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RADIO PROGRESS

"Always Abreast of the Times"

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RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 15

Contents for

OCTOBER 15, 1924

RADIO PROGRESS is issued on the 1st and 15th of each month by the Oxford Press at 8 Temple Street, Providence, Rhode Island. John F. O'Hara, Publisher. Yearly subscription in U. S. A., $3.00. Outside U. S. A., $3.50. Single copies, 15 cents. Entered as second-class matter, April 4, 1924, at the Post Office at Providence, R. I., under the Act of March 3, 1879. Address all communications to RADIO PROGRESS, 8 Temple Street (P. O. Box 728), Providence, R. I. Title registered at United States Patent Office.

RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. I, No. 15 | OCTOBER 15, 1924 | 15c PER COPY, $3 PER YEAR

How Capacity Works in a Condenser

Reason Why Every Radio Must Have At Least One

By HORACE V. S. TAYLOR

WHEN you look inside a radio set the thing that first catches your eye will probably be the various coils of wire. The next thing which meets your attention will very likely be the condenser. This is a fairly good sized unit and is rotated by a dial on the outside. Just why does the operation of this rotating condenser bring in New York, and then switch to Chicago, or perhaps San Francisco?

In the first place, let us see what a condenser is. It may be defined as two conductors separated by an insulator. This is a very easy definition and has

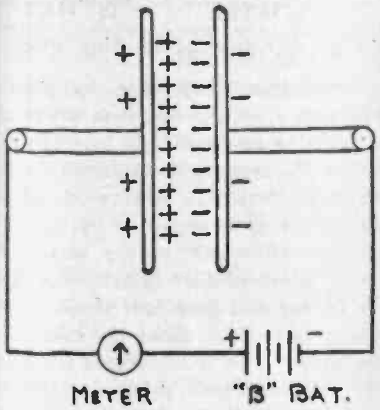


Fig. 1. Condenser Action

one great advantage. It brings into the fold of condensers a good many things which might otherwise escape the attention. For instance, suppose you are troubled with body capacity. That is, when you bring your hand up near the set it makes a squeal. Why is it? The definition just given explains right away that you have brought into play another condenser. The coils inside the set are conductors and your own body is a conductor and the two are separated by an insulator—air—between them. According to our definition this should make up a condenser, and indeed it does. That is why it changes the tuning, as will be described later.

Nature of a Condenser

As an illustration of a simple condenser refer to Fig. 1. This shows two heavy metal plates or disks separated by air as an insulator. According to our definition, they will make up a condenser. The two plates are connected in series with a "B" battery of say 22 volts, with a meter in the circuit, as shown. At the instant when the battery is first connected to the plates, there will be a rush of current which will be shown by the meter needle moving over on the scale. This deflection very rapidly drops back to zero, indicating that the current has stopped. What has happened is this. A positive charge has come from the battery to the left hand plate marked plus, and a negative charge has flowed to the right hand plate, marked minus. Of course, if the terminals or polarity of the battery had been reversed, the charges on the plates would have also been reversed.

The charge itself consists of very small particles or electrons, and these move long the wires with tremendous speed—so fast that it was a long time before their velocity could be measured. These electrons play a very important part in the operation of a vacuum tube, as it is their action which makes the tube work both as a detector and also an amplifier. However, in the theory of the condenser, it is not necessary to worry about the separate little electrons, as they can be grouped together under the the name of a "charge." The positive charge, of course, comes from the positive pole of the battery and the negative from the other pole.

What Makes a Current

When a charge is flowing along a wire it makes a current. The same thing is

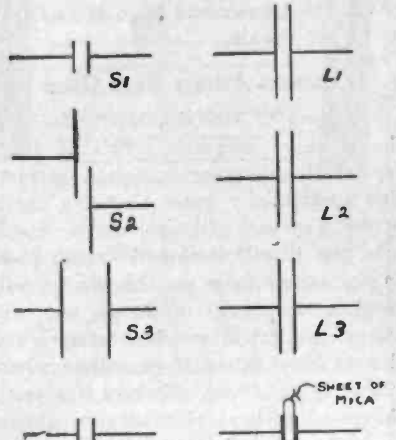


Fig. 2. Determining Capacity

true in water. Instead of calling it a charge of water, we say a quantity of water. When a quantity of water is passing along the river bed it means that a current is flowing in the river. If the river flows into a big lake then the water is stored in that body and even if the river should dry up later, the water would still remain in the lake until it was discharged by flowing over a dam or perhaps until it evaporated.

The same thing holds true with electricity. The quantity of electrons (charge) flowing through the wire makes a current. When it reaches the lake,

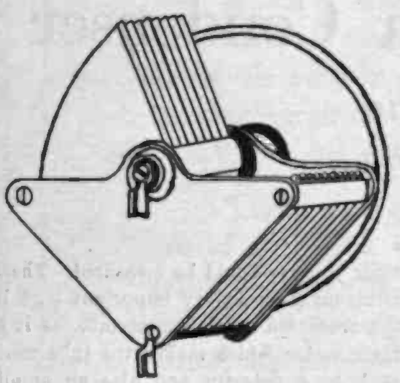


Fig. 3. Variable Condenser

which is represented by the condenser, it becomes stored and even when the current stops at a later time it still stays there until it is discharged through a wire or else "evaporates" by leaking through an insulator. So the fact that the meter first showed that a current was flowing for an instant, and then indicated that the current stopped, does not mean that the condenser is without a charge. It proves that a charge did flow into the condenser and when it was full it stopped running.

Opposites Attract Each Other

The laws of electrical attraction are the same as magnetic. This is, likes repel and unlikes or opposites, attract. You undoubtedly know that the north pole of a magnet will repel another north pole, but it will attract the south pole. In the same way a positive charge will repel another positive charge, but will attract a negative one. Furthermore, the charges exist in equal quantities wherever they are found. If there is a small charge of positive electricity, we know somewhere there is an exactly equal negative quantity to make up for it. For that reason in our diagram it will be observed that the number of plus signs is just balanced by the number of minus signs.

Suppose after we had charged the condenser plates with the "B" battery we disconnect the latter and leave the ends of the wire open. What will happen? Since the meter has showed that no current was flowing before, there will be no change, because with the wire broken, there is no chance for the electrons to move, since they will have nowhere to go. After the battery has been removed the conditions at the plates will be just the same as they were a moment before. Now let us touch the two wires together. Right away the meter needle will show a deflection, but in the opposite direction from the way it moved when the condenser was charged. This indicates that current has again started through the wires, but instead of charging the condenser still more it is discharging it, just as the water going over the dam was going out of the lake instead of into it and so emptied the body of water.

It may be asked where the charge goes. Here is the important principle that the negative and positive electricity is formed in equal quantities in charging the condenser, and on discharge they rush together and exactly neutralize each other. If there had been more of the one kind of charge the part of it would have been left over on the discharge and this extra amount would have distributed itself half on one plate, and half on the other. In such an event most of the charge would have been located on the outside surfaces of the disk, since as we know like repels like and the sections of the quantity of electricity want to get as far apart from each other as possible. When they are of opposite signs, as shown in the figure, they attract each other and that is why you will see most of the plus and minus signs marked on the inside surfaces of the disk, rather than on the outside.

How Much of a Charge ?

There are several factors which determine how much electricity will flow into a condenser. The first of these is size. A quart measure will hold more than a pint, and in the same way a big conductor will hold more than a small one. This is illustrated in Fig. 2. S1 shows two small plates and L1 two large ones, S will then have a small charge and L a large one, and the ratio will be just the same as the ratio of the sizes. That is, if L1 has three times the area of S1, then it will hold just three times as much electricity. It should be noticed here that it is the surfaces opposite each other which count. At S2 we have a part of plates exactly the same size as L2, but they slide edgewise, so that only a small part of one is opposite the other. In that case the area is correspondingly small, and the capacity will be in the same portion. If the active area S2 is only one-third, say what the area of L2 is, then it will contain only one-third the charge no matter how big the plates may be.

The next thing that affects the capacity is the distance between the plates. When you get a good way away from your friend, his voice is much weaker, and

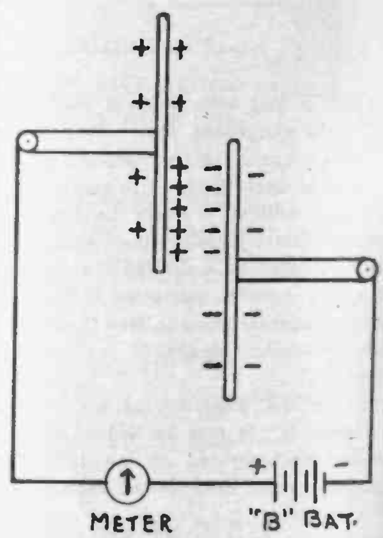


Fig. 4. Effect of Shifting Plates

for the same reason when one plate is separated from another, it is not nearly as effective as when close by. The rule is that the capacity decreases as the distance lengthens. In other words, if one pair of plates is separated by one inch, and the other pair of the same sized plates is spaced four inches apart, then the former will have four times the capacity (take four times the charge) of the latter. This is illustrated as S3 and L3. Although both pairs of plates are the same size, S3 has four times the separation of L3, and so the latter has four times the capacity.

What is Between the Plates?

Another important point to observe is that the material between the plates has a big effect on the capacity of the condenser. In a variable condenser, with rotating plates, such as is shown in Fig. 3, of course the dielectric between them is air. When some other material is substituted, the capacity will vary.

It so happens that a condenser with air has a lower capacity than with any other kinds of insulation. When mica is used instead the value of the condenser is three or four times as great as before. In order to find out how big to build one of these units, we have to take this fact into account and so it is convenient to have a name for it. Some people call it the dielectric constant and others the specific inductive capacity (SIC). Either of these means the same thing; that is, the ratio which condenser would have when insulated with any substance compared with what it would have in air.

To be strictly correct, it should not be compared with air as a standard, but with the value of capacity in a vacuum. However, the difference in capacity when an ordinary air condenser is placed in a vacuum is so very small (less than 1/10 of 1%) that it requires the most refined instruments to detect it. So it is quite proper to refer everything to air insulation for ordinary measurements. The value of SIC for various substances varies somewhat according to how pure they may be. Mica runs between three and five, depending on what kind it is. Paraffine paper is about 2½. This is shown as S4 and L4 in Fig. 2. Although the plates are the same size and have the same spacing, L4 is three times as big as S4. because the sheet of mica lies between them.

Varying the Capacity

We have shown the four different ways of changing a capacity of a condenser. The first and last are hardly practicable for ordinary use. The other two methods are both employed in units now on the market. The scheme shown at S3 and L3 is used in the "Book Condenser" put out by the Crosley Company. They use a pair of plates about three inches square, one of which is stationary and the other one swings back and forth on a hinge. A dial is arranged to operate the swinging cover, just like the cover of a book. When the cover is open the capacity is low as shown in S3. When it is swung up close it increases the capacity like L3. A thin sheet of mica serves to prevent the two leaves from actually touching each other and so short circuiting.

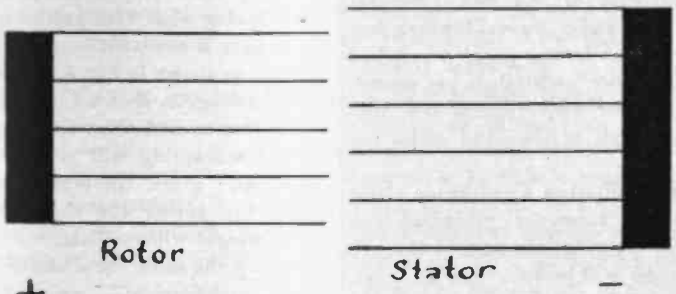


Fig. 5. Plates Like This When Dial Reads Zero

The more usual way of adjusting the capacity is that of S2 and L2. This may be seen more easily from Fig. 4. Comparing this with Fig. 1 observe that the plates are the same size and the same distance apart, but one of them slides edgewise. Now there is not enough room for many plus and minus charges to gather across from each other (opposites attract, you recall) and so of course the capacity has fallen. Fig. 3 shows the ordinary style of rotating condenser. Turning the knob one way makes the plates mesh or dovetail together, while the other direction separates them again. Fig. 5 shows how the plates look in the zero position. Fig. 6 is a view of the two sets when the dial reads 100.

No Zero Capacity

It would naturally be expected when the dial is turned to zero that the capacity would be zero, but this is not the case. This will be made clear from looking at Fig. 5. Although the two sets of plates do not mesh together at all, still the edges of one are close to the other and so the regular condenser action will take place. Besides this the shaft, which is used to turn the plates, will have an effect as it is opposite the stationary or stator plates. That is why the capacity never drops to zero, even when the plates no longer mesh. The ratio between full and lowest values is ordinarily around 10 to 1. Unusually good condenser may have a 20 to 1 ratio, or even higher.

In a condenser of this kind the active number of plates is always one less than the total number. This is because every plate is useful on both sides, except the top and bottom ones. Since these two have nothing opposite them on one side, it follows that they are only 50% efficient as compared with the rest. That is why a 9-plate condenser with 8 active plates will have just twice the capacity of a 5 plate of which 4 are active.

How Much Will Condenser Hold?

Since a condenser is used to store up electricity it seems as if it ought to be an ideal instrument to take with us on an automobile trip so we could have electric lights burning out in the country, but unfortunately the amount which an ordinary size will store is so small that it does not do much of any good. In this respect it is something like compressed air. You have probably seen the tanks about four feet high and about a foot in diameter, which are used to store compressed gasses, like oxygen which is used in welding and brazing. If power is wanted out on the road why not compress a lot of air into such a tank and then use it to drive an engine?

The reason this is not done is because the tank holds such a very small amount of stored energy, even though the pressure runs up to 2000 pounds (one ton) on every square inch. It would take a tank as big as a house to contain enough energy to be worth while. When you see compressed air hammers working in a quarry in chiseling out building stone you will always find that they are connected by a pipe line to an air pump driven by a motor or engine. Again the reason is that a compressed air tank right at the job would run the air hammer for only a few minutes, and then another tank would be needed.

Fig. 6. When Dial Reads 100

The same thing unfortuantely is true of a condenser. An ordinary size will hold such a small amount of electricity that it is of no value for doing any kind of real work. The use of these units is confined to places where they are needed to control something, or to help out the action of another device. Such use applies in radio, in protecting the contacts

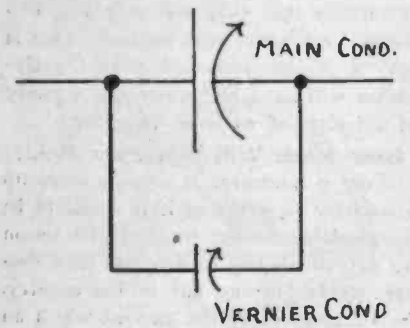


Fig. 7. How Vernier Works

in the ignition system of an automobile, in telephones, metering instruments and the like. When real power is needed a storage battery has to be used.

