are with regard to the plate. This wire is put in going up through hole at left end of Amperite.

Where wire number 2 passes under right end of the other Amperite, that behind the audio transformer, run a short extension up through Amperite.

3. Upper side of shelf, run short wire back from left end of left hand Am
erite to negative terminal on the first min
socet nearest to left.

4. Run short wire back from right end of shelf and Amperite to negative termi
nal on the socket nearest right end of shelf.

5. Where wire number 2 passes back of the rheostat, run a lead from that wire to short down to left terminal of rheost
t (located at set from rear).

6. From negative terminal of second socket from right end, drop wire through the eyelet and across over to the bottom of shelf, to the negative terminal of the socket. Wire goes up through eyelet.

7. From negative terminal of third, fourth and fifth sockets from right, run short wire from it up through eyelet to those terminal

coupler.

8. The terminal of rheostat is to be connected to wire 7 by wire paralleling wire 6 part of the way.

The five interconnecting sockets run a short lead up through each eylet to the plus terminals of those sockets.

9. 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.

10. 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.

11. From left terminal on left hand meter wire run down, beneath shelf and back to transformer strip, to left, and back to negative binding post, fourth from right at rear edge of shelf. (Passes between upper edge of transformer strip and shelf).

12. At top of the combination filament switch and lamp there is a third terminal. Run wire straight back from this to wire 12.

13. The Duhiler fixed .002 mil 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 mil, 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.

14. Go back to the condenser mentioned in paragraph 10. Pass the wire across operating end plate terminal at right down to the F terminal on upper side of the five intervening sockets run a short lead up through each eylet to the plus terminals of those sockets.

15. The next wire is to go to the right hand (plus) terminal of the Dubiler grid con
denser, referred to in operation 21, to
der the rear on under side of shelf and up through to the F terminal of the first oscillator transformer. Where this wire passes under the left end of the C battery, connect it back up through hole in shell to the binding post at left end of C battery.

16. Where wire 25 passes to the B terminals on the under sides of the other three transformers connect wire 25 with those terminals using the same method as the other connections.

17. The position of the second tube from right is to be connected to the rotor (lower) terminal of the Gleason midget condenser.

18. 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 the Celco unit.

19. Also on the upper side of that Celco unit is a G terminal. Connect with G terminal by means of a short wire running up through eyelet.

20. Connect P terminal of the top third Celco to P terminal of third socket. Connect G terminal of second Celco to G post on fourth socket of the plate. Connect G terminal of the third Celco goes to G post of fifth socket.

21. The stop on the plate of the fourth Celco is handled differently. From it a wire goes straight forward to the transformer shell, then to left to the left terminal of the Leckandenser.

22. From the right terminal of the Leckandenser pass a wire to the right and up through the eyelet of the G terminal of the sixth socket.

23. 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 34,1/4 inch. This plate passes under G terminal of second socket, then to the fourth socket. A wire passes from right forward passing between top of shelf and under side of shelf until in line with right hand terminal on the plate of the left hand variable condenser. Put in a short wire connecting this with G of second socket.

24. The third of the three loop binding posts is to be connected, by a wire running to the left to the lower terminal of the upper terminal of the fourth socket. The wire from the fourth socket is continued to the left to the right hand terminal on the plate of the fourth socket. The upper terminal is connected to the P terminal of the sixth socket.

25. The next spring connects to the P terminal on the Erala transformer.

26. Third spring is to be connected to the B post on the Erala unit.

27. 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 reads post 60, 40 binding post in this position and plus 45 at the end.
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 until you find a station. Be sure that this one, or twice and no signals are heard, shift the position of the selector knob slightly to the left or right and again revolve the left dial. This may have to be done three or four times before a signal will be brought in.

The voice or music will be heard faintly at first, and with the volume control increased on slight readjustment of the right dial, and also careful adjustment of the potentiometers. A few minutes of operation will bring the maximum strength by these refinements, try adjusting the rheostat and the potentiometer together. About one volt per watt will be found to be the normal in operation.

The position of the volume control is for the left, in which case there will be distortion, and it will have to be brought back. If the adjustment of both has been found, further adjustment of these two knobs should not be necessary.

Figure 7

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 for the grid resistor.

In no case was it found possible to use a resistor having a value of less than .05 megohm. The grid of the cartridge caused all signals to stop at once.

You can easily distinguish between the sockets in an endeavors 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 leakander. This was specified by the writer after a great deal of superheterodyne experience as the most used value for a grid leak in that position. Here again you have the problem of adjusting it. As to fine line one which will work best as a detector with that particular leakander, the writer has found that the 5, 1 megohm and 7-megohm values. It is highly probable, however, that you will secure most excellent results with the value specified.

Battery Voltage

The writer has not as yet seen a model of this set not a combination of 6-V. In one of these sets where there was any advantage in using other than the full 7.5 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 millimeter, and cut down the volume. The use of any voltage gave no increase in either range or signal strength, and gave no advantage for the battery current consumption.

After you have chosen the best tube of those which you have for use as second detector and A-C wavemeter the remaining five tubes should be shifted around in a bit of their sockets to find which are the most closely alike in their characteristics for use in the third detector. These last three are known as the intermediate frequency amplifiers. The volume as you change the range and volume with different combinations, you will find that one tube makes the best first detector or mixer in the second grid.

This is the reason why the tube is considered the set viewed as from the front. The reed switch and the small lamp which is part of this set should light. The reed switch is the lower of the two small knobs below the meter, should be touched to the right as far as possible and then slightly back by the tubes will be lit nearly but not quite the same brilliance.

Preliminary Operations

The potentiometer, which is the upper of the two knobs, should be set for the correct position. It is a good idea to have the control set at the right knob controls the frequency of the oscillations detected and the lower knob controls the right controls the conditioner 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.

Making Curves of Dial Settings

Thus, when you have a station you can determine the wavelength used by that station, set the superhet in the receiver in the loop. Grid, and locate this wave length on the loop antenna. The writer has determined the condenser settings at which you receive that station, move your pencil up from the bottom of the loop to the point where you reach the horizontal line corresponding to the dial setting.

You will thus have three intersection points for each station, and after you have drawn a line through the second and third points. You will find that three long lines can be drawn through your triplets of dots, one for each wave length, while the other will give you the upper and lower oscillator line, the horizontal line for a station without being levitated by clear line. You will find that three long lines can be drawn through your triplets of dots, one for each wave length, while the other will give you the upper and lower oscillator line, the horizontal line for a station without being levitated by clear line.

On local stations it may be found desirable to insert your antenna lead in the latching point of the right 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, in which case you may find that a full path to the earth is necessary.

Do not forget that the loop antenna is directional, and that the plane of the loop must be parallel to the direction from the point where you determine the maximum energy pickup from that station. Now the loop will not pick up energy around the station located in a direction at a right angle to the loop.

Another suggestions that he cannot give you a definite value for the two resistor values, as it will depend on how you have tuned your loop, while the aerials. In other worlds, it may be perfectly audible on one loop, and completely dead on the other.

All on other points, however, the directions given are best, and if you have followed them carefully you cannot go wrong.

Construction, Traveler Flip Tube (Continued from page 50)

These figures will depend, of course, on the tubes, the battery lighting them and the B batteries. Increasing Selectivity and Sensitivity

If one has trouble with selectivity and either cannot separate two local competing stations, or cannot get a station located in a direction at a right angle to the loop, he can increase sensitivity by increasing the sensitivity of the loop.

Another alternative is to take the flexible lead from the antenna binding post and solder it to .0025 mfd. fixed condenser, the other terminal of which is to be soldered to the antenna binding post.

There should be no trouble with selectivity even on the better of the two, the antenna length must be good for long range but there is considerable selectivity, including lead-in, may have to have two or three 10 ohm parallel capacitors. In the case of superhet transformers, these results can sometimes be improved by connecting it in any of the pairs mentioned, or. Connecting the loop to the antenna binding post of your choice will greatly increase the selectivity.
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 performance, deep basements, many controls, two controls, one stage of audio, two stages and push, preceded by some R.F. and even rephrased. Each has 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, even an advanced amateur, could construct and operate successfully. To which one might well answer, "Well, don't build a super. Construct something with less tubes and less necessity for accuracy, Whichever is 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 work on plans which 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 have, therefore, in 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 must be much more efficiently handled by the tubes.

Essential Parts 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, which is all the antenna necessary. Secondly, there must be means of tuning, which is a variable condenser, the usual size being a "twenty-five inch" known as a "twenty-five inch plate." It is mentioned above that one of the tubes is a plate 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 the frequency always has a certain predetermined relationship to any incoming signals, no matter what their wave length. For this purpose, too, we have a variable condenser, also of .0005 microfarads capacity. With this oscillator condenser is also used an oscillator coupler, which must contain inductance, so this coupler provides grid circuit as a "filter" plate circuit "feedback" coil and a small coil to be hooked into the grid circuit of the "mixing tube," which has the property of bifurcating the wanted from the unwanted and passing only the former.

Having mixed the energy from the oscillator, the question immediately comes up of how these amplifier tubes to use. It has been found good practice to use more than this brings the signal up to a volume too great for the average detector to handle. While less than this would not be taking advantage of all the strengthening possibilities, some means of coupling tubes together is always necessary and transformer coupling if found both simple and satisfactory. So, we couple the tubes with the wave lengths which were mixed to the first amplifier with a transformer, which is known as a "copper," because, since one winding of this transformer is tuned with a fixed condenser, the other winding has the property of bifurcating the wanted from the unwanted and passing only the former.

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 are the first amplifier to the second and the third to the third and the third to the detector, are not tuned in either winding and 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 input to the detector is necessary, so the signals are passed from the last radio frequency amplifier to one of the long wave transformers into a vacuum tube, which is tuned with p. of. coils 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 in each frequency is necessary. This single tube is coupled to the detector through a filter which is tuned in the usual way now familiar to most fans.

Two Tuning Controls

On the panel then, we require only two tuning controls for the two condensers and two subsidiary controls, but seldom touched, the position of the rheostat. Considerably better selectivity will result if the oscillator is left from the audio amplifier to a second detector and one amplifier at audio frequencies. Due to the necessity of using the detector points 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 radio schemes included such as a variable capacity condenser; if so, they need not be used. Some kits may be designed to pass a wave length of 5-5000 and include large meters, 4,600 meters, 6,100 meters, 8,300 meters and 10,000 meters. The exact parts are shown in the illustrations. The oscillator coupler may not look like it. It is sugging out to the point where frequency is exactly the same on a variable rotor as did this one too. Much too much stress cannot be laid on the use of high grade carbon or dielectric fixed condensers, as the writer has found that these condensers are second only to the matching of transformer in importance.

Panel and Baseboard Layout

Laying out the parts of the panel and placing the parts in the board is the first thing to be done. It is most advisable to fit everything on paper first and use the layout as a basis for center punching the parts and making the parts of the baseboard. The plans however, are usually provided with templates for the locating of the baseboard, it is not always necessary to do this.
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 use a different frequency transformer and the 0025S md condenser slightly thicker. One may be done without affecting the working of the set in any way. The wire and binding posts are also in the back cover with center holes marked, a decided advantage, and the point will probably be able to follow is exactly.

Wiring Instructions

In wiring this set the following leads to put in are the filament connections. Looking at the layout of the set as in Figure 2, on the left-hand side of the baseboard is the Hin A; a soldering lug is slugged under the head of the screw holding it in place, and a number of short spaghetti, spring, and binding posts will go around to the right of the last tube socket and through the holes in the side of the case. Spaghetti tubing over this lead and solder one end to the positive lug post and the other to one of the switch terminals.

A bar of bus along the front edge of the tube sockets; if it will not reach from the left to the socket 7, solder on an other short piece so that it will be a soldering lug on each binding post on each socket and be brought down to a angle. See Figure 3.

Figure 3

The binding post at the back of the set and second from the right is the positive A. A wire is best to pass from this socket to the filament audio frequency transformer and the C battery, then to the right of socket 6, over the 5, and to the positive lug post to the rheostat 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 binding wire directly in front of the sockets.

Figure 2

Now run a short spaghetti-covered lead from the rear binding post of the groups filament bus at the point where it connects to the left front post on socket 6 (counting from the left). The filament circuit should now be complete and may be tested with the 6-volt storage battery to the terminals marked "A Battery" in the sockets, turn the filament switch to "On" position and turn up the rheostat slowly. The lights will glow dimly at first and, finally, with some brightness. If all lights light, re- move the switch to testing position.

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 from its right terminal to the upper bus where it is supposed to be socket 4. Each wire should be bent, covered with spaghetti and attached to the post by means of a soldering lug. This leaves the center terminal to be connected later.

The Oscillator

We will now take care of the oscillator tube, couple and condenser. It is usual for the manufacturers of such sets to supply a lead from the grid to the filament of the oscillator, and every builder will probably have such a diagram. The oscillator should use a 025S md condenser, of the correct degree, and a 35-inch long tube which is 35 inches in diameter, wound with No. 12 B & S wire. One winding contains 18 turns and the end nearest the glass is connected to the negative lug post of the tube socket 1 and the static (fixed) plate of the variable condenser at the left end of panel. This is important. A coil should be made in each tube 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 about 6 inches from the binding lug. Since all couplers are not equipped with a 35-inch inch, the following deviations may be necessary: 3527...
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 insert the plug into the plug board. If all was done previously of course, but this second precaution will be useful to be sure that connections made since the first test have not been made so that the B battery will not blow.

How to Tune
Now plug in the loud speaker in the lower jack and the earphones in the upper jack. Leave the set from the front, the condenser to the left will be turned to its fullest extent clockwise, while the other one will be referred to as the loop condenser. It is important to remember that the 50 and slowly rotate the oscillator condenser through its scale. If no whistles or echoes on any of theEARCHOSeries of whistles or echoes is heard, turn the potentiometer about 20 degrees to the right of where you had it during this try out. Again rotate the oscillator condenser so that it is set for the range that is usable and of course, whistles or echoes should 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 right hand and swing the oscillator condenser back and forth with the left hand until the point is reached in which the potentiometer will be in the middle of its range.

Figure 5

Figure 5 is the chart of the potentiometer for maximum signal strength on any one station it can be in that position where it will produce the most signal strength with the two condensers. The loop tuning condenser will then be turned to the right in the area of super-heterodyne being almost entirely in the oscillator condenser. If for any reason the receiver does not work at first, refuses to work, the following tests will quickly determine where the error has been made in the wiring or the location of a defective piece of apparatus.

Testing the Circuits
Referring to figure 5 it will be noted that the circuits that are in series have been shaded or lettered to point to certain points have been lettered as points to which to connect when testing. Tests can be made with a simple voltmeter. Set the pointer to the right to the maximum. To test the point connect the battery and phonograph with a 1.25 volt battery and earphones. To test a grid of the oscillator connector connect test terminals to point B of the grid terminal and test the filament switch in the "On" position. To test the circuit of the oscillator condenser connector connect the terminals to point N and the center B battery binding post. The primaries of the intermediate transformers should be tested and connect the terminals of our test outfit to the plus B battery binding post and the other to point C, D or E. To test the secondarys of the first two long wave transformers connect the test terminals to point A of the output jack and test the filament switch in the "On" position. To test the grid of the oscillator condenser, connect the test terminals to point F and the plus 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.

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 phonograph should be heard. If 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.

Although the super-heterodyne is sometimes considered an extremely sensitive receiver, it is evident from the foregoing that even when carefully tested by the fixed condenser method, a considerable variation in condensers. If two or three fixed condensers are used it will be well to try inserting each of these, one after the other, to determine whether there is any difference in the readings causing both volume and sharpness. While UV-20A 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 that are specified. In the grid leak mountings. The tubes will function and function very well with two megohms in use since there is variation in tubes it might be well to try values as low as one megohm and as high as 100 megohms.

The best value that can be made is the C battery. C batteries are usually constructed with D batteries as well as at the 45-volt point. Try the 45 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 you already have, as occasionally a tube is found which requires 6, 7, 5 or 9 volts grid bias.

As a last test, it is not too impatient to get the 3,000-mile stations. This super-heterodyne will develop an unusual amount of distortion, but picking up the station is of course. It is efficient because it is simple and there is no shielding or other material put in this set, while by them 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 we have brought to the attention of Radio Digest was the sharpened ability to pick up DX stations that would be unable to DX stations through the nine or ten local and in around Chicago. This was not the case on but one might very well take the form of the information described by Mr. Fournier in the Digest of November 20th on the subject of receiver transformers.

Whether a fixed or variable condenser is used it should be placed in another cabinet from the super-heterodyne set, which is not true about receiver cabinet which is lined with thin copper or aluminum. You will find that you are not able to get two binding posts at the rear of the cabinet, where the super-heterodyne should go to two binding posts at the rear of the cabinet. The secondary should be mounted on a small strip of copper and ordinary used for the loop. The reason for shielding the coupling condenser is that the secondary is liable to pick up stations that are only a fraction of an inch absorbing them from the primary connected to the antenna and getting into the trouble of the secondary.

We have a letter from W. B. R. of Baltimore, Md., who writes that he is not satisfied with the foregoing of his receiver 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 receiver. This can be done, but as in the case of the antenna coupler, we strongly believe that this should be placed and the amplifier and condenser in a push-pull amplifier pushing at audio frequencies is quite strong and must be placed as far away as possible. The receiver does not get back into the receiver itself and cause the loud speaker, tubes and masts no possible effect on the efficiency. No such a small cabinet similar in design to that used in the receiver itself and made for a panel 7x10 inches can receive the contained and is placed on top of a small drawer or aluminum which should be grounded. A rheostat is always needed to appear on the rear of the outer panel and it will be found that the tube sockets and transformer with a small brush, about two inches wide, will go into a cabinet of this size. The fan can either place it used for cooling the rear of the left for connection to the receiver and to the left for the connection of the receiver to the loud speaker or two plugs to be placed in the right for the connection to the loud speaker or two plugs to be placed in the left for connection to the loud speaker and wishes to know if he can add a stage of push-pull amplification to this receiver. This can be done, but as in the case of the antenna coupler, we strongly believe that this should be placed and the amplifier and condenser in a push-pull amplifier pushing at audio frequencies is quite strong and must be placed as far away as possible. The receiver does not get back into the receiver itself and cause the loud speaker, tubes and masts no possible effect on the efficiency. No such A. It is often desired 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 multiplied with the incoming signal is not strong it will cause distortion to the strong signals from locals and unsatisfactory reception will result. If the connections for the oscillator circuit supplied by each manufacturer are not satisfactory, we are not going to be able to use the oscillator circuit made of any two fixed condensers, but it should not affect the operation.

A. It is often desired 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 multiplied with the incoming signal is not strong it will cause distortion.

Questions and Answers
No matter how carefully we try to warn the readers of this magazine, the summary of their questions is always the same. Many letters have come in regarding the most important, and some are simply children. Within these, Radio Digest readers have brought up points that have been the cause of many a doubt.

S. L. T. of Allenstown, Pa., writes as follows:

To the super-heterodyne which you are describing in Radio Digest beginning with the issue of November 15th, the writer wants to disturb your magazine, as it is very important to the receiver. I note in many of the kits on the market that the oscillator consists of a push-pull type, and I wonder if this is any advantage in the variable feature.

A. It is often desired 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 multiplied with the incoming signal is not strong it will cause distortion.

Dust in Set Causes Loss
Dust in Radio sets is often the cause of a large loss in the current due to the insulators of the tubes, especially when the weather, when the dust becomes damp, and allows the dust to leak.

The worst places for dust to be allowed to collect is about binding posts and terminals and between the leads to the battery. Dust can be removed from between wires and around terminals by using a small brush. Many radio engineers use pipe cleaners, the same as are used 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 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 a part of the second 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 completely destroy the beauty of opera Radio-casting from another station. As another loop aerial was on hand, the following experiment was tried out: A 25-plate variable condenser (900 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 to the station desired. This entirely cut out interference.

Another procedure is to tune the set completely out of the loop. Then the second loop is put in and all the tuning is done with this condenser, leaving set tuning alone. This means of improving 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.

The Triple Circuit Coupler

There was need, consequently, for the development of a tuning unit a little more advanced than that presently available, and the conclusion was reached that if a few more turns were added to the one turn primary, and these turns could be variable 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 realized, the second 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 large condenser and a variable condenser, 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 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, 2½ inches in outside diameter and 3½ inches long; another piece of tubing, 3½ inches in outside diameter and 4½ inches long; one brass mounting strap of 1/16 inch stock, 5½ 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 gage copper wire, and a winding form consisting of a wooden block, 3½ inches in diameter and 1½ inches wide, with seventy-two 1/16 inch brads 1½ inches long.

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.

The frame of the fixed windings is shown in Figure 3. Two 5/16 inch holes are drilled to 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 3/4 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 step 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 30 turns and the primary has 28 turns. The ends should be left about 3 inches long for connections after the winding has been completed. The turns in winding should be spaced so that the windings do not 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 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)
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 wish—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 secondary 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 90-turn variable condenser on the ground side of a variometer followed by the K-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 tuning, however, is entirely dependent on how well the operator becomes acquainted with handling this coupling. He must learn to discriminate between stations and signals that require close coupling, and those where a loose coupling is of most advantage. 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 your elf 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.

The variable condensers should be of good quality, but vernier control is essential on 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.

The potentiometer 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 is 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;
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 considered to the panel size.

In the panel layout shown in the illustration it happened that a panel inches by 10 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

(Continued on next page)
(Continued from preceding page)
variocoupler. They were therefore placed in the upper right-hand corner and spaced 4½ 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 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. Thepter oscillator controls are arranged in 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 the general practice, the two binding posts were added at the left side of the panel. To balance the right side, two posts were used 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 running 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 number of binding posts was available. These posts 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 0.5 inches, was then mounted on the plate. Only the three sockets and five binding posts are fastened to this sub-panel, the audio frequency transformers being mounted on the base. A metal brace helps support the entire assembly of the sub-panel. With the audio transformers just under the sub-panel, all leads are short. No new leads must be run. No holes were needed in the baseboard. A little thought revealed the fact that the binding posts for battery connections are located on the sub-panel. The five binding posts for battery connections are therefore located at the right side of 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 in the variometer tube and the one on the right, is the first audio stage, and the one in front of that is the second audio stage.

