THE EXPERIMENTER'S LIBRARY NO. 8

# ALL ABOUT RADIO PARTS

*by*

THOMAS W. BENSON

PRICE 25¢

THE E. I. CO.
233 FULTON ST., NEW YORK CITY

# *The*

# "Experimenter's Library"

## 25c. Books Covering Every Branch of Radio




Each book is written by a well-known author and contains 48 pages of valuable information, fully illustrated. Cover is in two colors, size 5½x7½ inches.

No. 1. Tips for the Radio Amateur Constructor.

No. 2. How to make Practical Radio Receiving Sets.

No. 3. Radio Questions Answered.

No. 4. Radio Frequency Amplification.

No. 5. Loud Talkers and How to Build Them.

No. 6. How to Tune Your Radio Set.

No. 7. 100 Radio Hook-ups.

No. 8. All About Radio Parts.

No. 9. History and Operation of the Vacuum Tube.

No. 10. The Neutrodyne—All About It.

No. 11. How Radio is Received.

No. 12. How to Locate Troubles in Your Radio Set.

No. 13. Reflex Radio Receivers.

*Each* **25c.** *Postpaid*


THE CONSRAD COMPANY, Inc.

*Selling Agents*

233 FULTON STREET NEW YORK CITY

# All About Radio Parts

By

THOMAS W. BENSON

TRADE MARK

Published by THE E. I. COMPANY
233 Fulton Street
New York City

Printed in the United States of America



1st Edition, January 1924
1st Reprint February 1924
2nd Reprint, March 1924
3rd Reprint, October 1924

# TABLE OF CONTENTS

# All About Radio Parts

## CHAPTER I

## COLLECTION

### Antenna Equipment for the Reception of Radio Waves.

Although many problems concerning the theory of radio wave activity are said to be yet unsolved, it still remains that radio waves, electrical in nature, are emitted from the transmitting aerial and travel out in all directions. When these waves meet with a conductor in their path, they induce a feeble current of electricity therein, and when this electrical current is passed through certain instruments, it is made to reproduce music, speech or code signals, depending upon the character of the transmitter.

We will first concern ourselves with the best methods of collecting these radio waves. The device used for this purpose is called the *aerial* or *antenna* and is classified in two types, namely, the *capacitive* and *inductive*. Every aerial has either a large capacity or a large inductance. Thus, when we elevate a wire or a number of wires above the earth a *capacity* is formed between the wires and the earth and we have a *capacitive antenna*. When a wire is wound in a coil or loop, we have formed a *loop aerial*, which is an *inductive aerial*.

The capacity aerial has proven the most satisfactory under average conditions and can be readily constructed at a low expense. The first thing to consider is the kind of wire to be used. At the present, there are available a number of different types of conductors intended for aerial construction. Among these various kinds include, solid copper, steel wire with a copper coating, stranded copper wire, braided wire, and lastly a copper strip. See Fig. 1. Bearing in mind that the electric current induced in an aerial is of very high frequency, and flows on the surface of the wire, it is clear that the conductor having the *largest* surface for the current to flow on, will have the *lowest resistance*. For this reason, a stranded wire is preferable since it has the largest surface area. Copper clad wire has

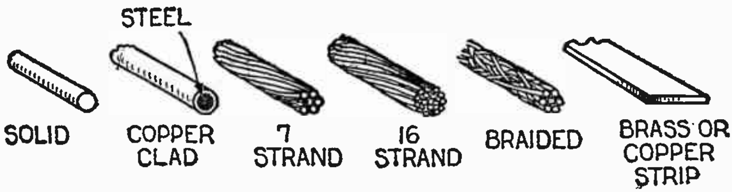



**Fig. 1. Cross-sectional view of the various conductors used for aerials.**

as low a resistance to these currents as a solid copper wire of the same size, but it is much stronger on account of its steel core. The copper strip has a larger surface area than a solid wire of equal weight. The braided wire is slightly better than stranded, because it is composed of a number of strands so arranged as to make its circumference larger. Preference should then be given to either stranded or braided wire.

The next step is to determine a means to support the aerial wires. A *low aerial* is more selective than a high one. There is a tendency toward encouraging the use of low aerials which is advocated by broadcasting stations. This height is suggested to be about ten or twelve feet above housetops. The length is another important factor. In order to tune properly, the length of the aerial, including lead-in and ground wire, should not be more than 150 feet. A single strand of wire supported by two ten-foot masts, made of wood or iron pipe, makes a good form of antenna equipment. Lengths of one-half inch conduit are very suitable and can be fitted at the top with an awning eye to attach a pulley, and with a flange at the bottom to mount on a block of wood as a base. Guy wires can be wrapped around the neck of the eye and fitted with turnbuckles to adjust their tension.

The insulation of the aerial should be given close attention. Both ends of the wire are fitted with insulators as shown in Fig. 2 and the wire lead-in should be fastened to porcelain knobs to prevent it from touching the side of the building.

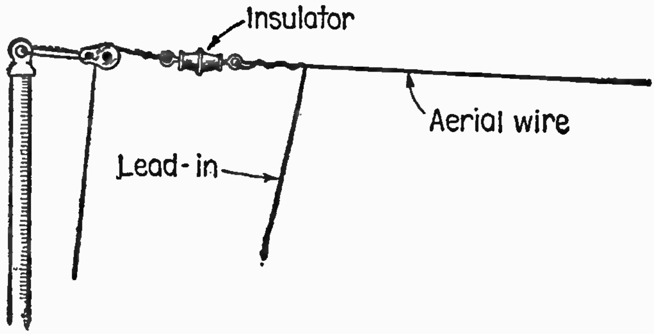



**Fig. 2. How an insulator is attached to a single wire antenna.**

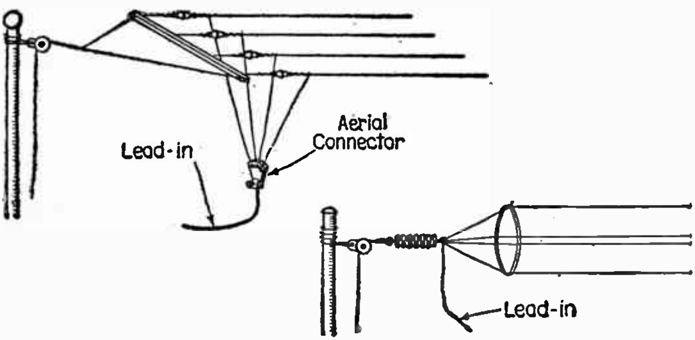



**Fig. 3. Insulating multi-wire aerials. Note the location of the insulators and the place where the lead-in is taken off from in each case.**

When more than one wire is used in the aerial, they are supported by a spreader or by a hoop. In the former case insulators are attached to each wire. The wires should be spaced at least two feet apart and the leads from them brought down to an aerial connector as shown in Fig. 3. In the hoop type, the wires themselves may form the bridle to the hoop and only one insulator be used. There is little or no advantage in multi-wire aerials for reception purposes as a single strand will be found just as efficient and effective. Often it is possible to support the aerial wire from a surrounding structure, and it is safe to do so if the wire is carefully insulated therefrom and not permitted to come within ten feet of the building at any point.

The lead-in should enter the building through an insulating tube of porcelain, glass or moulded bushing to prevent loss of current by leakage. The inside wiring from the lead-in can be No. 14 rubber covered copper wire such as that used for electric light wiring and should be run in as direct a line as possible to the receiving set.

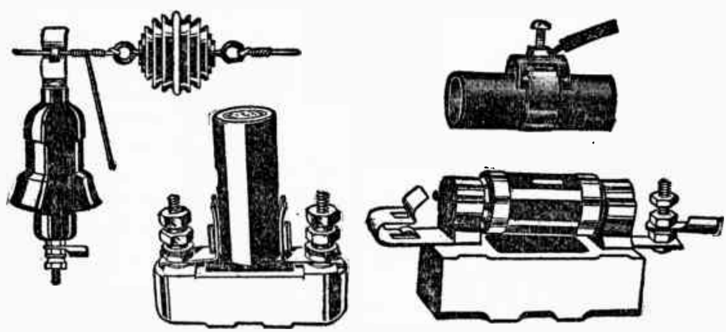


**Fig. 4. Different types of vacuum lightning arresters and a ground clamp. The arrester on the left is especially designed to be used out of doors and therefore it is attached directly to the antenna wire as shown.**

The question of *lightning protection* now arises, which is vitally important; in fact, the insurance companies demand that an improved type of *lightning arrester* should be installed. With a receiving set, a lightning switch is unnecessary, and a lightning arrester is all that is required. Arresters are of two general types; they are the air discharge and vacuum discharge. See Fig. 4. One terminal of the arrester is connected to the aerial lead-in and the other terminal is connected to a water pipe by means of No. 14 copper wire. Connections to the pipe should be made with a *ground clamp* as shown.

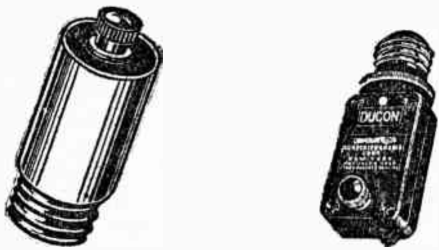



**Fig. 5. One of these plugs used in connection with an electric light socket, utilizes the system of wiring for an aerial.**

The pipe is first thoroughly cleaned and the clamp tightened in place. The ground wire is then soldered to the clamp. The ground wire to the set may be of No. 14 copper wire and connected to a water, steam or sewerage pipe in the same way so that a good ground connection is obtained. It is well to bear in mind that an aerial is no better than the ground used and it pays to have a good ground connection if the best results are expected. In all cases where grounds are made to pipes, make use of the ground clamp.

The fact that an insulated conductor will collect radio impulses has led to the introduction of the *socket plug aerial* which is simply a device for connecting the set to the electric lighting system and thus using the wiring as an aerial. These plugs are of several types and styles but are identical in principal, Fig. 5. It being necessary that they take the *radio currents* from the wires without drawing the lighting current; therefore they employ small fixed condensers which pass radio currents into the set but hold back the lighting current. They have been found to work exceedingly well under some conditions, but are complete failures under others. It all depends upon how the lighting wires run, the distance to the transformer, and a number of other factors. The only method of determining their usefulness in any given place is to try them. When proven successful, they are a very satisfactory form of aerial, being almost free from static disturbances and fairly selective.