Current Through a Condenser

When the current through a condenser is talked about what is meant is always alternating current (A. C.) Direct current will not flow through a condenser at all. The reason is that the two condensers are separated by an insulator and so once the plates are charged full, no more electricity can crowd on and the current stops. In alternating current, on the other hand, as soon as the condenser is full, the direction of flow reverses, and the condenser discharges again and charges up in the opposite direction. When it is full that way it reverses back as at first and again the plates are discharged and then charged. This constant change back and forth occurs once every cycle, or alternation of the A. C.

The amount of charge (number of electrons) which a condenser takes depends on two things. The first of these is the capacity as determined by the size of plates, spacing, etc. And the second is the voltage. It is like the compressed air tank again. The amount of air depends on the size of the tank and second on the pressure or pounds per square inch with which the air is forced into it. A big tank will hold a lot more air than a small one, and if we pump in the air at 300 pounds pressure we shall get in twice as much as if we used 150 pounds. So in the condenser. In Fig. 1 is a 22-volt "B" battery. If this pressure is doubled, then the plates will take twice as big a charge.

On alternating current the charge on each wave or alternation depends, as just explained only on the size of the condenser and the volts pressure. But the plates are filled and emptied, then filled in the reversed direction once for each cycle. So if the oscillations are fast we get more current than when they are slow. That is the explanation of the fact that in the radio set a condenser with a capacity of .001 mfd. (microfarad) will let radio waves through but not audio. The former go at a speed of about one million oscillations per second, while the latter vary from a few hundred to a couple of thousand cycles per second.

Since the radio has a frequency about one thousand times as great as the audio, it follows that the current through the condenser will be 1000 times as great. This size is big enough to pass all the radio current which is flowing. But when you divide the current by 1000 roughly you get only 1/10 of 1% as much radio frequency through and this is so small that most articles say that no audio will pass a .001 condenser.

The Vernier Condenser

Many people talk about a vernier condenser as if it were some other kind of breed. It is just like any other, except that it is smaller and so easier to control. It is always connected in parallel with the main condenser, as shown in Fig. 7. Of course, it may not be a separate unit, but will perhaps consist of one extra plate, which is mounted on the same frame as the main plates. In using such a unit do not think that more stations can be picked up than with the plain one. The only difference is that it is easier to get a certain value of capacity when turning only one plate, than it is to hit the same value when turning eleven or twenty-three plates. But once you have got the right value it is the same in either case.

Instead of a separate plate to be turned some vernier condensers use a method of gearing or levers to get a small change of capacity with a big movement of the dial. These are just as good as the first style, if they are well built. The danger in such construction is that there will be some backlash or loss motion in the gears. The better class of instruments have this provide for by some sort of spring or adjustment.

Varying the Wave Lengths

After we have got the condenser adjusted to the capacity which we want, just how does it work to change the wave length of the radio set? It must be remembered that the wave length and the frequency or speed of vibration really means about the same thing. That is, a high speed of vibration corresponds to a short wave length, and a low speed to a long one. The condenser acts just like a spring when attached to a weight. If we have a combination of spring and weights, as shown in Fig. 8, then a spring one inch long, as shown at the left, will give a fast up and down vibration, while a two inch spring will slow the speed down quite a bit. In other words, the bigger the spring the slower the one pound weight will oscillate.

Exactly the same thing holds in regard to the condenser. The weight is like a coil and when a big condenser (spring) is used, the vibration will be slow and the wave length long. By turning the dial toward the zero and so reducing the capacity, we reduce the length of the spring which gives a faster vibration and a shorter wave length.

Picking Out the Stations

When you want to hear a certain broadcaster you turn the dial of your condenser, until you pick up the particular wave from his aerial. What you have actually done is to adjust the capacity to the right size, so that it and the coil will vibrate at exactly the same speed as that of the sending station. When you get tired of this station and wish to pick out one with a longer wave

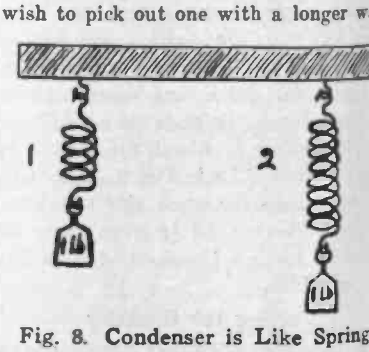


Fig. 8. Condenser is Like Spring

length (slower vibration) it is necessary to turn the condenser to a larger capacity, which is the equivalent of a longer spring, and this slows down the oscillations to the new speed.

Radio Waves Through Sky and Ground

By ALFRED N. GOLDSMITH, B. S., Ph.D., Fellow, I. R. E.,
Director of Research, Radio Corporation of America

VERY peculiar things sometimes happen in the receiving of broadcast radio concerts. Every listener, as soon as he gets acquainted with a number of nearby and distant stations, finds that he is puzzled by some of the results he gets. How can he explain such things as these:

1. Late at night he can hear stations hundreds of miles away clearly, while earlier in the evening, or by day, he can hardly pick up fifty miles.

2. He will hear some stations at night very steadily, and particularly the distant ones, but some other nearer stations will "fade" in and out rapidly and in irregular fashion.

3. Still nearer stations, say twenty-five miles away, will not fade in or out at night or by day.

4. In one part of a city, local station No. 1 will be heard loudly and local station No. 2 hardly at all. In another part of the same town, the reverse will be the case. Outside the city both stations will be about equally loud.

5. A listener in the country will sometimes hear stations hundreds of miles away much better than he will hear stations in a nearby city say fifty miles away.

Explaining These Facts

Radio engineers have developed a theory to explain these effects. It can be simply expressed, but it should be remembered that it is not yet positively proved. However, it is a very plausible and satisfying explanation of all the puzzling effects just mentioned. It is based on a theory of Sir Oliver Heaviside, the famous English electrician and scientist. Heaviside pointed out that, twenty-five or fifty miles up, the air surrounding the earth becomes very rare or thin, and is therefore an electrical conductor, just as it is in the rarified "violet ray" tubes sold for medical purposes. So, far up in the sky, there is a layer of conducting air which scientists have called the Heaviside layer. It is also well-known that substances which conduct electricity, such as metals, are good reflectors for radio waves, so that this layer is actually a sort of curved reflector in the sky. It is therefore called the "mirror layer" in this description, for the sake of simplicity.

By day, the mirror layer is spoiled in several ways. In the first place, the brilliant sunlight falling on it causes disturbing air currents and eddies, so that instead of being a smooth and polished mirror, it becomes a roughened irregular layer of little use as a reflector. Furthermore, sunlight converts rarefied air into a sort of "fog" (ionization) which, while clear and transparent to ordinary light, absorbs radio waves vigorously, so that by day, the mirror layer is rough and mist-covered.

Waves Take Either Route

Probably most listeners have never wondered as to whether the radio waves which reach their receiving aerial come sweeping along the ground or whether they are shot down to the aerial wires after reflection from a mirror layer in the sky. Yet actually radio waves arrive by either or both of these unlike routes.

In the illustrations of this article, Fig. 1 is a general sketch of a sky wave. It leaves the radio transmitting station at the left, passes up on a slant, until it strikes the mirror layer far up in the air, and is then reflected back again to the earth, arriving finally at the receiving station to the right. It may be mentioned that these sky waves do not die down very rapidly because their path is entirely through the air and they are but little absorbed or interfered with in their message. So we shoulld expect sky waves to carry radio messages loudly over great distances, particularly at night when the mirror layer is smoothest and most effective, and when the absorption of the radio waves by the "electrical fog" caused by sunlight is absent.

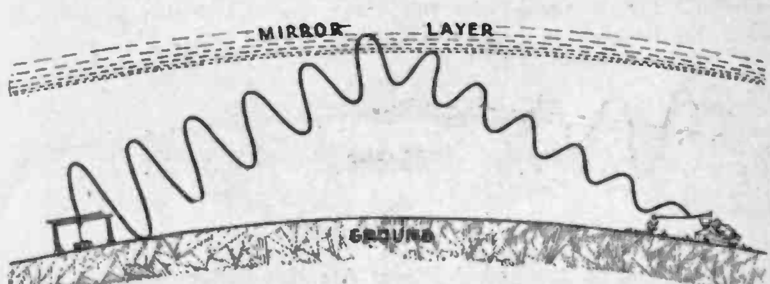


Fig. 1. Heaviside Layer is Like Mirror

Ground Wave Dying Rapidly

Fig. 2 shows the sort of wave which may reach a receiving station. It is a ground wave, and clings closely to the earth. Naturally such a ground wave meets all sorts of energy-absorbing obstacles in its path, which rapidly reduce its power and the loudness of the signals it can produce in the receiver. Such bad obstructions are steel-frame buildings, mountains (particularly those containing metal deposits), and to a less extent forests of large trees. The result is that a ground wave rapidly dies away, and this has been indicated in the diagram.

To take typical figures, which are roughly correct for the average sending station in the eastern part of the United States, the ground waves are very strong near the transmitting station for the first few miles, but rapidly die down, becoming quite weak at a distances of a hundred miles or so. The sky waves, on the other hand, are hardly received at all near the transmitting station, since their path is above the earth until after they have been reflected back to the ground. They come down to the earth and begin to be useful at distances of about seventy-five miles from the transmitting station, and beyond that point they are rapidly received with good intensity for distances of several hundred miles. It amounts to this, to summarize: For distances up to about seventy-five miles, the listener depends almost entirely on the ground waves for his signal. From seventy-five to two hundred miles, he gets both ground and sky waves. Beyond two hundred miles, most of his reception comes from the sky waves.

As the Mirror Moves

For locations where both sky and ground waves are received, operation may be very erratic with marked "fading effects." Fig. 3, shows why this happens. The two sets of waves, arriving at the receiving station by different paths, may help each other or may actually cancel each other. Furthermore, as the mirror layer shifts slightly from moment to moment, the ground waves may sometimes strengthen and sometimes weaken the sky waves, and thus cause fading. We can therefore explain the five puzzling effects at the beginning of the article as follows:

1. Night reception over long distances is accomplished by the slightly absorbed sky waves, and these cannot exist by day because of the absence of a smooth mirror layer and the disturbing presence of sunlight "fog." So that day reception is by ground waves, which do not reach out powerfully nearly as far as the sky waves. This partly explains the superiority of night reception.

2. Evening signals from very distant stations come by means of the sky waves only, and are therefore comparatively steady. Night reception from stations roughly from seventy-five to two hundred miles away is by a combination of both kinds of waves, and therefore fades in and out as these two sorts of oscillations interfere with each other.

3. Signals from stations nearer than seventy-five miles are chiefly by ground waves only, and are therefore reasonably steady.

4. Reception in a city from nearby stations is entirely by ground waves, which are very largely absorbed by the steel structures of the town. A mile or two of city buildings will so weaken the signals from a local station, as received by a city listener, that reception may become very poor. As a result, in those parts of the town where the signals first have to plough through miles of steel to reach the listener, the reception from such a station will be poor. In other parts of the city the reception may be excellent. Far outside the town reception will be by the sky waves, and so about equally good from all stations within the city if they have the same sending power.

Fig. 2. Ground Waves Are Not Reflected

5. A listener in the country will get signals from the city fifty miles away almost entirely on weak ground waves, but will get distant signals on the powerful sky waves. Thus the distant signals are sometimes astonishingly loud in comparison with the nearby signals.

It adds another chapter to the romance of radio to know that the concerts from distant stations have travelled up to the sky on their way to the broadcast listeners, and that an enormous mirror in the upper layers of the earth's atmosphere is chiefly responsible for the enjoyment of far away concerts. On the other hand, a great deal of trouble is caused by ground waves from neighbors' squealing sets. How can it be avoided?

The Golden Rule in Radio

No good satisfactory substitute for the Golden Rule has yet been discovered as a guide to human conduct and as a pathway to happiness. Consideration for the rights of others and "a decent respect for the opinions of mankind" are the only known lubricants which keep the wheels of life spinning smoothly. It is also a fact that in few fields is it more necessary to obey the Golden Rule than in radio. The reason is not hard to find. As long as people live isolated lives and do not come in contact, they do not have to worry about the rights of others. But when they live in congested areas in large cities and are bound to jostle each other on every corner, tolerance and consideration are urgently required.

In the early days of radio, when messages were few and far between, and receiving sets located at long intervals, the problems of mutual interference were not serious. But to-day the ether carries the hurrying traffic of five continents through the long wave (10,000 meter) stations; it carries the urgent messages of the nations to thousands of ships on the high seas through the shorter wave (600 meter) marine stations; it carries the multitude of personal and experimental messages of the short wave (200 meter) amateur stations; and last but not least it must carry the hundreds of entertainment programs nightly transmitted from the elaborate stations which serve the millions of broadcast listeners. The receiving stations are correspondingly increased in number and in nearness to each other. A trip through city or country will show rows of dwellings on the roof of each of which will be one or more aerial wires for collecting the energy of the radio waves. It is inevitable that some interference should result under such conditions, particularly if the field of sending stations were unorganized and the locating and handling of receivers were done without any system, and without due regard for others.

Using Your Neighbor's Air

Radio shares with all other entertainment devices, the necessity for thoughtfulness. It is neither wise nor decent to permit a phonograph to shout through open windows with full intensity under some conditions. The reason is that the air belongs to all, and the sound from phonographs occupies not only the user's air, but the neighbor's air as well. Similarly, the ether is occupied by all transmitting stations, and its successful use by all receiving stations is possible only under certain conditions.

The application of the Golden Rule to transmission has already been carried out in large part by the Department of Commerce acting on the recommendations of the First and Second National Radio Conferences held at Washington. Basically, the organization of transmitting stations as follows:

Organizing the Senders

1. All transmitting stations are classified as to the type of service they expect to render the pubilc.

2. Every sending station of a given class is granted a specific frequency or wave length on which to operate, as nearly exclusively as possible for certain hours.

3. Every broadcaster must divide time on its frequency or wave length with other equally good stations in its vicinity; the arrangement is made by the stations themselves with the advice and approval of the local Supervisor of Radio of the Department of Commerce.

4. The wave lengths assigned are such as to reduce as much as possible all interference between broadcast stations and to allow all listeners to get the greatest number of programs in an evening by tuning.

5. Amateur stations, which are usually located in residential districts near the radio listeners, are not allowed to send code during those hours of the evening when the best broadcast programs are being sent to the largest number of listeners. This is an obvious application of the principle of "the greatest good to the greatest number."

Order Among Receivers

These measures have been a great step forward. The full value of them is now beginning to be appreciated by the fans when they contrast the present orderly conditions with the confusion which used to exist before the new regulations were put into effect. The receiving field is now clearly in line for organization, and here the co-operation and understanding of the broadcast listeners is very urgently needed.

Here are some suggested rules and the reasons which, it is believed, would go far toward increasing the pleasure of broadcast listeners.

1. Keep your antenna or aerial wires as far as possible from your neighbors. If you must cross his antenna with your own, do so at right angles. Avoid long runs of your aerial parallel to his own and near it. Do not use a longer wire than necessary. Do not use the same ground connection that he does.

By observing this rule you will not sometimes rob him of part of his signal strength nor will he do the same to you. Furthermore he will not throw your set out of tune when he happenes to tune in to the same station to which you are listening. Your reception and his will become more independent and reliable as a result of separated antennas.