In mounting the special three-circuit coupler the 75-turn fixed coil should face to the right of sub-panel side. It was previously explained that the sub-panels were supported in front by means of the panel supports taken from the previous panel assembly. These were a metal strip bent up and fastened to the sub-panel and base series of openings in the rear of the cabinet. The A battery voltage should suit the particular type of tubes to be used. With the soft detector tube 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 tuning, 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 each other. 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 is heard, adjustments 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 role 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.
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

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 is and where it is believed to be that it has been a long distance. The further we have to go, the more important it is to have a distance of several miles. For this reason, it is very important to have the proper set of apparatus. 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 it is 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 deserted 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" telegraphic telephone, and they were using waves which were great distances. We couldn’t use the ordinary crystal detector to reproduce this from these stations, so we used what we called a "tikker" which was nothing but a small metal tube and the connections which were connected in parallel bridges leading to the head phones.

Tikker Type of Reception

This "tikker" type of reception worked all right and then Mr. Regency, a General, came along and developed a miniature arc to fit in a receiving set and generate a high frequency oscillation. He then did a heterodyne receiver for use in the reception of signals.

This form of reception was better than the tikker but not so reliable as the operator had a great deal of difficulty in keeping it in check 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 oscillator, is used in the heterodyne circuit, superimposed another wave on the incoming signal and the resultant frequency was the one that produced an audible sound.

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 service 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 became the principle for a while until the last war experiments were made and in 1929 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 circuit but the principle remains the same and is readily recognized in all of 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

strength as applied to the detector. Inasmuch as all detector tubes have a characteristic such that the output current increases as 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 the present day apparatus. Most manufacturers have built radio frequency transformers to cover all the wave bands from 200 to 1000 meters. In order to do this they sacrifice efficiency, because it is a very hard thing to make a transformer that will perform at maximum efficiency on all the radio carrier 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 circuits. We can use those that have been introduced lately, a tuned impedance, which overcomes this disadvantage but this has the disadvantage of having 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

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 it is the filter in the other coil, where the frequency is easily seen then with the proper filter in the circuit we cannot 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. From the filter we pass to the first intermediate frequency amplifying tube then into the first intermediate frequency amplifying transformer. Our problem here is to get a transformer that will give us maximum amplification.

We have three choices of amplification—namely: (Continued on next page)
first audio frequency transformer, then to the first amplifier, back to the second transformer, the second transformer to the second audio amplifying tube and into the head set or loud speaker.

Parts Divided Into Three Classes

The subject of transformers might well be divided into three main classifications—namely, good, bad and indistinguishable. The good transformers might be classified as all those essentials that go to make up any set in the construction of which the manufacturer has kept in mind the purchaser's needs and has intended to use the part of the transformer in a deli-
crate and unimportant manner. Under the heading of bad parts, we ought to clas-
sify 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 cut the cost of your set.

You might well wonder the basis the manufacturer would be justified in purchasing any transformer that is not of the first grade. The manufacturer must have his reasons for choosing the bad grade transformer. It must be remembered that the transformer is a part of the set and is an integral part of the circuit. A transformer that is satisfactory in one part of the circuit may not be so in another. The transformer manufacturer is in a position to design and build a transformer that is satisfactory in one set and not in another.

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 purchas-
ing the parts.

The most important parts of the super-heterodyne, given in the order of their importance are as follows: the transformers, the coil, the filter, the grid leaks and the various fixed condensers, the tube, the coil and loop condensers, the loud speaking coils, the B batteries, the A batteries, the C batteries.

The transformers would be the first ones to think of in any set of the super-heterodyne type. They are the heart of the set and are responsible for most of its operation. The transformers can be made to you by a reputable manufacturer and will cost right.

The Grid Leaks

The grid leaks, of course, could be variable so that they can be adjusted for the particular tube used but they do not have to be. Two transformers are shown here in the selection of a detector tube as it has been used in the past. One is a good detector tube as good as a soft tube as a detector. The condenser can be a glass-insulated 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 recom-

mends the type 199 for general use. It is a very good, the latter, 2DA, giving the louder signal. The choice between the two is immaterial, the former should be used for the oscillator. This should be a tube that will give maxi-

mum sensitivity and it follows that the oscillator must have sufficient inductance so that when the condenser is connected across it, it will cover a frequency range. This, of course, means that the condenser should be examined very carefully and unless so made that a positive contact is assured they should not be permitted to be used, 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. The grid may be held on loud speakers, A or B C batteries as they are already so well known that anything we write might say would only be repetition.

The Panel Layout for Drilling

The panel layout for drilling of holes should be divided into three main classifications—namely, good, bad and indistinguishable. The good transformers might be classified as all those essentials that go to make up any set in the construction of which the manufacturer has kept in mind the purchaser's needs and has intended to use the part of the transformer in a deli-
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The complete list of all the parts necessary for the con-

struction of the eight tube set is given, and the pur-

chase of which should be easy bearing in mind what has been said above.

The A battery will depend upon what kind of tubes are used and it will be large or small. Two volt and preferably storage type as the set with eight tubes requires a large maintenance system and dry batteries are paralleled, you will not get maxi-

mum life out of them. The type head and loud speaker are left for the user to decide as to which of the many is more to his liking. An adjustable volume control should be used as this will better enable you to handle the output.

Laying Out the Panel

In laying out the panel have it correct to the 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 parts clearly. Lay this pattern out on the panel and member, this panel cut to as large a size as this is because it makes a complicated look from laying out the panel on paper first. The next step is to mark out the panel get the rheostats, binding posts and variable condensers and check up the measurements as given on the figure with the parts that you have. This is a small job, but it looks good and is neat. Avoid changing the positions of the various pieces of apparatus to other than a straight line arrangement, at least you should lay them in a straight line inasmuch as it has been laid in a straight line. This will save you time 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 pat- tern you should cut away the parts that are not to be used such as the six small clamps. Clamp the panel with the paper layout on it to the table or workbench. Then take a sharp knife or razor blade and cut along the line as marked. Look carefully after you have tapered them to see that you have not missed any. Now remove the clamps and paper pattern and go over all the small taps with the center punch and punch them in-

(Continued on next page)
Radio Receivers—How to Make and Operate

Plan View of Baseboard Showing Apparatus Layout.

leads, using different colors to distinguish the leads before putting them in the holes. If the writer doesn't claim originality on the introduction of this plan, it doesn't matter, but you'd do well enough so as to make the wiring of the super just as easy as possible. Try this method once in making your next set, and you'll know how much better it is to do it well, with what ease you can trace the wiring and how much less time it takes you. Always use the code, and you will find it as quick and as easy as if you stuck to the color code, because it acts as a check on your wiring.

Advantages of the Color Code

The writer is not advocating a color code for all inexperienced as well as experienced men. It is far better to work without doing anything, and the check that it holds on these young men is far more than worth the extra cost. It is surprising how many errors are made in making up a lead or even a connection. A poor job is just as easy as a good one. Even in bad wiring, time is taken extra time and place "spaghetti" on the top of 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; the oscillator circuits; the medium-frequency transformers and then the audio frequency to the jacks and the job is done. A mistake, if made on the job, is easy to correct; but if you wish to correct it in your working on them if the filament leads are already in place.

The question of whether to use square brass, square tin, number 12 round or number 14 round wire, is one of the individual taste. If you think square brass makes a better job, and square tin is better at the other hand, if you wish to use a "classy" job as well as one that is of real service, use number 14 round and cover 90 with a point value of negative A. Use the brown or the plate leads of the two detectors, and wherever the Z2S S Positive goes. Use the black or the plate leads of the ZB S Positive. Use a color code, as we call it in telephone work, that will be an added check on the wiring and as well as enable you to wire it absolutely. It is also a check on your wiring. Always use the code, and you will find it as quick and as easy as if you stuck to the color code, because it acts as a check on your wiring.

Assembling Parts on Base Board

With the above explanation we are now ready to take the layout out of the base board. The first thing to do is to put the panel with the apparatus mounted on it on the shelf or the table before you are through mounting the apparatus.

The antenna leads, coil the fiber coils, the intermediate and audio frequency transformer and tube sockets and place them in position. This is the most time consuming. Be sure and mount all the apparatus so that all leads are as short as possible. You can get the leads more efficient a set you will have, and this applies more particularly to this than any other. Avoid long leads. The audio leads through long, unnecessary leads than through almost any other cause. It is usually a great deal easier to mount 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 tells him that he has chosen the thinnest. 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 on this way and then six or eight inches and 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 in 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 there were placed closer than two inches apart, assuming of course that they were using a good class of transformer, that 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 bowing, you have a different problem entirely to deal with. This is not due to the transformer, but to the circuit resistance. It is shorted in on the transformer, and all the leads in the set mostly of the body capacity the transformer is not in the circuit.

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 directly to be made.

The general arrangement to be followed in mounting the apparatus on the base board should be one that permits of short leads and no crossing of wires. It's very easy to get the general layout of the parts from the illustrations. Try following this layout exactly. It is not absolutely impossible to just what the connections go. In this way, by keeping in mind the panel layout, you will avoid doing mistakes. You can see if you have got very far wrong in laying out the apparatus on the layout of the base board. Now you can see how the holes are set.

Always start placing the various parts of the apparatus on the base board at beginning at the rear of the apparatus and then getting the set by the side opposite to the side in which the panel is fastened. In this way, you will avoid getting 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 apparatus, such as a hole punch, for about ten cents makes an ideal instrument to make the holes in the mounting screws, where you are using a hard brass wood board for the base board, as is often the case in the popular base board (this is what the writer recommends). In other punchers are suited also.

Try to get the apparatus placed symmetrically. Exercise just as much care in lining up the apparatus as you would in lining up a photograph. Remembering this, a set will laid out and secured properly, you will find your set much more efficient than one that just has the apparatus laid around and the parts are not put up correctly. It is always a wise precaution to put up one screw, some not even screws down and some left out of the picture entirely. Then when the wiring is started it is discover that the parts do not fit the holes which you have to be made.

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 percent. Always bear in mind that the apparatus use always does—think— all it can do is to perform along certain lines. It has one thing to do and usually will do it given half a chance. You who are constructing the set must do all the parts as quickly as you can fail to reason correctly then failure is the result. One of the most common causes for failure on the part of those who attempt the construction of a set, is lack of confidence in their ability to assemble the parts and the parts fitting up correctly. Another failure is due to over-confidence. This is made manifest more in tube work. The constructor has made a set simply by throwing the stuff together and then getting good results with it, which inspires over-confidence in the parts. But the fact is, that the set can be built so easily a superb should not be such an awfully hard proposition. There is a great deal to do in a manner, then he wonders why it doesn't work.

Procedure for Wiring Set

The wiring of the super-heterodyne set can be made quite simple and efficient by the use of leads. If the set is a simple one with the lead wires coming from the panel, the set is a simple one and can be placed on the base board, but if it is a more complicated one, it must be placed on the base board, but if it is a more complicated one, it must be placed on the center of the base board. A small angle of brass should be shaped and fastened to 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 leads from the base board must connect in such a way as to form a square. First, take over the assembled set and compare the placed apparatus 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; the oscillator circuits; the medium-frequency transformers and then the audio frequency to the jacks and the job is done.
Two Meter Wave Lengths

By Gene Messy

For a long time the waves of the order of a meter in length have been realized. It was just this class of waves which were produced by Prof. B. Deloy in France, 1887, in order to apply experimental verification to the ideas of Maxwell, but until the present time they have not been of any stage on their road to practical results.

Since the first successes of Marconi, constant search has been made for the shorter waves which can be utilized for communication. After having made use of waves of the 90-kilo binding post on the set, and connect the negative terminal of the B battery to the set at the binding post. Now hold the bulb in your right hand with the bottom contacts in the case and 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 set. If you have the set wired correctly the lamp will not light. Assum ing that you have it correct, remove the short lead from the binding post and connect the B battery, both the 20-jolt 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. If the set doesn't bow 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 you have the set correctly wired but the box is noisy. Assuming that you have wired the set correctly and get the howl, then swing the potentiometer around until it stops howling. You may have found the oscillator and condenser and as you move it one way or the other you can change the amount of whistle. This will tell you plainly that the set is working.

Tuning-In Stations

To tune in a station, you must first have 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 is 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 to about the middle of its range, 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.

Figure 1

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 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 part of the plate of the filament by means of two wires G and P. The length of the condenser is overcome by a resistance R of several thousand ohms in order to diminish the filament-grid current. In series with the plate lead is placed a potential of a hundred or of several hundred volts. The homogeneous elements of the two triodes are, therefore, at each instant at equal potentials but of contrary polarity, and the oscillations are canted 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 respect the advantage of this type of circuit arrangement over the assembled 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 ordinary wave short waves used by the French Military Telegraph we have obtained very stable oscillations upon wave lengths of 2 meters; which result only to decrease to 1.5 meters, but the operation then becomes irregular and it is impossible to obtain stability.

Figure 2

Have Made 12-Meter Waves

By modifying slightly the plates of these triodes, we have obtained wave lengths of 1.2 meters and have utilized very stable oscillations upon wave length of 1.5 meters. With two triodes of this type we have in the same apparatus an antenna where the natural period is one-half the transmitted wave and which coupled directly with the inductors of the generator. Thus is obtained what corresponds to a radiobroadcasting station of very short waves.

The upper band, 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. Furthermore, 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

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 amateurees in the New York city territory and the old De Forest experimental phone station at Highbridge, New York. It 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 frequency was put in front of the original set, and early last year a stage of transformer-coupled Radio frequency transformers was inserted.

Then came the reports of the wonders of reflexing, so, with a new panel, the assembly of parts was rearranged and the Neutrodyne. The Radio and intermediate frequency transformers, and incoming signals were neutrodyzed directly into the detector.

But all the time I wanted a "Rolls Royce" Theoretically it gave the best amplification and greatest selectivity, but 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 tubes, the size of the panel necessary and the number of tubes had to be much less in the 192-293 class; it would be necessary to purchase four more for the set I had in mind.

Controls Necessary

Careful study of all the available "dope" on super-heterodyne convinced me that the controls could be brought down to two and a half. I say "half" because it looked as though the oscillator could require a touch on about one-fifth of the transformers and the potentiometer a slight readjustment on a quarter of the size of the panel's position. This diagnosis was later proved very nearly correct—two-and-a-quarter controls would be sufficient.

The circuit that looked best to me is shown in Figure 1. It called for nine tubes, which could be of either the 95 or 26A1 class. Personally, I liked the 95's and since each drew but 06 am, mine would require only about 50 am, and six dry cells in series-parallel would furnish that. The matter of panel size was next. For my installation, and as the circuit shows, I had to put two condensers, two variable grid leaks, one potentiometer, four rheostats and one filament transformer. Much drawing paper was used in making layouts and the dimensions were found to be 31 by 18 inches.

Several points which came out during construction and when first putting the set into operation, and which figure at least to be clear to our readers, may as well be covered here. Filmament control jacks can not be used in this circuit since both must be adjustable. Detector, first or second stage of audio are in use. I had them in at first because that, after getting signal into the plug-in stage. The plug-ins in the two amplifiers threw off my previously made adjustments. Since I wanted all programs on the loud speaker anyway, the audio amplifiers from another. To get my superhet working I found it advisable to have a third B battery for the oscillator and intermediate long wave stages. The extra initial investment in the 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 used for more than a few milliamperes of current and putting too many tubes on the set of batteries runs them down prematurely. My super, then, used two 96 volt batteries, one 45 volt battery and a 6 volt D 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 wrinkles. 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 24 1/2 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 of jacks and fixed condensers; on the panel are (Continued on next page)

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.

The hook-up shown, the oscillator and tube and the four long-wave amplifiers are all on one baseboard. Some may desire to put the oscillator on a separate baseboard, 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 pentode type of grid, adapted 200 or 400 ohms; it appears little difference. The operating point of this panel one finds a little to one side of center.

The 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 II, is mounted in four rows and, looking at the diagram, reading from left to right, in the front row; the oscillator coupling, the second audio transformer and the first audio transformer; in the second row, the second detector, the oscillator, the second audio, the first audio, and the fixed detector sockets; in the third row, the tuned condensers, the first, second, third and fourth long-wave amplifier tube sockets.

This sounds like a good deal, and is, but since a super-heterodyne receiver is such a delicate device, the long distance loud speaker range on a loop and satisfactory selectivity that is necessary. The panel would be useless in this apparatus nicely mounted and wired; the final assembly 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 14-inch balticite, formica, dense hard rubber and to measure 24 inches by 8 inches. The operating point of this panel one finds a little to one side of center.
(Continued from preceding page) near the center of the left edge 24-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.

The illustrations indicate that some readers might like to use a fifth rheostat, it can be placed between the grid leak and potentiometer and in line with the other two holes on a vertical line just to the right of the center are for shields.

Holes Necessary in Panel

The groups of holes toward the right hand end of the panel are for the relay, fuses, and the holes in the rear are for the 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 to the rear of the chassis. Number 1 is 45 ft from the top, Number 2 is the plus 90 of the radio frequency amplifiers; Number 3 is the minus A and minus 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 frequency amplifiers.

The same suggestion applies to this half of the panel as to the left half, if you do not use the instrument panel. These holes and the center templates on them. The hole in the upper right corner is used for attaching the panel to the cabinet with a flat-head wood screw.

Assembling the Parts

This set may consist of two parts; the panel as one assembly, the baseboard as another. If instruments, no matter what the make, are used which are shown in the panel and baseboard layouts, these two assemblies will go together without trouble. At this point, I would like to note, a number of readers of the first page have reported that they did not receive mine while this omission seems to result in no ill effects. I am not bothered with many of these notes and have only a few questions which have been pointed out by friends who would be advisable. Among them are the fact that along with the long wave stations can go on the panel and be heard, and the fact that they do not always come through my set. If the reader desires to make a shield for the panel, the panel layout can be used for centering holes but the holes themselves should be large enough to clear any metal parts of instruments which are "Live." The shield used for the front and back of the shield is given.

Passing now to the baseboard layout, which is Figure 2, it will be seen that not only the locations of instruments given but the placing of shields as well. Some of the holes should be made in the panel which is shown in Figure 2, the panel layout being five strips the grain of which should be parallel. Make the holes are 1/2 inch wide, 3/4 inch deep be about 7/8 inch wide by 1/2 inch deep. As you can see from Figure 2, location are given, so that any make apparatus may be placed on this baseboard. The baseboard is made with three parts which are 7/8 inch wide. The whole shelf parts are pretty much the same size, which fact appears to be the chief of the baseboard.

Since I prefer the 159 and 293 class tubes I am using as I prefer that size but should be made in the panel containing five tubes the wires of which come from the baseboard layout. Figure 2, inches by 13 inches which will make the set somewhat deeper than usual but much shallower than the usual case. During construction, the transformers are pretty much the same in size, which fact applies to all the transformers.

I happen to know that one maker sets 1,000 turns in the primary, 2,700 on the secondary and inserts an iron core means wiring 3/4-inch by 3/4-inch tube. The transformers are very thin very vanishing laminations. The wire is criss-cross wound by machine, the primary is about 3/4-inch wide and the secondary about 3/4-inch wide and the core is a 2 1/4-inch long core. Try means of 1,000 turns if you want to but I'd advise buying them. They are available at any angle to another di. The baseboard layout plus the four tubes the socket tubes.

Manner of Construction

Manner of Construction of the circuit shown in the schematic or the secondary is easy. One has only to look down through the socket and get the little centering mark in the middle of the opening. Now, move the baseboard, with its mounted units, against the fronts edge of the baseboard and see that the units on each side are centered. Then line correctly the front and back, but due to differences in construction these 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. If the plate cord is placed in the front, be certain the front row is correctly placed, screw down the nuts and tighten the "pick-up" coils. The rod on which these slide should be parallel to the panel.

The leads to the receiver are connected to the baseboard by means of a non-inductive type. The batteries are arranged on the rear of the receiver and will not be mentioned. 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 leads to the transformer and as low as possible. Keep all leads which must pass under shields and put spaghetti tubing around the wires.

Some experimenters bend their bus so that the spaghetti rests on the board but a slight clearance is preferable. Before installing the binding posts, connect up the four tubes and four transformers comprising the intermediate amplifier at the rear of the baseboard. The long wire connecting the grid to the filament of the first stage is brought to the four plus B posts is brought to the transformers and sockets. At the base board end of the grid the baseboard shown is extended just beyond the edge of the board, bent at the bus and covered with spaghetti and brought up outside of the shield F to the second binding post from the top, as shown in the baseboard layout. This is done to base to this stage where everyone can allow enough wire and leave it. Now wire the detector and audio frequency tube sockets to the audio input, if they and terminators and, as before, leave enough wire to attach to the binding posts on the panel.

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 to the base of the first detector. The two .00025 mfd. fixed condensers are soldered to the bus wires leading from these coil. 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 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. The panel should be done with some care making sure that the baseboard and panel are at right angles to one another as otherwise the panel will not fit well. Then the two end screws are inserted and the two screws put through the holes in the baseboard. Having gotten them together you can now complete the wiring at the baseboard, hook up the rheostat and connect it to the proper binding post. The jack from the testing coil is first connected to the baseboard so that the wires can be checked for continuity. Next connect the binding post, the detector plate and to the number B battery to the plus 4.3 volts to the other to the potentiometer. Reference to the wiring diagram will make this clear.