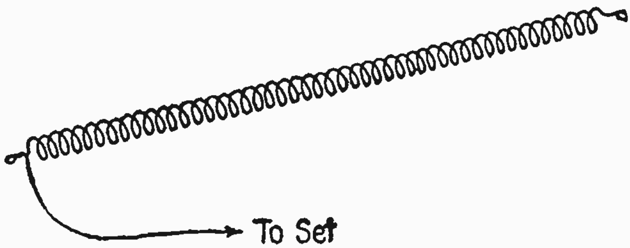



**Fig. 6. The spring antenna is installed by simply stretching it between two opposite corners of a room and bringing a lead down to the set.**

Another form of energy collector is the *spring aerial* which is simply a long spiral spring about two inches in diameter, Fig. 6. When stretched out to a length of twenty feet inside a room, it works very well on local stations but is not as efficient for long range reception as an outdoor aerial. It is essentially of the capacity type but also inductive for reason of its being coiled.

We now come to the inductive type of aerial which takes the form of a large coil of wire wound either in a spiral or a flat coil called the *loop aerial*. See Fig 7. These are made in different sizes and types and are about equal in efficiency, the difference being that the smaller the loop the more selective it is and of course the energy received is also less. There is little advantage in placing this type of aerial outdoors as it can be conveniently mounted on top or stood alongside of the radio cabinet and will work equally as well. Connection to it should be made with flexible wire so it can be rotated and advantage taken of its directional properties as will be described later. The loop is very selective both for reasons of its small size and its directional effect which reduces static interference to a minimum and is used where an outdoor aerial is not permissible or for portable purposes when the loop can be folded.

Tuning with a loop will be taken up in the following chapter, but a few words here to explain its directional features will be fitting.

We know that radio waves travel in a straight line, spreading out from the transmitter like ripples spread out on water from a stone thrown in a pond. When we turn the aerial with its flat side toward the transmitting station, the waves strike both sides of the loop at the same time, and the currents induced in both sides oppose each other and no current flows. Whereas, when the aerial is turned with one side

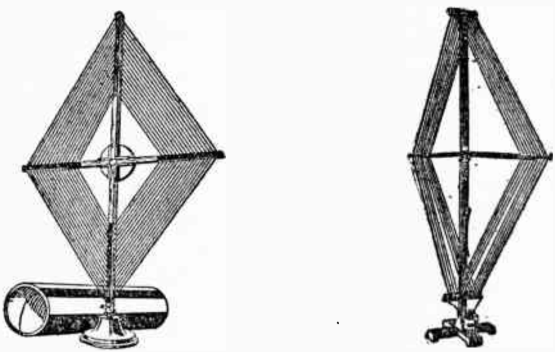


**Fig. 7. Two loop aerials. The one on the left is known as the spiral type and the one on the right, the Solenoid type.**

pointing directly to the station, the waves strike one side before they strike the other and induce a current in the winding which flows in the loop and acts upon the receiving set. Therefore, the signals from a station will be reduced to a minimum by turning the aerial with one of its flat sides toward that station, and they will be brought in with maximum intensity by pointing the loop in the direction of the transmitter. No ground is necessary with a loop and it may be considered as the secondary circuit of a two circuit tuner which will be described later.

## CHAPTER II

## SELECTION

### Apparatus and Methods of Tuning.

The radio *tuner* is simply a device used to select the signals from a desired sending or broadcasting station and to eliminate all others. The aerials or collection equipment described in the last chapter will pick up all radio waves passing them and the various waves will induce currents of different frequencies and intensities in the aerial circuit. The function of the tuner is to select from this mixture of currents that particular one induced by a desired station, and prevent all others from reaching the detector.

Since the currents differ chiefly in their frequency or the number of times per second they flow back and forth in the aerial circuit, our method of selection is confined to devices that will alter or control the character of the circuits so that one particular current can flow freely in that circuit and others of a differing frequency will encounter difficulty. This may be a little clearer if an example is given. Let us say that the current from one broadcasting station has a frequency of 600,000 cycles per second, or flows back and forth in the circuit that many times in the course of one second, which corresponds to a wave-length of 500 meters. Now if we adjust the aerial circuit so the first wave striking the aerial sends a current flowing down it, and the character of the circuit is such that will allow the current to flow back to the top of the aerial at the instant when the next wave, arriving 1/600,000th of a second later, strikes it and induces another current exactly in step with the first, the current in the aerial will be strengthened and each wave will be in step with those proceeding, thus building up the aerial current. The aerial is then said to be "in tune" with the transmitter. All waves of a different frequency striking the aerial will not be in step, and will result in one wave partially neutralizing the preceding one, and they will be so weakened as not to affect the detector.

By connecting inductance and capacities in a proper manner and providing means for adjusting them, we can control the characteristics of the circuit and thus make it respond to one *wave-length* or frequency. It will be found that adding *inductance* in series *increases the* wave-length of the circuit; connecting a *condenser* (capacity) across an inductance will also *increase* the wave-length. Connecting a condenser **in series** will *shorten* the wave-length.

**Fig. 8. Three arrangements of indnctances. On the left is shown a variometer, in the center a honeycomb coil, and on the right a spiderweb coil.**

Inductances take various forms; the simplest is the *tapped coil,* the *honeycomb coil,* the *variometer,* the *vario-coupler,* and the *spiderweb coil.* See Fig. 8. With the first, the inductance is varied by means of taps so that more or less wire may be switched into the circuit. With the honeycomb or spiderweb coils, the inductance value is fixed, but the circuit is adjusted by varying the capacity of a condenser connected across it. The variometer varies the inductance in an entirely different manner. This instrument consists of two windings usually wound in a spherical shape. One winding on a ball is arranged to turn inside the other. The two windings are connected in series so that the current will flow through both. Now when the ball is turned so that the current will flow through the two windings in the same direction, the two windings will assist each other and the highest value of inductance obtained. When the rotor is turned so that the current flows through the two windings in opposite directions, the inner winding no longer assists the outer winding but they oppose one another and the lowest value of inductance is obtained. Thus, it is obvious that the inductance in the circuit is controlled by adjusting the relation between the two windings.

It will be seen that we have at our disposal a number of methods for tuning the aerial curcuit, as shown in Fig. 9A. We can make use of a coil having both single-turn and multi-turn taps, so that with two switches the amount of inductance can be varied in the circuit. All the circuits in Fig. 9 show what are termed as single circuit tuners; that is, only the *aerial circuit* is tuned. Connections to detecting devices are made to the terminals as shown. Where sharper tuning is desired, a tapped coil is used with a variable condenser in the ground lead as indicated in Fig 9-B. Here the taps can be far apart, the condenser serving to tune the circuit closely. Where a long range of wave-lengths are desired, honeycomb or spiderweb coils are used and all the tuning is done with a variable condenser, as shown in Fig. 9-C-D. Each size coil covers a different range of wave-lengths and it can be placed in the circuit by means of a plug adapter provided for this purpose.

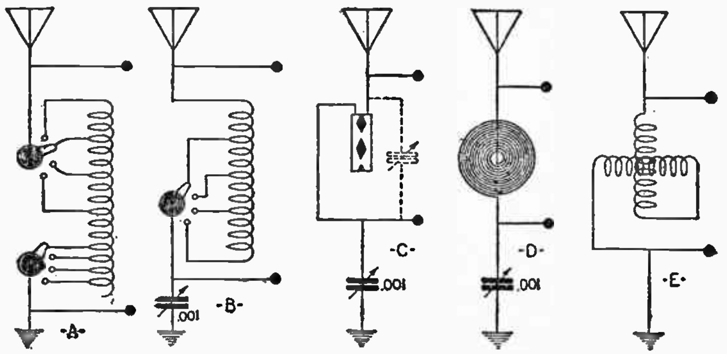



**Fig. 9. How inductances and capacities may be used to tune the aerial circuit.**

A variometer connected into the aerial circuit will serve to tune it, Fig. 9-E, although the variometer alone does not tune the circuit as sharply as the other methods. All these tuners will work with the various aerials mentioned in the previous chapter except the loop, which will be explained later.

Single circuit tuners are used very extensively and are fairly selective when used with a low and short aerial. They give louder reception than other types of tuners, but they will not tune out local stations very well. This is due to the fact that the currents induced by the local stations are strong enough to affect the detector regardless of how the circuit is adjusted.

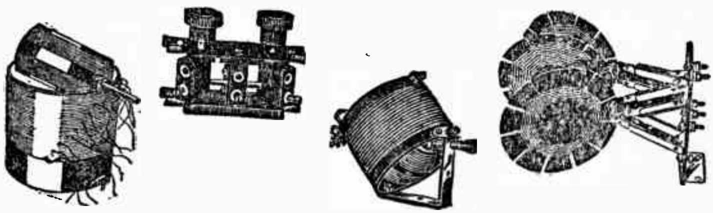


**Fig. 10. Coupling devices as used for varying the relation of inductances or coils.**

Therefore, when long distance work is to be done through local interference, some means for increasing the selectivity must be used. When a single circuit tuner is adjusted or tuned to receive one station and a number of others are operating on approximately the same wave-length, they are sometimes strong enough to interfere. Therefore, we must have some means of selecting only the desired wave and eliminating the others almost completely. To do this, use is made of a coupled tuner or what is termed a *double circuit tuner.*

The two-circuit tuner works on the principle that the magnetic field set up around the aerial tuner, when currents flow through it, can be made to act on another coil and induce currents in it. For this purpose, vario-couplers, honeycomb and spiderweb coils and the older form of loose coupler are used. Fig. 10. The vario-couplers are of two types, the 90° and the 180°. They differ only in that the rotor or secondary windings are so arranged that it requires a quarter turn or 90° rotation of the control knob to give the full range of coupling between the coils in one case and a half turn or 180° in the other. The 90° vario-coupler has its rotor arranged so that its shaft is at right angles with the stationary winding or stator. When the windings on the rotor are paralled with the winding on the stator the coupling is closest and more of the aerial circuit energy will be transferred to the secondary or rotor winding. When turned at right angles, the coupling is loose.