Do Not Oscillate

2. If you use a single-circuit or two-circuit regenerative receiver avoid excessive "feedback coupling" (otherwise known as "tickler" or "regeneration" or "intensity control"). Try to pick up stations without having the set oscillating; that is, without swinging the tickler knob around so far that you hear the squealing "birdie" sound every time you pass through a station setting. If you find that you have made the set oscillate in picking up a signal, instantly throw the tickler handle back when you locate the station and bring it up again very cautiously until you get a satisfactory signal. Be satisfied with a little less loudness at times rather than producing a howl or squeak by bringing the tickler up too far.

The reason for this method is that, every time you produce a squealing note in your own set by excessive regeneration while tuning, your receiver has actually become a feeble transmitter and is producing the same sort of disturbance in your neighbor's radio. He may be all tuned in, enjoying the concert, and your thoughtless squeals will be a real annoyance to him. A minute later he would be justified in treating you to the same sort of careless handling of his set. In other words, whatever you are doing to produce such unpleasant sounds in your own receiver you are doing to your neighbor as well. It is better by far to avoid this yourself, and to explain to your neighbor in a friendly way why he should do the same, showing him how if he does not know how to handle a radio set. Skilled amateurs can do a great deal for radio if they will carry this message to the broadcast listeners in their vicinity and show them how to work receiving sets in considerate fashion.

Separate the Coils

3. If you have a two-circuit regenerative set, work with the coupling between antenna circuit (primary) secondary circuit as loose as possible so that if the set should by accident get into the oscillating condition through too much tickler coupling, you will radiate as little interference as possible.

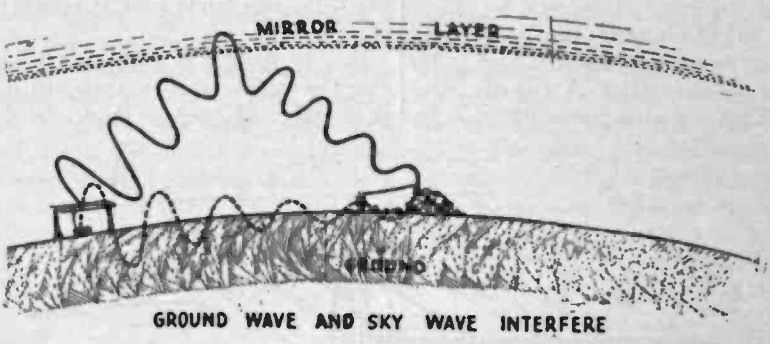


Fig. 3. Two Waves May Help or Hinder

4. Keep a little table of settings (a log) for stations which you have heard and enjoyed. That is, have a chart of the various scales of your receiver and mark carefully on it the positions of the various stations so that you can readily pick them up by setting everything as indicated on the chart.

If You Read Code

It is also desirable for all those who can read the Continental telegraph code to keep a record of all interfering code messages which bother them during the broadcasting hours, particularly noticing the call letter of the sending station and the station to which the message is addressed, and the general nature of the message (commercial, personal, official, etc.,)

Moon Modifies Radio Wave Length

Queer Case of Lunar Influence On the Sending Station

IT seems a far cry from radio to the moon and few people would admit that the latter could have any effect on sending. But as is well known, the moon is the cause of the tides in the ocean, and a case has been recently recorded by the American Radio Relay League where the tide *did* bother a sending station.

In the town of Wiscasett, Maine, a sending station was built to communicate with Capt. Donald MacMillan, the Arctic explorer. This was his home town and of course the people were very anxious to get in touch with him on his return voyage, which he recently completed. A first class transmitter was installed and the radiation seemed to be very powerful, but on preliminary trials various amateurs in the Eastern part of the U. S. complained that they could not keep in tune with the station without continually shifting their dials. There seemed to be a slow change in the wave length on which Wiscassett was sending.

When the sending set was tuned to a wavelength of 165 meters, there would be a variation of eight meters in a few hours; when it was tuned to the short wave of 80, a change of about three meters would occur in about the same length of time. This phenomenon continued in spite of all efforts to keep the oscillator sharply tuned, and amateurs, with whom the station was in communication persistently asked why the sending wave was being changed.

Locating the Cause

The adjustments of the station were gone over very carfully several times and a wavemeter was employed frequently to check the oscillations. Finally it occurred to Traffic Manager Schnell that, since the antenna and counterpoise had been suspended from the dock over the water, the tide might have something to do with it.

Then he decided to take his readings with the wavemeter at the ebb and flow of the tide and compare them. He discovered that in every case the wave length increased with the rise of the tide and decreased with the fall. So in order to keep the transmitter at a constant wave, he had to make regular adjustments to correspond as far as possible with the tide's movements.

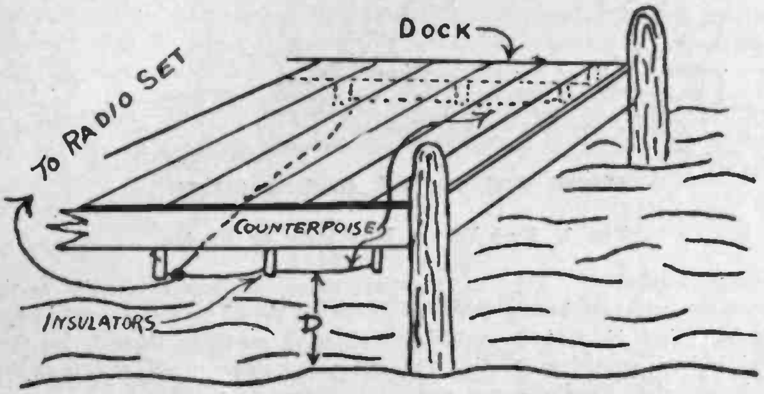


Fig. 1. Counterpoise and Ocean Condenser

Ocean a Variable Condenser

The reason for this change can be seen from referring to Fig. 1. The counterpoise consisted of a series of wires, which were fastened on insulators to the underside of the dock. Of course, underneath these flowed the ocean as the dock extended quite a distance out. As is well-known, water is a good conductor of electricity, particularly salt water. Indeed it is the moisture in the soil which acts as the conductor in an ordinary ground connection. That it why directions always say that the grounding pipe must be in contact with *moist* earth. So of course, the ocean formed a very good path for the radio waves after they left the transmitting set.

As a matter of fact, the counterpoise wires and the surface of the ocean formed a first class condenser, with the air between them acting as dielectric. Of course, when the tide came in the distance between the two plates (wires and water surface) became considerably less, whereas, on ebbing tide, this distance kept increasing. The formula for a condenser contains the factor of the distance between the plates and the capacity varies inversely as this space. In other words, by cutting the distance between the plates in two we get twice the capacity, while if we divide it by three and reduced the distance between counterpoise and water to a third what it was at low tide, so it follows that the value of the condenser increases three times by the change.

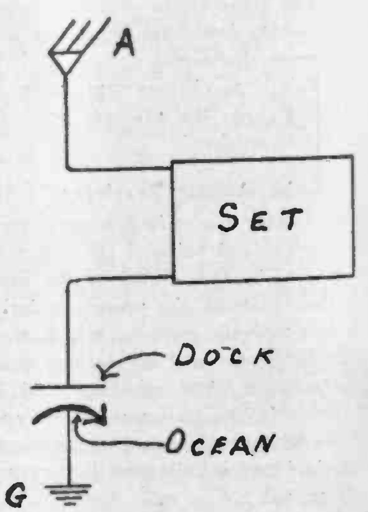


Fig. 2. Tides Change Waves

Continued on Page 18

Current in a Radiola Superheterodyne

Puzzling Paths of Various Circuits are Shown Simplified

By VANCE

THOSE of us who work the Radiola Superheterodyne are naturally pleased with the performance of this set. But when we come to try to understand it, that is a different matter. So far the Radio Corporation has not published the complete wiring diagrams. The reason they give is that so much depends upon the laboratory adjustments of the various parts of this set that it is really impossible for any one not having an experimental laboratory to put such a piece of apparatus together for himself and have it work properly.

However, it is often asked what the basic principle of the set is, and what the various tubes do. A short description of the current paths will be given and also some notes on the use of this particular set.

Waves Start from Loop

Referring to Fig. 1, we see a skeleton diagram of the path of the radio waves. These waves are gathered by the loop which is at the extreme left when facing the set from the rear. Of course, the frequency of the vibrations is from 600 kilocycles (600,000 vibrations per second) up to 1300 kc., depending on what stations is doing the broadcasting. These waves are impressed on the grid of tube No. 1, a radio frequency amplifier, which increases their energy about five-fold, and feeds them to the grid of tube 2.

This second bulb is the detector and oscillator combined. The oscillator action is caused by the same apparatus which is used in an ordinary regenerative set; that is, a variocoupler which will cause squeals when the tickler is turned up too high. When your neighbor's regenerative set squeals and you find the concert you are listening to is spoiled, you are apt to form a rather poor opinion of too much regeneration. But in this case it is not too much; it is just what is wanted, and tube 2 causes a squeal between the output of its own tickler coil and the wave coming in through tube 1. The difference between your neighbor's squeal and that of tube 2 is that, whereas the former changes its pitch or tone, depending on how he twirls his dials, in the latter case the pitch depends on the music coming in, and it is the constant variation in pitch which becomes the music which you eventually hear in your loud speaker. To put it another way, the broadcasting waves control the squeal in such away that the squeal itself becomes music. The output from tube 2 is at a wave length of 7,500 meters. It is fed back again to tube 1, or reflexed, as it is called, where it is amplified at this intermediate wave length.

The Intermediate Amplifiers

The intermediate tubes are those which pick up the music from tube 2 and carry it through to the detector. There are two of these, tube 1, which as already explained, is reflexed, (that is, carries the incoming frequency from the loop and also the reduced frequency from the oscillator tube) and tube 3, which is connected to 1, through an intermediate frequency transformer. The frequency mentioned is 40,000 oscillations per second, which corresponds to 7,500 meters,—the wave length put out by detector 2.

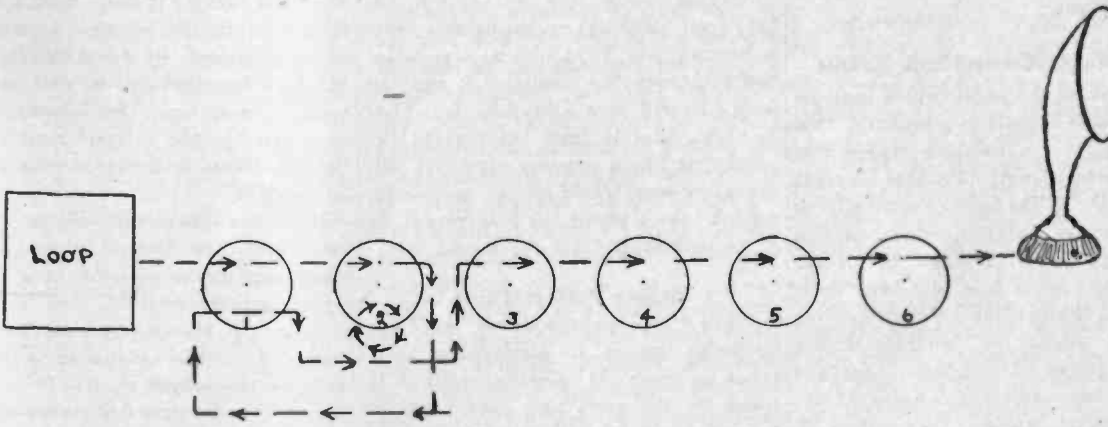


Fig. 1. Tracing Signal from Loop to Loud Speaker

Tube 3 is connected to 4 by a second intermediate frequency transformer. The detector, tube 4, is just like the detector tube of any ordinary circuit in construction, and works in the same way. It drops the speed of vibration from 40,000 down to a few hundred, depending on the note that is being sounded. These audio waves are passed to tubes 5 and 6 by audio transformers in the usual way. These last two tubes act as two steps of an audio frequency amplifier.

Why 40,000 Vibrations

Some people ask why the middle tubes work at the particular frequency of 40,000. This is because the rest of the circuit is tuned to exactly this frequency. There is a big difference in the transformers used in this position and those used in radio or audio steps. The latter class are not tuned for any particular wave length and so will work over a broad range of speeds. But the case with the middle transformers is quite different. These are cut quite sharply to the speed mentioned, and for that reason, do not respond to any other. Of course, the detector and oscillator tube is getting all sorts of wave lengths from all the stations which may be on the air at the time. All these different frequencies are reduced to much lower speeds by the action of the oscillator and detector. These new speeds, of course, are fed in a bunch to the rest of the apparatus, but the two tuned transformers, connecting tubes 3 and 4, are adjusted to accept only the wave which vibrates at 40,000 oscillations per second, and all other pulsations are not transmitted. This, in a large measure, accounts for the sharp tuning of the superhetrodyne.

The Volume Control and Handle

The knob on the panel, which controls the volume, is sometimes a mystery. This handle operates a rheostat, which acts like a vernier controlling the current through tube 3. The battery setting knob is an ordinary rheostat, which adjusts the voltage to the filament of all six tubes. Tube 3, as has just been mentioned, has the additional vernier control merely to adjust the loudness of the music. Instead of "loudness," perhaps we should say softness, because when the volume control handle is way around to the right as far as it will go, it merely allows the third tube to take the same voltage as the others have. This will not be too high, provided, of course, the battery control knob has been set to give proper pressure on the tubes.

It might be asked why the volume of tone could not be adjusted by working the main filament, rather than the vernier on tube 3. Of course, it can be worked in this way, but the disadvantage is that the oscillator and the two detectors cause an undue amount of distortion if they do not have their normal pressure on the filaments. On the other hand, the intermediate amplifier, tube No. 3, will operate without serious distortion, even at a reduced voltage. Since this tube is directly in the line of travel of the waves, it is quite evident that if we cut the loudness down to half as it goes through this stage, then the output from the last tube will be decreased to the same extent. This makes a very simple and satisfactory way of reducing the loudness of nearby stations.

No Radiation from Set

A good many home-made supers are known to be bad offenders in the way of mussing up the ether by radiating. Such a set will destroy the enjoyment of the neighbors for a distance of several blocks in all directions. This set, however, does not cause any such trouble. One of the reasons why the set does not radiate is found in the fact that it is used with a loop, and even if oscillations were supplied to this loop by the oscillator, the amount of energy which went out on the air would be very, very small. This is because a loop, as is well known, makes a very poor sending aerial, indeed.

Another reason why you do not disturb your neighbors operating this radio is because tube No. 1 acts as a so-called buffer between the oscillator 2 and the loop. It will pass vibrations from left to right, that is from the grid to the plate, but like a one-way street, it will not allow any traffic in the reverse direction. As a result the loop gets little or no oscillation from the second tube.