Shielding

Before proceeding to make shields, go over carefully all the wiring you have done, checking it carefully. As a matter of fact, the first step is to see that no B battery wires are liable to jarring or slight pressure to touch the filament circuit; second, to see that no grid and plate wires are parallel; third, if the grid leak is within 12 inches of each other, that the wires are not parallel to each other. If the tubes 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 rheostat. Leave the tubes to (Continued on next page)

Figure 3—The Baseboard Layout

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Practical Remarks for Beginners in Radio

The ordinary beginner in Radio starts with a "listen in" on some friend's receiving set. If he is fortunate enough 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. If he has 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's weather conditions may be reversed; yet through all these variations there is a rough average distance that the set may be relied upon 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 what a set will do.

Sets constructed in like manner when located a short distance from each other will be heard at the same time. 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 tunes the set to receive from a greater distance and also makes it louder.

Comparison of Different Circuits

Bear these facts in mind we will now consider the individual circuits. The one that is mindful 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. A comparison between single circuit, double circuit and triple circuit receivers in 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 want to work frequently through more or less serious interference.

Figure 5—Shielding

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 the rheostat X to the first detector tube, and the Number 3 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 each of the four condensers 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 notches 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 front V 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 five 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 junction 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 combinations are secured. The shield F is to be used to the binding posts. About I inch from the rear, the plus A battery wire to 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. The grid wire back from the panel, the plus B battery from the audio frequency amplifier jack comes through to go to Number 5 binding post, and the plus B 45 volts comes from the detector jack and the first detector, to be bent up to the Number 4 binding post. This grid 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 apparent, to avoid any shorting to a container or a stethoscope of an inch. Again the tubes should be inserted and the A battery connected first to its own posts when the tubes should be fastened. The battery posts should be put in when the tubes should not light. The set is now ready to try out.

Battery Connections

One stage Audio Frequency

If a powerful Radioactive station is operated within 10 or 15 miles and comes in with good round volume, the detector will be heard in and out of the car and anything that 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 hear it without difficulty. The one or two stages of amplifiers 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

The circuit shown is for use in an a.m. receiver. It is not practical for a c.w. or f.m. set because the oscillating signals which are to be removed are not able to be applied to a circuit similar to this one. The circuit is especially designed for dual-conversion receivers because the first tuned circuit is outside the detector and the second tuning is outside the first tuned circuit. The discriminator is placed between the two tuned circuits to prevent interfering signals from being amplified. The discriminator circuit is a type of non-regenerative amplifier and the signal from the discriminator is used to control the amplitude of the second tuned stage. The discriminator circuit is a type of non-regenerative amplifier and the signal from the discriminator is used to control the amplitude of the second tuned stage. 

Watch Insulation

The radio receiver user who desires efficiency, volume, range and selectivity cannot attach much importance to insulation of the aerial and ground. A collector of birds who is interested in the "signature" of the bird is of supreme importance, and on a par with it, is the problem of wiring away these frequencies from the receiving apparatus, is the ground connection. 

An analysis of radioactivity will, very probably, explain this more clearly. The wave that is sent out from some radioactivity at some distance, will cause it to increase in the surrounding area, gradually becoming weaker and weaker as it goes hundreds or perhaps thousands of miles through more or less absorbing atmosphere and over important geographical features. The receiving antenna may be pictured in the mind as the "hanger of the air." To make use of this frail instrument, the aerial must be adjusted, in such a way that it 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 fault in one of the parts is present in the place there is a "leak." That is, the current is able to flow off the aerial wire and into the ground. This is an unfortunate condition of the circuit and should be corrected. 

Ground Wire Needs Insulation

After passing through the registering instruments the signal currents flow into the ground, and here insulation is again highly important. You might imagine that what is important 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 is the best available. 

The important thing about the ground connection is that if a wire is made with a great deal of resistance it is likely to be used. The best thing about radio currents is that they do not follow the resistance of the wires. The ground wire is here used in its technical sense of electrical resistance, but this is not necessarily the path of least resistance. The simplest path for radio currents is the shortest path. We can, therefore, have the following quer 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 coming into the ground connection is likely to flow through the nearer ground connection. Very little of it will flow through the remote ground connection. 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 may flow through the distant ground connection—it has no choice. The result is that the nearer the ground is to the receiver, the nearer the ground connection happens to have a large resistance, the signal strength will be greater than when there were two grounds.

The theoretical 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. The insulators 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-ins across the sill and close the window. A short piece of porcelain tubing should be used to prevent the wires from rubbing against the window ledge. 

It is a waste of time and money for an amateur to try to make his leads receptacle for ground wire 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.
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, 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 as well as an 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.

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 hoistings, anything and everything that projects above the roof. If possible, the aerial should be held as high as possible.

The T-type aerial is best suited for use where one's station is located midway between two high points.

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 along 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 if it applies to those types of aerials which have in one 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 between two insulators 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, copper, copper, 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 current 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 of each 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 elekrose; pieces of scrap bakelite or, when economy is important, strips of wax-impregnated wood. Wood strips bored in wax will do but are inferior to the others. The insulators used just above the bridle must be large and possess greater tensile strength as they support the heavier spreaders and wires when used throughout the country, for they are often used in houses. 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 of the aerial, the weaker the waves to which the aerial best responds. We increase the inductance rapidly and the capacity a little as we increase the length of the wire. We increase the capacity rapidly and the inductance but a little as we add wires. Therefore, one long wire is best, that is, more often than not, impossible, especially in cities. For the reception of Radiocasts signals on 360 meters, one single wire 130 feet long with a lead-in of 40 feet or less is excellent.

Figure 4 shows an aerial of this kind. The natural period is equal 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)
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 con-
ected 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 parallelwire inverted L that each is receive 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 in-
creased 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 30 feet. By erecting a 30 to 40-foot pole in the center we can obtain sufficient distance from its top to end of the wings to erect very satisfactory aerial wires. The same idea can be applied to an apartment house roof when a water tank, 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 to-
gether at the upper end of the pole.

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 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 ground 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, being fasten-
ted each time they cross the fishlines. Twenty-five to thirty 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.

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 U aerial is the same type with the leads coming from the center. In the inverted L, 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 used 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 3 feet long, and planted at one end to keep out the dirt. Drill a few holes above the plug and drive earth about the ground 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 light-
ing striking the aerial. The aerial is actually a pro-	ection 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 exposed 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 amper 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 operate from dry cells. The dry cells, thus making the set more compact and portable.

Many fans still use a storage battery, especially when the radio is to be operated for any considerable length of time, particularly when the current for the field windings. Much has been written as to the care of the battery, but the fact is that so many do continue unintentionally to abuse the battery. When the battery is being charged, it is a common practice to connect the filling to the filament terminals. The care and feeding of the battery is of very great importance, and a little study will show how to make use of various types of wet cells for lighting the filaments. The voltage of the Edison cell is rather low, about 2 volts. Each Ni-Cd cell for each dry cell used. They are remarkably constant in service, remaining in good condition for a year unless introduced till the carbon and zinc elements are exhausted.

The Edison cell is a zinc plate forming the negative terminal and a positive terminal made of an oxide of copper, the solution being a saturated solution of zinc sulfate in water. The plates are difficult to make; they should not be made at home. The solution is very sensitive to all acids and bases. To care for it is spilled on the hard bau burns or the solution in the porous cell and they will not result. A thin layer of paraffin oil is poured on the surface to prevent the air destroying the active properties of the solution.

There are several types of batteries that can be made at small cost and which will serve in the place of dry cells. They are not as good as the dry cells but cannot be used for the purpose since the current drops off rapidly with storage. Another type is perhaps best suited to the purpose; it is shown in the illustration Figure 1. The voltage of the cell is a little low, and when fully charged with tubes using one quarter amper or less.

The container is about 4 inches in diameter and 6 inches high. A porous cup of unplaged cardboard or wood is placed within 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 is placed in the porous cup. The zinc plate may be suspended from a wooden cover or two carbon rods and a zinc rod, as shown, as the illustration. The zinc rod is amalgamated with mercury when not in use. The first reaction is the formation of dilute sulphuric acid and then applying mercury, which will coat the zinc.

To set up the cell, place two teaspoonful of table salt in the porous cup and fill it three-quarters full with water. Into the jar is introduced by mixing 3 ounces of potassium bichromate, 15 percent of sulphuric acid and 1 quart of water. Mix the acid and water first and add the bichromate. The level of the water is allowed to rise to the level of the zinc, which is also kept standing. The zinc and carbon rods may now be inserted and the cell put in service. This cell can be put in some of the experiments that have been described, when it is necessary only to renew the zinc and solution to keep it in good working order. These cells are purchased from electrical supply houses, ready to set up and can be charged from the ordinary battery and will give good service wherever it is possible to use a battery containing liquids.

The current from any battery can be converted to the bichromate type by using a porous cup to hold the zinc rod. See Figure 2. The porous cup fits inside the carbon cylinder as shown. Any number of prattite cells may be employed. This is an inexpensive form of construction which should appeal to the experimenter.

The plate, or as it is usually termed, the B battery, builds up the energy that operates the loud speaker or other reproducing devices. And so can operate at its best unless the batteries are in good condition. The B battery is sometimes referred to as the B storage battery—termed B batteries—the answers are ominous alarming. The truth is that in the early days of the advent of radio tube the filament battery was usually lettered A in the circuit, and the battery for the plate. In some sets the plate battery was used as the B battery; the name has stuck to the present day.

Small flashlight batteries employed in injuries were used in the early days, but special batteries of the dry cell type are now being manufactured for the purpose. There is one type, the Weston storage ammeters 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: as learned text books have advised, it was possible to couple tubes in cascade with resistances, the principle being to locate a high resistance in both the plate and filament circuits. Now, were they to couple the B battery to have a high resistance it will be clear that when two elements are connected in series there is a resistance coupling between them.

The action of the Weston storage as additional current is drawn from the battery by changes in the resistance of the tube due to changes in grid potential and plate current is very prompt. There will be a voltage drop in the liquid when this plate current in the last tube of a 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 loud tube, giving a feedback effect.

And for the same reason an old B battery makes a set noisy. As the battery becomes old increases the coupling between circuits so formed and gives rise to noises that are annoying to the least. When the voltage of the battery has dropped 20 percent it is advisable to replace them; thus a 20 cent battery becomes useless when it has dropped to about 17 volts. Larger batteries can be figured on the same basis as testing B batteries do not use an ammeter. A high resistance voltmeter should be used for the purpose while the battery is untagged. As it is once removed from the circuit the chemical action taking place liberates hydrogen and carbon monoxide gas. Unfortunately 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 is required and the bubbles collecting on the carbon offer a high resistance to the flow of the battery.

Reliability of Voltage Reading

After standing unused awhile the battery will re-cuperate, that is the hydrogen will either escape through the sealing compound on the battery or will be absorbed by the chemicals in the battery. Therefore a battery that has stood unused for a time and is put into service or old reading on the voltmeter, may when put into service the voltage will drop off rapidly, as the chemical solution may damage the battery or destroy the insulating qualities of the parts of the instruments.

The battery should be recharged every month and kept in a charged state as long as the life of the battery will permit. It is a good plan to change out the wires from time to time. It is also a good plan to disconnect the filament from time to time. It is then closed up and started again. It is a good plan to close the filament and filament wires for 20 seconds and then should be opened while it is warm and the filament wires will be in a moist state. If the wires become dry they should be recharged.

There are two ways of recharging the dry cells. One is to place the cell in a charge of water and keep it in for 20 seconds. This will cause the water to be boiled and the water will be in a moist state. If the wires become dry they should be recharged. The other way is to place the cell in a charge of moisture and keep it in for 20 seconds. This will cause the moisture to be boiled and the wires will be in a moist state. If the wires become dry they should be recharged.

For that reason a voltage reading is reliable only when the battery is actually working. Many fans have discovered that heating the B battery to a half role of life will make it seemingly exhausted. The reason is apparent—the application of heat always causes chemical reactions—the hydrogen absorbing chemicals are made to work more energetically than when heated, because no doubt the heat assists in the escape of the hydrogen around the cell. This revival of action is at best very short and serves no purpose.

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 amounting to 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 prove useful. When it has the positive lead enters the set or, better still, right, at the B battery itself. A short filament in a good place will be cut from the B battery by the wire. The wire should be clamped under the nuts on the bolts to serve as a short circuit and then become shorted this fuse will blow and open the circuit.

Many of us have 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.
Charging Your Storage B Batteries

Doubtless every possessor of a storage B battery, having an electrolyte 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 batteries. The writer has been using this method for over a year and has changed quite a number of rectifiers for friends.

In the diagram, a bulb rectifier schematic diagram is shown. The only thing that is necessary in addition to this is a lamp socket with the positive B battery going to one side of the tube socket. G goes to B with an attachment that is connected at the same point, which is connected to the lamp socket with the negative B battery. A short lead is run from F (left side of diagram) to the other side of the tube socket. The lead at the top for taking care of different alternating current voltages of 110, 220, and 60 volt. The connection between D and E, is the supply for charging the A battery, or any other battery that is the same leads as previously named. VB is placed in the bulb holder (with clamps) and the black lead A is used for the B battery. D being negative or minus and VB or positive or plus. VB the voltage between D and F, is the voltage which should go to a lamp socket. The bulb socket leads should be cut, and this wire should go to the 110 volt lead A. As in the first connection, a battery charger is to be used which would be connected to the line. The 220 volt or any other suitable size lamp may be used. When charging a large battery in several parallel sections, a larger lamp will be required. The method of connecting a bulb charger connected like the circuit to charge a 110 volt battery is the same as described in the previous paragraphs, using a 220 volt lamp. The 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. It may be found that the charger is operating safely but not violently, the charger is about right.

Connections for Charging B Batteries

The Hydrometer

Unfortunately some conditions hydrometer readings may be misleading as to whether a battery is charged or not. The extent to which this occurs, for example, when fresh distilled water is added to a cell to bring the electrolyte level to the proper level, which does not actually combine with the electrolyte until it comes in contact with the cell. Therefore, Consequence, if a hydrometer reading is obtained which particular cell just after the water had been added, the measurement of the contents of this cell can be determined, which indicates whether a charge has been obtained, would show the cell to be nearer the fully discharged state than it actually is. 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, which might actually be the case.

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. A battery is used which has the hydrometer readings up to 1.00 and allowing the charger to be used for long periods of time, only if the voltage 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 battery which electrolyte will show 1.30 when the battery is fully charged; it is a fairly accurate method of knowing the condition of the battery.

To Remove Subhlation

It is a good principle to keep the battery compartment very well scrubbed about every third or fourth charge and then to give a slight overcharge. Subhlation is a condition which causes a vacuum in the battery and the hydrometer readings up to 1.00 and allowing the charger not to be used for long periods of time, only if the voltage 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 capacity of the tubes used is known. A battery which electrolyte will show 1.30 when the battery is fully charged; it is a fairly accurate method of knowing the condition of the battery.

Batteries for Tube Filaments

It is not advisable to use wet primary batteries as a source of current for heating the filament of the ordinary type of tube. A dry primary battery would necessitate frequent renewal of the elements of the battery.

For a circuit employing one or more stages of amplification, a storage battery should be used unless it is desired to avoid the trouble of stepping-down the 110 volt house-lighting circuit to a potential of 6 volts by means of a special transformer. Alternating current cannot be used to heat the filaments of detector tubes as the hum due to the rapid reversal of current drowns out the Radio signals.
F}

FOR several years in the earlier stages of Radio and for a long time at the present writing, I was in the position of having worked on various crystal detectors. Although they are scoffed at today for long-range work, very remarkable records were hung up in other years. Perhaps this was due to the fact that one had to use a crystal and for that reason the most of it out. Even today it stands superior to the tube for clarity and freedom from noise as one can testify after listening to a reed set using a crystal detector.

Just how the crystal detector functions is still a matter of debate, but the prevailing theory is that of rectification. The currents induced in the receiving apparatus, as we have learned previously, are of extremely high frequency. At 400 meters the current has a frequency of 270,000 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.

A crystal detector connected into the circuit acts to rectify the current, that is, it 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 micro-

receiver and 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 pulsating, that is, flows in jerks. The effect of this current is to displace the condenser connected across the plates 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 the movement of the telephone diaphragm in synchronism with the music or words striking the microphone at the sending station.

A VARIATION OF VOLTAGE OF CONDENSER ACROSS PHONES

Figure 1—Showing Action of Detector in Radio Receiving Circuit

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 used most are galena and iron pyrites. Galena is a natural sulphide of lead, its crystals being cubical in form, having a bright metallic luster and a metallic color. Iron pyrites is a natural occurrence of the same being a natural sulphide. It is of a brown-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.

The How and Why of Crystal Detectors

Current Rectification Explained

By Thomas W. Benson

Galena is very sensitive to heat and its detecting properties are often destroyed by the heating it receives during its mounting in metal. For that reason the crystal should be obtained loose and held in the detector in such a manner as to be set in a mount of 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 crystal, for it is very sensitive to light contact. This is easily jarrad out by slight variations in its position. A form of detector stand easy to construct and particularly suited to galena is shown in Figure 2. It can be readily adapted to the standard type being a double binding post with a short brass rod through which a spring clip is put. The top end is silver wire soldered to the stiff wire serves as the 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 used until the most sensitive spot is found.

Figure 2—Details of Detector Stand

Figure 3—Detector Stand for Iron Pyrites

Figure 4—Circuit Employing Potentiometer and Transformer

The Figure shows the three simple forms of galena detectors, both as regards sensitivity and their function in burning out static.

A Pyrites Detector

Let us now consider the iron pyrites. This crystal is shown in 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 any delicate contact so any stand on the market can be used successfully. Good for iron pyrites, however, is the stand shown in Figure 3, possesses several features to make it worthy of construction by any one interested in making up his own crystal sets. With some changes several of the detector stands on the market can be adapted to this iron pyrites. It consists simply of a glass or other insulating tube mounted between two metal rods. This iron pyrite is put in one end as shown and a thin sheet of tinfoil placed over the crystal. The contact member is made of brass and soldered to a thick brass disk for the purpose and its face cut fine ridges with a sharp, thin-edged file, to give cuts at right angles. The face of the disk 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 for the contact to the iron pyrites. With the detector connected into the circuit the screw is run in slowly forcing the points on the screw against 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 almost as 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 and reed comb. This 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 crystals of this type are not. 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. The crystals obtained can be found covered with black silver sulphide and will function as a detector crystal. This form of detector crystal can be brought into service and the first replaced in service when the silver is used up alternately and will last indefinitely. This is worth trying.

When a metal 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 to the signal strength falls off a clear, fresh surface of the metal. This is the cure 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.

Handling a crystal has been said to destroy its sensibility when a matter of fact the sensitive crystals 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, it is recommended that the surface be wiped with a file or cutting pliers will usually uncover more sensitive spots and make the crystal sensitive to some extent. There is sometimes a slight advantage in using a battery in connection with a crystal detector and for the best results, it is considered necessary to use this arrangement a method of connecting the battery and detector is shown in Figure 4. The crystals may be impressed on the detector by adjusting the potentiometer so that the tangent of the curve is a good one.

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 attaching a variable potentiometer to the detector according to Figure 4, will allow you to turn it one way or the other a slight current of the proper potential is applied to the detector.

Maximum signal strength can only be obtained when the detector is used with a small condenser and this permits received to be varied. Use a mica condenser, or better still, one with air as the dielectric. Receivers will work without a vacuum tube. The vacuum tube crystals are seldom used in radio work and the potentiometer string is a matter of preference. The synthetic crystals have photo-electric properties while the others have 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 slides against the shaft and not against metal. This is a cheap and easy way to make a connection, but it will develop into a bad contact. The sliding between the shaft and the contact point decreases the efficiency of the entire set. Exposed connections, usually made in the form of pigtails by wire fastened to the shaft and bearing, form a superior contact. A contact will be found to last a year or so, if the connections are often traced to a friction contact on a variable condenser.

Sliding and friction contacts are all loose connections and are not so reliable. It must be remem-

bered that most of the energy radiated by a trans-
mitting 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 paths of the feeble impulses passing through the receiving set and the sound is greatly decreased if not inaudible in the phones.

The How and Why of Crystal Detectors

Current Rectification Explained

By Thomas W. Benson
Functions of Vacuum Tubes in Radio Receivers

How They Work in the Set

By Thomas W. Benson

We were the current in the plate circuit plotted in the form of a curve. By using the voltage, wattage, etc., we would have a curve similar to that shown in Figure 3. It will be noted that the curve is flat at the ends and decreases as the negative potential is increased. This is because the electrons are repelled by the grid and the plate, and their number decreases. Beyond the flat portion, the curve will show an increase in the number of electrons passing the grid due to the increased potential difference.

Function of Tube in Circuit

Now let us consider the tube used in a Radio receiver as a plate detector. The usual circuit is shown in Figure 4, which shows a voltage across the grid and plate, the grid being connected to the positive side of the battery.

It has been found that up to a certain point the current is due to the electrons flowing directly as the voltage across the plate and filament. Beyond this point, the saturation point, a slight increase in the voltage causes a much larger increase in the current. The obvious thing to do is to maintain the plate at a voltage just below the saturation point of a battery, so that the increase of voltage on the plate will be so small that the current will be constant, and that the potential across the filament will be held constant. This is achieved by connecting a condenser across the plate battery to enable the operator to work the tube at its highest efficiency.

The tube is a sealed vacuum vessel, with a grid and filament in the best types of tubes although it is mounted above the filament when an external control is desired.

Controlling Current

Now let us consider the three element tube connected as shown in Figure 2, where 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 brilliance, 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 grid, the voltage on the grid will increase, and thereby increase the plate current. The grid current can be controlled in this way.

Changes in Grid Potential

The curve in Figure 5 shows the changes in plate current and voltage for various grid potentials. The plate current, as the grid becomes more negative, increases, and the plate voltage decreases. This means that the plate current increases, and the plate voltage decreases. The reason for this is that the negative potential on the grid repels the electrons away from the grid, thereby increasing the plate current.