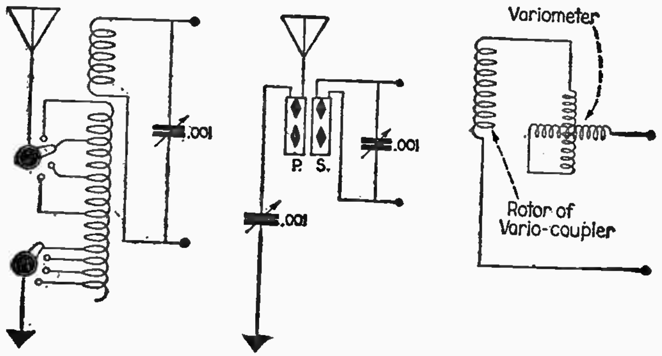



**Fig. 11. How coupled circuits are connected and tuned. The first is a tapped vario-coupler, the second honeycomb coils, and a third a variometer.**

In the 180° type, the rotor is set at an angle of 45° with the stator so that in one position the two are parallel, but by turning the rotor one-half a revolution, the windings will be at right angles giving loose coupling. The advantage lies with the 180° type, for much closer adjustment of the coupling is possible.

Honeycomb and spiderweb coils are arranged on pivots so that they can be swung close together or separated to adjust the coupling between them. The loose coupler which is now rather out of date, employs two coils with the secondary coil sliding into the primary or aerial circuit windings.

When a coupling device is employed, some means must be provided to tune the secondary circuit and we have recourse to the same methods as used in the aerial. Thus in Fig. 11 we can shunt a variable condenser across the rotor of the vario-coupler or the honeycomb or spiderweb, as the case may be.

In no instance should this condenser be greater than a 23 plate or .0005 Mfd. or the signal strength will be reduced. An alternative method of tuning is to place a variometer in series with the detector lead in any of the circuits as shown in the diagram at the right. The function of the third coil on honeycomb and spiderweb mounts will be taken up later.

The action which takes place in the coupled or two circuit tuner should be fairly evident. The aerial circuit is tuned to the desired wave-length to which it will be most responsive.

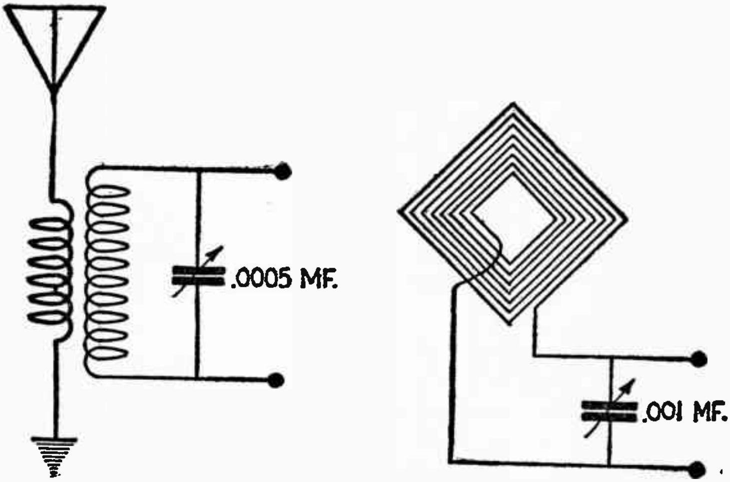



**Fig. 12. The untuned primary circuit and method for tuning a loop aerial.**

Then the secondary circuit is also tuned to the same wave-length, and the coupling between them varied until only the desired station is heard. There is a slight loss in energy when this transference from one circuit to the other is effected, but this is offset by the fact that the secondary circuit can be made of a low resistance and the currents therein can flow freely and build up in the manner described in connection with the tuned aerial. In addition, the lower resistance of this circuit results in sharper tuning. It is well to bear in mind that resistance in a radio circuit makes the tuning broader and the set will not be as selective. When a single tuned circuit is used, it is absolutely necessary that the resistance of the aerial and ground connection be kept as low as possible; hence, the importance of good ground connections and stranded aerial wire.

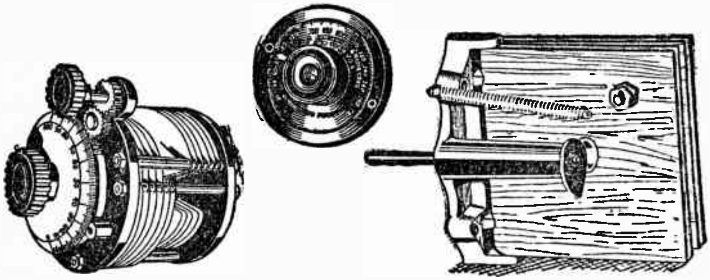


**Fig. 13. Variable condensers of the three styles as mentioned. Left to right they are, the intersecting plate with vernier device, the mica dielectric, and the book type.**

Extensive use is made of what is called the *untuned primary circuit*. See Fig. 12. This type employs 15 to 30 turns of wire in the aerial circuit without any means for tuning. The principle of operation does not differ from other two circuit tuners, although all the radio currents are permitted to flow in the aerial circuit without being tuned. The secondary circuit is closely coupled to the aerial circuit or primary coil, and by properly tuning the secondary coil, it will pick up the currents of a desired station and neglect the others.

The loop aerial can be compared to a double circuit tuner in that it might be said that the loop, being shunted by a variable condenser for tuning porposes, is loosely coupled with the radio waves and absorbs only a small part of the energy but selects stations to which it is tuned. See Fig. 12. The loop aerial, in other words, really acts as a secondary circuit; the radio waves themselves generating a magnetic field which induces a current in the loop.

*Variable condersers* used in radio sets are of three general types, namely, intersecting plate, book type, and those having a mica dielectric or other insulator. Fig. 13. The most commonly used is the intersecting plate type in which a set of movable plates are pivoted and swung between fixed plates to vary the active area and thus the capacity. This type of condenser is made in several different styles, each suited for different requirements. Some are fitted with a *vernier* which is simply an arrangement to obtain very fine variations in capacity and give close tuning. The vernier effect is obtained in various ways, either by having a single plate controlled separately, by a gear arrangement giving a reduction in movement of the main element, or similar means. The result in any case is the same, i. e., close adjustment of the capacity. A vernier condenser should be employed where sharp tuning is essential; in the secondary circuit of a double circuit tuner for instance. The condenser in the primary circuit need not be a vernier because the tuning in this circuit is not required to be made very sharp on account of the resistance always present.

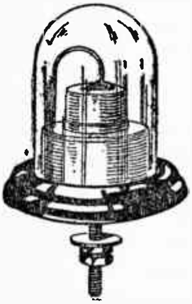
The book type of condenser and those employing mica insulation between moving plates were introduced for simplicity sake. The book type employs a hinged plate that can be swung close to a fixed plate with a mica sheet between them. The only disadvantage of this condenser is that it is very critical as the plates approach and are rather difficult to manage near the high capacity point of adjustment. The use of mica between the plates permits them to be brought close together without making electrical contact and gives a greater capacity with only a few plates and also gains in that the use of mica between the plates gives a capacity five times greater than when air is used as the insulator. The other types of mica condensers are constructed on the order of the rotary air condensers, only mica is used to separate the plate. The use of a solid dielectric or insulator such as mica results in losses in a condenser, and for that reason, the air type is most popular.

# CHAPTER III

## DETECTION

### Apparatus for Converting High Frequency Radio Currents Into an Audible Frequency.

It has been previously stated that the currents induced in the receiving set from a series of waves having a wave-length of 500 meters have a frequency of 600,000 cycles per second. On the other hand the human ear will not respond to air vibrations greater than 30,000 vibrations per second; therefore, the received currents are of too high a frequency to be heard and some device is necessary to detect the lower frequency musical or speech notes that are carried by the high frequency waves. The devices used for this purpose are termed *detectors* and take two general forms, namely, *crystal* and *vacuum tube* detectors. There are many other types of detectors of historical interest, but we will not discuss them here.



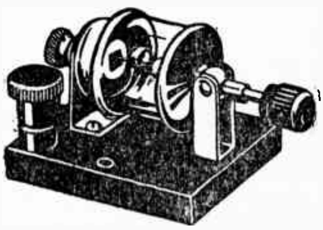


**Fig. 14. A fixed and an adjustable crystal detector.**

The crystal or mineral detector is one of the oldest forms of this instrument and to-day finds wide use because of its efficiency and inexpense. Fig. 14. All the various types of these detectors are simply an arrangement to hold a crystal of galena, iron pyrites, or one of the many synthetic crystals on the market, and means for adjusting a movable contact on the surface of the crystal. This contact wire is called a *catwhisker*. In a galena detector it is essential that the contact be very light while with the others the contact may press fairly hard on the crystal. The latter type then is the more reliable because it holds its adjustment better and is not liable to be jarred out by a slight vibration, but it is not quite as sensitive as the galena. Some detectors are made with a permanent adjustment. The contact wire or catwhisker is placed on a sensitive spot and clamped or sealed in position.

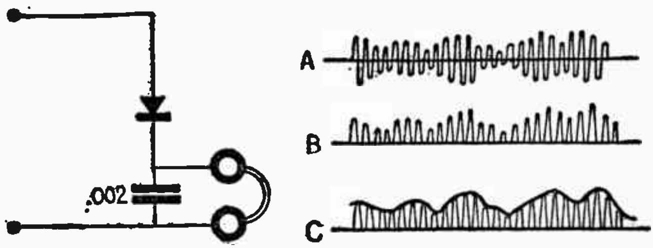



**Fig. 15. Connections of a crystal detector and graphs showing rectification of radio frequency currents and the resultant audio frequency current that actuates the phones.**

The action of a detector is essentially that of *rectification*; i. e., a crystal detector when connected into a radio receiver will permit the high frequency radio currents to flow through it in only one direction. Consider Fig. 15 which shows how a crystal detector is connected. The radio currents from a tuner flow into the detector. These currents are alternating in character, that is, they flow back and forth in the circuit. When they flow in one direction they can pass through the detector; when they flow the other direction the detector acts to shut them off. Therefore, in the circuit shown, the currents flow one way through the detector and thus charge the small fixed condenser which is connected across the phones called a *phone condenser*. Now the radio currents are not all of the same intensity because they are modulated or carry the voice or audible wave as will be clear by referring to the graphs in Fig. 15. At *A* is shown the current as it flows from the tuner with the voice impressed on the radio currents which results in each alternation of the current having a different maximum value. At *B* we have the current after it flows through the detector with half of it cut off by the rectifying action. As these varying currents are flowing into the phone condenser, the voltage across the condenser varies in accordance with the low frequency notes. The varying voltage affects the phones and the current in the phones is given by *C*. The current is of low frequency, of course, and gives an audible note in the head phones.