Picking Perfect Tubes

While the manufacturers are undoubtedly trying to standardize their tubes as much as possible, still it is found by the users that each breed of tubes varies a lot individually. The radiola super uses the UV-199 and this runs as nearly uniform as any of the other styles. Unfortunately, however, we find that different bulbs will vary somewhat, some being unusually good, and occasionally one is found which will not oscillate. Such a one is hopeless in position 2, the oscillator. The most important tubes in this set are the first three. It is well to try out various different units in these three sockets. If you have any extra tubes, or can borrow one or two from a test, then put the borrowed ones in 4, 5, and 6, and try the different specimens in the first three sockets. It is well to change one tube at a time until a good one is found for that particular location. Of course, if you are fortunate enough to get a lot which are all good, then it will make little or no difference which is which.

Life of Batteries

If the set is used around fifteen or twenty hours a week, then a set of six dry cells will ordinarily last a couple of months. This is assuming that the normal voltage pressure of three volts is applied to the filament. If the large loop, No. AG-814, is used instead of the small one, which comes in the set, then it is possible, particularly on nearby stations, to reduce the pressure on the filament to 2½ volts without getting serious distortion. By doing this the current taken by the tubes is cut down quite a bit, and this prolongs the life of the batteries in the same proportion. It naturally increases the life of the tubes at the same time. For this reason it is just as well when listening to a single station for a considerable period of time to experiment with the battery setting knob and turning it down until a change is noticed in the loudness or clearness of the program. By doing this the benefits just described can be obtained. In such a case, turn the volume control away over to the extreme right to give the maximum loudness for the station in question.

If on the other hand, the set is operated with the idea of picking up as many stations as possible, or a distant signal is being received, then it is best to have the filament run at rated voltage and control adjustments can be made by the volume control knob. This in no way damages the tubes or batteries, since this is the method of use for which the set was designed, but of course the added length of life, which was mentioned above, will not be expected.

SPELLS STATIC WITH X

A five-year-old boy, while listening with his father, to a radio concert experienced much annoyance from crackling sounds caused by disturbances in the atmosphere. He stood it as long as he could; then remarked, with disgust, "That music is too ecstatic for me. I'm going to bed—good night, Daddy!"

"With A Grain of Salt"

How to Catch the Liar, But Not Get Caught Yourself

By HARRY A. NICKERSON

THIS is a plea to the radio reader to stop swallowing whole all he reads and put it to the acid test of trial or at least of thought.

Those old at the radio game generally find considerable amusement in reading radio magazines and especially newspapers. The publishers, of course, have to cater to the popular demand. Unlike the Chinese, we in America have little reverence for the ways of our ancestors; so in radio, one has only to describe the new "Umptydne" and the flock of purchasers starts for the radio store. Experience is a good teacher, though most people find it an expensive one.

There is, ineed, a certain danger in accepting as Gospel all one reads. Many

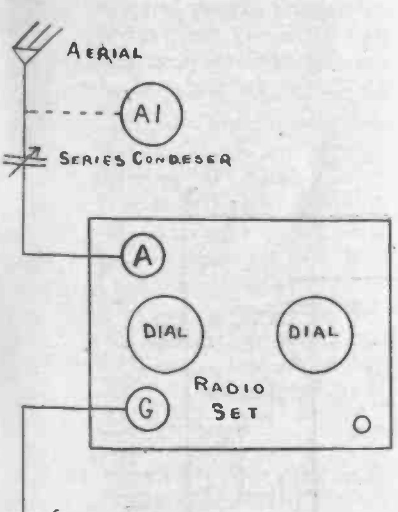


Fig. 1. Condenser in Aerial

fans read a particular newspaper radio column and pretty soon unconsciously have adopted the pet ideas and theories of the radio editor. It is then with a shock that some other person is found with radically different ideas. It is pretty generally advised that the tuning condenser of the so-called standard single circuit be inserted in the antenna lead; how many of our readers have tried it that way as compared to inserting it in the ground lead? Which gives less hand capacity and better tuning control? Figures 1 and 2 show how this change can be made. In the first case the condenser is in series with the aerial. Terminal A1 can be short circuited to A in case it is desired to cut out the condenser and use an untuned primary. Fig. 2 illustrates the same thing, except the condenser is now in the ground lead. In either case there is quite a difference in body capacity effect. Try this out and see which you like better.

Set No Better Than Its Aerial

It is the writer's opinion that we have too many trick circuits, but too few sets that operate at maximum efficiency. We are told that regeneration has the effect of lowering the apparent resistance of the grid circuit: but does the reader know that if there is a loss through resistance in the antenna or ground, then the regenerative action does not make up this loss? Many a good set fails to give good results because of faulty installation of antenna or due to a high resistance ground.

The only method of making a ground which is recommended by the fire underwriters, is to connect to a cold water pipe just where the water supply line comes from the street into your cellar. This is almost invariably the place where the water meter is located. For that reason you will find the ordinary rule to locate the ground at the water meter, not because the meter inself has any effect on the radio waves, but merely for the reason that it happens to be in the best place. You will almost always find that the telephone people have used that place for grounding their instruments. If so, it does no harm to put your ground right alongside. A good installation is shown in Figure 3.

We all of us know that radio has made tremendous strides in the last few years, but the "hay wire Ford" or regenerative set, often of the one-tube variety, still frequently hangs up the DX (distance) and number-heard records. One expla-

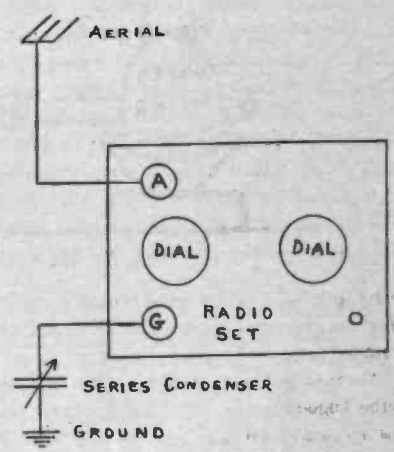


Fig. 2. Condenser in Ground

nation may be that there are still so many users of the one-tube regenerative set, that the chances are that some of them will be able to create records. A hook-up of such a set is drawn in Fig. 4. This consists in brief of a 23-plate condenser C for fine tuning, stator S of a variocoupler, which is adjusted for coarse tuning by the taps of the inducance switch T, and the rotor of which, R is connected in series with the plate to adjust the feedback.

But another explanation may be this: the great proportion of the one-tubers are home made and usually much remade, so that eventually they get to be built up around a particular tube, rather than (like the factory sets), built for the average one, but not always working at their best with the particular bulb at hand. The radio frequency sets, with four to six tubes, on the other hand, due to the increased cost, go ready made into the hands of the man who considers his radio like a piano or phonograph,—a piece of furniture, but not an opportunity to tinker and improve.

How To Compare Locations

Here's a suggestion to the user of any set: Find some other person who has a radio similar to your own, and compare the efficiency of the two,—using his antenna and ground and batteries on both sets in both locations. Also exchange tubes for trial. It should not be difficult to find out what difference there may be in the two antennas, etc. You should, of course, try to find someone who gets unusually good results, in order to receive much benefit from the comparison.

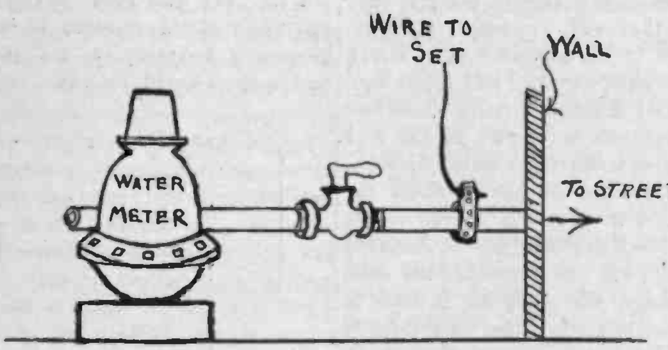


Fig. 3. How Good Ground Looks

No one needs to apologize for his one tube regenerative set. An apology may be necessary for the results had with it, or for its construction, but the hook-up is exceedingly efficient in that it gives such fine results for the apparatus used and compares favorably with most other types of sets, so far as distance and number of stations heard. Instead of hunting up a new hook-up, let's see what can be done to improve the operation of the average single circuit set.

Playing with the "Plop"

A fault of a great many single circuit sets is their tendency to go into oscillation with a "plop",—when the variation of the regeneration control to get louder music is made, by turning up the tickler, then there comes a sudden click, with distortion or entire loss of music with a squeal or howl. The set is not sensitive or selective when it operates like that, but may be called "critical," and is certainly a nuisance to the operator. This happens with the "tickler feedback" type much more than with the "plate variometer" style of single circuit. If you do not want to tamper with the soldered parts of the set, you can try lowering "A" or "B" battery voltages or both, and if, as is usual nowadays, the grid leak is removable, try substituting another unit having a higher megohm resistance, or if the grid leak is adjustable by moving a lever, try rasing it by turning the knob. If you wish to experiment with the wiring, decrease the number of turns on the tickler coil. Sometimes a resistance inserted in the antenna or grid circuit may produce the desired result, but that throws away some of your energy. If you can buy or borrow other tubes, you will perhaps find one that will operate nicely with a very smooth control of regeneration in your set, without making any other changes in it.

The writer and many of his friends have found that it is not so much the particular type of tube used in a regenerative set as the detector, which makes the difference in results, as it is the particular specimen of a certain type. This is only another way of saying that tubes vary in their characteristics considerably. If you want to check up on this, try a half dozen tubes of the same kind in your set on distant stations using same battery voltages, etc. You will probably get a big difference in results.

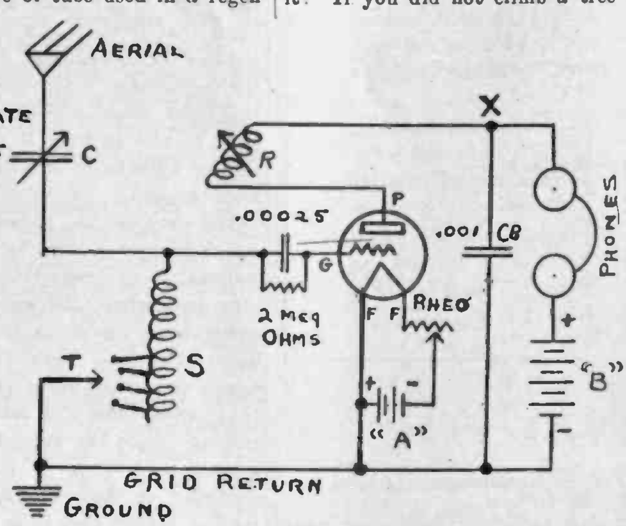


Fig. 4. Hook-up of Single Circuit Set

It has been the writer's experience that if a set will operate on 45 volts of "B" battery with smooth control of regeneration by the tickler, then much better results are obtained rather than if the "B" battery pressure has to be cut away down for smooth operation. The theory of the working of the vacuum tube would seem to bear out this experience. So try more than one tube as a detector before you start to condemn a set.

Driving An Auto at Sight

The radio novice is inclined to forget that tuning a set is something to be learned and is inclined to give credit for increased range and volume in a particular set to the set rather than to his own increased experience gained through practice in tuning it. Don't expect to get results without learning how. Tuning most sets is a job for both hands working at the same time. Most people who get poor results use one hand at a time. It can't be done. It is just like learning to drive an automobile. It looks simple to steer by pulling the wheel around the way you want to go, but do you remember the first time you tried it? If you did not climb a tree it was probably because there was no tree there.

We agree with those who say that quality is the first need in a radio set. Most of the larger broadcasting stations start the signal on its way with excellent quality. Then we hear it on our detector tubes, say, with fine quality. We add two stages of audio amplification and a loudspeaker and make new enemies for radio. It is not an easy thing to build a good two-stage audio that gives both volume and quality, when subjected to the further distortion of a loudspeaker. There is a chance to improve most audio amplifiers by adding a grid leak or condenser or both across the secondary of the audio transformer. This is especially true of the secondary of the second stage audio transformer. The connections for such a condenser across the secondary are shown in Fig. 5. Here the ordinary connections of a single stage are shown in full lines. Condenser C is added from the grid to the "A" battery of filament connection. In our diagram the condenser is shown adjustable, but ordinarily this is not required. If, however, there is some particular frequency which is screaming badly, then it is sometimes possible by proper tuning to eliminate it. The value of this capacity should be .001 mfd. or a 43-plate condenser, if adjustable. Besides the condenser a grid leak of one half or one megohm is sometimes used with advantage. Both these schemes reduce the loudness of the signal somewhat and should be used only in case no other means can be found to get rid of bad distortion. Different transformers vary greatly in "quality."

Static from "B" Battery

We hear a good deal about noisy "B" batteries. The experience of the writer indicates that one dead cell in a block "B" battery will often cause a "spitting" sound, which is remedied when the dead cell is removed or short circuited with a piece of wire. Audio amplifiers will seize upon a worn-out "B" battery as an excuse to howl or distort.

In spite of the advertisements, we see but little of the 1500 to 2000 miles on the loudspeaker every night, unless the conception of "loudspeaker" by the advertiser is a weak one. The writer has a one-tube regenerative set of the "Greene Concert Receiver" type, that on reasonably good nights will render audible on the loudspeaker stations several hundred miles away, *if* you put your ear close to the horn for the announcements. And near by stations are pleasantly loud around the room, sometimes faintly audible downstairs. But when it comes to volume such as a phonograph with a soft needle would produce, it is rare that the writer has seen or heard more than eight or ten distant stations even within a thousand mile radius "gettable" one after the other on the loudspeaker with any set. Ask your boastful superheterodyne owner to tune in 2000 miles away, more than one station an evening, and he will tell you of last night and the night before but he generally will give you those within a few hundred miles as a limit. It probably is no fault of the set but merely that the volume of the signals from the long distance is not greater than the volume of static and local electric disturbances and so his very sensitive set cannot pick out the signal from the static.

Catching the Liars

Ask those who boast of distant reception how often they hear PWX at Havana and WKAQ at San Juan, if those be distant from your own location. Remember that PWX is regularly on the air only Wednesday and Saturday, while WKAQ is heard regularly on Tuesday and Friday at present. This is an easy way to find out some of your friends who are stretching the truth a little bit. Pick out a Tuesday or Wednesday morning, for instance, and tell them how well your set worked the night before. If, on casually mentioning Cuba they tell how well they heard it the past evening, you can inform them that Wednesday and Saturday evenings are the only times they can be picked up.

After quality, we desire sensitivity, in our sets. We want to hear distance and hear it loudly. A high grade pair of phones sometimes seems to give the volume almost of another tube in a set, as compared to a poor pair of phones.

Along with sensitivity those who live near powerful broadcast sations are ever hunting for selectivity,—"tune 'em out" is the slogan. A double circuit tuning device aids in this or several stages of so-called "tuned radio frequency" sets, like the neutrodyne. The superheterodyne is receiving great praise for its superselectivity and some condemnation for its reception of unwanted harmonics of stations higher and lower than the one wave wanted; but because a set is of that type does not mean that it is necessarily superselective. It has to be made properly, with even more care than the simpler sets and it must be operated properly.