Solder All Connections Well

It is of the utmost importance that all connections be soldered securely. A tiny amount of soldering flux may cause a connection to break or short circuits in the receiver. A small amount of energy operates the telephone receiver, and if maximum audibility is desired, this amount of energy must be made use of in the telephone circuit. Loose connections and poor contact are the cause of many receiver troubles. Care should be taken to allow only the minimum necessary amount of solder to flow and thus prevent an unwhistle 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 less than the controlling current in the grid circuit. Obviously, in order to add this energy and feed it back into the grid circuit and thus cause a still greater change in the plate current, it is necessary to remember that it is 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 the grid-battery through 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 four classes, inductive, capacitive or resistive. The first two methods lend themselves to use in portable receivers and we shall first consider their application to simple circuit tuners.

Consider the simplest 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 inductively across the grid circuit to cause a greater electrostatic charges to reach the grid and hence greater changes in the plate current with an increase of signal.

The adjustment of the tickler is rather critical, when the ignition signal is too close, too much energy is sent to the grid and the whole circuit oscillates, acting as a radio transmitter. In fact, the device transmits speech for a half mile or so if a telephone microphone is connected in the ground lead to modulate the waves emitted from the grid circuit.

Loose Coupling Between Coils

On the other hand, when the coupling between the coils the maximum effect upon the plate current will not be obtained and the loudness of the signals decrease to a point of operation is just before the oscillating point. The circuit is then just balanced, a balancing point is thus obtained.

An incoming signal just unbalances the circuit so that the grid voltage is not constant in the grid circuit and hence the grid and the whole circuit oscillates, acting as a radio transmitter. In fact, the device transmits speech for a half mile or so if a telephone microphone is connected in the ground lead to modulate the waves emitted from the grid circuit.

To obtain maximum results with this circuit, two things are essential. The first thing on the tickler must be in such a direction that the force of inertia in the plate 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, the grid current will be so large that the grid input will affect the plate circuit. The grid leak should be set just high enough to prevent block in the grid circuit.

Figure 2—The True Ultra Audion Circuit and Two Modifications

The two windings may be honeycomb coils, or spider web coils. A variometer with the stator in the grid circuit and the rotor in the plate circuit will serve the same purpose.

It will be found that the filament brilliance 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 mounted 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 plates. 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 in both the grid and plate circuits. Thus when a difference of potential occurs across this condenser was varied by variations in the plate voltage, the changing values were impressed upon the grid circuit, giving a feedback effect. This is shown above with the original circuit.

This circuit is used in a somewhat different form at present, shown as B in Figure 2.

The variable condenser in the aerial circuit will be found to be most useful and is applied to one set of plates and the other plates being connected to the negative B battery. Thus when the plate current is varied by the original signal wave current the potential across this condenser will vary and condenser will be impressed upon the grid circuit to assist those from the wave, thus giving a feedback effect. This is shown in Figure 3.

The action is assisted by the inductive effect of the tickler in the aerial lead, the self-induction current in it increasing the variation in the potential differences across the variable condenser.

With the tickler, the grid leak is very critical, for the positive of the B battery reaches one side of the grid condenser and if too much current flows 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 as 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 greater inductance being connected to the grid and plate.

The simple 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 transmitting 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 winding, made for the regeneration, while on the other the two being so mounted that they may be swung aside. The primary, or the one that is the primary or aerial, induces the energy into the secondary circuit, and the tickler of the secondary circuit makes the primary circuit, and while the other two being so mounted that they may be swung aside. The primary, or the one that is the primary or aerial, induces the energy into the secondary circuit, and the tickler of the secondary circuit makes the primary or aerial circuit, while 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 sensitivity. Then the phone coil, because 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 circuit or 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 low circuits and thus assist in controlling the regeneration.

As a rule, a variable condenser across the phones instead of the tickler condenser used in most regenerative circuits, will permit better control of the regeneration and make for more purring 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 a secondary, which is very apparent that any attempt to vary the coupling to obtain selectivity will alter the feed-back, or in attempting to increase the selectivity the coupling will be sacrificed.

Various other arrangements of inductively coupled methods are described by the technical press, but a few are inductive feed-back and will assist in the selection of a suitable set.

Feedback in the Receiving Antenna

The well-known Reitnauer tuner is a form of capacity feedback with a special untuned or aperiodic aerial circuit. This circuit is a variable condenser in the aerial lead, the tickler condenser, and the aerial tuning circuit form the secondary circuit. The Reitnauer 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 plates and grounded through a variable condenser. Another variable condenser is connected to the terminal to a small condenser, which is connected to the grid circuit.

This set functions as a closely coupled two circuit tuner. Half of one variometer stator and the aerial circuit is in series with the variable condenser in the secondary circuit. Reitnauer tuner is obtained in this form the capacitor that the variable condenser, the wave current flows 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.

To obtain maximum results with this circuit, two things are essential. The first thing on the tickler must be in such a direction that the force of inertia in the plate circuit will be in the correct direction as regards

(Continued on next page)
TROUBLE SHOOTING FOR RADIO SETS

A TROUBLE-shooter's key for locating troubles and finding faults in Radio receiving sets has been devised and given out for the benefit of Radio-phonians. It is the combined work of several engineers who have worked out the various problems and boiled down the information to practical conclusions.

The object of this article is to present a list of the various symptoms of trouble and then to explain what causes each symptom. The reasons for the various symptoms are given in the form of a table, and the table is followed by a list of the trouble symptoms and their causes.

The purpose of the trouble-shooter's key is to enable the non-technical person to find the cause of any trouble that may arise in a Radio receiving set. It is a simple and easy way of finding out what is wrong with a set, and it is based on the principle that every symptom of trouble has a cause.

The key is divided into two parts: the first part contains a list of the various symptoms of trouble, and the second part contains a list of the causes of each symptom.

The symptoms are listed in the order in which they are likely to occur, and the causes are listed in the order in which they are likely to be found.

The key is a valuable tool for the Radio-phonian, and it is one that should be kept handy at all times.

Good Tools Essential

AFTER one becomes interested in receiving Radio, one is likely to find that he needs some additional equipment. This is because the Radio receiver is not designed to be used with all the accessories that are available. The following are some of the accessories that are necessary for a good receiver:

1. Filament Aids Regeneration
2. Sounddeadening
3. Adequate insulation
4. Good tools
5. Quality of components
6. Adequate space for the receiver

The first item on the list is filament aids regeneration. This is a device that is used to keep the filament of the receiver at a constant temperature. This is important because the filament of the receiver is used to heat the filaments of the tubes.

The second item on the list is sounddeadening. This is a device that is used to reduce the amount of noise that is produced by the receiver.

The third item on the list is adequate insulation. This is a device that is used to keep the receiver from being affected by the outside world.

The fourth item on the list is good tools. This is a device that is used to make the receiver easy to use.

The fifth item on the list is quality of components. This is a device that is used to make sure that the receiver is made of good quality materials.

The sixth item on the list is adequate space for the receiver. This is a device that is used to make sure that the receiver is not too crowded.

Connecting Tube Sets

When the construction is keeping set employing vacuum tubes either as detectors or amplifiers is used, the conditions of the filament must be known. The relation of the filament to the grid and plate voltage is important. It is possible to connect up to be certain that all the connections to the tubes and control rheostats are correct for filament loading. The filament connections must be connected last so as to eliminate the possibility of high currents in the filament before the battery is connected.

A single-circuit set will pick up almost as many stations with its back end 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

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 huffer, or "DIY hound" as Radio enthusiasts 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 effective) 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 coupled in series with the aerial or the ground lead, others are inductively coupled to some portion of the tuning circuit, and then 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 system is shown in Figure 1. This consists merely of a 25-turn honeycomb coil with a 23-pale (.005 mfd.) variable condenser connected across it. The cost is low even though the most expensive type of condenser is purchased.

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, 9/16 inch in diameter. Lay it in a spiral similar to that which have been previously described in articles and some connection wire. Inasmuch as these small ferrite cores are very expensive, it is desirable to use the 25-turn units it will be necessary and to remove some of the turns from them. Best values are determined by a little experiment 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 then for a 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 inside coil is then connected on one side to connect the plate directly to the coil to the set. In the two smaller illustrations the following methods are shown for establishing the wave trap which simply add one additional control to the set, but 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 below 25 mfd. and dce, respectively. And single and double silk-covered wires—see, and dce. There is 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 dielectric 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 wounded 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 required. 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 inverted in the aerial circuit 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 where and what the plates touch.

Concerning Condensers

In selecting variable condensers make sure that there is no loss motion between the shaft and the bearing, and that the provision for the waves that are wound on the dielectric material of that type, are sufficient for the thickness of the panel or other material in your circuit. 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 where and what the plates touch.

Material for Winding Forms

Bakelite, kiln-dried wood, hard rubber or composition winding forms should be used in making the cardboard. The initial cost is greater, but the increased conductivity is worth while. If cardboard forms are used, untreated board is preferable to the treated kind. The shellac and varnish used in treatment affect the winding and result in unwisely large losses to coils that are used in high frequency short wave work.

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. If you are using one end of each of the two windings, and be sure to see that the two are all run in the same direction. Across the remaining two ends of these coils connect the .005 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.

Constructional Details

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 that the inductivity type is much preferable. 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 that is battery operated quite a problem as to where they will fit best in a home. Obviously we must avoid adding some more bulk, space, or parts; or this could possibly be rectified from the appearance of a well designed receiver. The wave trap illustrated should be, then, within the limits of all and affords no serious problems of construction.

The requirements are a baseboard, a small mounting block for the coils and disc type condenser, two binding posts, three 25-turn spools, and to be similar to those that have been previously described in articles and some connection wire. Inasmuch as these small ferrite cores are very expensive, it is desirable to use 25-turn units it will be necessary and to remove some of the turns from them. Best values are determined by a little experiment 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 then for a 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 inside coil is then connected on one side to connect the plate directly to the coil to the set. In the two smaller illustrations the following methods are shown for establishing the wave trap which simply add one additional control to the set, but is sufficient to eliminate all unpleasant interference.

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**Comments on Audio Frequency Amplification**

*Function and Operation*

By Thomas W. Benson

**AUDIO** frequency amplifiers serve to increase the amplitude of signals from the transmitters 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 audio current from the transformers and amplifies them sufficiently so that 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 necessary to take into account the desired range, the amount of power that can be made available, and the maximum volume that can be obtained regardless of range then two stages of audio amplification should be used.

The circuit 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 reduced to the level at which they are not too high, and the reduced and capacity losses in the tube and circuits are greatly reduced. On the other hand, when we have considered the amplifier invented for the purpose foreign transformers used must work efficiently over a comparatively small range.

To accomplish this the transformers are designed with large plates, a 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.

**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 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 been placed in the 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. This control is adjusted to the highest value that the plate current is half down the curve showing the gain in sensitivity. As we reduce the frequency amplifiers.

When signals are being received the current that would flow in a telephone receiver now flows in the primary of the transformer. These current 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 and therefore will enable the circuit to overcome the noise of the amplifier.

Squealing and Howling

Another source of great annoyance with audio amplifiers is the squeal or howling. This annoyance 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 parallel to any point and should always cross at right angles. Squealing in a set of circuits can be prevented by reversing the leads to the transformer elements, trying different arrangements until the trouble is eliminated.

Jacks are a frequent cause of squealing and they should be well seated and fastened. A loose jack will often cause 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 method was developed. This method of operation at a distance costs considerably less than with transformers. This should appear in future editions.

A circuit employing this type of coupling is shown in Figure 3. A fixed impedance is connected in the circuit in place of the transformer and a small fixed condenser inserted between the grid and the amplifier tubes. The grid condenser is shunted by a small grid leak to control the potential of the grid.

The action of this form of coupling is similar to that of the transformer or impedance coupling used for audio frequency amplifier depending for its operation on the change in different potentials of the grid and the operating point of the grid. The grid condenser is shunted by a small grid leak to control the potential of the grid. The action of the grid condenser is similar to the operation of the grid condenser in the transformer or impedance coupling.

**Homemade Impedances**

For the benefit of those who may care to experiment with this circuit some construction data might prove of interest. For an ideal transformer or impedance coupling depending for its operation on the change in different potentials of the grid and the operating point of the grid. The grid condenser is shunted by a small grid leak to control the potential of the grid.

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**Grounding Transformer Cores**

If not adjusting the Blankets of the amplifier does not stop it from howling, try attaching a wire to 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 too closely spaced that a spark discharge takes place.

The contact points of the best jacks are made of silver points are not as strong as the points of gas fuses are present which corrode these contacts. Use of salt 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 are very common in some of the home-built sets are responsible for virtually every failure of radio and some very careless or hasty 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 60) 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 using coil windings from standard audio frequency transformers. Doubtlessly 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 5.0 to 1.

Using Separate Transformers

Before an illustration of these two transformers a few words may well be devoted to the statement that, for triad, the transformers can be connected as separate units. For example, in type PP-1 the circuit, connect the B+ of one to F of the other (primary windings), using only the F 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 (second 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 which leads to the B+ or plate battery. The secondary joint has no connection, and the loudspeaker 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 joined so that opposite. Reverse the connections (primary and secondary in one unit) from their core. It is best to tag the four ends so that the mistake will be made afterwards in identifying them.

Produce a sheet of silicon transformer steel not less than 0.02 inches thick. Cut this into strips 3/8 inch wide. Measure the length of two windings and add 1/2 inches. Cut about 100 pieces this length. Now measure the thickness of one winding from inside edge of hole in core. To this add 1/4 inches and cut 20 pieces. Then cut 40 pieces 3/8 inches shorter than the last.

The illustrations show how these strips are assembled to build up the core. 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, as the windings are connected to one another in such a manner that 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 Amplifier Circuit

The proper circuit for using these transformers is shown in the diagram. The front 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 the 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 entry 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 transformers 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.

How to Make an R. F. Transformer

REFLEX sets and Radio frequency amplification are becoming more and more popular every day. The Radio design in this issue is of Radio frequency amplification to his set, but his purse usually lacks 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.

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This transformer acts very efficiently over a wave length band of 200 to 500 meters, with a peak at about 300 meters. It is therefore ideal for Radiocast reception.

The complete cost is twenty-five to thirty cents. This is quite different from what the amateur usually puts in for a transformer.

From a chemical supply house get a bottle of iron powder. This is chemically pure, and very soft. Heat 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 3 inches 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 enamelled or silk, and starting at one end, make a bomb 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 3 inches 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 a cardboard or bakelite tube. Dip the tube with paraffin, sealing wax or resin. Connect the transformer as shown by the diagram.

Details of Assembly

The view above shows the method of assembling the transformer. The view to the left shows the push pull amplifier hook-up.
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 2. 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, take a piece of 6/32 inch balelite cut a piece three inches square and bore holes near each of the four corners so that screws can be put through to fasten the cross arm, as in Figure 1. Then, from 3/16-inch balelite cut four pieces like Figure 2. Four 6-32 socket screws are needed and two nuts. The two ends holes are not tapped. Insert the screws; these balelite 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 a gap for connections. Now fasten these balelite 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 the 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. The lower end of the vertical arm should now be drilled with a 3/8-inch bit and a piece of 3/8-inch balelite rod, 10 inches long, inserted to a depth of 2 inches. This should be a tight fit. The supports are made of 1/2 by 1/4-inch material, 5 inches wide and 1/2-inch: then 1-inch to second notch; then three more notches 1-inch apart; then 1-inch to notch 6: four more notches, 1-inch apart. Ten turns of wire are wound around this structure, then the brad is driven into the bolt to the binding posts for connection.

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 wire, and even bare copper wire. While the larger size loops, 5 to 8 feet squares, may be slightly more efficient, they are more 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 to cover the wire with "Litz" and bared bare copper wire. The larger size loops, 5 to 8 feet squares, may be slightly more efficient, they are more cumbersome and too large to be used in the average home, and the 3 foot size is to be preferred.

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 between it, it is very convenient to clean and adjust contact springs. More than one socket can be made on one base. The wall of the socket is large 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 wall 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 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.

Pipe 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 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 bolt. The brass is drilled 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 3-32 bolt. The bolt should be long enough to have its head clinched into the head and another base by which means connections is made to the springs. It is better to punch a hole to take the contact springs if the wiring of the set is to be permanent. The contact spring should extend slightly beyond the base when no tube is in the socket.

Bank Winding

The best width of tape is 1/8 inch. Wrap one turn of the tape around the part at the end where the edge 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 low tension current flows in many household appliances, such as toasters, vacuum cleaners, motors, fans, etc. These currents are always present, and cause interference in the receiver. The interference is caused by the current flowing in the appliance, and is not affected by the position of the receiver.

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. Small bugs drilled with binding posts on each side or with the wires from the set can be fastened to the bolts. Then bring your battery 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 automobile lighting and starting battery. There are enough parts left over to make three very neat and serviceable 20-volt storage B batteries.

Each jar of the B battery is made from the 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 parallel down the jar. This will not cut the rubber through but it may be turned over and the cut repeated on the other side. A rubber band will break where the cut was made by bending it back. When cutting the jar, be careful 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 of the jar. These are five 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. Set 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 the plate and the jar. This is a little compound as possible. This may be done best by having the compound poured hot into the cell, then pour the compound on the top of the glass and then proceed with the next cell in the same manner.

After the cells have all been sealed they should be very closely set together to form as tight a strip as possible when they are in place as shown.

Homemade Spider Web Mounting

The cell control described in this article takes the place of the ‘honeycomb’ control, and it gives many advantages over these cells. The cells 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 tin foil, thus reducing capacity effects.

The cells are similar to spider web coils in construction, and the form for making the cells is the same except for one of the wires, which is made longer for connecting the battery shown. All arms on the primary or stationary cell are the same length, and the coil is fastened to the panel with small black B, and a bolt as shown. This stationary possible play or 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 shorting. A flanged washer, together with the necessary washers and nuts, keeps the shaft with the coil mounting on the top of the tubing. A dial C is fastened onto the other end of each shaft to turn the coils to and away from the others. The coils are arranged in order as clearly shown in the illustration. They are wound with the proper number of turns of wire, starting at 40 for the primary, 40 to 90 or more for the secondary, and from 40 to 120 for the tickler, the numbers turning in accordance to the manner in which the coils are to be used.

Two of the cells may be used as a varicoupler, or three as with hombay 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 at this time. The reception, as regards summer and winter, is similar; in December and January reception is much better than in July and August.

Panel Bushings

For those of you who "make your own" the following hints 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 1/24 or 1/32 hole. Drill on the other end of the part so the shaft is 3/16 or 1/4-inch. Drill the hole in a lathe, thus leaving and machining the right length. The illustration is self-explanatory.

Winding Spider Web Coils

I procured several fiber disks with fifteen spikes all 4 inches in diameter. When winding in the usual spider web manner I found that 50 turns of wire could not be wound on them. In order to overcome this difficulty I 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 the next coil in the same manner. 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 North, East, South, and West, 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 was pointed in one direction, was used.

Measurements have shown that signals are strongest 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.

Audio Frequency Transformer

Pick up from your neighboring garage a few Ford car fenders, and these coils are divided into two small coils each about 3/8 inch long, which constitute the secondary, and the other parts of the transformer, as the case, binding posts, vibrator, and the various equipment, are still in place. Save these things, but will not be needed at first, but will become useful 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 a good practice. On most coils there are 35 and 37 layers. If we have a 35-layer coil and desire a 1 to 1 ratio it is necessary to have a 30 to 3 coil.

For the winding of the coil, the ends of the wire are pulled out of the inside and the ends are brought out. Remove 30 layers from the outside of the remaining coil and bring these wound on the smaller coil. Wind enough tape around the smaller coil to make it fit snugly into the larger coil. Bring the ends from the large coil out at one end and the other at the 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.

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 it 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.

Filament Heating Transformer

Data on how to build a filament transformer seems to be very scarce in the Radio magazine.

Have the tinners cut on his machine (hand-cut strips are worthless) from number 28 gauge black iron enough to make two 1-inch piles. Put 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 end, near the core, to start the wire and wind winds to 1,600 turns of number 21 enamel sec. magnet wire. This will require a heart less than 3 pounds if neatly wound on layers. Drill a hole in the bar with a penknife and tape the winding well. Drill another hole in the other end to start the wire, and wind winds of number 21 enamel sec. wire, winding over to center, back to end and then to center. These three layers between the end and the core should make 30 turns. Bring in a tape a turn; 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 should have, but I am using it with three 5-watt tubes and believe it would carry six. The voltage is 2.2 and it is fine for three tubes using a 1.5-ohm. rheostat.

Homemade Coil Winder

Illustration shows a way in which coils may be wound for the Radio apparatus by the application of this tool. 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 3/8" bolt five inches long and file off the head. A nut is put on the threaded end and turned as far as it will go. The coil forms are placed on the bolt and a second nut used to hold the form in place.

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 harshness of the music is removed, and the tones are reproduced much more clearly and sweetly. The switch is not so pronounced when headsets are used on a Radio set, but on a loud talker the effect is very noticeable.

All crystals can be improved 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.
Some text is missing due to the image quality.
Stations in Order of Call Letters

United States

ATW, Fort Scott, N. C. 605 meters, 120 watts. P. M. Donnelly.


ATU, Atlanta, Ga. 540 meters. P. M. Donnelly.

ATX, Kansas City, Mo. 320 meters, 40 watts. W. H. Hurley.

ATW, Fort Scott, Kans. 950 meters, 50 watts. P. M. Donnelly.