In the crystal detector we see that the received currents themselves actuate the phones. In the *vacuum tube detector* we also have a rectifying effect but the charges on the condenser serves to control, by a relay action, the current from a local battery which acts upon the phones, thus giving much

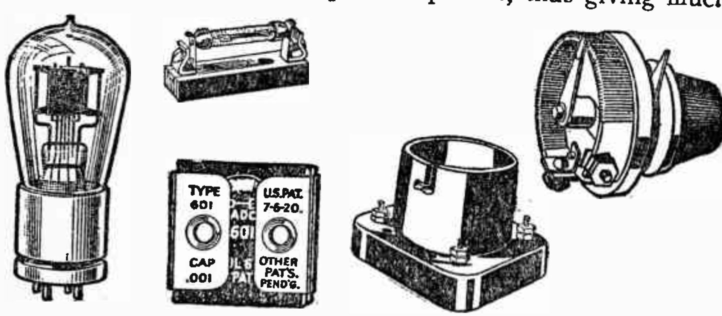



**Fig. 16. A vacuum tube and component parts which are used in conjunction with it as a detector. A grid leak, condenser, socket, and a rheostat are shown to the right of the tube.**

louder signals. There are a number of different types of vacuum tube detectors but the most efficient ones contain three elements, viz., a *filament,* a *grid,* and a *plate*. The filament is a wire which is heated by the passage of an electric current. In the U. V. 200 tube, it is simply a tungsten filament; in the W. D. 12 and U. V. 199 tubes, the filament is coated with an oxide rich in electronic emission. The function of the filament is to give off *electrons*. These are negatively charged particles of electricity. The plate encircles the filament and is connected to the positive terminal of the *"B" battery* as shown in Fig. 17. Between the plate and filament is mounted a network of thin

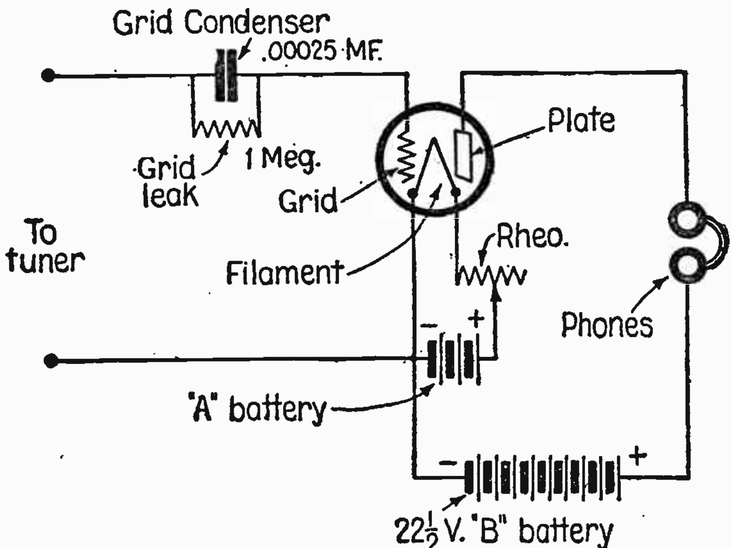



**Fig. 17. Circuit showing how the vacuum tube is utilized as a detector**

wire called the grid. The grid lead is connected through a small fixed condenser to one terminal of the tuner, and the filament is connected to the other terminal on the tuner. An *"A" battery* of the proper voltage recommended by the manufacturer of the tube is connected in series with a filament *rheostat* of the proper resistance and the tube filament. The *"A"* battery is used to heat the filament.

The action of the vacuum tube is as follows: When the filament is lighted it throws off electrons which are attracted to the plate by reason of it having a positive charge. These electrons must pass between the fine wires of the grid. The electrons are the only means of current flowing between plate and filament of the tube, therefore, a current can flow through the tube only when the filament is connected to the negative terminal and the plate to the positive terminal of the *"B"* battery. Now when we connect the grid and filament to the tuner, an incoming signal will impress an alternating current on the tube. When the current is flowing in such a direction as to make the filament negative and the grid positive, current will flow from the grid to the filament. When the current reverses, the flow is cut off, because the grid is negative and the electrons are repelled. The result is that a charge builds up in the grid condenser just as a charge builds up in the phone condenser of the crystal detector circuit. A *grid leak,* which is a high resistance, is connected across this condenser and so adjusted that the charge is gradually drained off. However, the charge in the condenser will vary just the same as that of the condenser in the crystal detector circuit, and the potential of the grid will vary in the same way, but it is always more or less negative with respect to the filament.

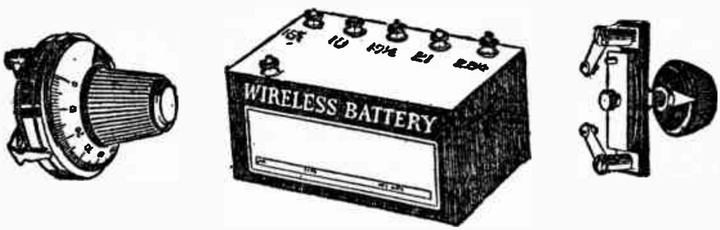



**Fig. 18. A vernier rheostat, variable "B" battery and variable grid leak are employed to obtain more accurate adjustment of the vacuum tube.**

Recalling the law that "likes repel," it will be seen that the varying negative charges on the grid will repel, to a greater or lesser extent, the negative electrons thrown off by the filament. Thus, the grid will vary the number of electrons reaching the plate and therefore control the flow of current from the plate to the filament. With the phones connected into the plate circuit, they will reproduce the variations in plate current and the signals are thus made audible.

There are several factors that enter into rectification and detection that determine the resulting signal strength and the clearness. A *soft tube* such as the U. V. 200 or C 300 gives the best results on detection because there is a slight amount of gas present that becomes ionized by the electrons from the filament and assists to carry current from the plate to the filament. Since a lower plate voltage is used with these tubes the attraction for the electrons is not as great and a very slight charge on the grid will serve to deflect them.

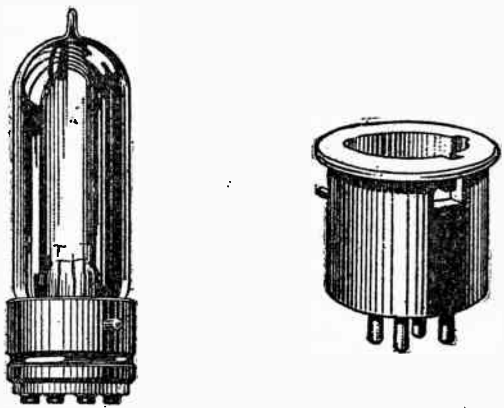


**Fig. 19. The U. V. 199 vacuum tube and adapter to fit the standard socket.**

The best operation of a vacuum tube depends upon proper filament adjustment, proper plate voltage, and the grid leak adjustment. For the filament control of a tube used as a detector, a *vernier rheostat* is preferable if not a necessity, Fig. 18. These rheostats permit very close adjustment of the filament current, giving good control of the temperature. The plate voltage is adjustable by taps on the *"B"* battery and various voltages should always be tried until the best results are obtained. The grid condenser and grid leak are vital. We depend on them for the detection in the tube and care should be given to their selection and adjustment. The condensers should have mica insulation, or better still, air as the dielectric. A number of *variable grid leaks* are on the market and are very desirable. Contrary to the general belief, a variable air condenser used in the grid lead will give better results both in control of the tube operation and signal strength than a fixed condenser. One of the smaller condensers with a maximum capacity of .0005 will serve this purpose nicely.

The *hard tubes* such as the W. D. 12 and U. V. 199 which have a coated filament that enables them to work at a lower temperature, the adjustment is not as critical as the soft tube and the best feature is that they can be operated from dry cells for the *"A"* battery current supply. Whereas, the U. V. 200 and C. 300 tubes operate from a six volt storage battery and consume one ampere of current and require a 6 ohm rheostat for their control. The other tubes operate on one and three volts, respectively. The U. V. 199 draws only 1/16th of an ampere and is operated on three dry cells. This tube requires a 24 to 30 ohm rheostat. The W. D. 12 draws 1/4 of an ampere from one dry cell and requires a 12 to 20 ohm rheostat. These dry cell tubes do not require a vernier rheostat as the filament adjustment is not so critical.

There are numerous makes of sockets on the market for detector tubes. All the tubes with the exception of the U. V. 199 and the older form of the W. D. 12, which is known as the W. D. 11, take the same socket. The two other types of tubes require special sockets, but when standard sockets are installed in a set, the smaller tubes may be inserted in the standard sockets by making use of an adapter, Fig. 19. Since the primary object of a socket is to make connections to the tube no socket is better than its contacts, therefore, a good socket is one that holds the tube snugly, makes good contact with the tube prongs, and last but not least, is made from some material that is a good insulator, on which the contact springs and terminals are mounted.

# CHAPTER IV

## AMPLIFICATION

### Increasing the Intensity of the Currents Received.

Amplification is the means employed to increase the radio current strength. At our disposal are two general methods, *Regeneration* and *Cascade Amplification*. These methods are entirely different in principle and the circuits that employ either or both of these methods are so very numerous that an explanation of them all would be impossible in a book of this size. We shall consider then only representative circuits on which the various modifications are based.

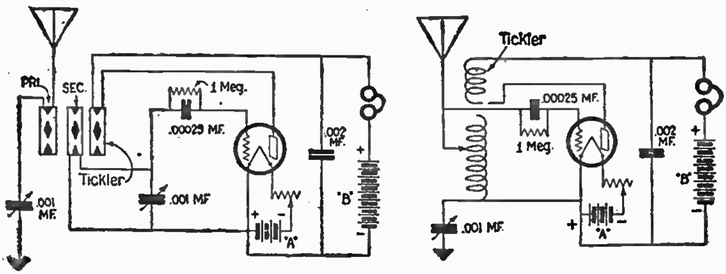



**Fig. 20. Amplification by regeneration. The circuit on the left is known as the "Honeycomb coil tickler feedback" and the one on the right the "Single circuit with tickler feedback."**

Taking up Regeneration first, we have learned that the incoming radio currents act to control a local battery current which in turn actuates the telephones. It is reasonable then to assume, that if we were to feed a small quantity of the energy in the phone circuit back into the control grid or circuit we would obtain louder signals. This condition is realized in regenerative receivers, the receivers differing only in the method of obtaining the *feed-back*.