What to Do with "Bloopers"

For the good of radio, there is no doubt that the best suggestion to owners of straight regenerative sets (bloopers) is to "chuck" them. As long as radio fans are human, distant stations are going to be hunted for with regenerative detectors in the oscillating condition, because that is the easiest method of picking up DX. There is no doubt that inexperienced operators and careless children make a very great deal of the "howling" that is so annoying. Note the increase in that type of interference after Christmas.

With the increase of broadcasting stations and the greater power used, the radio public has gone in strong for "untuned primaries," low-loss condensers and "air-mounted" coils. This is as it should be. But there is one place where radio constructors continually go wrong. After spending five to seven dollars for a high grade condenser, the set-builder proceeds to shunt it across his high

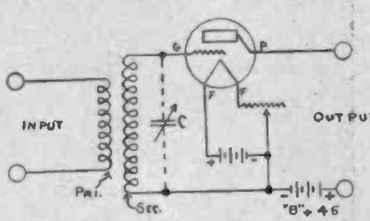


Fig. 5. Transformer with Condenser

grade coil using terminals of the coil imbedded in some insulating substance that produces all the losses that the other apparatus was designed to avoid. What use is it to eliminate practically all the dielectric (insulation) in the variable condenser and then insert a tube socket with plenty of poor quality dielectric connecting grid, plate and filament.

Foreign Tubes Unlike American

It is unfortunate that the American manufacturer did not devise and adopt a socket that held merely the glass part of the tube or its brass or molded base, with small binding posts easily accessible in place of the tube prongs. Some of the foreign tubes are built in this way and as a result the leakage and also the bad capacity effect from grid to plate is very largely omitted. Using our standard American tubes the best we can do is to use sockets which are made of bakelite or its equivalent. With these the leakage is so small as to be negligible.

Portraits of Popular Performers

Professor Edward C. Smith

Our photograph shows Prof. Edward C. Smith, Professor of Political Science at New York University. He is conducting the "Air College Course" in Politics and Statesmanship. This subject for the fall term, as arranged by the New York University and Station WJZ, is particularly timely.

The course will cover the various phases of our governmental system for the benefit of the radio listeners. The first lecture will treat of the Functions of Government, the next will describe the Federal Form of Government, the third will explain the work of the National Government at Washington, the fourth will enumerate the duties of State Governments, and the fifth and final lecture will list the duties of town and city organizations.

Professor Smith, who is Assistant Head of the Department of Political Science at NYU, is a graduate of the same university as John W. Davis, Democratic nominee for President. He received the degree of Bachelor and Master of Arts there, and more recently received his Ph. D. from Harvard. Prior to accepting the professorship at New York University he was a member of the faculty at Lafayette College.

Professor Ralph V. D. Magoffin, President of Archaeological Institute of America, opened the fall term of the New York University "Air College" with a nightly lecture on popular Archaeology from WJZ, early in October.

Professor R. V. D. Magoffin

MOON MODIFIES LENGTH

Continued from Page 12

Changing the Wave Length

After finding that the tides change the capacity of the condenser, let us see why it affected the wave length of the set. Notice in Fig. 2 that the hookup is just like what is recommended in a great many diagrams for adjusting the wave length of the receiving set. At A we have the aerial with the lead-in running directly to the radio. The ground connection goes to ground through a variable condenser. In this case the condenser was formed by the ocean and counterpoise, as just described. When the ocean rose it was like turning condenser plates, so that they meshed more deeply. This naturally has the same result in sending that it does in receiving; that is, it increases the wave length. Increasing the wave length has the effect of throwing the receiver set out of tune with the sender, unless the former is adjusted for the change at the same time as the latter shifts its wave.

Since it was not practical to require all receiving sets to be changing their dials to compensate for the shift in the tide, it became necessary for the sending operator to put another condenser in the set and keep turning this down to decrease the capacity at the same time that the moon was pulling the tides around to increase it. In this way the total capacity and so the wave length was kept constant. This is the first time on record that the moon has interfered with radio broadcasting.

An Inexpensive Reflex Set

Single Tube Outfit Can be Combined with the Crystal Detector

By VANCE

THERE is considerable interest these days in reflex sets. These, as you know, are distinguished by the idea of using each tube twice. The first use made of this unit is when it acts as a radio amplifier to increase the volume of the radio waves coming from the aerial to the detector. Each step of such amplification will multiply the energy by several fold. Such an increase means that the range of the set is so much greater than before.

After the radio frequency has been amplified, it is fed to the detector, which may be a crystal, or else a regular vacuum tube may be employed. The advantage of the tube is that it is considerably more sensitive, and can be made to regenerate, if desired, which still further increases the range of reception. On the other hand, those who prefer a crystal, can point to the fact that it is much cheaper, it is easier to construct, uses no battery current, and furthermore, the quality of the reception is unusually good; that is, distortion is entirely absent.

A Single Tube Reflex

For the particular set to be described only one tube is needed. The detector consists of a galena crystal. The amount of apparatus used is comparatively small. Here is a list of parts necessary with approximate prices.

Aerial and ground complete	$1.50
2 Three-inch fibre tubes	.50
2 11-plate variable condensers	4.00
1 Bakelite socket (UV-199)	.50
1 30-ohm rheostat	.50
1 UV-199 tube	3.50
1 Crystal detector	.25
1 Galena or Audion crystal	.25
3 Midacon Condensers .001	1.20
1 Audio Transformer (6 or 10 to 1 ratio)	4.50
2 Dials, 3 or 4-inch diameter	.60
3 Dry cells	1.20
45-volt "B" battery	3.50
7 x 14 Hard rubber panel	1.00
Magnet Wire	.25
Bus bar wire	.25
Binding posts, etc.	.50

Winding the Coils

In this radio there are two sets of radio frequency coils. The first pair is used as a coupler, and the second as a radio transformer. The secondary of each of these coils is just the same. It consists of a winding on the three inch diameter tube. Start through a hole about a quarter of an inch from one end of a tube and wind on 60 turns of double cotton covered (d.c.c.) magnet wire. The size of wire may be 22, 23, or 24, whichever is conveniently obtainable. The wire may be wound in either direction, right hand or left, without making any difference.

The primary is to be wound of the same size of wire as the secondary. It may be put on the same tube, spacing it a quarter of an inch from the end of the secondary, or if you want to make a shorter coil, the winding may go on a smaller diameter tube, say 2½ inches to fit inside the larger one. Either construction is satisfactory. For the coupler, however, we prefer to use a winding on the same tube, as taps may then be brought out to see which is the best number to be used. For the coupler, 15 turns wound in either direction is usually about right, but it is sometimes desirable to bring out a tap at 10 and at 15 turns and wind on 20 in all. This gives a choice of three numbers in operating. To pick out the particular tap it is possible to install an inductance switch on the panel, although this is not shown in the hook-up. Another way which is equally satisfactory is to have a small clip attached to the aerial wire and hook this clip on to one after another of the three taps. When it is found which is the best then a permanent soldered joint can be made.

The Radio Transformer

The primary here consists of 30 turns wound in either direction, without any taps. As has already been mentioned, this can go on the same tube spaced half an inch from the other winding. However, the general tendency is to wind this on a smaller tube to fit inside the secondary. In such a case, it should be wound at one end of the inside tube and it will extend for a length of only half that of the secondary. In assembling the two coils, let the two ends come together which are connected—the primary to the phones and the secondary to the primary of the audio transformer. This is shown in the wiring diagram.

Winding these radio frequency coils is the only work necessary, except laying out the panel. A layout is not given in this article, as the arrangement may be anything which the builder desires. The audio transformer can not be wound by the armature; as there are about 15,000 to 20,000 turns on it, a satisfactory job can not be made by hand. It should be bought of a regular dealer. A ratio of 6 to 1 up to 10 to 1 can be used with satisfaction. The two variable condensers should be of the low loss variety, of which there are a large number on the market. The stationary condensers may be any make of mica construction, but Micadons are recommended.

In hooking up the set the best way to do is to lay out the various parts unwired to see the approximate location. The aerial usually comes in at the left. Then in line are the audio transformer, the tube, the radio transformer, and the crystal detector.

On the panel are mounted the two variable condensers with the rheostat between them. A battery switch for turning off the "A" batteries and a jack for the phones or loud speaker make a refinement which is often used although they are not necessary. If a jack is to be used any of the ordinary styles, with either 1, 2, 3 or 4 springs will do well; if it has more than two springs, leave out the center ones.

Kind of Batteries

Since this set works with a set of radio frequency amplification, it is necessary to use either 2 UV-201A or a UV-199 tube. The former will give slightly louder volume, but requires a six volt storage battery to operate it. If the storage battery is to be used a small size is preferable, as the cost is considerably less and a larger one is not needed. The current consumption will be one-quarter of an ampere, which means that the set can be run four hours for one ampere hour out of the battery. A 40 ampere hour battery will thus last 160 hours before needing a recharge.

Since storage batteries are expensive and somewhat messy, many prefer to use the UV-199. This operates on three dry cells connected in series. The zinc of one cell should go to the carbon of the next and so on. The rheostat should be connected as shown, except that it is often found desirable to use it in the negative filament lead rather than the positive as illustrated. By such a connection, the negative bias or grid voltage is greater than with the rheostat in the positive. This is an advantage, if more than 22 volts of "B" battery are used. If more than 45 volts of "B" are connected, then it is a good thing to hook up a "C" battery between the audio transformer and ground as illustrated. The amount of voltage of the "C" depends on the kind of tube and the pressure of the "B." A leaflet showing the various values accompanies each style of vacuum tube. A pressure of 22 volts of "B" will give very fair results, but 45 is quite a bit better. Using more than this latter value will increase the volume slightly, but many experimenters do not think that it is enough better to pay for the extra expense and complication of the larger number of "B" battery units.

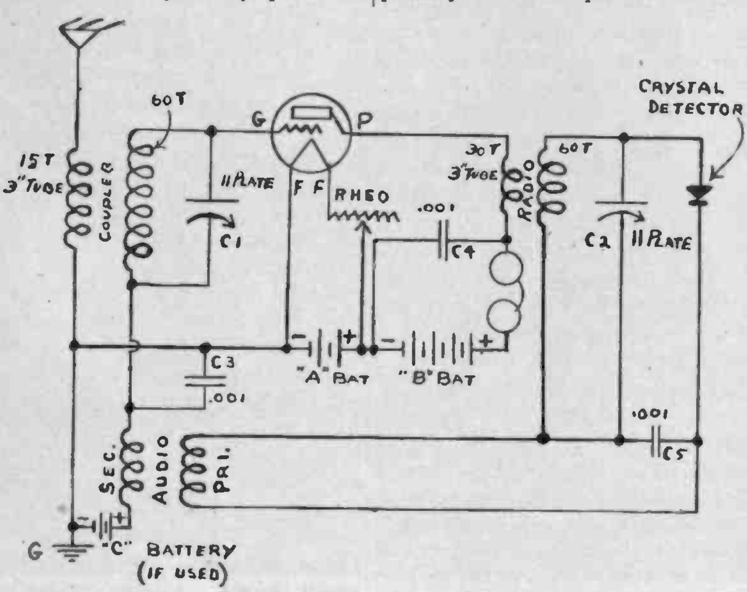


Fig. 1. Hook-up of Reflex

Hook-up of the Set

An explanation of the way this radio operates is as follows: The ether waves strike the aerial and run through the primary of the coupler direct to ground. This coil will consist of 10, 15 or 20 turns, as has been discussed above. Magnetic energy is transferred from the primary of the coupler to the 60 turn secondary. This latter is tuned for wave length by the adjustable 11-plate condenser, Cl. The oscillations from this tuned secondary run from the grid through the coupler, condenser C3 to the filament. This completes the primary radio frequency circuit.

The output of the plate, which is at radio frequency, traverses the primary of the radio transformer, through condenser C4 to the filament. The high speed oscillation does not go through the telephones after leaving the radio transformer because the inductance or electrical weight of its magnets is so great that it can not take up such a fast speed of vibration. The primary of the radio transformer feeds the energy across the 60 turn secondary, which is tuned by C2, a variable air condenser. This must be set for exactly the same wave length as Cl. The output from this radio transformer which is at high frequency goes through the crystal detector and down to C5. This condenser passes the radio frequency back to the transformer but the low or audio frequency, which the crystal detector has rectified, can not pass through such a small capacity (.001 mfd.) so it has to take the path through the primary of the audio frequency transformer.

Audio Will Not Pass C3

The secondary of the audio frequency unit goes through the "C" battery, if it is used, direct to the filament. Its other end is connected through the secondary of the coupler to the grid. The audio frequency which comes from this transformer cannot short circuit through C3 because its capacity is too small, and so it has to go through the secondary of the coupler. However, this does not impede it at all, because it consists of so few turns (only 60). This forms the audio frequency input to the tube which is thus reflexed.

The audio output from the tube is led through the primary of the radio transformer which has no effect on it, for the reason just explained. From there it can not go through C4 owing to its small size, so it traverses the phones or loud speaker and "B" battery back to the filament again.

Operating the Set

This radio is quite simple to operate, since after adjusting the rheostat to give the proper filament current, the only controls are the two variable condensers, Cl and C2. These two should read nearly the same on the dials. They would both be identical if it were possible to construct the two secondary coils and the two condensers so that they were just alike. This set will give very good results on local stations where the performance will equal the output from an ordinary two tube set. Furthermore, as the detector is a crystal, there will be no distortion from improper adjustment and the tone will be very clear. On distant stations the volume will depend a good deal on the amount of care used in constructing the instrument and also on the conditions of ground and aerial. Some builders claim more than 1000 miles with this hook-up but we do not believe that the average set will get as far as that.

How a Sending Station Works

Various Circuits of Modern Transmitter are Explained

By C. WILLIAM RADOS, 1BFA

THIS is the first of a series of articles on the radiophone transmitter. Everyone has seen pictures of studios and of radio operating rooms but few know how and why the equipment works. As a technical problem wireless transmission of the human voice and music was probably one of the hardest questions that engineers had to solve. This series of articles will attempt to make clear the little understood how and why of this problem. Elements and general principles of phone work will be discussed in this article.

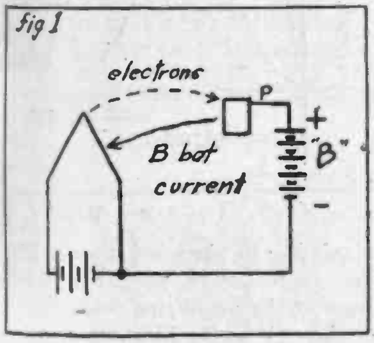


Fig. 1. Path of Electrons

Vacuum Tube Theory

A brief outline of how a tube amplifies and oscillates will first be given.

When a piece of metal as a filament, is heated, it throws off electrons or very minute particles of negative electricity. The higher the temperature, the more there are thrown off. These electrons or particles of negative electricity, are attracted by a positively charged electrode or piece of metal. This, in the vacuum tube, is furnished hy the plate close by, to which is connected the positive end of the "B" battery. When an electron leaves the filament, it strikes the charged electric field between the electrodes (filament and plate) and moves to the plate. Opposites attract, and that is why the positive plate attracts the negative electron.