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<td><strong>Location Cross Index of Stations</strong></td>
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**Note:** The table above provides a cross-index of radio stations by state and city. Each entry includes the station call letters. For a complete list, please refer to the original document.
<table>
<thead>
<tr>
<th>Location</th>
<th>Wave Length</th>
<th>Power (W)</th>
<th>Call Sign</th>
<th>Frequency (Hz)</th>
<th>Sales Price (A)</th>
<th>Make (f)</th>
<th>Model (f)</th>
<th>Serial No.</th>
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<tr>
<td>New York, N.Y.</td>
<td>540</td>
<td>1,000</td>
<td>KFBB</td>
<td>1,100</td>
<td>500</td>
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<td>Chicago, Ill.</td>
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<td>WBBG</td>
<td>1,100</td>
<td>500</td>
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<td>KFWB</td>
<td>1,100</td>
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<td>San Francisco, Calif.</td>
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<td>KRON</td>
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<td>Houston, Texas</td>
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<td>KTRH</td>
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RADIO RECEIVERS—How to Make and Operate
V% = 75

INCHES = 1 2 3 4 5 6 7 8

For fractions of an inch, add \( \frac{37}{100} \) of an inch.

Inches are 1\( \frac{37}{100} \) of an inch. 1\( \frac{37}{100} \) inch = 75

Miles

MAP by The G. F. Cram Company, Chicago
**How to Operate**

**The Radiola Super-Heterodyne Receiver**

This Radiola uses the second harmonic principle and has only two amplifiers; therefore it is enclosed in one cabinet including batteries and loop aerial, resulting in a highly selective and sensitive receiving set for a broad wave band.

The **Radiola Super-heterodyne** is a Radio broadcast receiver utilizing the super-heterodyne principle, which provides unusual simplicity of operation and low cost. The cabinet contains the operating mechanism and the battery equipment. The super-heterodyne method, making the set self-contained, is designed for reception over the broadcast wave-length band 225 to 550 meters.

**Technical Data**

In addition to the following apparatus; 6 vacuum tubes, neon bulb, 1 loud speaker, 1 telephone plug.

1 set of A, B and C batteries. The battery may be connected to any one of the three cells of the battery compartment. For the B battery, four 22-volt plate batteries connected in series, or two 45-volt battery may be used if desired. The battery is contained in the cabinet. Anode of 45-volt units measuring 4 by 3.1/2 inches. A set of 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 on the "+" terminal of the left battery, the other end on the "+" terminal of the right battery. The large size 45-volt blocks will be used, the two jumper connectors will not be needed. Connect these batteries to the set, fastening the lead marked "+", coming from the right cell, to the binding post of the battery compartment on the battery terminal, and the other lead, marked "−", to the binding post on the left cell. With the batteries installed and connected, replace the battery doors. Radiola super-heterodyne may now be set for any station of your choice, convenient and desirable to its owner. It need not be located in any position that is bad for any reason; any position in the room with respect to the receiver.

**Operation**

Before inserting the tubes, turn the "battery setting" knob R to the right-hand, or "off", position. Then insert the four filament tubes, bulb VN, UV-199, which should be handled with due care. Pull the Radio panel forward to the half-open position, allowing enough room to operate it.

**Operation**

1. Pull out the filament switch E. Turn the "battery setting" knob R to the right-hand, or "off", position. With new batteries, the pointer should be set approxi- mately in the middle of the dial. As the batteries grow older, this setting must be gradually advanced toward "100". Turn the "volume control" knob U away from "100" toward "0", turn off the jack switch S; shift the set on the table, until best position is found.

**Eliminating Interference**

Signals from an interfering station may be eliminated or at least minimized by either of the following methods:

1. Turn "station selector II" pointer V, either to the right or left, by approximately 1/4 to 1 inch, to find another position of this knob, where the desired station will be again heard. The setting of "station selector II" nearer the left end of the scale is techn- ically called the "lower wave length peak," and the other the "upper wave length peak." Try setting 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 I" be consistently set at one of these two "peaks" 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.

2. Rotate the receiver on the table. For every trans- mitting 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, try- ing to locate the position where the interference does not continue.

**Four Signal Pairs**

Four pairs of dials for each of the "station selectors" will be needed. These are shown in the illustrations for the instruction book, and one each in place on the panel. The "station selector I" dial is in place, grasp pointer N with the left hand, turn and remove the knurled nut which holds it in place. Grasp the knob on the other side of the "station selector I" dial and pull it out of the cabinet. Place the knob back on the "station selector I" dial and replace the knurled nut. Pull the clamp wire from its shaft, locate the "station selector II" dial to the right, grasp the knob on the "station selector II" dial with the left hand, turn and remove the knurled nut which holds it in place. Grasp the knob on the other side of the "station selector II" dial and pull it out of the cabinet. Replace the knob back on the "station selector II" dial and replace the knurled nut in the order mentioned. Follow the same process for "station selector III" and "station selector IV.

The paper dials provide a means of recording the settings of the "station selectors" for use in "station selector I" 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 the "station selector II" be used.

**General Information**

Each of the "station selectors" is provided with four pointers that may be chosen at pleasure. To change the same set- ting may be recorded on the dial without crowding the marking. The same settings may be recorded and pointers be reserved for wave length or frequency markings, and that the "station selector II" settings be recorded on the three remaining pointers in the following order: Long black pointer, right short pointer, and left short pointer. When a new station is tuned in, the proper pointer is recorded, then use the short pointers for the markings.

The only precaution to be observed when making settings is not to use a pointer that is near any large metal objects, such as a steel radiator, or that it is not near any aerials or electric wiring. Such positions may cause changes in the setting of "station selector I." When the "battery setting" knob R should be kept as near the "off" position as possible, without decreasing the signal strength or destroying the quality of recep- tion. The six tubes should be used at all times. It is advisable to replace any one of the three only five are used, to reduce volume. Reduce volume by dimming all film- pens, and use only the tubes necessary to employ this method. Both these preca- tions are necessary if the life of the batteries and tubes.

**Battery Possible Difficulties**

Should any trouble develop in the use of Radiola super-heterodyne, or if the following symptoms are observed, it should be done about once every six months: Two of the filament tubes have been used for a long time, their filaments tend to lose emission, and the neck should be renewed. If the neck tube is not, it will be necessary to renew both of those filament tubes, or three of the six tubes.

Two of the filaments may or may not be used, all other filaments should be renewed. If the set becomes inoperative, try interchanging the tubes. The second tube from the right is the important one and if中国国际直播, if this tube is not functioning, it should be renewed. There trouble is local, it is recommended that the dealer from whom the set was purchased be consulted.

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THE Crosley Tridyn is the most widely distributed, popular priced receivers now on the market. A schematic diagram 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 set. The change 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 brilliance of the filament of the three vacuum tubes employed and they do not enter into the tuning.

Crosley Tridyn is unique in the fact 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 tube 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 around the current enters tube 1 and is strengthened at radio frequencies. You will note that the radio frequency current leaving this tube is shaded, denoting that it is relatively unamplified in passing through the tube. The energy then enters this primary circuit of the detector, leaving it as an audio frequency current. This current doubles back and passes through tube 2. It is further amplified at audible frequencies in tube 3. Figure 3 shows the view of this receiver, and tube socket 13 is to be taken as the tube which has been referred to above as tube 1, socket 14 takes the tube referred to as tube 2, and socket 15 is to receive the tube referred to as tube 3. Figure 4 shows the usual schematic diagram to which the receiver is connected. The upper path, between tube 1 and tube 2 shows the current path as described above. The lower path, in tube 1 and in tube 2 it is amplified or strengthened at audible frequencies. From tube 1 it goes by the upper, heavily shunted path to tube 3 and it is further amplified at audible frequencies in tube 3.

The Crosley Tridyn is a three tube receiver using radio frequency amplification, a regenerative detector, reflexing and audio amplification. Have tuned circuit absorbers will be passed into that tube.

Having been amplified, we wish to go to the detector in tube socket 14. The flat disc of wire, which is really a coil or inductance, which has been labeled JA in the drawings, includes two separate tuned circuit absorbers will be passed into that tube.

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Figure 1

Figure 2

Figure 3

Figure 4

The adjustment of the two rheostats 4 and 5 will not be found to be of any particular importance, because the controls have been brought in, as outlined above, these rheostats should be adjusted for maximum volume and amplification. 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, would 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 clearer sound when the volume is turned up, and clearer sound, than any of the others, and you can use one or the other as the clips.

To Hear Stations

Push the filament switch (6). Turn the amplifier control (4) and the detector rheostat control (5) to the "off" position. Put the tubes in their sockets (if a 200 volt battery is not used, it should be placed in the center socket) and plug the receiver into the inside of 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)
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 schematic diagram of the Jewett Five Tube Radio Receiver is shown in Figure 1. The receiver is a simple system composed of a filament battery, a transformer, a rectifier, a filament regulating rheostat, a filament filter, a detector, a pentode, a tetrode, a valve, and a circuit. The receiver is designed for operation on a 6-volt storage battery, and is capable of receiving all of the commercial broadcasts in the United States.

Figure 2 shows the wave form of the Jewett Five Tube Radio Receiver. The receiver is designed for operation on a 6-volt storage battery, and is capable of receiving all of the commercial broadcasts in the United States.

The Jewett Five Tube Radio Receiver is a simple installation of a few components. It consists of a filament battery, a transformer, a rectifier, a filament regulating rheostat, a filament filter, a detector, a pentode, a tetrode, a valve, and a circuit. The receiver is designed for operation on a 6-volt storage battery, and is capable of receiving all of the commercial broadcasts in the United States.

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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 Freshman line make this the pioneer in the field of low-priced tuned radio frequency receivers.

TUNING
The dials on the front of this set have been so adjusted that the three tuned circuits are at about the same wavelength when the three dials read alike, and while there may be a slight variation of a degree or two in these dials, they will be found to run pretty close together. Start in by setting dials two and three at 10 and then rotate dial 4 slowly between 13 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 only once each evening and will not have to be changed. The dial readings will 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 tuning 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 so carefully, keeping the relation between the dial settings about the same.

Then, if you find that dial 1 reads 00, dial 2 reads 70 and dial 3 reads 13, rotate the scale of the readings 34 and 35, and the settings should read 68 and 31 which may or may not be any good on any part of the scale. After some practice in tuning this set you will learn to tell you 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 wavelength you do not know, you can find it on the dial, naturally you should set the dials at 54, 55 and 53. A little more or less 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 serial and done either with a button hook, a crew driver or any other thin but strong instrument that will enable you to bend up these springs slightly.

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 brilliancy 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 by 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 more heat is produced, and the more the filament glows. If a current is passed through the filament it will burn out. When the filament becomes hot, electrons, which are negatively charged, fly out of the filament, and these electrons then flow as a current through the tube. If they did not, the tube would not operate, for all the tubes require a number of electrons that fly from the filament, up to a certain limit determined by the construction of the tube and the material of which it is made.

As the filament is heated, it becomes incandescent; that is, it gives off light. The more the filament is heated, the stronger the light it gives. But it isn’t the light that hurts the tube, but the heat. If the filament became heated but did not give off a single ray of light, the electrons would not, and 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 Neutrodine**

The Fada Neutrola Receiver is a five tube neutrodine 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. 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 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 WEA, New York, N. Y., which transmits on a wave length of 452 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 97 degrees. Set dials 2 and 3 of the receiver at this setting and rotate dial 1 very slowly from 42 to 60, or dial will be obtained either at a setting identical with dials 2 and 3, or more probably a few degrees lower. Then that dial 2 and 3 independently very slowly until the maximum signal is obtained. In any particular neutrodine receiver, dials 2 and 3 read identical, 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 higher than dials 2 and 3. 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 tubes to get too bright and reduce the life of the tubes considerably.

If it is desired to receive any station located at a wave length of 259 meters, note that the receiver has been set to a station about one at 263 meters at about 145 degrees, therefore the station broadcast will be approximately midway between these.

As a further aid in locating stations, the wave lengths of which are not listed in figure 2, the calibration curve shown in figure 2, the two tuning dials were determined from representative receivers, but in practice, due to commercial stations, the specific receiver calibration may vary a degree or so from that indicated.

In all cases when tuning a neutrodine receiver it is best to keep dials 2 and 3 always within one or two degrees of the value of the wave length in question, as the receiver will occasionally move from one station to another at a slow rate, about a degree a second. In all cases the five-tube receiver and move slightly below and 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 defective one by interchanging the tubes among themselves. Generally the detector tube will be found faulty.

If no more amplifiers are available for the determination of a possible defective tube, the user of one of these amplifiers on the Selectors Switch No. 5 to "MED," release his second as amplifiers and determine which of the two radio frequency amplifier tubes. Interchanging tubes will usually enable the broadcast listener to find a defective tube.

**Locating Trouble**

Be sure a Broadcast station is operating within the range of the receiver. Be sure the following key 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 inside of the battey case to the negative and one on the positive. A decided click will be heard when this is done. Connect only momentarily.

Ten vacuum tubes in a properly set up, and provide for the operation of the receiver. Remember that it requires no little skill to tune a set with which you are not acquainted.

**Storage Battery Aids**

When using a storage battery, damage from spilling acid on floor or carpeting can be prevented by setting or making a small box, about 3 inches larger all around than the battery, and putting a piece of cardboard in the bottom. Paint insides with several coats of paint, and place over open cracks. Put casters on the bottom of the box. The box will keep the battery clean, and will often afford a place to keep a receptacle for the byidometer and a small bottle of distilled water, all together and out of reach.

This makes it very easy to move the box to one side, and the battery can be easily set in the box. 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

The Grebe Synchrophase is a five tube set incorporating two stages of tuned radio frequency, detector and final stage of radio frequency amplification. The coils are of the new fieldless binaire type and the volume is controlled by a special "Color-tone" dial.

Tuning
Now, with volume control knob 5 at maximum, remove plug 1 from the receiver and plug in the control. The pointer under the letter A in the word increase, decreases to 59, 58, 58 the east was heard from through WABP, and...
**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 radio signal fading. The only thing discovered was the fact that there was less fading of signals transmitted by wire than by radio, and that the fading was 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 one clearly, while the other is inaudible. The wave lengths of the respective stations are the same, but the signals from the one station will be heard at the same time, while the signals from the other stations will be heard at different times. This difference will not continue very long. The signals from one of the stations begin to fade while those from the other station may be heard. But the fading of the wave of the electromagnetic current may continue until the fading of the signal is inaudible in volume at a point where it may be necessary to reduce the voltage on the filament in the tube. Have 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 of me. The wave length of the former station is 429 meters, and of the latter 423 meters. Hence, the difference in 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., and station WDCN, a short wave station, 20 miles north of me. The wave length of the former is 411 meters, that of the latter 417 meters. Here, too, is a considerable difference in wave lengths, but not as much as in the former case, the signals were heard distinctly and the fading of the signals continued longer. I have had no experience on the same setting of the receiver. As the signals from one station faded those from the other became stronger.

Several nights later I was again able to hear WDAF, Cin-
cinnati, 700 miles east of me, I was surprised to hear someone else, but it turned out that this person had never heard of the Oakland station before and hence was not looking for it. I had dropped it into my nightly routine. The to-and-fro scraping 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.
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 pages will be devoted to the operation and setting of this model and the others. Super-Zenith VII is generally considered the largest cabinet receiver on the market, as the apparatus has not been designed to be small and compact. The amplifier tubes are large type 5819's at each end for the batteries. This is a tuned radio frequency receiver, incorporating two stages of coupling in the output and three stages of amplification. The frequency range covered in this set is as it is the first time that a receiver has appeared for use by the Radio public in which various stages of tuning were employed. This is the tuned radio frequency version of the Super-Zenith VII.

The above shows the front view of Model VII. Note the neat and attractive panel and the various controls and panel arrangement at each end. The view at the right, shows the arrangement of the instruments back of the panel, and should make it easier to understand the operating instructions in following pages. All of the Super-Zenith models are six tube sets employing two stages of amplification, detector and three stages of audio frequency amplification. The difference between the various models is in the cabinets truly, 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. By moving the phone plug to the rear of the loud speaker into operation, plugging in the phones puts them into operation. 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. While not the popular method it is a great improvement as it is suggested that head phones be used in tuning the receiver. After the operator has had experience with tuning in the frequency, the various stages of tuning the major tubes may be tuned by the use of knob L.

Due to slight differences which are bound to occur in the cabinet and connections which will be described, the cabinets of these two tuned circuits, the vernier condenser H is numbered as L, the primary condenser G and the secondary condenser F. The tuning procedure outlined first will include the circuit including H and, of course, into resonance with the program it is desired to receive. Adjustment of the vernier condenser H then brings the circuit including G into exact resonance with the other two just mentioned. The control E enables to operator to keep the first tube U at maximum efficiency while there may seem to be a great many controls, but 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. The use of the vernier condenser is by far the easiest and the most efficient way of getting the maximum amount of the received signal into the amplifier stages.

All tests of the various instruments are made with the receiver turned on for five minutes. The tubes and transformers and condensers and making sure there are no shorts 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 which then together with a click the telephone will be heard. This shows that the circuit in the receivers is right, and the test on the coils can proceed. Touch one of the open terminals to one end of the condenser and the other to an end of the log coil. If the click sounds in the receiver, the coil is all right.

To test the transformers, the phones click when the two terminals of the primary or the two terminals of the secondary of the transformer are touched. If the transformer is good, there should not be heard when one of the testing wires is touched to one of the terminals of the primary and to any terminal of the secondary. In other words, there should be no circuit between the primary and the secondaries of either transformer. When the testing wires are touched to one of the terminals of a condenser there should be no click. If a click occurs, this is indicative of a shorted out condenser. There is probable that the plates are touching. If a fixed condenser, it is defective and may as well be thrown away.
FIVE vacuum tubes are used with the Freed-Eisemann NR 20 receiver. It is best to use either five 50A or 30A tubes. Do not use any other kind of tube and one for a long time as the plate heater, regardless of advice to the contrary. The NR 20 receiver is arranged as though it were 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 filament of a vacuum tube used in the NR 20, which is sometimes known as the A battery. In addition to the storage battery to light the filament, a B battery is used in the receiver in the plate heater of the vacuum tube, and this is the energy which operates the speaker when the switch is on. B batteries are usually made in 22% or 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 telephone is connected, it may be connected in as desired. A telephone plug should be attached to the switch.

When connecting up the loud speaker for the first time, be sure that the two terminals of the plug are connected with the two binding posts provided. Better reproduction may be had with the connections to the loud speaker made to the current flows through the loud speaker in the right direction. Once the proper method of connection is determined, it should not be changed.

Antennas

For best results with NR 20 an outdoor antenna should be used. It should be a single wire from 70 to 100 feet long, as high as possible, and well isolated 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 lead as far away from a wall as possible. Always run the antenna lead, both indoor and outdoor, away from the receiver. Never let the antenna or ground lead run on top, under, or along 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 insulated by a small amount of solder.

From the ground binding post, on the rear of the receiver, a wire should run directly to the rear of the building, or some exterior metal object of permanent location. In the home, a good ground connection can be made to a radiator pipe, water pipe or gas pipe. This pipe should be provided with a short antenna, say 40 feet, more or less, in length, and one for a long antenna, say 200 feet or more. 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 sound. The correct ground 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 and exterior mark "long antenna," tuning will be sharper.

Within the Set

In order that there be understood 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 explanations. 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 when set at a certain number the door will not open and in this receiver, as in all neutrastage, 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 of "beat notes," new settings of the "neutrastage" dials should be only about 2 degrees apart, when picking up a station. Thus, if no broadcasting is heard with the "neutrastage" dials at 60 degrees, reset these dials to 66 degrees, then 64 degrees, then 62 degrees, until a station is received. Then move each dial separately either up or down the scale, slightly until the broadcast is heard.

Dials 4 and 5 should be adjusted until broadcast reception sounds clear and loudest. This adjustment should be only made after the receiver is thoroughly finished with this set, so 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 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 reduction in any signals which are within ten degrees on either side of its loudest point on the dial setting. Shortening the aerials as above will say within two or three degrees of its loudest point. When the receiver is finished, all coil connections can be effectively separated from one another.

Loss of amplification and selectivity is usually due to a run-down storage battery or run-down D 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 tin-gold solder and all condensers and transformers are tested.

If there is any noise, it is caused by something external to the receiver, such as 6 battery tubes, local induction that is picked up from telephone lines, or lighting circuits in the house, etc. etc.

Distortion in the loud speaker may be due to overlapping of the detector tube, and this overlapping can be eliminated by detuning the detector and antenna circuits as explained in the instruction booklet under "Tuning." If there is any meshiness, it is undoubtedly due to no liquid is spilled out of the battery onto anything so powerful on nearby broadcasting that you are deafening 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 battery run down and steel replacement, a bow may sometimes be heard when the switch connects the 2nd and 3rd tubes. To overcome this condition, use a battery eliminator.

Eliminate Hazards in Radio

Do not permit wires to trail into thoroughfares or across high-power electric lines. When connecting your guy wires to prevent its falling during a storm.

To prevent accidental shocks, the ground wires should be kept at least 5 inches away from the building. All joints should be soldered and made with approved types of clamps or splicing devices.

If fuses are used, they should be of approved types, and made of copper wire or copper pennies. Small fuses should be used. The resistance (in ohms) of a storage battery leads to prevent short circuits. Keep all doors closed on storage batteries, especially after the batteries have been freshly charged, as highly explosive hydrogen gas is expelled. Be careful of the gas from storage batteries, especially after the batteries have been freshly charged.
Thorola Isodyne Five Tube Receiver

The Thorola Isodyne is a five tube radio frequency receiver making use of the new doughnut type of coils.

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. While the hydrometer is a float on which there is a scale reading from 1.000 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 1.250 or better; when between 1.250 and 1.300 battery is fully charged.

The first three terminals for batteries are for the B battery supply and are labelled B+40, 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. It will be noted that there are three binding posts and one terminal of this battery will be marked POS. + and the other POS. - and the one next to the last binding post while the second terminal of the storage battery connects to the last post on the set.

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, will be used to call numbers 2 and 3, will be found to read a male a majority of the time and the same on any station. The number 1 will probably read some-what lower due to the effect of the antenna installation varies, it would be impossible for any manufacturer to alter this point. Below the dials there are two others 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 on position through with the set. A battery eliminator is used instead of B battery, the switch at the light socket should also be turned off.