There are two methods employed at present, namely, *inductive* and *capacity* feed-back. Just as the energy in the aerial circuit is transferred to the secondary circuit of a double circuit tuner by inductive coupling, so we can use another coil connected in the plate circuit to feed a portion of the plate circuit energy back into the grid circuit. This third winding is termed a tickler coil and is used in the circuit employing the

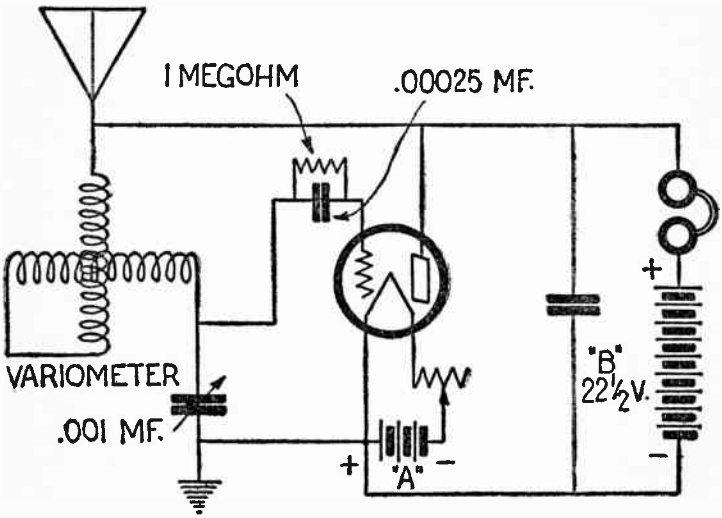



**Fig. 21. An ultra andion circuit illustrating capacitive feedback.**

*three coil honeycomb* or *spiderweb tuners,* Fig. 20. The primary coil on the left of the mount is connected to the aerial circuit and tuned with a variable condenser; the middle coil is the secondary, also tuned with a variable condenser; the coil on the right is connected in the plate circuit and is usually untuned. The latter is termed the *tickler.* With a honeycomb coil tuner the coils are removable, as explained before, and various sized coils may be used to obtain different wave-lengths. For Broadcast reception the usual practice is to employ a 50-turn coil as the primary, a 75 as the secondary, and a 100-turn coil as tickler. The condensers should not be larger than .0005 Mfd. or 23 plates across the secondary, but a .001 Mfd. or 43 plate condenser may be used in the primary or aerial circuit. The spiderweb coils are connected in the same manner and condensers of the same capacities should be used.

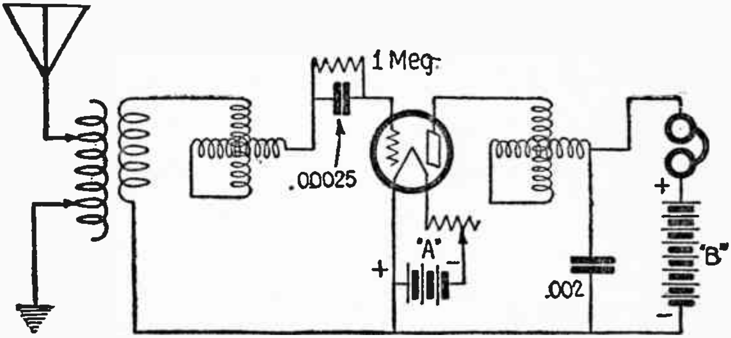



**Fig. 22. The three circuit tuner regenerative circuit.**

This circuit gives excellent results, the important point being to connect the tickler coil so that it feeds energy back into the secondary and assists the current in that circuit, rather than oppose it. When this type of tuner does not operate properly the leads to the tickler should be reversed. The adjustment of the tickler is very critical which is the disadvantage of this type of tuner, and too closed a coupling will cause the vacuum tube to generate oscillations causing a whistle and howl every time a broadcasting station is tuned in. With a regenerative circuit it is important that a .001 Mfd. fixed condenser be connected across the phones and *"B"* battery to permit the radio frequency currents to flow freely in the circuit because the resistance of the phones and battery are so high that they choke off these currents and prevent regeneration taking place properly.

The same method of feedback is used with the single circuit tuner which employs a vario-coupler, Fig. 20. The primary or stator of the vario-coupler in this case being in the aerial circuit and the rotor acting as a tickler coil. This is the simplest form of regenerative circuit and is widely used at present. The rotor is simply revolved to control the regeneration. The adjustment is rather critical, but excellent results are obtained in regard to range and volume.

Users of these regenerative circuits should be careful not to let them oscillate while receiving. The best reception is obtained at the point where the circuit is about to oscillate and after this point is reached the signals will be "mushed." Bear in mind, that while the circuit is oscillating the set is a miniature transmitter and is sending out waves which cause interference that is extremely annoying to receivers in the neighborhood. It is simply a matter of adjusting the set so that it does not howl and whistle and then you know that you are not interfering.

The matter of connections to the rotor of the usual 90° vario-coupler is not important, for a wrong connection can be remedied by simply turning the rotor around, but with the 180° coupler a different condition is met. The rotor coil can only bear one relation with the stator at maximum coupling as far as the magnetic field between them is concerned; so when a single circuit regenerative receiver using a 180° vario-coupler does not feed back properly, reverse the leads to the rotor.

The *ultra audion circuit* has gained much popularity for efficiency. The present form of this circuit as shown in Fig. 21 differs somewhat from the original ultra-audion circuit. It is a form of capacity coupled feedback. As will be noticed, the same voltage that is applied to the plate of the tube is also on the condenser in the aerial circuit. Then when the plate current is varied by an incoming radio impulse, the voltage at the plate will be varied slightly and these variations will be impressed upon the condenser in the grid circuit and thus act upon the grid of the tube, further affecting the plate current.

The remaining form of capacity feedback and one that is practically standard for selectivity and long distance reception is known as the *tuned plate* or the *two variometer circuit*. Fig. 22. This circuit employs a vario-coupler in the primary or aerial circuit with both unit and multiple turn taps, thus eliminating the condenser for aerial tuning. The secondary includes the rotor of the vario-coupler and a variometer. Just as we can tune a circuit by putting a variable condenser across the inductance, we can tune the same circuit by using a variable inductance in series, as is done here. The variometer in the plate circuit is used to tune this circuit. There are three circuits that must be tuned to obtain maximum signal strength, hence this circuit is very selective.

When the three circuits are tuned to the wave-length to be received, the inductance in the plate circuit has the effect of opposing any change in value of the plate current so that when the grid acts to reduce the current in the plate circuit, the inductance tends to keep it flowing and the resultant "kick," as it were, pushes the plate voltage above normal which attracts a greater negative charge to the grid and tends to reduce the plate current still further. This action greatly increases the variations in the plate current and gives louder signals. The circuit depends for its operation on the capacity between the grid and plate of the tube and is essentially a capacity feedback circuit. For the above reason it will not be found to work well with tubes having low internal capacity such as the W. D. 12 and U. V. 199 tubes, but works well with the other tubes.

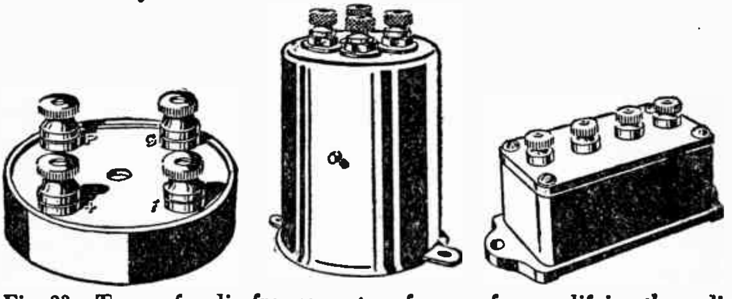


**Fig. 23. Types of radio frequency transformers for amplifying the radio currents before being detected.**

We come now to *cascade amplification* which employs more than one tube to obtain the desired results. Since we have found that any change in grid potential will give a much greater change in the plate current of a tube, it is evident that if the plate current were caused to act on the grid of a second tube, the change in the plate current strength of the second tube would be correspondingly greater. This is the principle of cascade amplification.

Furthermore, we know that the signals come in at a radio frequency and are detected and reduced to an audible frequency. Therefore, we can amplify the signals before they

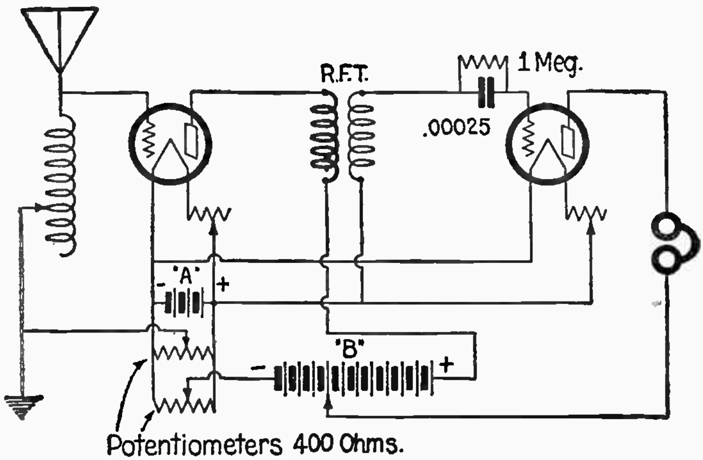



**Fig. 24. A circuit employing one stage of radio frequency amplification and a detector tube.**

are detected or after they are detected. Each method has its advantage and a combination of both methods is to be preferred. The tube detector will not respond to radio currents below a certain strength, hence the weaker ones are unheard. Were we to amplify them before detection they would then be strong enough to operate the detector. The purpose of *radio frequency amplification* then is to amplify the weaker currents that would not affect the detector alone, and acts principally to increase the *range* of the receiving set. A circuit employing one stage of radio frequency amplification and detector is given in the diagram, Fig. 24.

On the other hand, the *audio frequency amplifiers* can only amplify currents after they have been detected. The aim of audio frequency amplification is then to increase the volume of sound from the phones or loud talker. Both of these methods can be used in the one receiving set and thus obtain the maximum range and volume of sound.

The tubes preferred for radio amplification are the hard tubes such as the U. V. 201, U. V. 201-A or C-301, or the dry battery tubes previously mentioned. The reason for using hard tubes is that a high voltage can be used on the plate without the tube hissing or "spilling over." The higher the voltage used the louder will be the signals.