As long as the filament is lit and the "B" battery is connected, a steady flow of electrons occurs. See Fig. 1. As this flow or stream is carried by a conductor, the "B" battery current can flow from plate to filament. Note that there are two opposite flows or paths; one, the electron stream from filament to plate, and the other from plate to filament. This is rather confusing to any one who has not noticed it before. It is caused by the unfortunate circumstance that back a great many years ago when electricity was first experimented with, no one knew anything about electrons, or about which direction an electric current flowed. It travelled so fast—seven times around the earth in a second, that naturally it seemed to reach both ends of a wire at the same instant. In order to follow diagrams of connections it was necessary to assume that the current flowed from zinc to carbon in a battery or from carbon to zinc. No one knew which way it was. The best the early experimenters could do was to toss up a cent and call the direction according to the way it came. Unfortunately, they guessed wrong from the standpoint of electron flow.

That is, if we say that the current is

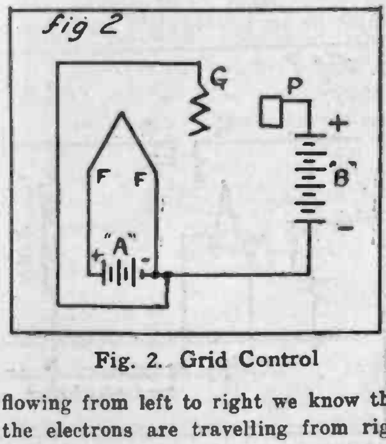


Fig. 2. Grid Control

flowing from left to right we know that the electrons are travelling from right to left. This condition holds throughout the entire science of electricity. The direction of current flow is found by measuring with a volt meter. But the volt meter is always marked in such a way that the electron flow is opposite to its indication. In most discussions of electricity this condition does not need to be considered at all, but when dealing with vacuum tubes it has to be explained, or else experimenters will not understand why the electrons seem to run backwards. Once we realize that the

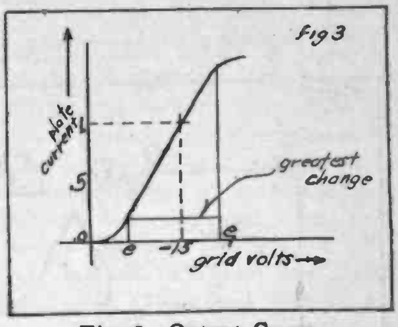


Fig. 3. Output Curve

electrons and the so-called current flow in opposite directions, then we need worry about it no longer as everyone will understand what we mean when we discuss the question of flow.

Two Ways to Control Flow

When the electron flow has been started as shown in Fig. 1 it will continue steadily if nothing is done to modify it. It may be stopped or regulated by two methods. If the potential of the plate is high (90 volts), there will be a much greater electron flow and so more battery current than if a low plate potential is used. By cutting down the plate voltage to zero we practically stop this flow. However, this method is not so flexible as the "third electrode" scheme. This uses a grid placed between the filament and plate so that electrons must pass through its meshes (Fig. 2). The "B" battery voltage is kept steady with this method.

If the voltage of the grid is positive, a large flow occurs from filament to plate. The electrons are attracted both by the plus grid and the plus plate. This is because the positive attracts the nega-

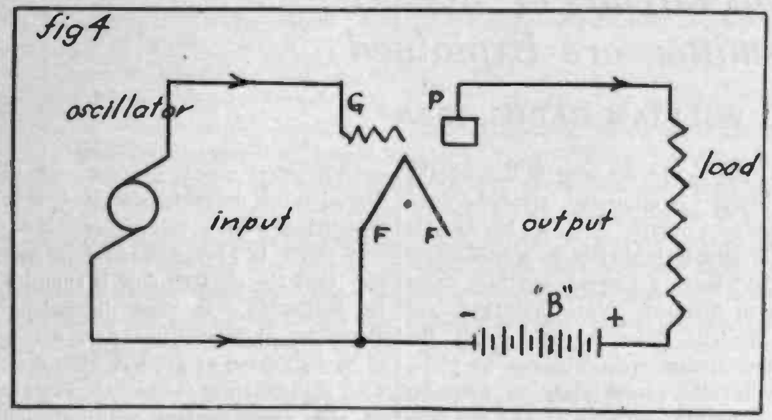


Fig. 4. Outside Oscillator and Amplifier

tive as has already been explained. If the grid is negative it stops or reduces this flow depending on how strong a

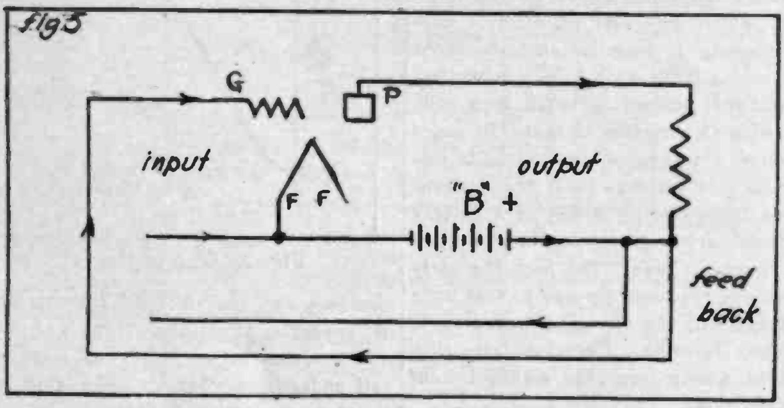


Fig. 5. Self-excited Oscillator

negative charge the grid has. This is one of the reasons why negative "C" batteries are connected to the grids of receiving tubes. It reduces the drain on the "B." Thus the grid acts as a throttle on the electron stream. In Fig. 3, the plate current—grid voltage curve is very easy to read and shows this action clearly. When the grid pressure is —1.5 volts (the vertical dotted line) we see that the plate current (horizontal dotted line) is 1.0 milliampere. These values are from an ordinary receiving tube. Between the e and el, we see that a small change in grid potential causes a large change in plate current. In other words, we have amplification. This is the basic property of the vacuum tube.

Why a Tube Oscillates

Suppose we use a set-up as in Fig. 4 and with one watt input to the grid, we get eight watts output from the plate. We can then feed back one watt from the output and do away with the oscillator. This makes it a self oscillator, Fig. 5. This will vibrate continuously, giving about eight watts output. Do not think we are getting eight watts output from one watt input as the "B" battery supplies the necessary energy. Referring to Fig. 5 it can be seen that once the system is started it will continue to oscillate. To keep up the energy fed back must be in phase (in step) with the original input and also the feed-back coupling (tickler) must be great enough so as to return to the grid, a voltage greater than the initial input voltage. If it is less than this the circuit will amplify but not oscillate. This theory is the same for receiving and transmitting. So now you know what happens in your tube.

To start such a circuit, simply close

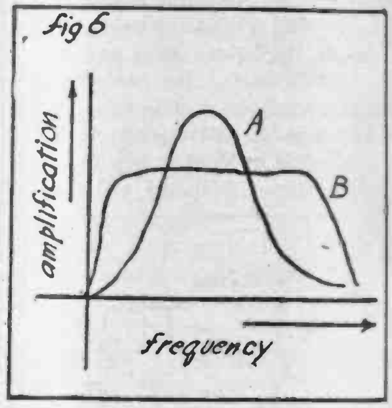


Fig. 6. Good and Bad Results

the switches in plate and filament circuits. Oscillation is possible therefore because of the amplifying properties of the tubes. We may have amplification without oscillation but not the opposite.

Each Step Is Louder

The basis of amplification is that the plate current of the first tube varies the grid voltage of the second tube, and due to the properties of the vacuum tube, not only is the power applied to the grid of the second tube greater, but the

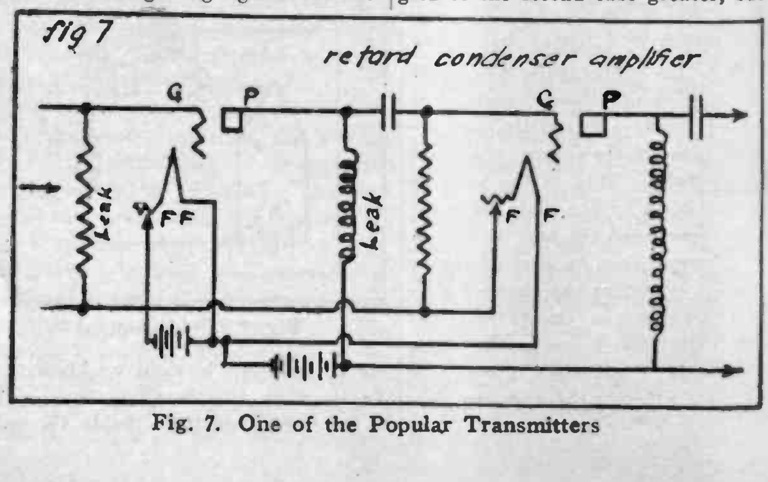


Fig. 7. One of the Popular Transmitters

voltage variation will be many times as large as in the first tube. The several amplifier circuits in use are the following:

1. Transformer coupled. 2. Resistance coupled. 3. Push-pull connection.

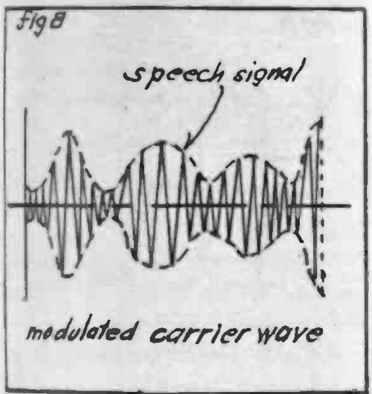


Fig. 8. What Modulator Does

4. Resistance condenser. 5. Retard condenser.

The transformer coupled amplifier is the most common one. The resistance and resistance condenser amplifiers are not widely used. The push-pull amplifier is valuable as it allows considerable current to pass without much distortion. It is often used as the last step when extra loud signals are wanted. The one used in broadcasting stations however, is the retard condenser amplifier as it gives practically a uniform amplification throughout the speech range of 100 to 3000 cycles. It will be discussed in greater detail later.

The Voice Is the Test

The big problem which engineers had to solve before radio broadcasting was made successful, was transmission of the human voice and musical sounds. Radio telegraphy or wireless is comparatively easy because the circuit requires only to be opened and closed to form the characters of the code. The frequency of the emitted wave is steady and is usually at some vibration speed between 60 and 600 cycles per second. However, in telephony (both wire and radio), the emitted wave must reproduce faithfully at the receiving end every frequency between 100 and 4000 cycles per second. It is a much more difficult task. For ordinary local wire telephone distances, no amplification of the voice energy is necessary. We speak into the ordinary transmitter and thus vary a considerable amount of current. The sound wave used in ordinary speech has a power of about one ten-millionth of a watt (Bureau of Standards) and as this must control 500 to 1000 watts of radio frequency energy, it must be first amplified. In a radio microphone, too, the quality must be better than ordinary so that the voice controls less current than in a telephone and is then amplified more.

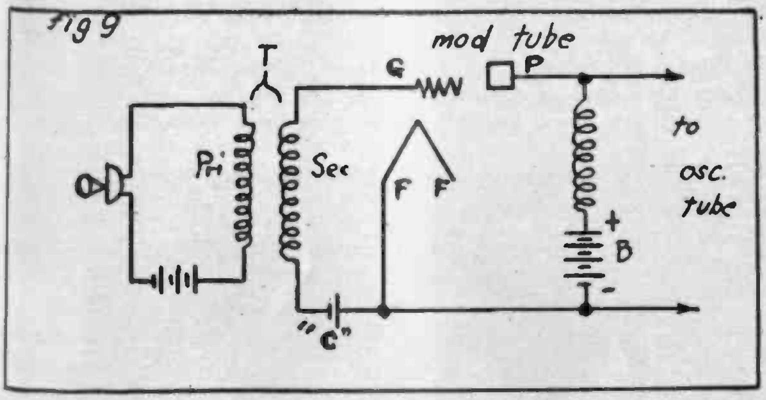


Fig. 9. Putting the Voice on the Aerial

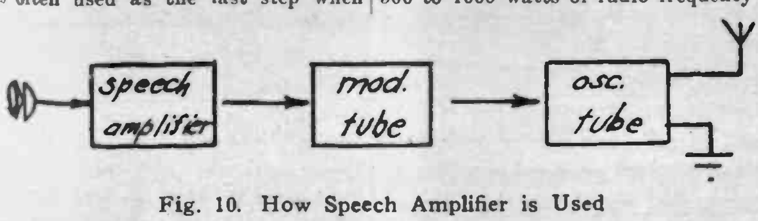


Fig. 10. How Speech Amplifier is Used

This is done by the speech amplifier. It works the same as an ordinary unit but is more carefully constructed. On account of the simplicity with which the usual receiving set is built the amplifier is somewhat selective. This means that it increases the loudness of one particular note more than all others and so causes distortion. In fig. 6 curve A shows the amplification of an ordinary amplifying transformer. It will be seen that at one particular frequency or note, the curve is peaked and rapidly slopes away on both sides. In a broadcasting station such distortion is not wanted and so they use the retard-condenser amplifier as being best. Three five watt tubes are used, two of one kind and one of another. Retard or impedance coils, resistances and condensers are placed in various parts of the circuit to smooth out the amplification over a wide range of frequencies. The result is that the amplification curve is like that of curve B Fig. 6. Fig. 7 shows the dragram.

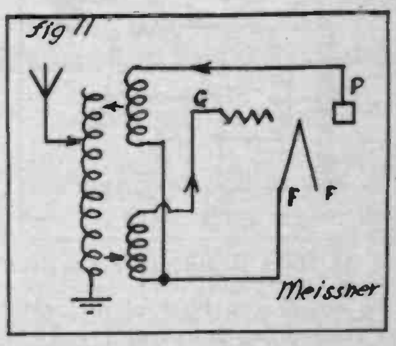


Fig. 11. Meissner Hook-up

What We Mean by Modulation

As under amplification, a definition of modulation is best given at the beginning. Modulation means varying the amplitude or intensity of a high frequency wave in such a way that its envelope becomes a low frequency wave. The envelope is a curved line which just touches the tops of the waves in the drawing. This means that radio frequency is sent out by the antenna at perhaps 700 kilocycles (700,000 oscillations per second). A sound wave of perhaps 700 cycles is impressed on this oscillation and as each sound wave lasts over a considerable number (1000 in this case) of radio frequency oscillations, it varies the amplitude or intensity of the emitted wave. See Fig. 8. There are several methods of modulation used in radio-telephony. The simplest way is to

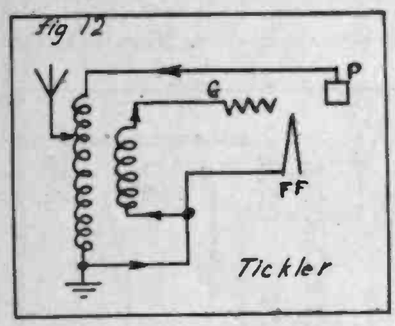


Fig. 12. Like Regenerative Receiver

wrap one or two turns of wire about the transmitting helix (coil) and connect a microphone to it. This is used in arc transmitters and low power amateur stations and gives good results but the power is low. For high power broadcasting stations, some other method of modulation must be used. Variation of the grid voltage of the generator tube either directly or through a master oscillator is called grid modulation. This method is used only because it is economical. To secure good modulation, a linear relation (straight line curve) must exist between the grid voltage and the antenna current. This does not occur

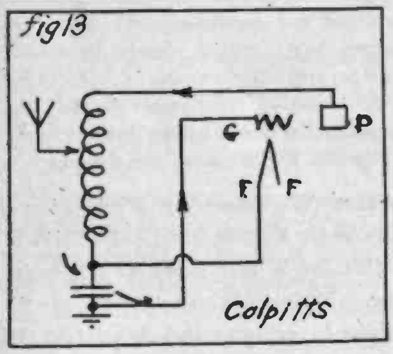


Fig. 13. Colpitt's Oscillator

with grid modulation and this is its advantage. This type of modulation, however, is useful in communication circuits where several telephone or telegraph channels are desired on the same pair of wires.