The knob to the left controls the brilliance of the first three tubes, the two which may not be used are still at radio frequencies, and the detector. This knob must be turned to the right to a point where a wave is heard, the circuit is considered properly balanced and control over any tendency toward oscillation on the lower ranges, 6 to 30 on the dial, is obtained. Evidence of this is found by squelching and turning. Disturbance of the carrier or any work done on the tube or any other part of the set.

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 as far as possible, and further, between 30 and 40. If no program is heard, turn the Id of the connections, including and B, and try it again. If again there is no result, reset dial 1 at 30 and revolution the other two between 30 and 40. If, in the author's opinion, to the left of the dial closest to it.

As in any receiver of the tuned radio frequency type, it is a good policy to switch tubes and check with the best tubes in the set. It is found that the 6Q5-7 and 6BQ5 do not do as good a job as the others.

In case of trouble always check over all connections, before changing the aerial and ground wires; test both the aerial and ground and see that they are properly made.
How to Operate

Howard Five Tube Neutrodyne Set

THERE is no question that the Howard receiver is a neutrodyne of the latest type and the most approved design. It is simple in its construction and is of such design that it will give 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 Howard receiver are the aerial and ground. If it is desired to receive 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 will be picked up than on any outdoor type. Aerials of two to three feet of insulated wire strung clear of the walls in a half-circle will be sufficient. 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 will provide 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 reach 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 radiating system or water piping system is generally satisfactory.

A 6-volt storage battery of 50 or more amper-hour capacity, and batteries totaling 90 volts should be provided.

The Howard receiver is designed for use with 5-UV-20A or C801A 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 safety cord supplied should be run straight back from 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, the primary battery on the left and the secondary on the right, as shown in the set. It is a wise precaution to connect the A battery to the set and to install all five tubes with the rheostats (the five small dials along the bottom of the panel) turned up to about fifty divisions. The tubes should then all light up. If not, some error has been made which should be corrected before connecting the receiver to the aerial.

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 clasp will be heard in horn. This is due to vibration of the elements of the tube.

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 50 meters, which corresponds to a frequency of 50 kilocycles per second. If a Radio-casting 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.

When a station has been tuned the setting 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 controlling the aerial or by turning down the dials of the first two rheostats until good, clear and sufficiently loud sounds are heard.

Kinds of Interference Experienced

Interference experienced by listeners is chiefly of three kinds. These are: interference by static, atmospheric disturbances and spark stations; and interference from reradiating receiving stations. The Howard receiver is so designed as to largely exclude interference between Radio-casting stations, especially when a small or indoor aerial is used. If, however, the Radio-casting 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.

Poor Tube Bases Cause Current Loss

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 tubes, tube sockets and other parts, as well.

A modern and fairly efficient receiver radio will receive signals which have as low a pressure as .001 volts. Even in very good antennas this will not produce an energy of more than .000001 electrons. It is hard to imagine such a small quantity of energy, but forty million receiving sets would produce sufficient power 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

The second only 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 being assured by the use of Bakelite or similar material of uniform cross-section which assures thorough elimination of metallic material as well as dielectric properties, as well as making it mechanically strong.

No Noisy B Batteries

A further interesting fact that has been developed through research is that one of the largest battery manufacturers, is the "hissing" and "fry- ing" which results from B batteries is in reality caused by poor connections, usually between tube terminals and the socket contacts. Their research shows that there are very few manufacturers who have not 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 first struck when the model 225 was handed out of its heavy corrugated board packaging. So many sets that are exceptional in results present such a poor appearance that to the feminine mind they are impossi- ble in the telephone business unless it is one is a delight to the eye.

The antenna lead-in and the connection to ground should be as short as is reasonably possible and should not be run together at test points. Many Radio set users bring these leads together at some point 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 connection of the aerial and the ground. Blind plugging should be noted, in particular, that one of these is marked "+" while the other is marked "−." The terminals of the speaker cord are local placed in such a manner that in one there will be found a red or blue tracer woven into the covering. This means that the phone wire in this wire goes in the "−" jack on the set, while the unmarked tip goes in the other small jack. The ideal way to take care of this is to make a five wire cable, the coverings of each wire being of a different color, and to splice them together in the usual way. Do not do this under any circumstances. The wire from the aerial is to be brought into the set through this 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.

Panel Light for DX Hunters

Many have in the operation of their DX sets a marked desire to have a drain on the battery, for the reason that the covering must be a high resistance type, with the terminals of the speaker cord of the proper colors.

Accessories Required

For operation this receiver requires one 6-volt storage battery of approximately 15 ampere hours, or one 24-volt battery, either of the lead acid type or their equivalent in a "B Battery Eliminator." One of the storage battery terminals is marked POS or + or with a red dash point. This is the positive terminal. The other end of the battery cable which is pure yellow in the color of its covering must be attached to the battery with a battery, that is, black with a yellow tracer thread woven in, to go to the negative. Should a Philips, General Electric or equivalent "B Battery Eliminator" be used, it will have these same two terminals, + and −. The B battery 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 or 15 ampere hour battery plus battery 45 and 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 to this minus post on the second 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−, and B0. B− and B+ are the same, and the black and red leads go to B−, the maroon lead goes to B+ and +45 and the black tracer connector is to be cut off. The bright red covered wire goes to the +50 post.

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 insulated wire marked by color for use as antenna, as it will not corrode and will not affect and is recommended in the case of aerial breakage. Use porcelain or Pyrex glass insulators at each end of the aerial, and either extend the wire itself down to the set or use heavy rubber covered lead-in

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.

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 a drain on your battery and light is independent of tubes.—John Mul- likon, Washington, D. C.

Radio Frequency Choke Coil

A good radio frequency choke for the plate circuits of a 300- or 500-ohm type receiver may be constructed with a three-inch piece of wood dowel rod one-inch in diameter and 30 to 32 dec. wire as it will hold. One end con- tacts to the plate coil of the receiver, the other to the P terminal of the first audio frequency trans- nverter. Another lead is taken from the place of the tube to the fixed tickler and then to the other plates of the regeneration control condenser.

When looking for long distance stations, this switch should be at the right or "Full Volt" position. The volume might not be great enough for you to hear the program at all. When through testing just be sure that the little switch at the right is turned to "Off" position.
APEX SUPER FIVE is a tuned radio frequency receiver of the better group of sets of this type and has many unique features.

The Apex Super Five is a five tube tuned radio frequency receiver of the better group of sets of this type and includes:

- A battery as the storage battery is, of course, the negative and this terminal is connected to the positive terminals of an A power unit which would be the same. If the storage battery should be uncharged, the supply that they can be charged without removing cable connections, or from a terminal on the receiver, which can be done through the hole in the back. This set may be operated without a battery.

**How to Operate**

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**Installation Instructions**

All radio receivers must be connected to the antenna through a cable, and the connector must be tightly secured to the antenna. The radio receiver must be properly grounded to prevent static electricity build-up. The antenna must be mounted on a stable surface and should be located away from sources of interference such as power lines or other electrical devices.

**Batteries Necessary**

All radio receivers require batteries to operate. The type and number of batteries necessary will depend on the specific model of the radio receiver. Typically, a single battery is sufficient for most radio receivers. However, some high-power models may require two or more batteries. The batteries should be properly maintained and replaced when necessary to ensure optimal performance.

**More Insulators Are Important**

It is important that a small insulator be inserted at each end of the wire, between the wire actually used and the wire not used. This will prevent any possibility of the wire touching the tube or the chassis, as well as reducing the possibility of static electricity build-up. The insulator should be of a type that is specifically designed for use with the radio receiver.

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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 a really two-handed set as it has but two tuning controls.

Space is provided within the cabinet for two forty-five-volt batteries or four twenty-two-volt units, and also for the three tube short-wave receiver, the one-half- volt cells can be housed inside without crowding. All binding posts are mounted on a hanger- 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 on 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 in 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 turn the knob to the right about three-quarters of its possible rotation and, if connections have been rightly made, the filaments of the four larger ones will light and the tubes will be ready for use. The knobs on the panel should be set at 1 on their respective scales, the left hand dial on 2 and right hand dial on 3. Turn both over slowly, keeping them set at 1 on both, and look at the meters on the dials. The better way to tune is to use the verniers; they are set in the manner of the left of the tuning dials 2 and 3. Just push them in lightly and turn. By acclimatizing oneself to using the verniers a lot of the labor of tuning may be got a more sensitive "feet" and will not pass over distant stations which may otherwise be missed. The first thing to do when using the Model XV is to get familiar with the controls and practice tuning. Remember that each local station which has been picked up adjust the selectivity control of the stage that is being tuned, this way only one of the two right hand dials has to be used, the left hand dial will be set on a place that will give you a sufficient signal for the stations you wish to receive, but not so strong as to cause the set to oscillate or radiate.

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 this, I find that the assertions are true, and will fade not withstanding 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 various stations supplying the transmitter of the Radiocasting Station. We cannot say this will not cause fading, but by what W.T.A.M., the Crystal Palace Battery Co. of Chelsea, supplies the entire power, I understand, is supplied by storage batteries. If this is the case, I do not see how the fading can be caused, for the system is a closed electric circuit, and the electric current is constant, and should not cause any fading.

Another writer claims that the fading is caused by fluctuations in the transmission of the station. This is not true; for the circuit is an open one, and any fluctuations of the transmission of the station do not affect the receiver in any way. All the radio sets are connected in series, and all the stations are connected in parallel, and if the fading is caused by fluctuations in the transmission of the station, we should have the same result with all the stations.

The fading of a radio set is caused by fluctuations in the current in the radio set, and not by fluctuations in the current in the station. The fading is caused by the interference of the waves from other stations, and not by the interference of the waves from the station.

In the case of radio sets, the interference is caused by the waves from other stations, and not by the interference of the waves from the station.

Another writer claims that the fading is caused by fluctuations in the current in the radio set, and not by fluctuations in the current in the station. The fading is caused by the interference of the waves from other stations, and not by the interference of the waves from the station.

Antenna instead of Wave Trap

In the ordinary receiver, the antenna is used for the radio set. In this receiver, the antenna is used for the radio set. The antenna is used for the radio set.

HINT TO NEUTRONYDE BUILDERS

If you have trouble neutralizing your tubes and find that the tube is better neutralized with the 
next than the present, try adding extra capacity across the grid and plate. This can be done by adding a second or a third one, as the case may be. This is especially valuable for those having a strong field strength, as the tube is used in this way give greater selectivity with little or no decrease in volume.

Hint to Neutrodyne Builders

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The Stromberg-Carlson Model 1-A is a five tube neonetrude re-processor and two stages of audio frequency amplification. Both the total qualities and the volume are very good when fully charged. This will maintain good, loud speaker volume at all times.

Some few of the tubes used may be the C-300, 2B-40, and 1C-300. This type of tube can be used in the number 1-A neonetrude receiver by merely connecting the receiver set binding post B, to any of the small neonetrude tubes, and the particular B battery block that connects to the 1-B binding post of the receiver. This change in battery wiring gives the required 2200-volt 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 jack. For UV-200 or C-300 tubes, all four rheostats on number 1-A receivers above serial number 500 can be set at the following markings at the time this receiver was installed and need not be disturbed unless the A battery voltage drops below the safe limit.

<table>
<thead>
<tr>
<th>Rheostat</th>
<th>Location</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Radio Amp.&quot;</td>
<td>Front Panel</td>
<td>60</td>
</tr>
<tr>
<td>&quot;Detector&quot;</td>
<td>Rear Panel</td>
<td>30</td>
</tr>
<tr>
<td>&quot;1st Audio&quot;</td>
<td>Rear Panel</td>
<td>30</td>
</tr>
<tr>
<td>&quot;2nd Audio&quot;</td>
<td>Rear Panel</td>
<td>30</td>
</tr>
</tbody>
</table>

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 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 interference to other dial stations. If the number 4 can be used as a volume control. The Detector rheostat, number 3, serves as a control on the sensitivity of the detector tube action but in no case should it be turned so close to the 0 setting as to cause interference. The position of the rheostats is not critical. When using a head plug for tuning or selecting a new station it is advisable to plug into the second audio jack as the signals will be amplified.

**Tuning With Headphones**

When using a loud speaker, always plug into the "Detector" jack first, and if the desired station does not come in with sufficient volume after setting dial, number 4, the "1st Audio" jack and then the "2nd Audio" jack, and then the "1st Audio" jack again. If the pointer comes half way between two markings on a dial it will be advisable to record the reading on the station log sheet, say 245, the numbers being entered on the 2nd dial in the usual manner. If no audio is present, all three large dials should be set for the loudest signal from the desired station, and then decrease the volume-getting the signal and the less the interference from a loud local station.

Most loud speakers are so constructed that the best results are obtained only when they are connected to the Radio receiver set in a certain way, that is, so used to connect the cells together in order that 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 to the dial to or to the end of the cord. 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.

**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 vacuum space in the immediate neighborhood. The space charge between electrons between filament and plate. The influence of this space charge depends upon the potential of the grid. If the grid is made positive, it will tend to repel electrons in the plate and the space charge which is negative and the result will be an increase in the flow of plate current. If the plate current is made negative, it adds to the effect of the electrons in the space, and decreases the flow of plate current. If the filament is at a constant temperature the plate current in the plate circuit may be altered 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

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. The wire for the antenna was passed through a small hole in the basement window frame and up to the window through the hole in the storage tube lead. An antenna lead from the outside wire was passed. Both tubes were tested with a 0.10 ohm pellitine tubes, through a board under the sash.

Following the manufacturer's instructions, five "birdies" were used, in the a.m. on A tubes and a soft detector. Although the set performed well on the first insertion of tubes, they were removed and replaced by other units. Some improvement in both volume and clarity was perceptible when the battery was a 5 volt, 120 ampere hour unit and, while it may be used for severa hours, it is recommended for general use at a high rate, it has been found better practice to charge it when it was not in use to make up what was used the evening before. A charging rate of two and one-half amperes for an hour is thought to keep this one about right.

Tuning Interference

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 station. In a single-circuit receiver, or on any such a set is unaware that he or she is causing such interference. It is hard to believe that anyone would knowingly drag across the various wave bands to find the best of the wave band of the desired station, rather than simply tuning to the desired stations and particularly apt to be present during the summer months, and the interference caused by "birdies" is something that is called on account of its 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 "whail of lost souls" was much more descriptive of the sensations produced by this type of interference.

Two-Circuit Sets Not Immune

There is a mistaken popular impression that the single-circuit receiver, set up in a good room and that sets having two circuits are immune from interference. This is not the case, as is shown by the following experiment.

A two-circuit receiving set with the tube oscillating in the second circuit, can receive the maximum strength of signals, will act as a discriminator to tune to just the same extent as the single-circuit set.

That such a condition should be expected, is apparent in the design of the largest and most powerful transmitting sets are constructed with two circuits, in order to limit the oscillation of the point of the tube, causes no disadvantage. The British Radioactivity 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 oscillation point is permitted.

The particular point to be made is that the practice of hunting a distant station with the oscillograph is impolite and 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 out of the battery so that they are bright and will form good contact.

See that there is no acid or water spilled upon the top of the battery which may get into the cells and between the cells. Keep the top of the battery dry.

Keep the plates covered with water at all times. The water on the plates will prevent the oxidation of the top of the plates. Use only distilled water.

Do not charge the battery when it is completely discharged for any length of time. It should be recharged when the terminals show 1.200. When fully 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 readings also see that the tube is both clean and not indented, as otherwise suction would prevent incorrect reading.
MANY have tried, but few have succeeded, as have the designers of the Day-Fan S, in producing a Radio receiver of such remarkable simplicity.

Its semi-sloping panel in black and gold, relieved by a number of hand-crafted nautical objects, indicates the one dial major tuning control, which is this receiver's one alluring 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 from outside stations, which speaks well for the selectivity of any make of receiver.

In 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 being 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, one to two feet of the back of the ground wire tightly around the cleaned portion of the pipe. When completed, cover this wrapping well with ordinary clay and over it pack the pipe to the wrapping of an electrician's tape. If this is not available, a galvanized iron pipe about six feet long, to which the ground wire has been secured, in the same manner as outlined above, fastening to a cold water pipe, may be used. This should be driven its full length into moist earth.

The installation of this system is slightly better than its weakest link, it is of importance that only proven accessories should be used. Look for quality batteries and loud speaker which you purchase. Price is not a criterion of goodness, while reputation is.

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 recceiver. 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 1255 and 1300, while a 45-volt dry B battery 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, 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 1. 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 hook-up is included with the Day-Fan S, 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 pointer marked "Selectivity" and "Volume" so that they are vertical.
2. Tune the dial full all the way to the left and then all the way to the right, which will line up the tuning condenser. (Figure 2)
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. Tune the speaker switch to the loud position.
5. Tune the volume control dial well over to the right and then slowly back to the left until the tone and volume are as desired by you.
6. If the volume is still too loud, turn the speaker switch from loud to soft.
7. Once a station is tuned in, slight adjustments of the dials to the right and left of the large dial will clear up any signal.
8. Slight adjustments of the "Selectivity" dial will materially assist in the tuning of stations which are too close together.

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 verdigris, which refuses to respond to the usual treatment of being wiped with vaseline, or perhaps the brush terminals are immersed in vaseline, which will only be necessary to apply the solution with a cloth dampened in it to the parts which require cleaning. Bubbles which make a trying 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.

In the interest of the operator, we have included a graph of the characteristics of a true average A.B.C. receiver, which may be a guide to the amateur radio operator, and also to the radio dealer who needs such information to sell more equipment.

Figure 1

Figure 2

Figure 3

RADIO RECEIVERS—How to Make and Operate

The Day-Fan

How to Operate

Five "Telephone Book" Set

Semi-sloping panel finished in gold and single control of five tube radio frequency receiver are its principal features

should test with a reliable voltmeter 38 volts or better, in order to be of value.

Before attempting to connect the batteries and antenna and ground, carefully read the instructions on this chart how closely it adheres to the manufacturers claim.

Trouble Shooting

Naturally, each reputable manufacturer of a Radio receiver devotes much time and thought toward assembling the total apparatus contained within the receiver, as to insure uninterrupted pleasure to the purchaser, with its minor inspection of the antenna, 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

Yet with all of these safeguards, such accidents will occur in any device as 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

Batteries when they have served their useful life, as a whole: a regular inspection of the antenna, and

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 verdigris, which refuses to respond to the usual treatment of being wiped with vaseline, or perhaps the brush terminals are immersed in vaseline, which will only be necessary to apply the solution with a cloth dampened in it to the parts which require cleaning. Bubbles which make a trying 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 effect felt too late. Even if it is true that there is little such interference to be overcome. When the static eliminators are in service, the static charges on the rf, hiss, crashing discharges of the summer season.

There is then nothing much left for the listener to do, since those devices which are not satisfactory for the reduction of static, are usually compensated by the necessity of construction, beyond his resources.

Publicans and their wives are willing and anxious to make any sort of experiment that offers any promise of profit. The methods that are the most successful, are not with any positive statements as to what may be expected, the writer ventured to offer the following to be developed and tested for their value.

The methods outlined here will result in some diminution of the volume of reception and the head phones, which in many cases may be substituted for the loud speaker.

Receiver Silent in Operation

For the sake of receiving 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 hisses and static crashes should. Along with the increased intensity of static interference with coming summertime, this condition becomes probably due to two causes: the conditions which give rise to statics are also unfavorable to transmission. The presence of static in the receiver or static in the line will be found at times to be very little to be gained by changing the sound waves into electrical apparatuses.

Distances Travelled

It is found that the electromagnetic wave will travel to enormous distances. The term high frequencies refers to wave lengths of about 30,000 cycles per second to about 3,000,000 cycles per second. It will be seen at once that these frequencies of a high intensity, and another, the very frequencies of the voice and music frequencies. Roughly, they are 1,000 times as long as the lower frequencies. One cycle of the high or Radio frequencies will occur during one second. The modulation wave is a combination of the audio and the Radio frequency. The Radio frequency part is the wave that is used to carry the audio frequency. The carrier frequency is modulated by the audio frequency, and it is commonly thought of as the frequency of the carrier 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 speak of the electromagnetic wave, 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 one piece of glass with another. When the statics are present, the statics are found to be the source of the static interference. When the static is not perceptibly diminished, this is because the wave is not affected by the coupling. Therefore, the coupling of the statics is less than the statics, but in any event the coupling between the statics and the dynamic coupling is more likely to be less than that of the statics.

Telephone By-Pass

The second telephone by-pass is a simple telephone by-pass of not less than 0.001 mile. If audio frequency transformers are used, this fixed condenser should be placed between the transmission.

Across the secondary of the first audio frequency transformer, it is found that the cathode of the tube, where between 0.005 and 0.005, this may be determined.

The plates of the tube, where between 0.005 and 0.005, may result in almost complete suppression of reception. Good fixed condensers should be used, their capacitance being the same, as good mica condensers are resistant to power. The signal condensers with the high frequency transformers, if any, should also be by-passed.

Grid Leaks Required

Leaks across the grid of the transformers, made with a soft lead pencil, may also improve the situation. 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 charges of the static circuit and result in a permanent chucking of the grid circuit and result in a reduced static annoyance which is thus partially eliminated.

The condensers across the transformers not only store the static charges, but if the condenser is so large, like those in an automobile. If the static charges of the static circuit, they will not be removed, but they will be removed. Therefore, it is essential that every leak be removed from the receiver and from the circuit to be containing them. This is essentially the case, but if the leak is large, this will not be the situation, or if it is, the leak will be large.

The Relation of Modulation to Tuning

The limits between which the frequency of a modulated wave changes are the sum and different frequencies which we have called the side bands. Therefore, we 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 modulate corresponds roughly to a wave length of 380 meters, that is, 9,000,000 cycles per second. This frequency of 9,000,000 cycles per second is 380 meters, or about a quarter of a mile apart.