The greatest problem is the efficient coupling between one tube and the next. This problem is of greatest difficulty in radio frequency amplification because of the capacity that exists between the elements of the tubes and other portions of the circuit. It should be remembered that these currents are of a very high frequency and even a very small capacity will effect the circuit. The very capacity that enables us to

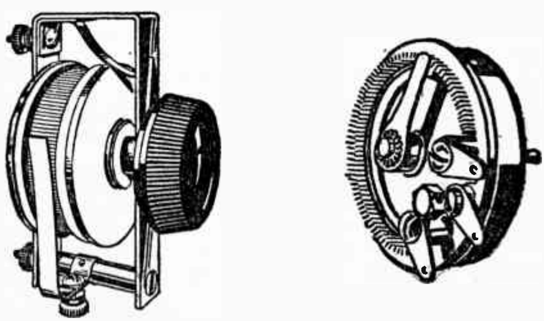


**Fig. 25. Potentiometers are used to control the potential or voltage supplied to the radio circuit.**

use a tube in a tuned plate circuit acts to render the same tube inefficient in a radio frequency amplification circuit. Therefore, the dry battery tubes such as W. D. 12 and U. V. 199 are most efficient as radio frequency amplifiers, but the U. V. 201 can be used with success only when the proper coupling devices are used and the leads kept short.

There are in use three general methods of coupling between tubes for radio frequency amplification. The transformer method is used most extensively, but as a rule is not as efficient as tuned impedance or tuned transformer couplings. Resistance coupling is employed for the longer wave-lengths. It has been found inefficient for the broadcasting wave-lengths. The disadvantage of transformer coupling is that it will not function efficiently over a wide band of wave-lengths, its efficiency being high for a certain wave-length and falling off considerably on shorter or longer waves.

Radio frequency transformers are sometimes built with a high resistance windings for primary and secondary, some employing a soft iron core and others an air core, Fig. 23.

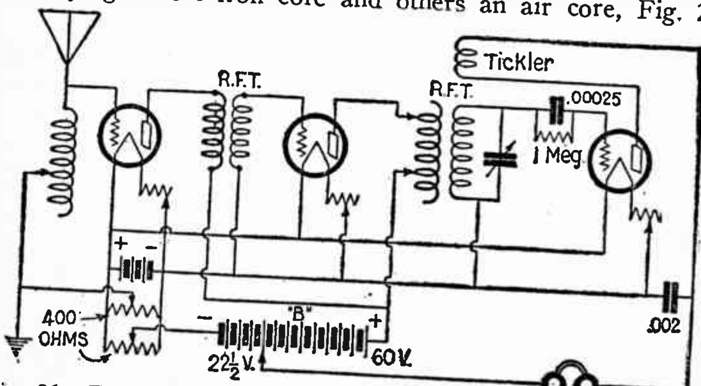



**Fig. 26. Two stages of transformer coupled radio frequency with a regenerative tuner used as coupling to the detector.**

The usual circuit for connecting transformer coupled radio frequency amplifiers is given in Fig. 26. It will be noted that two potentiometers are connected across the filament battery. Potentiometers are shown in Fig. 25. The function of the potentiometer is to adjust the potential of the grid until the tube is at its best amplifying condition. The second potentiometer is used to control the plate voltage on the second or detector tube. The aerial circuit is usually tuned with a single circuit tuner, but where greater selectivity is desired, a double circuit tuner can be employed. The operation of the circuit is simple. The incoming radio impulses will act upon the grid of the first tube, where they are amplified by the relay actions of the tube and passed on through the medium of the transformer to the grid of the second tube. The currents are then rectified and made audible in the phones as described before.

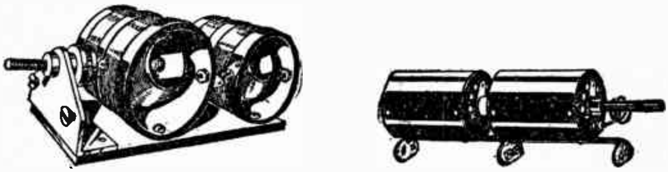


**Fig. 27. Two forms of adjustable transformers for radio frequency amplification.**

As many stages of amplification can be employed as desired by simply using more tubes and transformers. The last radio frequency amplifier tube can be coupled to the detector by a double circuit tuner instead of a transformer and thus obtain greater selectivity. Regeneration can be obtained by employing a feedback arrangement. The potentiometer in this case will vary the voltage on the amplifier as well as the detector tube plates, but the hard tubes are not sensitive to small changes of plate voltage and the effect on them is negligible. It will have a pronounced effect upon the detector tube.

One type of transformer recently introduced has the windings arranged similar to a variometer instead of being fixed with relation to each other. This allows for a variable coupling between them and permits a slightly tuning effect with increased selectivity. See Fig. 27. When more than one stage of amplification is used, the instruments are mounted in tandem on the one shaft so they can all be adjusted with the one knob.

Another type of transformer has tapped windings that are controlled by a switch. These instruments are also mounted in tandem fashion and by adjusting the inductance of the windings, the wave-length range is greatly increased and efficiency is retained over the entire range. Both these instruments are connected into the circuit in the same manner as the fixed transformers.

Another method of overcoming the wave-length limitation of transformers and the capacity effect of the tubes is to make use of tuned transformers as used in the *neutrodyne circuit.* Many types of radio frequency transformers can be thus connected with improved operation. The principle is simply to connect a variable condenser across the secondary of the transformer and thus tune this circuit to the incoming signals. The capacity between the tube elements enter into this tuning effect and are thus prevented from by-passing the radio frequency currents. Another advantage of such an arrangement is that the voltage induced in the grid circuit can be stopped up by properly proportioning the windings of the transformer.

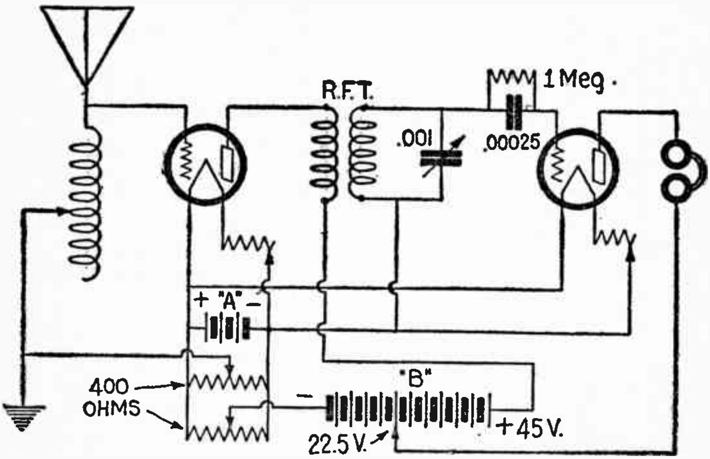



**Fig. 28. A tuned secondary circuit of a transformer as applied to radio frequency amplification.**

The neutrodyne transformers supplied for use in the *Hazeltine circuit* are an example of this type of coupling, the real secret of this circuit being in the neutralizing condensers that feed back to prevent regeneration instead of assisting it. The author has successfully used such transformers as radio frequency transformers as shown in Fig. 28, and the step-up effect gained showed a decided advantage over regular transformer coupling and tuned impedance coupling.

With tuned impedance coupling an inductance is included in the plate circuit of the amplifier tubes with a variable condenser connected across it. Details of the circuit are given in Fig. 29. A 65-turn honeycomb coil and a .0005 Mfd. condenser are about right for broadcast reception with a .00025 condenser in

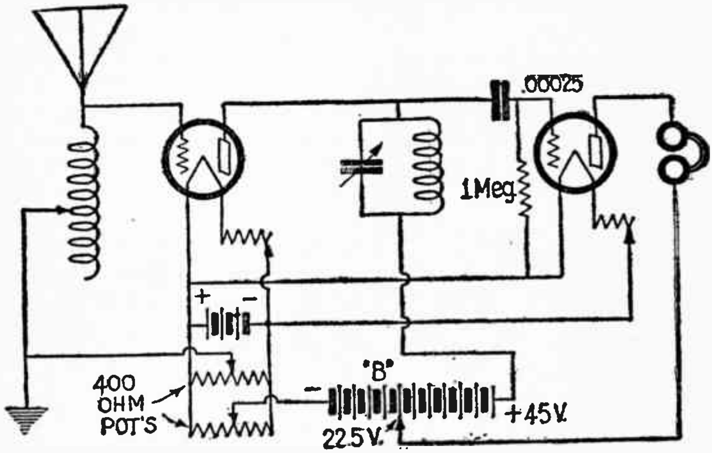



**Fig. 29. Tuned impedance coupling for radio frequency amplification.**

the lead to the grid of the second tube. We have here a circuit very similar to the tuned plate type of tuner, in fact a variometer may be used to tune the plate circuit with equal results. The difference in operation being that the "kick" from the inductance in the plate circuit now acts on the grid of the second tube as well as on the grid of the first tube through the capacity of the elements therein. This circuit is very efficient and increases the selectivity of the receiver. Not more than two stages of tuned coupling can be used as a rule because the circuit feeds back readily and goes into oscillation, besides being difficult to tune. One stage of such coupling is a very good arrangement and a number of manufacturers are now making sets employing this circuit with audio frequency amplification after the detector tube.

Resistance coupling is very similar to tuned impedance coupling, for a tuned impedance, when properly adjusted, causes the inductance to offer an infinite resistance to the radio frequency currents. In resistance couplings, we include a resistance in the plate circuit that will offer a resistance to currents of all wave-lengths and frequencies, but it is inefficient on short waves because of the electrostatic capacity between the connecting wires, etc., and the inability of the resistance to react at such high frequencies.

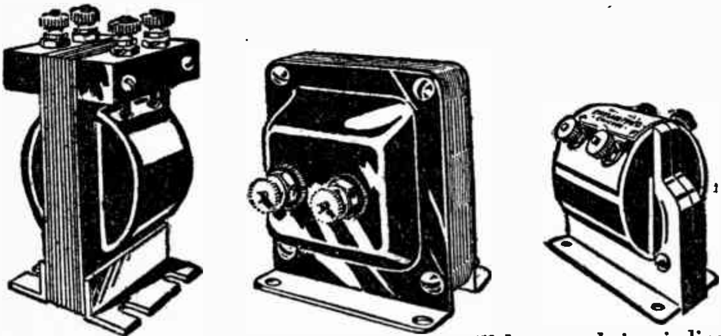


**Fig. 30. Audio frequency transformers. As will be seen their windings are enclosed in a metallic shielding.**

So much for radio frequency amplification. We come now to a consideration of *audio frequency amplification* or the amplification of the signals after they have been detected. By this means we increase the volume of sound, but by experience it has been found that more than two stages can seldom be used practically because audio frequency amplification amplifies tube noises and other disturbances that cause disagreeable sounds in the loud talker.