The Most Popular System

The Heising system of modulation, named after its inventor, is the one in greatest use today. It is a variation of plate voltage or power supplied to the plate circuit of the oscillator tube. This system requires extra tubes and other apparatus but gives complete modulation. A simple diagram of the Heising modulator is given in Fig. 9. T is a step up modulation transformer, the primary of which is operated by the microphone and small battery. The oscillator tube, connected across the modulator tube is regarded as a resistance. The microphone and battery set up a varying voltage in the primary which is stepped up in the secondary and applied to the grid of the modulator tube. Thus the speech is amplified and passed to the plate of the oscillator tube.

Think of the modulator as a generator (excited by the microphone) of speech (audio) frequency power. This varying power is supplied to the plate of the oscillator tube. The oscillator tube acts as a resistance (load) and when its resistance equals that of the modulator tube, the maximum power is supplied it. Oscillator and modulator tubes are always of the same size and electrical power because they will have equal resistances. The power is then sent out to the antenna and radiated.

When One Step is Omitted

For portable sets, small amateur and broadcast stations, no speech amplifier is needed. The modulation transformer usually supplies a secondary voltage high enough to modulate completely the oscillator's output, when normal speech is used. When 50 watt tubes are used their grid losses and the dielectric losses of the modulation transformer are so high that the simple control cannot be used. An amplifier must be added between the microphone and the modulator tubes, Fig. 10. This is the retard condenser

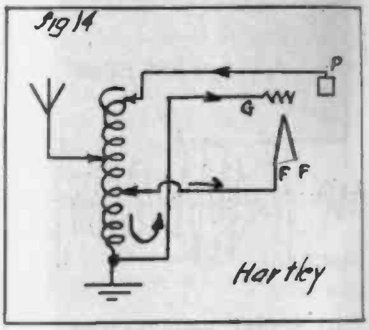


Fig. 14. Hartley Transmitter

coupled speech amplifier previously mentioned. A broadcasting station then, has usually a 50 watt speech amplifier, two modulator tubes and two oscillator tubes. The tubes are all of the same size, either 50 watt or 250 watt. The speech amplifier tube is usually only 50 watt as this is plenty large enough. A grid bias of about —60 volts is used on 50 watt tubes. Under certain conditions, when the grid pressure exceeds ten volts, some electrons may be shot off from the grid. These go to the plate and may exceed the number striking the grid itself. The oxide coated tubes (WD11 and WD12 are smaller models) emit more electrons from the grid under these conditions than the tungsten filament tubes.

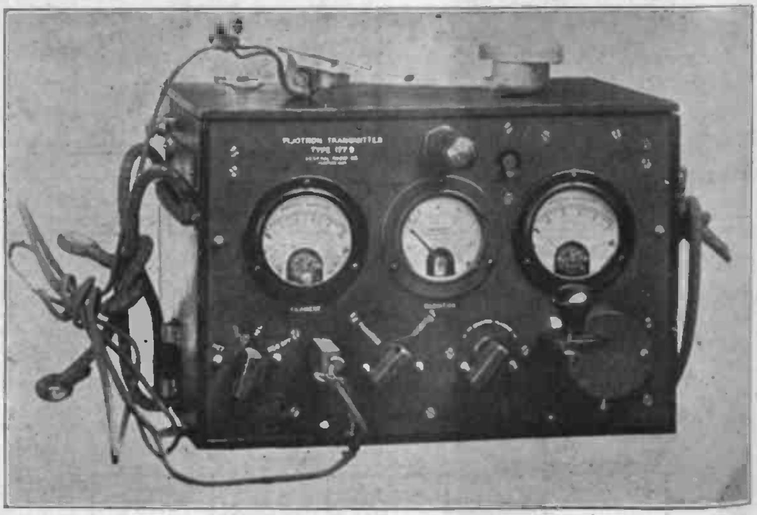


Fig. 15. Complete Transmitting Set

Continued on Page 28

Special Features of Nov. 1st Issue of Radio Progress

Radio is invading every field. Just recently a big organization, extending all over the United States and into Europe, held a banquet at which 10,000 employees sat down together, but they were scattered through 62 cities. How this was accomplished is explained in "10,000 EAT TOGETHER BY RADIO."

There is no doubt that sooner or later the various nations of the world will have to get together on some common language which radio can use for reporting international events. Such a new language will have to be fairly easy to learn or else it will be no use. There are several rivals at present, and the radio press contains various articles in favor of one or the other. The only article we have seen actually comparing the two is "WHICH RADIO LANGUAGE DO YOU WANT?"

Every set is built largely of coils. Why is it that some are considerably better than others? Just what does a coil do anyway? These questions are answered by H. V. S. Taylor in "COILS—WHY ONE EXCELS ANOTHER."

The superheterodyne is a wonderful set, but as usually built it needs eight tubes to work well. The November 1 issue of RADIO PROGRESS contains an article, "CUTTING TWO TUBES OFF SUPERHET," which tells how two tubes may be eliminated.

If you see a horse race and the favorite noses out his rival by a fifth of a second, you think that it is a pretty close race. When a gun is fired and the bullet hits the mark in one one-thousandth of a second, it seems so fast that you can hardly conceive of such tremendous speed. But when a radio wave vibrates back and forth so fast that it gets in one million complete swings every second, it requires an article like "PICKING OUT 1/1,000,000th OF A SECOND," by A. N. Goldsmith, to get any grasp of the idea at all. This article in our next issue makes us feel at home with this small quantity.

you can hear him louder than before and at the same time B and C cannot be heard as well as previously. When you shift the direction to B, then he becomes loud to the exclusion of the others. But suppose that A is the only person in the room. When aimed at him he is clearly heard and as the horn is directed away from him you notice that the loudness diminishes a great deal. Still you will be able to hear a little bit even with the horn pointed in the opposite direction. This represents a set which is a pretty good one.

Now suppose you make the ear trumpets of better material and a better design and perhaps longer, so that you have better luck in tuning out Mr. A when the horn is pointed away from him. By making the trumpet good enough it is easy to imagine that you would not be able to hear him at all in such circumstances. Does that mean that no sound vibrations come to your ears? Not at all. It only means that your ears and brain are not sensitive enough to hear the faint whisper which now comes through the horn. If some one else with better hearing were in your place, then *he* would still be able to hear Mr. A. A still better horn would be able again to tune out A in spite of the new listener's unusually good hearing. Of course, this process could go on indefinitely.

In other words, when you say that you have tuned out Mr. A, that is a relative term. We all know that some sound waves are still coming in, but they are so faint that you do not hear them. If Mr. A, in the same location, should suddenly start yelling at the top of his voice, we would be able to hear him again even with the improved horn. What we can say definitely is this — with this particular trumpet tuning him out the volume of sound which reached your ears is reduced to say 1 per cent. of the loudness which comes from the sending station (Mr. A). Furthermore, it requires a certain amount of sound, which for want of a better name we will say is ten units, in order to make your ears operate so that you will know there is anything going on.

If, then, Mr. A is broadcasting with anything less than 1000 units loudness, then taking 1 per cent. of it will reduce it below 10 units, which are necessary for you to hear, and the result is that that station is completely tuned out. But if this station increases its power to say 1500 units, then 1 per cent. will be 15, and this is considerably above the 10 which you need to hear and so, of course, you can no longer tune out this local station.

From this you can see how foolish the various claims of some advertisers are when they make the bald statement that they can tune out any local interference and get distant stations. By throwing the tuning dial of a certain set exactly ten divisions on the dial you can reduce the volume of that particular wave length to say 10 per cent.

If this amount of dial shift is what is necessary to change from a local wave length to the distant station which you want to get, then the local will be reduced to 1/10 as loud as it would be if you were tuning to it directly. If it happens that the local station is just ten times as loud as the waves from the distant station when they strike the aerial, then since you have divided it by ten, you will get the two stations at exactly the same volume of tone.

If your set is a better one so that ten degrees will reduce the volume 1 per cent. (instead of 10), then, of course, the distant station in these circumstances will be ten times as loud, and if your ears are deaf enough so that 1 per cent. of the local sound is not enough to make them work, you will be able to tell your friends that you have tuned out the local completely. You must realize, however, that if your ears were ten times as keen as they are, you would hear him again. Furthermore, if you put on a step of audio amplification, which multiplies everything by ten, then of course this will bring the unwanted station up to a point of loudness where you can easily hear him. That is why adding an amplifier sometimes seems to make tuning harder.

From this discussion you can see that a sensitive set will do just one thing more than an unsensitive one, that is, it cuts down the percentage of the distant station below the figure which you would otherwise get. It *never* really tunes it out *completely*. A good set may cut the ratio down to less than one-tenth that of a poor one, but it never drops the ratio to zero.

Now, as to the question of whether a set can be too selective. The more it excels in this quality, the more accurate you have to be adjusting the dial to the right place. But when you do get it right the music will be louder and clearer, just as the good ear trumpet will make Mr. A heard better above the babble than a poor trumpet. In case you take such a set to a city where there are several local stations going at once, perhaps it will not be able to eliminate entirely one of the loud nearby broadcasters. If so, it is not because it is too selective, but because it is not selective enough. If this quality were still further improved, then all locals except the one you want could be eliminated for your particular ears.

The next time you hear anybody discussing this subject, just imagine yourself in this circle of people — some whispering and some yelling—and that you have your ear trumpets trying to pick out one from all the rest. That will give you a correct idea of whether the statements being made are true or not.

American Radio Relay League

KEEP IN TOUCH WITH SHENANDOAH

F. H. Schnell, traffic manager of the American Radio Relay League, has turned over to the Navy Department the names of about thirty amateurs who will communicate with the Shenandoah during the western part of its transcontinental flight. At the same time he advised the amateurs of the procedures to be followed in keeping the airship in contact with the ground.

Many of these operators have agreed to maintain a twenty-four hour watch while the craft is in their immediate vicinity. Amateurs have been selected in the following states: Texas, New Mexico, Arizona, California, Oregon and Washington. About eighteen additional operators, using short waves, may be called on in an emergency.

NERK Will be on 90 Meters

The decision to delay for a few days the start of the Shenandoah's flight has enabled the navy department and the A. R. R. L. to work out the plans for communication in detail. Using the call NERK, the ship will transmit to amateurs on a wavelength of 90 meters while she will listen for amateurs on the band between 75 and 80 meters.

NERK will have complete control of communication at all times, Mr. Schnell told amateurs, and no operator should attempt to call the airship unless NERK calls CQ (the general call) or some amateur. NERK will attempt to communicate every day with NKF, the Naval Radio Research Laboratory at Bellevue, D. C., at 12:30 A. M., 4:30 A. M., and 8:30 A. M.; also at 1:30 P. M., 5:30 P. M., and 8:30 P. M., E. S. T.

If NERK and NKF are unable to communicate after five minutes of operation NERK will give the general CQ, or call specifically the nearest amateur operators. Both official messages and press despatches will be handled in this manner.

ELECTRIC POWER BOWS TO RADIO

Should the erection of a power line be permitted, if it causes interference with broadcast reception? This question was raised here recently when farmers south of Milwaukee objected to a petition of the local electric light company for permission to run high tension wire through their property. The farmers opposed the grant on the ground that the line would cause interference with the operation of their receiving sets. Two radio amateurs were called upon to give expert testimony.

Edward T. Howell, president of the Milwaukee Radio Amateurs' Club, Inc. and G. Forrest Metcalf, club technical committee chairman, testified at the hearing before Judge Walter Schinz. Attorneys on both sides examined them on technical points affecting power line interference with radio reception. Mr. Howell, who is an engineer by profession and an ardent amateur, mentioned cases where interference had occurred in Hartford, Conn., and Augusta, Me., and told of investigations made by the American Radio Relay League. Mr. Metcalf explained how such interference could be reduced.

May Go to Supreme Court

This is believed to be the first instance that a point of the kind has been raised in court. It is regarded as possible that the case may eventually be carried to a higher court for decision before work on the power line can be started. It was pointed out that with the advent of broadcasting, good radio receiving conditions have become an asset to a community. In selecting radio amateurs as expert witnesses, tribute was paid to the ability of the amateurs.

In places where power lines have caused trouble to radio reception, it has been found that the trouble generally has been due to poor construction rather than the existence of the line itself. In almost all such cases the interference has been eliminated by making the necessary repairs. The farmers believe the line may be a permanent cause of trouble, and they are determined to stand pat till the court gives its decision.

AMATEUR WAVES FIXED TO STAY

Secretary Hoover during a recent visit to Milwaukee expressed the opinion that the short waves allotted to radio telegraph amateurs, including their accustomed band between 150 and 200 meters, would not be altered for some time. Very few broadcast stations are desirous of getting down on the short waves, he said, most of the applications being for assignments between 400 and 526 meters. Only a few so-called "super" stations want short waves.

Mr. Hoover was in Milwaukee to address the banquet of the National Dairy Exposition, his only reference to radio being made to amateurs who interviewed him at his hotel. He said that the co-operation of various radio services had been so good that new radio legislation was not immediately necessary, at least until more data could be gathered. He declared that the present national radio conference would be open to all branches of the science.

Ships Troublesome on Great Lakes

When asked about the troublesome spark interference experienced by listeners in the Great Lakes region, he replied that the Department of Commerce had done all it could to get the co-operation of the shipping interests, but unfortunately the waves for commercial radio were fixed by law, and the government at present cannot shift ship stations to 800 meters as is desired.

He paid a tribute to Hiram Percy Maxim, president of the American Radio Relay League by saying that the latter, more than any other individual, best represented the amateur telegraphing fraternity. He asked if Milwaukee amateurs regarded Mr. Maxim as their representative. They answered in the affirmative. Mr. Hoover said that his son was an amateur radio operator and found much enjoyment in communicating with other "hams" throughout the country.

CORRECTION

The article, "Rebroadcasting the Correct Time" in our September 15 issue of Radio Progress was wrongly credited to R. H. Langley, of the General Electric Company. This article was prepared by Oliver D. Arnold.

Fone Fun For Fans

Not a "Stall"

Stranger entering postoffice: "Any mail for Mike Howe?"

"No, of course not. Who do you suppose would send mail to your cow?"—The Jewelers' Circular.