Let us say that the voice frequency at the instant of modulation corresponds exactly to the frequency of the voice waves, which corresponds roughly to high C on the piano. The frequency of the voice wave is 440 cycles per second. The frequency of the voice wave is 4,400 cycles per second, but this frequency is not necessarily the frequency of the voice wave. It is the frequency of the voice wave, but this frequency is not necessarily the frequency of the voice wave. It is the frequency of the voice wave.

Side Bands

Musical notes contain frequencies as high as 4,000 or 4,500 cycles per second. The receiver must therefore be capable of unifying these frequencies and making them heard. It need not, however, have a band wider than that of the voice frequencies. Thus, we find that a Radio receiver can be carried, and to which it should be carried, if we are to be able to choose between Radiocasting stations. Each station uses a different nominal frequency, and these nominal frequencies are somewhere over 1,000 miles, and the side bands vary up and down 4,000 or 4,500 cycles each way. The difference between transmitting each other.

As the advent of the super-heterodyne receiver, nothing even approaching the degree of selectivity just described could be obtained. Thus it was that the wavemeter was introduced as a means of determining the proper resistance for a particular tube, against the wavemeter, usually in units varying from 0.5 megohm to 5 megohms.

Resistances of Grid Leak

An important feature in securing proper operation of a detector tube is the resistance of the grid leak. A leak which is too small offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube. A leak which is too large offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube. A leak which is too large offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube. A leak which is too large offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube.

Tips About Tubes

Certain types of vacuum tubes used as detectors will give the best results. This is the type which offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube. A leak which is too large offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube. A leak which is too large offers the advantage of being easily varied by increasing or decreasing the water of the method to adjust the resistance until maximum amplification is produced by the tube.
Determing Rheostat Resistance Values

There has been created a decided confusion in the minds of the Radiohans 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 sea of rheostats of a resistance running from one ohm for a power rheostat (controlled, line-fed, 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 of a single resistance 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 excessively great, but not so great that it 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:

\[ V = I \times R \]

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. The filament of 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 resistance, the range of variation also can be increased, from even lower values, 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 the potential 1 ampere, the filament resistance can be computed by applying Ohm's law.

\[ R = \frac{V}{I} = \frac{5}{1} = 5 \text{ ohms.} \]

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.

\[ I = \frac{V}{R} = \frac{3}{5} = 0.6 \text{ ampere.} \]

The filament resistance varies slightly as the heat of the filament is changed, but this can be disregarded. Ohm's law is supposed to be correct, however, has a 5 volt drop. If only, 6.6 amperes is wanted, the required tube resistance, including filament and rheostat will be:

\[ R = \frac{V}{I} = \frac{5}{0.6} = 8.33 \text{ ohms.} \]

The filament resistance of 5 ohms only 5.6 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 effective resistance becomes:

\[ R = \frac{1}{2} \times \frac{6}{1} = 3 \text{ volts.} \]

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 of such a capacity is 3 ohms. The factor to be considered in power rheostats is whether the resistance wire is the correct type for the required amperage. If not, the resistance wire will fuse. If an ordinary 6 ohm rheostat is used for more than one tube, this unity happens. The safe limit for the standard 6 ohm rheostat is 1.5 amperes.

Dry Cell Tubes
As previously mentioned, the development of the dry cell tube that started most of the trouble in respect to filament voltage. 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 2.5 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 voltage storage battery is used, the total resistance required is:

\[ R = \frac{V}{I} = \frac{5}{15} = \frac{1}{3} \text{ ohms.} \]

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.

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>Battery Volts</th>
<th>Current</th>
<th>Filament Resistance</th>
<th>3 Volts Parallel</th>
<th>4 Volts Parallel</th>
<th>5 Volts Parallel</th>
<th>6 Volts Parallel</th>
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</thead>
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<td>UV-199 and C-299</td>
<td>6</td>
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<td>1</td>
<td>10</td>
<td>22.5</td>
<td>6</td>
<td>6.65</td>
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<td>UV-200 and C-300</td>
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<td>1</td>
<td>10</td>
<td>22.5</td>
<td>6</td>
<td>6.65</td>
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<tr>
<td>C-201A and C-202A</td>
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<td>10</td>
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<tr>
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<td>6.65</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data Chart for Tube Accessories

The use of a fixed resistance is recommended only where the voltage at the source greatly exceeds that required for operation. A small one of the operating voltage is always necessary, in order to compensate for deterioration of battery connections 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.

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 sum of one divided by the number so connected. If a number of capacities of different condensers are connected in series, this formula must be applied:

\[ \frac{1}{C}_{total} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots \]

Let us see how these rules are of value in actual practice. Say, we have a variable condenser whose

\[ C = \frac{1}{0.0005} = 2000 \text{ mfd.} \]

Should a circuit require .0005 mfd. capacity, we use all three in series. Using our formula, and changing .001, .001 and 0.0005 to microfarads, we have:

\[ \frac{1}{0.0005} + \frac{1}{0.0005} + \frac{1}{0.0005} = \frac{1}{0.0005} \]

That is 250 microfarads, or put in decimal form 0.00025 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 wave antenna circuits, in a loop receiving circuit, in a wavemeter and in a Radioline filter. The .0005 microfarad condenser works well as an antenna series condenser with the Radial Condenser and a Radiocaster station 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 Radiocaster stations, the antenna condenser will help to eliminate the dots and dashes if the antenna is not too large. A condenser connected 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

RADIO RECEIVERS—How to Make and Operate

The rapid development of the Radio industry has been the main factor in the collection of highazar apparatus that is being sold over the counter. The prospect of getting rich quick has lured many into the making of Radio apparatus of all types and descriptions. Some were wise and employed the services of someone who knew something about the subject. Others copied the designs of established makes, while still another class just made stuff up to sell. As many as 100 different designs of radio and related industries that took up Radio as a side line, thereby creating high-grade competition, and therefore placed the design of apparatus in the hands of competent engineers.

The ultimate result 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 size of the coils, was often taken in and found the apparatus to be 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 vocalized.

For all of 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 inclined to try to construct himself, making the question of proper selection of greater importance.

A tube analysis has been demanded and described—the next step has been the transformer problem. Few are anxious to sit down and make frequency transformers. The prospect of having to count the required number of turns in transformers and secondaries, running from 10,000 to 66,000 and over, is not an attractive one, leaving alone the consideration of the requirements of proper winding for minimum capacity reactions; and selection and construction of laminated steel for cores does not improve the situation.

For all 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 give them a series of results in advanced mathematics and a technical knowledge possessed only by a qualified engineer. To be fair and give a comparative value of efficiency under similar conditions, it is not intended as a laboratory analysis, but a sufficient guide to give the fan a fair idea as to what results may be expected from various types.

Test Circuit
An effective circuit for a test of transformers, as shown in Figure 1. It will be noticed that the coil 10 is the primary and is used as the transformer in a normal condition of frequency amplification. The test consists of impressing a current in the primary, and measuring the voltage across a condenser and a potentiometer in the circuit of the secondary. This condition is more often given the circuit of a transformer problem, where the current is not reversed in the secondaries, and the direction of the potentialmeter is reversed in the secondary when connected directly to the phone. This direct tone must not be too loud, or adjustment is difficult. The measurements of the transformers 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. The test of the 5-ohm fixed resistance can be made by winding a 29 gauge wire on a 14-9/16-inch iron core, putting the primary resistance wire on a small spool, taking care that adjacent turns do not touch. This wire has a resistance of 3 ohms per foot.

The Calibrated Resistance
A dial is then placed on the wire, in the distance of 5.356 ohms. Then the other 5.0 ohms. Whether the turns required measure 5.4/5ths of the inch, the wire will be about 1.1/15 inches. Each inch represents 2.536 ohms. Therefore, the wire is wound in the proper ratio. The slot in the tube permits contact with the resistance wire, which lies in a horizontal plane.

This calibrated resistance will come in very handy for other uses.

Wave Motion, Length and Frequency
There seems to be, among Radio beginners, considerable confusion as to the general 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. One cannot grasp the meaning of the terms wave length and frequency and the relation existing between them merely by observation and remembering a mental picture of just exactly what takes place.

Suppose, for the sake of illustration, that you hold an automobile tire and shake it up and down and move it back and forth at a constant rate, much as you would see a wheel turning on your automobile. As you shake the tire, it creates an area of compression by forcing the air in its left hand side of the tire. At the end of its travel to the right and is brought back to the left, it creates an area of rarefaction by pulling the air out of the right side of the tire. As it goes to the left again it repeats the process of compressing the air on its left side and sucking the air out of its right side. This left and right motion creates an area of low pressure or partial vacuum. As the wave is transmitted toward the right, the air is made up of alternate portions of compressed and rarefied air. The portion of the tire is from a point of highest pressure 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 point of the wave, which can be considered as a wave is in a condition of pressure or tension called 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 point to starting point is termed its cycle.

In moving through successive cycles the compressions and rarefactions follow closely upon each other. 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 condition is described 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, represent the points of low compression, a, b, c, d, in Figure 1.

The frequency of the wave is directly proportional to the number of cycles per second, as shown in Figure 2. If you want to describe a wave as for example 100 cycles per second, you say it has a frequency of 100.

The wave length is the distance from any point on one wave to the same point on an adjacent wave. In this case the distance from A to B, or from B to C, or from B to a 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 place in a unit of time and is usually taken as one second so that the frequency of the wave produced 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 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. The frequency used by a Radio caster is 1,000,000, or 1,000,000 cycles per second. This means that the wave length is 300 or his wave length is 3000,000,000. Also, if his wave length is 300 then 300,000,000 x 300 is his frequency, or 1,000,000. Frequency is sometimes spoken of in kilocycles, a 1,000,000 being 1,000 cycles; an 800,000 frequency is 800.
ORNELE OF THE MOST FREQUENT SOURCES OF TROUBLE IN RADIOSET RECEIVERS WHICH FAIL TO FUNCTION PROPERLY IS SIMPLY OBSERVATION OF THE SET FAILING TO OBSERVE THE NECESSITY FOR OPERATING THE VACUUM TUBES ON THE CORRECT PLATE VOLTAGES WHEN PROVIDING A GRID LEAK AND CONDENSER OF THE RADIOSET IN CONNECTION WITH THE DETECTOR TUBE AND FURTHER, IN THE FAILURE TO GIVE TO THE SELECTIVITY IMPROVED IN USING A GRID BIAS OR C BATTERY IN THE GRID CIRCUIT OF THE AUDIO FREQUENCY AMPLIFIER.

In order to get the most and best out of your vacuum tubes, it is of the utmost importance that the various voltage values for A (filament), B (plate) and C (grid bias) of your radio set be used. The correct voltage will give the best results in the grid, 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 amplifiers, very small changes in the voltage or potential of the signals, and when the proper amplified filament and filament, have the effect of causing large changes in tube plate current and in order to secure the best possible reproduction of the speech or music, the grid of the tube is not drawn on the electron. Should this happen, it is possible to fail in obtaining the best values of the plate current, which would be alternately larger than normal, which condition would result in the distortion of the voice or music.

To properly accomplish or avoid this possible condition, the grids of the amplifier should at all times be kept at a negative value with respect to the filament, and should be one of the two or more possible, i.e., by the insertion of a condenser or the connection of a C battery in the grid return lead. The schematic diagram of connections for various circuits is shown in the accompanying diagrams.

Some circuits, however, cannot be used which require the application of higher grid biasing values (see tables), it becomes necessary to use a different plate voltage for the values which are set forth in the table and the connections for which are shown in the accompanying diagrams.

Practically speaking, the voltage of the C battery should be kept at a negative value in order to secure the best possible results. To be used, as the characteristics of the individual tubes may vary with the result that certain abnormal C battery potentials which provide best results with one tube do not provide satisfactory results when used with another tube, even those manufactured by 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 various types will be needed to give best results with various individual tubes of the familiar UV-200 A family.

**PROPER VALUES OF "C" BATTERY TO USE FOR GRID BIASING**

<table>
<thead>
<tr>
<th>Type</th>
<th>Plate Voltage</th>
<th>Grid Bias Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV-200</td>
<td>700</td>
<td>1.50 to 2.50</td>
</tr>
<tr>
<td>UV-201 A</td>
<td>600</td>
<td>1.00 to 2.00</td>
</tr>
<tr>
<td>UV-299</td>
<td>600</td>
<td>1.00 to 2.00</td>
</tr>
</tbody>
</table>

**What to Expect from a Set**

Just what you can expect of any Radio set depends upon a number of factors in addition to the voltages and currents. The number of factors is so large and the selection of the vacuum tubes is so important, that it is impossible to make a general statement of guide the way of the valve, which is in the process of making. When the selection is made, the manufacture of the valve, it will give the tube a complete and durable service.

**MAGNETIC FILTERS AND CONTROL CONDENSERS**

Employ High Grade Grid Condenser

Practically speaking, the value of the grid condenser to be used with the detector tube should be approximately 10,000 micromicrofarads, though some individuals prefer the use of a slightly larger capacity. It is recommended that the best results be obtained with the UV-200 or C-200, is used.

Generally, however, the value of the grid condenser should be kept below .0005 micromicrofarads, and it will amply repay the home constructor of a Radio set to take care of this one and any other self-amplified and well designed grid condenser is used, for a fault or defect in this will be the cause of objectionable noises in the set. And by all means, be sure to have it of 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 to the broadcast, to as weak and distant station. The writer has repeated this experiment a number of times, and the result has been the same. In the case of the plate voltage to be used with the amplifier tube, the voltage will be the proper one and the voltages of from 45 to 120 volts can be used without trouble. Furthermore, 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 set is used for ordinary listening.

**Adjusting Filament Control Rheostat**

Too many radio amateurs generally neglect 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 Clara of reproduction is vitally dependent on this operation. And never, by all means correct the set, however brightener is then adequate 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 realize the best results, but it will greatly prolong the working life of your batteries.

Further, be certain that you are using the proper applied filament voltage and the filament control rheostat of the correct wattage and of the proper value of the particular type of tube you are using (see table). Where possible, it's a good plan to incorporate a small voltmeter or ammeter in series with the current to the set, either being inexpensive and the use of which will make it easier for the operator to operate the tube filaments at constant voltage or constant current values (the former preferred) to further safeguard their working life.

**Remove Tubes When Making**

As a further precaution for the protection of the batteries, it is well to keep the batteries out of reach of children and other persons who might be tempted to use them without a proper knowledge of 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 electro-magnetic waves that radiate from the broadcast station. Since the aerial is the collector of the energy that acts on the receiver the more efficient the aerial the greater the amount of energy reaching the receiver, the power of reception in range and volume of the set.

The Radio waves will induce a current of opposite value 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.

**Use of Dry Cells**

The A battery supplies the energy to heat the filaments of the vacuum tubes. The filament elements such as those used in the UV-195, DV-3 and C-301A may be heated by impressing a current through them. A battery. The current consumption of these tubes is .060 amperes, at a filament terminal potential of about 25 volts. The filament voltage of the amplifier sets for the amplifier tubes service to reduce the voltage of the A battery before it is impressed across the filament terminals of the amplifier tube.

Use three dry cell batteries. These may be the ordinary dry cell type designed for use in flashlight, but the batteries which are especially designed for Radio. Dry cells especially designed for dry cell batteries, but they 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.

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 pass.

\[ \text{Resistance} = \frac{\text{Voltage}}{\text{Current}} \]

Plate Resistance and Impedance

In all electrical circuits there is an action or condition of the vacuum tube and its characteristics. The passage of current in other words, it limits the amount of current that can pass through it. It would correspond with the size of a water pipe. Naturally, the greater the pipe, the greater the volume of water that passes through it, likewise, the greater the voltage the greater the current which passes through it. 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 alternating current, the direct current resistance no longer holds true to another value which 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. In the question of time before all apparatus will be accompanied by manufacturers’ charts of characteristics values in order that circuits may be more carefully balanced for maximum results.

Amplification Constant

The amplification constant is one of the most important constants of the vacuum tube. This constant represents the maximum voltage amplification factor of a tube. It is 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. It varies slightly with changes in plate voltage, increasing as plate voltage is raised. Therefore, when operating as a detector, the amplification constant is not critical unless there is a loss of signal strength.

How to Derive Amplification Constant

In deriving the amplification constant, a given value of plate current is assumed; taking a given reduction in plate voltage, the grid voltage is increased 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:

\[ MU = \frac{E'p - E_p}{E_p} \]

where \( E_p \) = plate voltage and \( E'p \) = grid voltage.

Figure 1 is a chart showing the plate current and grid potential values in 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 current of 25 volts effective, the plate current is 35 volts positive. Then if the plate voltage is reduced to 40, the grid must be increased to 25 volts positive in order to get the plate value back to 3. Substituting these values in the formula we get:

\[ MU = \frac{25 - 15}{15} = \frac{10}{15} = \frac{2}{3} \]

Repeating this procedure at a plate current of 3 milliamperes, at 70 volts plate potential the grid must be increased to 25 volts positive; then if the plate potential is reduced to 60 the grid must be increased to 24.25 to keep the plate current at 3. Substituting these values in the formula we get:

\[ MU = \frac{24.25 - 15}{15} = \frac{9.25}{15} = \frac{37}{60} \]

The amplification constant obtained does not remain in a fixed value, as will be noted. The value decreases somewhat at lower voltages. It is sometimes constant over a range of a curve with its values plate potential plate potential in plate voltages. Due to inductance voltages and outside factors in the circuit, these variations may have a possible 5 per cent error, but will be found sufficiently accurate for the purpose the amateur requires of the use.

As to Plate Resistance

Making use of Ohms law, the direct current resistance of the plate circuit is equal to plate voltage divided by the plate current. The alternating current resistance, however, depends on the slope of the characteristic curve; since the curve is the same as the direct current resistance.

If the readings are taken at a zero grid potential the alternating plate current resistance equals:

\[ E_p - E'p \]

2 \( I_p \)

where \( I_p \) is the plate current in amperes. This will give a fair estimate of the resistance. 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:

\[ R_p = R'p + \frac{E_p}{I_p} \]

This formula gives the effective plate voltage; this value is used in reading off the proper resistance curve in 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

\[ R_p = 3.8(60 - 4) + 3 = 292 \]

\[ R_p = 3.8(60 - 4) \]

Therefore, reading from Figure 2:

\[ R_p = 10,000 \text{ ohms} \]

The negative value of the grid potential changes the plates to a substitution.

It has been stated and shown that the amplification constant depends almost entirely on the structure of the grid, its position relative to the filament and plate. It is defined as the plate 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 product 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 it changes considerably with different values of grid potential, it is determined at certain points at which the grid tube is going to be worked. The grid potential used are that represented by the marked 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 voltages.

(Continued on next page)
evaluation of the amplification factor of any tube. The three successive rheostats have graduated readings in equal steps of readjusted. The mutual inductance is adjusted when the switch 1 is closed the milliammeter will show a current flow in either direction (zero is the mutual inductance is not adjusted. Then the battery voltage is to be replaced 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 or coil is quite out of the question. It would be as long as a steamship. The steamship is almost as long as the length of the wave. The frame of a steamship is, however, much stronger than the frame of the loop. The whole thing would be replaced by a loop if the length of the loop was no more than 1000 feet.

### 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. A wave would pass by the loop as if it were passing by a wave in the ocean. The waves in the ocean would be very much like great smooth waves on the ocean, which of course, are generated by wind. The waves would be generated by wind and move in the wind. The waves in the ocean are not generated by wind, but by the wind itself. The waves are generated by the wind, and move in the wind. The waves in the ocean are not generated by wind, but by the wind itself. The waves are generated by the wind, and move in the wind.

### 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, the inductance of 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 the voltages generated are therefore, equal and in opposition. There is no voltage at the terminals of the loop since complete cancellation of voltages cannot occur.

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 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 a small condenser has a very definite maximum capacity. The maximum capacity of the variable condenser must give resonance to the lowest wave. 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 and just as high as possible, and still have no more than the maximum capacity of the variable condenser. The higher the loop is, the greater will be the voltage generated in the loop. The difference in the voltage that these voltages are, and the difference in the voltage that the loop of course, is determined by the maximum capacity of the variable condenser, must give resonance to the lowest wave. The maximum capacity of the variable condenser is, however, limited. This maximum capacity of the variable condenser, must give resonance to the lowest wave.

### Why Waves Are Spaced Apart

Now the inductance of a coil wire increases 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, it is necessary to have just as many turns as possible, each turn being just as long and just as high as possible, and still have no more than the maximum capacity of the variable condenser. The maximum capacity of the variable condenser is, however, limited. This maximum capacity of the variable condenser, must give resonance to the lowest wave. The maximum capacity of the variable condenser is, however, limited. This maximum capacity of the variable condenser, must give resonance to the lowest wave.

### 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 spliced together, the insulated wire and the bare wire are to be spliced together. This wire with the insulated wire and the bare wire are to be spliced together. This wire is to be spliced together so that it is shiny bright. A right-angle bend should be made in each wire at a point about 4 inches from the insulation, leaving about 3/4 inch of clean wire between the bend and the wire. By first bending these right-angle bend, each may be wrapped around the wire of the other, care being used to wind each wire tightly on the other. This will keep this kind will be strong mechanically and a good conductor.
Marking Condenser Dials in Wave Lengths

Reference Charts Are Best Solution

It is not unusual to receive a letter from some one who wonders why the dials are not graduated in wave lengths. His idea is not unreasonable, and the time is not far away when sets will have wave lengths graduated 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:

\[ W = \frac{59570 \times \sqrt{LC}}{m} \]

where \( W \) = wave length in meters.

The construction of the condensers now available makes impractical the marking of dials in wave lengths. Charts are popular and easy to use.

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 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 millihenries) as used in the inductances. 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 length would run from 500 to 250 meters, or a total of 350 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 only 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 designed. They are used, mostly in wave meter work and for laboratory testing.

The Square Law Condenser

The wave length formula can be changed around to read:

\[ C = \frac{W^2}{225500000} \]

using the same unit values as before.