Our problem here is somewhat simpler since we are handling lower frequency currents. The chief point is to be sure that the impedance or resistance of the plate circuit is approximately equal to the resistance of the tube itself. Transformer coupling is used almost exclusively for audio frequency work and the design of these instruments have been reduced to extreme accuracy. Audio frequency transformers (Fig. 30) consist of two windings on a soft iron core, the entire instrument being preferably metal inclosed to prevent stray lines of magnetic force causing feedbacks in the circuits, resulting in howling or squealing. The primary winding is designed to have an impedance equal to that of the tube. The secondary winding has a greater number of turns of wire than the primary, varying in ratio to the primary from 3 to 1 to as high as 10 to 1. The reason for this is to increase the voltage in the secondary of the transformer which increases amplification.

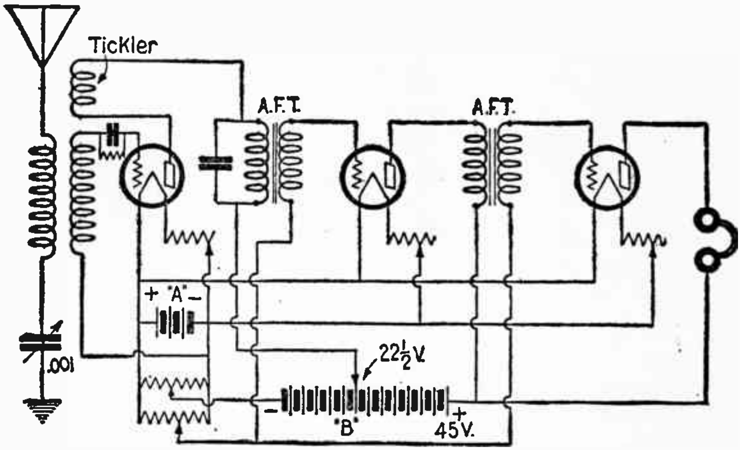



**Fig. 31. Diagram of a regenerative circuit further amplified by two stages of audio frequency amplification.**

The method of connecting these transformers is shown in Fig. 31, and differs little from that used with radio frequency transformers. A potentiometer is shown to control the potential of the grid to the best operating point, a fact often overlooked by amateur constructors. When one stage of audio amplification is used it is permissable, though undesirable, to use a high ratio transformer, but when two stages are used, low ratio transformers are recommended. The reason for this is, the tube is limited in the amount of plate current that it will pass and the use of two high ratio transformers may make the grid potential arrive to a point where the plate current will reach its saturation point or limit and the music or speech will be distorted. When an audio frequency amplifier howls or squeals continuously, it can sometimes be remedied by reversing the leads to either the primary or the secondary of the transformers, but best results are obtained when they are connected as marked on each transformer.

Hard tubes are always used for audio frequency amplification, but neither the filament adjustment or the plate voltage are very critical, and it is unnecessary to use vernier controls on either. The plate voltage should be as high as found practical to the extent of maximum volume without overlooking clarity.

# CHAPTER V

## REPRODUCTION

### The Use of Telephone Receivers and Loud Talkers.

Having collected, detected and amplified the currents, we need means of reproducing them so they become audible in respect to speech or music. The most popular method is adopted by means of *telephone receivers.* We are all more or less well acquainted with the various styles of headsets employing a small electromagnet wound with very fine wire having a metal diaphragm placed close to its poles. The poles of the electromagnet are kept magnetized by a small permanent magnet enclosed in the shell, and the currents flowing from the radio set pass around the winding and assist or oppose the

**Fig. 32. Telephone headsets especially designed for radio purposes.**

magnetism in the core, thus varying the attraction on the diaphragm which then vibrates and reproduces the sound. A good telephone receiver is constructed with a high grade of skill in both mechanical and electrical design, and for that reason a headset deserves the same care as you would accord a fine scientific instrument. When used with tube sets, the headset should always be connected into the circuit with the cord having the red mark connected to the positive pole (+) of the "B" Battery. When connected thus, the current through the phones tends to assist the magnetism in the core; whereas, a reversal will cause the magnetism in the phones to be opposed by the plate current, and in time results in the magnets becoming weakened.

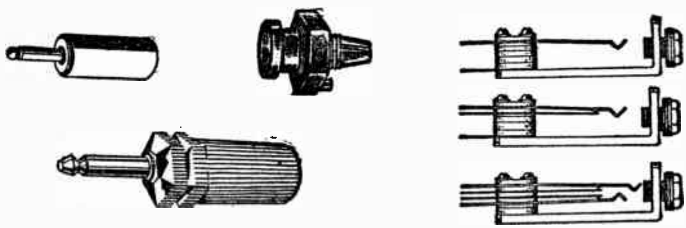


**Fig. 33. Telephone plugs, a phone tip jack, and jacks of the single, closed, and double circuit variety.**

The various radio manufacturers have prepared an extensive line of apparatus to permit various connections of phones to the radio set. Next to the older type binding posts there are the *phone tip jacks* which are mounted on the panel and it is only necessary to slip the cord tips into place to make connection to the set.

In addition, there are a number of types of *standard jacks* intended for various purposes such as automatically controlling the lighting of tube filaments and switching in amplification stages, etc. The regular double circuit jack is in more common use and can be utilized in a number of ways, such as plugging in additional instruments, loop aerials, and such. In Fig. 34 are given a number of applications of jacks that can be used by the radio constructor. The connections of jacks in which telephone receivers are to be plugged should be so wired that the red marked cord will be connected to the positive (+) of the "B" battery. This is only possible by connecting all jacks alike and then properly connecting the phone cords in the plug. A wide variety of phone plugs are on the market designed for different purposes, but here, as in other instruments, simplicity is sure to give freedom from trouble.

The popularity of broadcasting for entertainment purposes has led to the production of numerous types of loud talkers, too numerous, in fact, to permit of a full description of all styles. We find that all these talkers can be divided into three general classes as regards the sound producing medium. The simplest form of talker is that in which a telephone receiver of the usual magnetic type is attached to a horn. This type, despite its simplicity, is very satisfactory in operation when a good horn is employed. They will not handle the volume of sound that a power talker is capable of, but for home entertainment, they are entirely practical. Realizing that the phonograph represents in its horn construction the result of much experimental work on acoustics, the manufacturers are furnishing devices to attach a receiver to the phonograph horn.

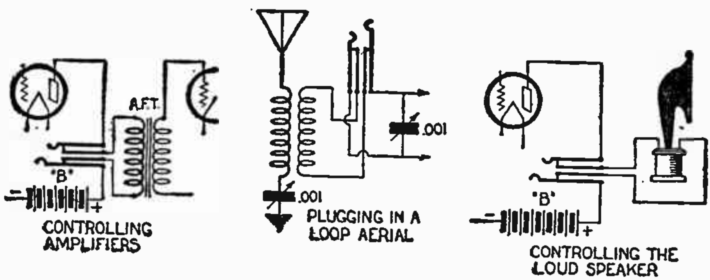



**Fig. 34. Several applications of the double circuit jack.**

The quality and volume of sound will vary somewhat with the receivers used, and this must be taken into consideration. The Baldwin type receiver, with its lever action and mica diaphragm, is not particularly suited to this work because it will not stand the heavier currents and the armature strikes the pole pieces. When the mica diaphragm is replaced with one of metal or heavier mica, the volume is increased and they then perform nicely as loud talkers. Designed particularly for sensitiveness, the Baldwin receiver should not be abused by too heavy currents.

Various arrangements of resonating surfaces are used to obtain clear tones that are really too numerous to cover in detail, and the best method of selecting a talker is to hear it in operation and in comparison with other talkers. It has been found that the best arrangement for a horn is one that does not vibrate and thus interfere with the sound waves. Strange as it may seem, many types of phonographs use a cast iron sound chamber which does not vibrate and permits the enclosed column of vibrating air to act with greatest effect upon the air in the room. The vibration of a horn will be noted in the tinny overtones and side tones emitted. Some types of talkers are built with an arrangement to adjust the sensitiveness of the talker which enables it to work efficiently on both loud and weak signals. This is a very good arrangement, for it is manifestly impossible to build a talker that will stand heavy plate currents and then be sensitive to the weak signals emanating from distant stations.

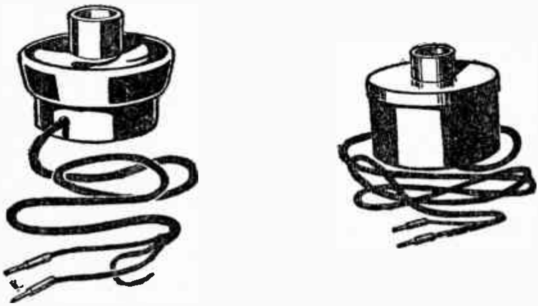


Fig. 35. Loud speaker units adapted to attach to a phonograph.

The power talkers are designed for extreme volume where great carrying power is required and do the work very satisfactorily. They are built on the dynamic principle, that is, the diaphragm instead of being vibrated by a variation in the magnetic pull, is actuated by a coil of wire in a magnetic field that moves in accordance with the principle that drives an electric motor. They consist of a powerful magnet energized from a storage battery. Between the poles of the magnet is arranged a coil of fine wire rigidly attached to the diaphragm.