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 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 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. Naturally, 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 varicoupler 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 shuttled 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 little, if any, 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 made with sharp 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. Gradual development and improvements in design will help eliminate these uncertain factors. The other points of construction, if efficient, are usually too high.
Radio Inductances and Tuning Functions

Their Effect in Radio Circuits

By Thomas W. Benson

T HE 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 one 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 permit only desired impulses to be reproduced.

Since the waves transmitted at differing wave lengths the length of time elapsing between successive waves striking the aerial will vary and consequently the amount by 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 it while blocking those of other frequencies.

tinction, when the current tends to decrease, the lines of force around the coil collapse and induce a current that is 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 from that of a coil. If a condenser is placed in the same direction as the current, it will reduce the current. In other words, the condenser will oppose the flow of current.

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? Without the correct jack attachment, as I have been asked this question I thought many others would be glad to know the answer.

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 used, only the detector tube will light.

Condenser Across Secondary

When you have a condenser across the secondary winding of the transformer, try to use as small a condenser as possible, and as much inductance as possible. The reason for this is that large inductance and small capacity will change the voltage induced in this circuit with very little effect. With a large inductance and small capacity, beautiful results are obtained.

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 coil or transformer will 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 receiver which the condenser is connected across the grid coil, the rotor plates connect to the filament end; if the condenser connects to the grid, it will be between the rotor plates and connected to grid.

Filament Switches

Filament switches which are turned on and off with a tube are well worth while. Using the loud speaker, you will want both tubes. If you use DX with the phones, two tubes in the same set, one for good news, and the other for the bad news. If you use two filament switches you can turn off the last tube while using DX. As you can see, it is not a bad idea. When the second tube is ready, it is proper rheostat setting, at the pull of a knob.

In wiring A batteries, heavy insulated wires must be used to connect the cells together so that they will be completely separated. Heavy leads should also connect the battery to set.

There are many ways the wires can be wound around the pegs, but the result from the viewpoint of efficiency will be about the same. It is the winding with plenty of empty space, and the ability to use materials, both inductance, almost free from distributed capacity with no high voltage loss, should be retained if the coil is mounted close to other masses, especially in the transformer, and the two should be kept in the open as much as possible and not mounted flat against the panel or base or placed around condensers.

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 will be about the same. It is the winding with plenty of empty space, and the ability to use materials, both inductance, almost free from distributed capacity with no high voltage loss, should be retained if the coil is mounted close to other masses, especially in the transformer, and the two should be kept in the open as much as possible and not mounted flat against the panel or base or placed around condensers.

Grounding Interference

A very annoying problem arose in a small country town where the power company had installed a new 5,000-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, but it was subjected to a high voltage test. But this was successfully withstood, showing that no flaws existed in the insulation, in fact, no defects existed with an oscillograph showed what caused the trouble. On the peak of each voltage wave there appeared a small ripple of a high frequency, thus the source of this higher harmonic then led to the conclusion that the trouble lay there. The next step was to try to change the leads, sending the high frequency, but this was no easier than the other.

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 high frequency, which was the generating current, and interfering to the ground as it should have been if proper connections had been made. By grounding the sheath this trouble disappeared entirely.

Use Tinned Lugs in Set

It is surprising how many Radio set builders make the greates mistake, that is, when using the leads supplied by the heads of screws. The majority will say this is a very good method. But, you have to remember the heads 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 to those of diagrams. From electrical engineering, Radio has borrowed four terms with which every fan and experimenter should be more or less familiar—volts, amperes, ohms, and watts. The terms ohm, volt, and watt are defined as follows:

1. Ohm: The resistance of a substance to the passage of electricity is called resistance, and the unit of resistance is the ohm. The resistance of a conductor is the opposition offered by the conductor to the passage of an electric current. The unit of resistance is the ohm; the symbol is Ω. Resistance is expressed by the equation:

   \[ R = \frac{V}{I} \]

   where \( R \) is the resistance in ohms, \( V \) is the voltage in volts, and \( I \) is the current in amperes.

2. Volt: Pressure or voltage is the term used to describe the force that drives a current through a conductor. The unit of voltage is the volt; the symbol is V. The equation for voltage is:

   \[ V = IR \]

   where \( V \) is the voltage in volts, \( I \) is the current in amperes, and \( R \) is the resistance in ohms.

3. Watt: Power is the rate at which work is done, usually expressed in watts. The unit of power is the watt; the symbol is W. The equation for power is:

   \[ P = \frac{V^2}{R} \]

   where \( P \) is the power in watts, \( V \) is the voltage in volts, and \( R \) is the resistance in ohms.


Four current losses in the circuit are:

1. Ohm's Law: Ohm's Law states that the current in a circuit is directly proportional to the voltage and inversely proportional to the resistance. The equation is:

   \[ I = \frac{V}{R} \]

   where \( I \) is the current in amperes, \( V \) is the voltage in volts, and \( R \) is the resistance in ohms.

2. Inductive Reactance: Inductive reactance is the opposition that an inductor offers to the flow of current. It is calculated by the equation:

   \[ X_L = \frac{2\pi f L}{R} \]

   where \( X_L \) is the inductive reactance in ohms, \( f \) is the frequency in hertz, \( L \) is the inductance in henries, and \( R \) is the resistance in ohms.

3. Capacitive Reactance: Capacitive reactance is the opposition that a capacitor offers to the flow of current. It is calculated by the equation:

   \[ X_C = \frac{1}{2\pi f C} \]

   where \( X_C \) is the capacitive reactance in ohms, \( f \) is the frequency in hertz, \( C \) is the capacitance in farads, and \( R \) is the resistance in ohms.

4. Resistance: Resistance is the opposition to the flow of current in a conductor. It is calculated by the equation:

   \[ R = \frac{V}{I} \]

   where \( R \) is the resistance in ohms, \( V \) is the voltage in volts, and \( I \) is the current in amperes.


We speak of the number of times the current changes its direction per second as the frequency. For example, if the current changes direction 100 times per second, the frequency is 100 Hz. The units of frequency are hertz (Hz), per second (s⁻¹), and cycles per second (cps).

Alternating current is current that changes direction at a regular frequency. The most common type of alternating current is the alternating current (AC) that is used in homes and businesses. AC is produced by a device called an alternating current generator, which consists of a coil of wire rotating in a magnetic field.

In conclusion, while there are many different types of electrical and radio terms, it is important to understand the basics of ohms, volts, watts, and frequency to fully comprehend the workings of radio and electrical systems.
Secrets of Selectivity and Regeneration

Resonance and Fundamental Principle

By William W. Harper

W
ith the advent of increased broadcasting, the Radio world has been compelled to devote a great point 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 peculiarities for a selective circuit in a simple Radio receiver.

Sharpness of Resonance

In a system 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 in and in that way estimate the selectivity or its ability to discriminate against a strong interfering circuit. The resonance curve is shown in Figure 2, which may be applied to the tuning circuit of Figure 1, which consists of 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 we may consider the wave length of the transmitter T, or more technically, it is in resonance with this point. This 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 reduced with diminishing intensities on each side of 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 diagram that 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 in a second station operating on an adjacent wave length, no interference will exist due to the first station.

Figure 2

The Use 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, the sharper will be the resonance curve obtained for the circuits. 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 condenser C, which is effected by proper design.

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. From the past, regeneration has been used with the intent of increasing the volume of received signals, and little consideration was given its ability to improve the selectivity of the curve of the reduction of the resistance which it effectively accomplishes.

In the application to a simple receiver, we have two possible methods for securing regenerative action. One is based on electromagnetic coupling between plate and grid circuits. Such an arrangement is shown in Figure 3. The condensers D and E are used and depends upon the electro-static coupling which exists by 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. If

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 (25-plate), and .00025 (11-plate). The value .001 is taken as the approximate capacity of a secondary circuit when the tuning condenser is selected to give the minimum capacity plate and coil and is considered as the lowest wave length that may be reached.

It is possible to reach lower wave lengths than shown by using windings on the coils; however, it is not advisable unless the primary and secondary and tickler values for the complete wave length range of the coils is known. It should be noted 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 wound with heavier wire (number 18 or larger). This data is given for the primary, secondary and tickler coil combinations for various wave length ranges.

TABLE A

<table>
<thead>
<tr>
<th>Wave Lengths in Meters with Following Capacities</th>
<th>Connected in Parallel with Coils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Condenser in millifarads</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>.001</td>
<td>600</td>
</tr>
<tr>
<td>.005</td>
<td>1200</td>
</tr>
<tr>
<td>.0025</td>
<td>2400</td>
</tr>
</tbody>
</table>

Proper Honeycomb or Various Wave Lengths

<table>
<thead>
<tr>
<th>Wave Lengths</th>
<th>Proper Coil Lengths in Meters</th>
<th>Primary Condenser</th>
<th>Secondary Condenser</th>
<th>Tickler Condenser</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>250</td>
<td>250</td>
<td>500</td>
<td>500</td>
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<tr>
<td>175</td>
<td>300</td>
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<td>350</td>
<td>500</td>
<td>500</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

When Phonics Rattle

If there is a rattle in one of the phones, carefully remove the data of the coil and check and see there is no dust or filings between the magnet and the coil. Fillings and dust would have an effect on the telephone, and as the diaphragm 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 mast 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 varistor. This coil should be wound in the same direction as the windings on the plate varistor.
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 translated to the line by a tube or crystal detector. Strictly speaking, an amplifier of this type modifies the current of the grid, filament, or plate in such a way as not to distort the modulation wave. The advantage of this form of amplification lies in the fact that it can be used for a wide range of frequencies and can therefore be carried farther than audio frequency amplification which is limited to the range of the ear. The other features of Radio frequency amplification are that it makes the set more stable and enables the existing transformer often to be used. Also, the current flows in the aerial tuning circuit which would otherwise be wasted.

When a positive potential is impressed upon the grid of a tube it will attract electrons already in the filament and plate, and the plate current will be increased. When a negative potential is impressed upon the grid of a tube it will repel the electrons from the plate and less current will flow in the plate circuit. The plate current will then rise and fall in exact proportion to the variations in the electrical pressure in the aerial circuit, at Radio frequencies but of much greater values.

Function of the Transformer

The purpose of the transformer is to transfer the current from the供电 circuit to the grid circuit when they are made and operated upon and to that extent only. This is simply done by connecting the transformer to the filament of the tube and the grid and making a connection from the plate of the tube to the second transformer. The transformer current in the grid circuit will then be as the plate current is impressed upon the grid of the tube. In this way the transformer is used simply to transfer the a current from one transformer to another.

The first tube in the series is called a direct coupling tube and 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 signal.

The second tube in the series consists of the two currents being coincident and then opposite in phase to give rise to a current of twice the frequency of the carrier output signal. At this time the frequency is the same as that of the input signal, and it is to this stage that most of the amplification is accomplished. This is the reason why the resistance coupling is made to work efficiently and why a receiver never does the best it can to build at the present stage of the art.

Some Radiohams have excellent results with Radio frequency amplifiers while others seem to fail entirely when they attempt to build this type of apparatus, as in satisfactory output, change in coil resistance on a fan and installed a five stage amplifier and connected it to a detector. Failure is usually the result of inattention to detail and a little experimenting will often clear up the trouble.

General Rules Necessary

By following the above rules we can assure that our results are assured. Use only apparatus of known quality. Check all connections and resistors in series or parallel. Connect the resistors to the batteries only if they are not used. Use only mi condensers and tube sockets that have all metal current-carrying parts well spaced from each other.

Where but one stage of Radio frequency is desired it is best to tuned type of coupling then obtaining a 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 signal.

The second stage is to remove the low frequency from the signals and then repeat the process. Thus the second tube further amplifies the wave, repeating the action through the circuit. At this stage the amplified coupling is practically useless for short work work by reason of tube capacities by-passing the frequency bands, and further coupling is not desired. The grid of the tube is removed in the usual method of coupling to the grids of the tubes. Its advantage lies in the selection of wave over which it will work best. They quote 2.5 to 3.0 meters. It is impossible to overcome this, Armstrong used the Super-Heterodyne circuit. The principle of operation of this circuit is rather complicated but the idea is beautiful in its simplicity.
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 discovery of the trouble. It can usually be definitely pointed out or covered over every kind of trouble. It is the aim of this article to present sufficient information to enable the Radiophonist to eliminate in great many cases the more common noises produced by alteration of his operating set rather than in the equipment itself, will remedy the trouble.

Loose Connections

Perhaps the most disconcerting trouble is dead silence, with occasional noises. The first step in working up the trouble is to find the exact location of the noise. In this case, it is advisable to 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 is failed to be successful, or after making a thorough check in the socket, the batteries down, the phones defective, or the phone condenser, if one is used, is short circuited.

When the springs on the phone do not make good contact with the tube prongs, it is advisable to bend the springs or sandpaper the prongs, as the case may be. Usually, the braided tinsel cord in the phone leads presents an easy means of a poor connection, and may be shifted 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 appears to be dead, the filament, with a filament voltage, that the A or B battery voltage may be below normal; the polarity of the plate battery reversed; the grid condenser dirty, shorted or not making contact; if the set is of the resonant type, the tickler coil connections may be faulty.

Weak signals in the detector circuit may also result from low filament temperature and plate potential, or the tube may be forced to work below its critical filament temperature, due to the increased load on the battery. The resistor or that can reduce the tickler coil or cut down the plate circuit, is in the frequency band situation.

If the signal weakens considerably when switching on the receiver, the stage or stages affected by the antenna or lead-in wire swaying to and from objects, and is turned on, and from objects, and in ear it, or make no other connection to 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.

Trouble in Amplifying Circuits

A frequent source of general trouble in amplifying circuits is the magnetic interaction between the cores of the transformers, with the tendency of the primary in the primary of the transformer. A high-pitched tone is often heard in amplifier circuits, in many cases high enough to blot out the main signal. Small variations on the output side of a tube being fed back to the input side.

This produces voltage variations on the grid, which are transmitted to the plates resulting in audio frequencies.

Fading

Variation of signal strength without making any tuning adjustments may be attributed to fading effects. Such conditions are caused by the antenna or lead-in wire swaying to and from objects, and in ear it, or make no other connection to each other. Such conditions

Amplifying Frequencies

IS not so long ago—yes and even now—fades between Radios were taking places with audio frequency. Then we discovered that broad- frequency was about 200 meters. This trouble was caused by the antenna or lead-in wire swaying to and from objects, and in ear it, or make no other connection to each other. Such conditions

Airwaves

Airwaves are a source of oscillating current the frequency of which is controlled. This circuit is coupled to the main circuit so that the incoming wave combines with and modifies the oscillating or radio waves with high cond. control is then tuned so the resultant frequency of the super-audible transmitters maximum efficiency is achieved. Then the operation of the transmitted frequency of course, is tuned at its source for the transmitted waves to combine with the super-audible transmitters, and the frequency available for being transmitted is then the frequency frequency is then applied as usual.

Insulate Lead-In

A lead-in wire is always good practice in bringing a lead-in into the receiver. If the lead-in then loses its touch anything. If the lead-in touches any metal, some of the signal strength will be absorbed, and it is the same as if the lead-in touches wood there is, however, in different cases where the lead-in touches wood there is, however, in different cases.
Wood Finishing for Radio Cabinets

We'll Made Sets Deserve to Be Enclosed
By W. S. Standford

There are many amateurs throughout the United States and Canada who are constructing their own radio cabinets. These cabinets are often made by hand, using small tools and simple materials. The cabinets are sometimes used as home decor, but they also serve a practical purpose as they provide a home for the sensitive components of the radio receiver. The cabinets must be made with care and attention to detail to ensure that they are not only attractive but also functional. In this article, we will discuss the process of finishing a radio cabinet, including the selection of wood, the preparation of the wood, and the application of the finish.

Selection of Wood

The type of wood used for the cabinet is an important consideration. Hardwoods such as oak, cherry, and maple are popular choices for radio cabinets due to their durability and beauty. Softwoods such as pine and fir are also used, especially for more affordable cabinets. The wood should be selected for its grain, color, and texture, as these will affect the overall appearance of the finished cabinet.

Preparation of Wood

Before the wood can be sanded and stained, it must be prepared. This involves removing any knots, cracks, or other imperfections, and filling any holes or splits in the wood. The wood should be sanded to a smooth finish, and any rough spots should be removed. This will help ensure that the finish will be applied evenly and will last longer.

Application of Finish

There are many types of finishes that can be applied to a radio cabinet, including stain, varnish, and polyurethane. The choice of finish will depend on the desired look and the type of wood being used. A stain will change the color of the wood, while a varnish will add a glossy shine. Polyurethane is a clear finish that will protect the wood and give it a lasting shine.

Final Touches

Once the finish has been applied, the final touches can be added. This may include adding hardware such as knobs and handles, or adding decorative elements such as inlays or carvings. The cabinet should be allowed to dry completely before final use.

In conclusion, finishing a radio cabinet is a process that requires careful consideration and attention to detail. By selecting the right type of wood, preparing the wood properly, and applying the finish carefully, a beautiful and functional radio cabinet can be created. Whether it is used as home decor or to house a valuable radio receiver, the cabinet will be a lasting symbol of the builder's skill and dedication.
Sockets and Rheostats

RADIOING has become America's greatest sport. The normal radio enthusiast is as attracted to the latest set as is the baseball fan to the largest stadium. Simplicity and compact design has made all its pleasures available to him, camp, yacht, ship board and while touring. It will continue to remain our greatest sport for years to come, for in our age of great inventions, market and success must be found in the simplest type of apparatus that is efficient and advanced with the elements of skill and chase intermediary.

What to Expect from a Set

Just what you can expect from the radio set depends upon many factors, some within and some beyond the control of the manufacturer. The size and shape of rating sets in miles range is rapidly dying out. When one makes a purchase today it is dependent upon the nature of the ground in the vicinity of the set; adjacent buildings, trees and other obstacles; the time and kind of equipment used to operate the apparatus and itself and the skill of the operator; the difficulty of changing stations is important.

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 is determined by the same distance that can be covered under favorable conditions. Therefore, a set that will receive clear stations 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-watt station 250 miles away.

The advent of the dry cell tube requiring a high resistance has eliminated the necessity for vernier attachments because the fine wire gives a vernier effect without the necessity of these tubes are all hard tubes make the filament control less critical than with the soft detour tubes. In selecting the correct resistance for the necessary factors should all be considered. For soft detectors 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 with a given number of turns of wire for the tubes but the writer believes the best method is to follow the tube manufacturer's suggestions in this respect when a common wire is used. Where more than one tube is used on one rheostat the following rule will prove a guide to the correct resistance. Diagnolic the increase 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 a lower one and work to higher resistance that can be purchased. As a rule the detour 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 temperature of the parts of a Radio set recourse is had to the so-called automatic rheostats. These consist of a fine wire sealed in a glass bulb in a evacuated space with the tube filament. Their action depends on the fact that the resistance of certain alloys increases rapidly with increasing temperature. By running the current through the tube the current will exceed the proper amount the wire heats up and therefore will not pass the current as a result of the resistance of the wire. The storage battery falls off in voltage, the current is reduced and the wire cools down and the current is maintained at the current constant. This control is entirely satisfactory for the small amount of frequency amplification under certain conditions, but is not recommended for the latter purpose.

Use Tinmed Lugs in Set

It is surprising how many Radio set builders make the great mistake of soldering the various wires to the lugs of the terminal board. It is well to keep in mind that all right, providing the heads of all screws are caref- fully sunk beneath the set attaching lugs and not actually to them. If you are destitute of saving yourself a lot of unnecessary trouble it is necessary that you make connections in that way. If you want to make a neat job of lugs you are soldering, use a generous amount of 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 discharges between them.

The contact points of the best jacks are made of some form of brass, in one case 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 rattling noise in your headphones, carefully remove the shell cap and the diaphragm, and see that there is no dust or filings between the magnet and diaphragm. The noise may be due to improper winding of the cable, or due to the diaphragm being torn, sometimes, and as the diaphragm vibrates, will cause a ripping noise. If you have a rubber braid on the cord goes to the positive terminal of the 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? It is important that your aerial be as near your house as possible. 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 lead-in wire is a very poor conductor and is not a good counterpoise in this case, and if you have an extremely long one, just try disconnecting it from the cold water pipe if you have one and see how far it will reduce your 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 of the building 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, you can get a short lead-in. By running the aerial wire through the eye of the insulator at the "near end," it is possible to keep right of way. If you want a short lead-in, tie it down to the outside of your window, where an insulated wire will have to be attached. By doing it this way, you make a short lead-in to the aerial, you will save one joint and make things just that much easier, for both space and the broadcasting.

Every joint in both aerial and ground lead should be carefully soldered.
# Universal Log Sheet for Any Type of Set

<table>
<thead>
<tr>
<th>Station Call Letters</th>
<th>Location</th>
<th>Wave Length in Meters</th>
<th>Frequency in Million Cycles</th>
<th>Dial 1 or Loop</th>
<th>Dial 2 or Lower Oscillator</th>
<th>Station Call Letters</th>
<th>Location</th>
<th>Wave Length in Meters</th>
<th>Frequency in Million Cycles</th>
<th>Dial 1 or Loop</th>
<th>Dial 2 or Lower Oscillator</th>
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Note: The table above shows the universal log sheet for radio receivers, detailing various stations with their call letters, locations, wave lengths, and frequencies, along with the corresponding dial settings and oscillators.
### Universal Log Sheet for Any Type of Set

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<tr>
<th>Station Call Letters</th>
<th>Location</th>
<th>Wave Length in Meters</th>
<th>Frequency in Kilocycles</th>
<th>Dial 1 or Loop</th>
<th>Dial 2 or Lower Oscillator</th>
<th>Station Call Letters</th>
<th>Location</th>
<th>Wave Length in Meters</th>
<th>Frequency in Kilocycles</th>
<th>Dial 1 or Loop</th>
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