The coil of wire is connected to the secondary of a step down transformer built in the instrument. The primary of the transformer is connected to the radio set. In operation, the audio currents from the radio set flow in the primary of the transformer and induce a current in the secondary of lower voltage

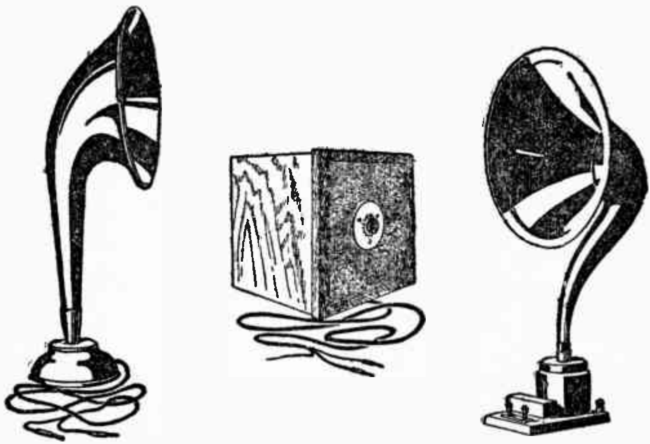
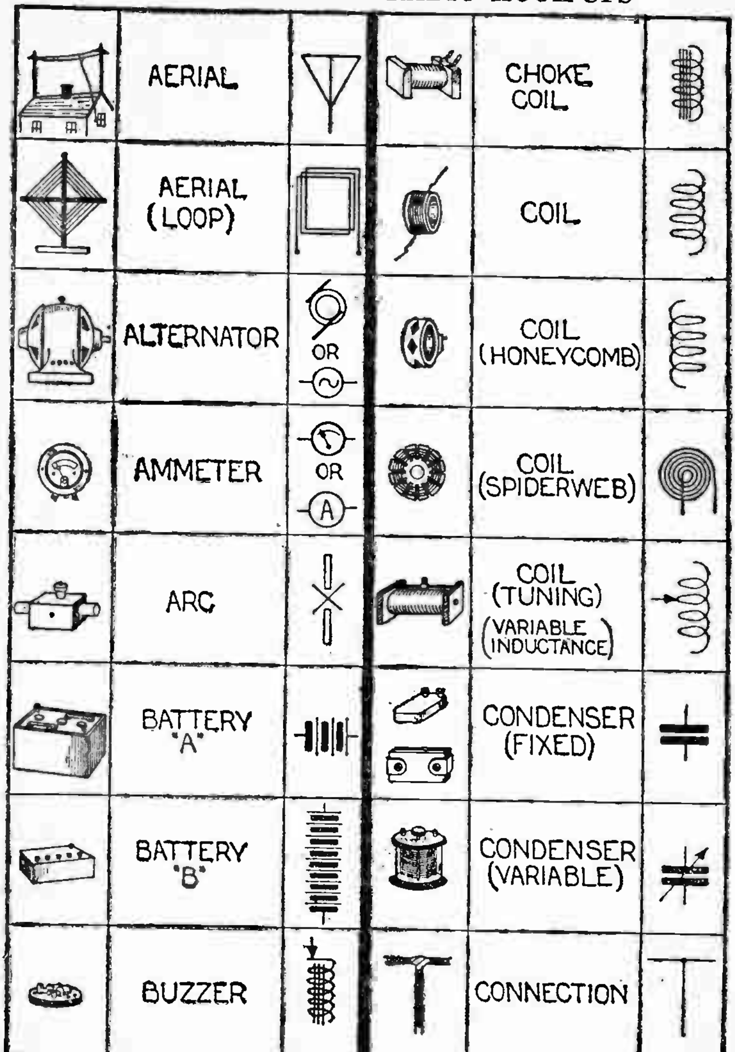


**Fig. 36. Popular types of loud speakers. They are, in order, the receiver unit, adjustable, and power talkers.**

but greater current. This current, flowing through the coil, causes it to move across the magnetic field of the fixed electromagnet and thus move the diaphragm in unison. These talkers are suitable for large auditoriums or outdoor demonstrations, but require at least three tubes for operation, and the manufacturers advise the use of a power amplifier in addition to the regular radio set.

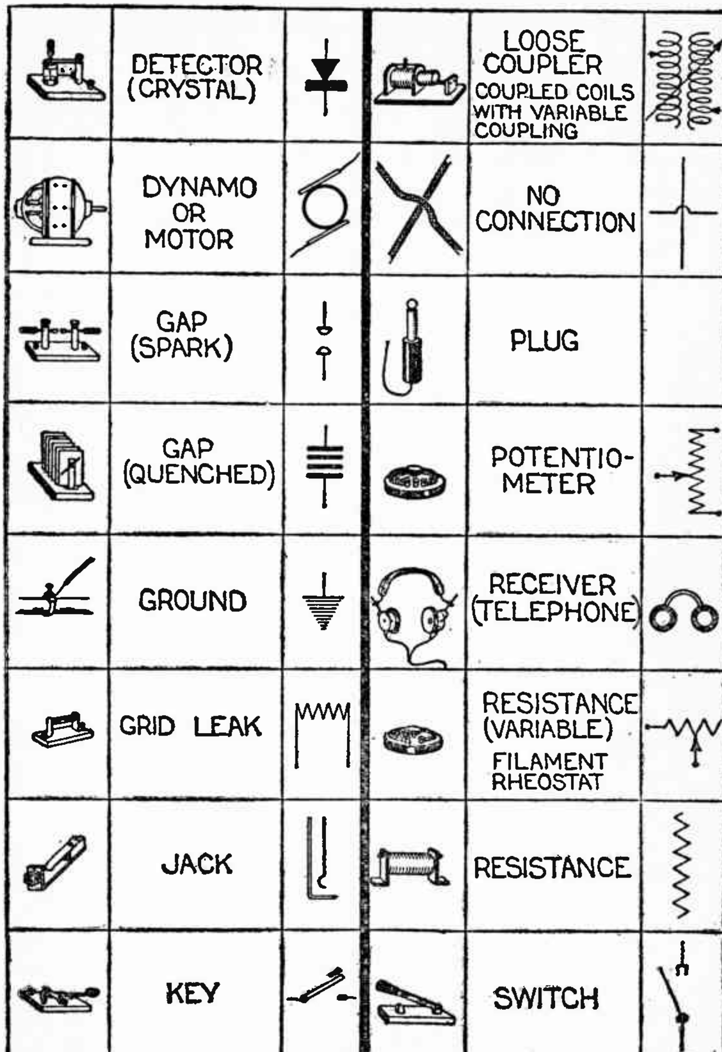
The selection of a loud talker is up to the individual user. Only by a consideration of the conditions under which it is to operate, such as for extreme volume, sensitivity to weaker signals, etc., will aid him in selecting one.

## SYMBOLS USED IN RADIO HOOK-UPS



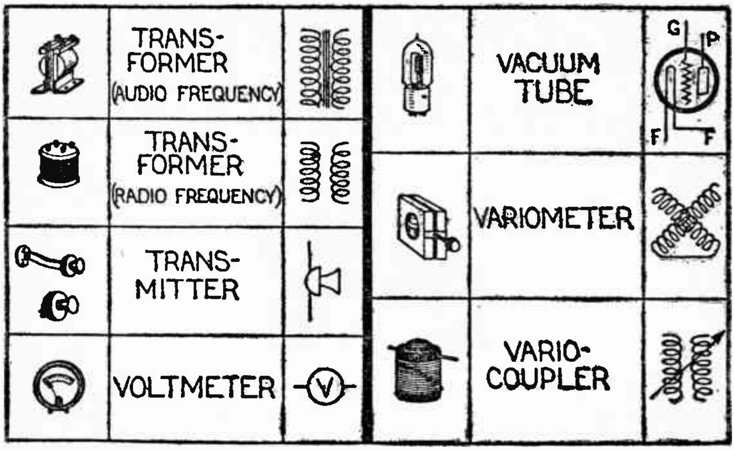

The left shows a picture of the apparatus while the right shows the symbol used in all radio hook-ups.

## SYMBOLS USED IN RADIO HOOK-UPS




The left shows a picture of the apparatus while the right shows the symbol used in all radio hook-ups.

## SYMBOLS USED IN RADIO HOOK-UPS




The left shows a picture of the apparatus while the right shows the symbol used in all radio hook-ups.

"THE RADIO CONSTRUCTOR"

Pattern No. 9

## HOW TO MAKE

# The S. T. 100 Receiver

**A Two-Tube and Crystal Dual Amplifier**


This receiver is of British origin devised by John Scott-Taggart, of London, England, and has been one of the most popular circuits abroad. Many amateurs and professional radio men in the United States have tried and had astonishing results with this set, therefore it warrants high rank among the best receptors of modern times.

The circuit is based on the well known Reflex action which has won so much favor of broadcast listeners, and those who are familiar with this form of radio circuit, will be amazed at the results obtained with the S. T. 100.

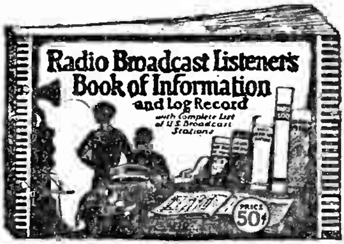
A four-page direction pamphlet and two large blue print pattern sheets are furnished with this packet in an envelope, size 9 x 12 inches, printed in two colors.

*Price* **50c.** *Prepaid*

**THE CONSRAD COMPANY, Inc.**

233 FULTON STREET NEW YORK CITY

# Radio Broadcast Listener's Book of Information
## and Log Record




To the countless thousands of enthusiastic broadcast listeners thirsting for information but lacking in technical knowledge, this book is specially dedicated. It describes in every-day understandable language how to select the set for your particular requirement, how to erect the aerial and install your set, how to operate it and the proper method of upkeep and maintenance of batteries etc.

The four main divisions of this book are as follows:

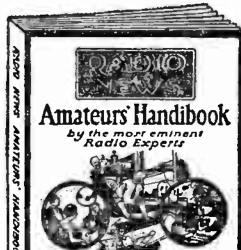
Part A—Information for the Broadcast Listener.
Part B—Radio Broadcast Station of the U. S. by call letters.
Part C—Radio Broadcast Station of the U. S. by States.
Part D—Log of Broadcast Stations and Station Log Chart.

In part B you will find a complete list of Radio Broadcast Stations with name, location, power, wave-length and sending hours of the Station indexed alphabetically according to their call letters. There are several pages of Log sheets for the keeping of records of the broadcast stations heard and also special tuning charts for making curves of the wave-length and dial settings for a set. Contains 2 pages, size 5⅞x9¼ inches, loose-leaf.

***Price* 50c. *Prepaid***

---

# "RADIO NEWS"
## AMATEUR'S HANDIBOOK
### Volume No. 1




Chock full of radio constructive and instructive articles from cover to cover. Written by foremost radio authorities, in plain everyday language which everyone can understand. Sections include articles on Receiving Sets and Sundry Apparatus, Transmitters and Accessories, Radio Theory, Vacuum Tube Data, and Practical Hints for the Amateur. A book which also serves as a ready reference and should find a place in the library of every amateur. It contains 244 pages and over 375 illustrations, diagrams and photographs bound in a multi-colored heavy board. Size 6x9 in.

On sale at all leading radio stores. If your dealer cannot supply you, send a dollar bill and the book will be forwarded to you postpaid.

***Price* $1.00 *Prepaid***

# THE CONSRAD COMPANY, Inc.

**233 FULTON STREET** **NEW YORK CITY**