RADIO LULLABY

When days are dark and dreary
And nights are long and cold
I won't forego my Radio
For wagon loads of gold.

When days are full of sunshine
And nights are cool and fair,
My joys begin when I tune in,
There's music in the air.

When the heart is full of trouble
And thoughts are sad and blue,
You'll find this so; a Radio
Will change your point of view.

So follow my instructions—
No matter where you go,
You'll always find real peace of mind—
Just take your Radio.

—*Crosley Radio Weekly.*

Appropriate

After many conferences had been held by the board of directors of a small-town bank about buying a new water cooler, a grouchy old member had this to say:

"Gentlemen, before we adjourn, I move that our next conference be held on a merry-go-round."

And as they looked at him in astonishment, he added the tag of explanation:

"We never get anywhere."—*Wall Street Journal.*

Wrong Order

"Miss Curleycue," murmured the office manager to the stenog, "I don't wanna be harsh. Nothing like that. I really don't."

"Let's have the answer," said the damsel nonchalantly. "What's gone wrong now?"

"I just wanna ask you not to write your young man during business hours. Letters are apt to get mixed. Herb & Blurb report we have sent 'em a shipment of love and kisses instead of the axle grease they ordered."—*Pittsburgh Sun.*

No Gift

A business man stepped into a butcher's shop.

"A piece of beef for roasting," he ordered briskly.

The meat, mostly bone, was thrown on the scales.

"Look here," remonstrated the man, "you are giving me a big piece of bone."

"Oh, no, I ain't," said the butcher, blandly, "yer paying for it."—Radio Merchandising.

Powerful Pie

The lady—"I gave you a piece of pie last week, and you've been sending your friends here ever since."

The tramp—"You're mistaken, lady. Them was my enemies."—*Birmingham Weekly Post.*

"WITH A GRAIN OF SALT"

Continued from Page 17

It is of no great use to plug one hole where there are numerous others; so eliminate the leaks all through the radio set, as well as that found in many of the older style variable condensers.

And whatever you do, before you discard your present set, in favor of a newer "dyne," be sure that the present one is working at its best. Remember that the DX listener spends a long and weary vigil and endures the torture of static and code interference in order to boast of his distance and number heard and can occasionally be pardoned if he gives you the impression that he hears 3000 miles almost nightly when as a matter of fact he may hear it once a season.

HOW SENDING STATION WORKS

Continued from Page 24

Choosing the Circuit

There are several circuits available for use in the radio phone transmitter but they fall under two broad headings; the self excited and the externally excited. Fig. 5 falls on the former class while Fig. 4 is separately excited. The majority of stations use self excited circuits as two less tubes are needed. Starting with the simplest we will show the big differences between the self excited circuits, leaving out the unessential parts. By following the arrows a rough idea of the feedback may be formed. Fig. 11 shows the fundamental Meissner. This is similar to the three coil radio set. This is very easy to adjust to different tubes, antenna, grounds, etc. and is a favored circuit. The elimination of one of the coils in the Meissner results in the circuit of Fig. 12. This is a tickler circuit. The Colpitts (Fig. 13) is the familiar "flivver circuit." It is easily seen that this is no new invention as it has been in use for years as a transmitting circuit. Fig. 14 is the Hartley, which is the simplest of them all. However, it is the hardest to adjust as there are no variable coils or condensers. This is best adapted to the high capacities of broadcast station antenna but like all single circuit sets causes interference.

Broadcasting stations use mostly the Meissner circuit, because it is flexible and of all the self excited circuits, its wave is steadiest.

The Master Oscillator

The other type of transmitter is the externally excited circuit. This is the master oscillator. A small tube is set oscillating and its output amplified by a large tube and passed to the antenna. On account of the antenna not being part of the oscillating circuit, its movement in the wind does not affect the radiated wave as with the self excited circuits. It is this absolute constancy of wave which is the advantage of the master oscillator. It is more expensive and so not greatly used.,

A typical broadcasting circuit uses two 50 watt or 250 watt tubes in a Meissner circuit for oscillators. Two 50 or 250 watt tubes are employed as modulators in the Heising system of modulation. A fifty watt speech amplifier is found in the radio set. Between the transmitter and the studio, a three tube speech amplifier (previously menioned) is used to boost the weak voice currents.

This concludes a part of the simple explanation of the how and why of the radiophone transmitter. The reader by carefully studying and learning the above presented facts will know as much as some self styled radio experts.

℞ DR RADIO PRESCRIBES.

NOTE: In this section the Technical Editor will answer questions of general interest on any radio matter. Any of our readers may ask not more than two questions, and if the subjects are of importance to most radio fans they will be answered free of charge in the magazine. If they are of special interest to the questioner alone, or if a personal answer is desired, a charge of fifty cents will be made for each answer. This will entitle the questioner to a personal answer by letter. However, if the question requires considerable experimental work, higher rates will be charged.

Question. What is meant by a radario?

Answer. This is a new word which has been used by some of the broadcasting stations to mean a play which is particularly adapted to radio broadcasting.

Question. There is a hum in my radio, which is oftentimes quite annoying. Is it likely that this comes from outside or is it in the set itself?

Answer. The chances are about even. There is only one way to test out which part is at fault. This is to substitute either another aerial or another radio set. Take your radio to a neighbor's house and try it out on his aerial. If the hum still continues, then your antenna and ground can not be the cause. Then listen to his own set operating. If the same hum comes in this will indicate that the trouble is outside and is effecting all the radios in the neighborhood. But if his set is quiet and yours is noisy, the answer must lie in your own outfit.

Question. How many guy wires should be used in supporting an aerial pole 40 feet high?

Answer. If this is made of iron pipe it is usual to guy it at each of the joints, and at the top. This would mean three sets of guys as such a pole would probably be built in three sections. At each level it is wise to put on either three or four wires. It is not considered good practice to use only two unless they run in opposite directions from the joint. The strain of one is neutralized by that of the other. It is also well to have a guy wire at the top of the pole run in the same direction as the aerial. When an aerial breaks in a heavy storm the pole snaps back with considerable violence, and if no guy holds it it may easily topple over backwards.

Question. How do you charge a "B" battery from a Tungar?

Answer. By using a special attachment which may be obtained from your radio dealer this "A" battery charger may be converted to charge "B" batteries. An article will appear shortly in RADIO PROGRESS which describes the method of operation of this device.

Question. What is the advantage of using one loop inside another when working with a loop aerial in a radio frequency set?

Answer. There is no gain at all by this connection. The two coils are connected in series and act as a single unit. The only reason for using two coils is either to make the construction of the frame simpler, or else as a talking point in selling the loop.

Question. The new UV-199 tubes are coming through with a bakelite base, instead of a brass shell, why is this?

Answer. Although the cost sheets of the Radio Corporation are naturally not open to inspection, in all probability the new base can be made at a slightly lower expense than before. But aside from this it is better than the old. As is now well known, it is an advantage to have as little capacity between the grid and plates as possible. The prongs by which the connection is made to grid and plate act like a condenser and for that reason should be as small as possible, and separated by the widest distance. This is one of the failings of the old style tubes—the UV-200 and the UV-201A. At the time these were designed the laws of radio were not so well understood, and it was not realized what a disadvantage the old arrangement caused. In them the prongs were quite long and the grid and plate were side by side instead of being opposite.

The change to the style used in the UV-199 made quite an improvement. Instead of the grid and plate leads being side by side, they are spaced opposite each other or across the diameter of the tube. This gives the widest separation possible. Besides this they are cut just as short as will make a good contact. This also reduces the capacity. However, when the brass shell is used to support the base that in itself introduces an unnecessary condenser action. The change now made in omitting this will reduce the unwanted capacity to its lowest value. Of course, as an audio amplifier, the change will cause no improvement, because in such a hookup a small amount of capacity does no harm. But as a detector, and especially as a radio amplifier, the new tubes are the best ever put out.

Question. How does it happen that some radio sets omit any rheostat for controlling the filament?

Answer. As far as we know, there are only two styles which leave this unit out completely. One of them works with the UV-199 tube and as the latter requires about three volts to operate they employ two dry cells in series. Each cell when new gives 1½ volts, and so they two add up to the necessary three. As the batteries get old and weak this pressure drops off and so the music does not come in as loud and clear as before. However, the tube operates very well down to a pressure of 2½ volts and this allows quite a long service from a pair of batteries.

The other style of radio which does not use the rheostat is one which takes a WD-12. This tube operates at 1.1 volts on the filament. The set in question puts the full battery voltage direct on the tube. That means that when the dry cell is new you are feeding 1.5 volts to it, which is in excess of .4 volts or 33% too much. Of course, the tube works all right for a short while, but finally it burns the oxide coating off the filament and makes the tube useless. By turning the rheostat around to full on, any radio set can be made to operate without any filament control, but in such a case it will have the same disadvantage—that it shortens the life of the tube to a small fraction of normal. The only advantage of such operation is that it is cheaper to get along without the rheostat. The cost comes in buying replacement tubes.

Question. What is meant by a matched head set?

Answer. If two phones are made by machinery and are supposed to be exactly alike they probably will not differ very much in tone. But owing to small irregularities in the iron core, and also in the winding it happens that the magnetic strength may vary slightly. Besides the diaphragm is a very sensitive device, and it is difficult to get these identical. That is why two phones will oftentimes have slightly different tones. In the matched head sets, care is taken by the manufacturers to make sure that the tone of both head phones is just alike. This will probably result in slightly better music, although the average user does not find much trouble from this score with good phones that have not been especially matched.

BROADCAST BILL IS QUITE A MUSICIAN

My father's a musician,
Said Broadcast Bill one day,
And that's one reason, I suppose,
Why I just love to play.

What instrument? We asked him,
He said, "Why, don't you know,
At first I played a phonograph,
And then a radio."

—By Del.

Thrilling Man

He (ardently): "Have you never met a man whose touch seemed to thrill every fiber of your being?"

She: "Oh, yes, once—a dentist."—*Boston Transcript.*

Why, of Course

"My dear, where did your wonderful string of pearls come from? You don't mind my asking, do you?"

"Certainly not. They came from oysters."—*Regiment (Paris).*

TAIL TRIES TO WAG THE DOG

Local authorities can erect big signs outside their city limits, restricting the speed at which autoists can pass through their territory, but they cannot legally regulate the use of the ether for any form of radio communication. It is unconstitutional for cities to regulate radio traffic.

This opinion was anticipated by Secretary Hoover at the radio conference in Washington, D. C., in March of 1923, when he stated specifically that "the Government owns the ether." It is also the outcome of a peculiar legal entanglement that threatened at one time to set local, city and State authorities at variance with the Federal Government. It was finally made clear to those interested that no lesser regulatory body can govern any subject already regulated by Congress.

The State Radio Inspector

Last year, when the radio season was in full swing, one State was on the point of creating the office of "State Radio Inspector," and a number of cities were giving serious consideration to the matter of prescribing how and when the ether should be used. Their only authority for so doing was the so-called "police power" which State charters confer on them for the abatement of nuisances that endanger the health, morals or prosperity of a community.

That this special authority should be interpreted as covering the subject of radio communication was regarded by the legally informed as being little short of humorous, and practically all cities where such agitation had cropped out hastily pulled in their horns and ruled out proposed ordinances of this nature.

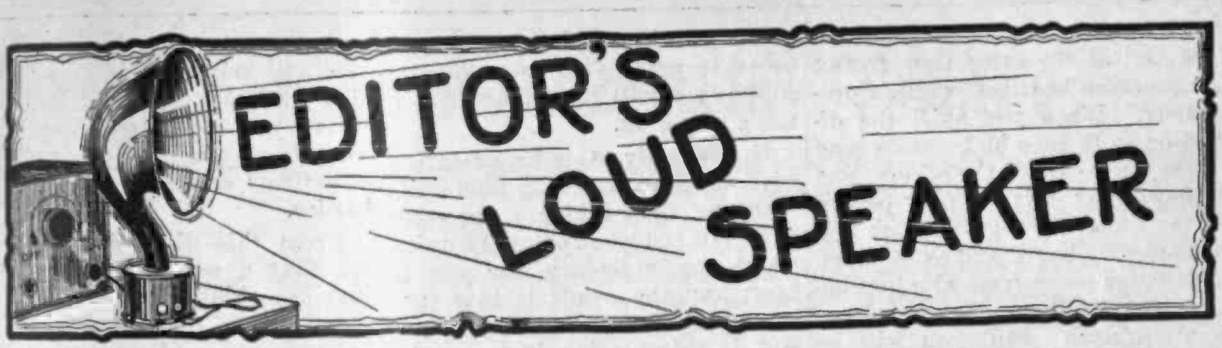
Probably no city in the country outside of Atchison, Kansas, actually passed an ordinance of the kind and this one was worded so indirectly that it was not regarded finally as encroaching in a literal sense upon the recognized and undisputed Federal powers.

Timely Warning

He—"There's something very special I want to ask you, dear. Could you—er—will you—"

Clock—"Cuckoo! Cuckoo!"

He—"—er—write something in my autograph book?"—*London Humorist.*



WE are glad to notice that a lot of interest is being shown in the various sets which have been described in this magazine. It may be that some of our readers have built sets which they find are unusually good in some respects and which they think will be worth describing.

In trying to live up to its name RADIO PROGRESS is always glad to get descriptions of any new hook-ups, sets, or interesting experiments which you may know about. Of course, it is necessary to have tried them out before going any farther. Probably most everyone has found by experience that sometimes a scheme looks pretty good on paper but does not seem to work out so well when it is reduced to coils and condensers.

Oftentimes a fellow who is very good at radio work, and is a first-class designer and experimenter, feels that he is not so good when it comes to writing. This is a mistake, at least for this magazine. As you have probably noticed our policy is not to print articles which are written in an elevated style, with long sentences and long words. In describing radio we find that it is easiest to understand when ordinary words and sentences are used. So if you have any idea of value, do not be discouraged because you can not put it into high flown language. Just write it down the way you would explain it to your friend Bill.

For instance, do not say, "From the above discussion it will be evident that the before mentioned coil must be of considerable magnitude." You would never talk that way. You would probably talk like this, "From what I have just said you will see that the coil must be a big one." That is the style which RADIO PROGRESS wants. From the number of letters which are received praising the clearness of our articles it seems that most fans prefer such a form of writing.

The season of experimenting is just starting. The next time you run across an idea which is particularly good, just sit down, and write a description in your own words, make a pencil sketch (which our artists will do over in ink) and send it in to RADIO PROGRESS.

SELECTIVITY—GOOD OR BAD?

A GREAT deal is being said nowadays about selectivity. Some people are discussing it in a way which seems to show that it is sometimes a bad thing. Most of such articles are incorrect.

By selectivity is meant the ability of a set to pick out some one station and cut all the rest, so that no others interfere with the station which we wish to hear. Of course, in general it is a local station which is not wanted and a distant one which is desired. There are two reasons for this situation. In the first place the water lilies across the pond always look prettier than the ones right by the boat. So a concert coming from a thousand miles away always seems like a better performance than the one given by local talent right next door.

Besides this it is no trick to pick up the broadcasting coming from across the way. A $2.00 crystal set will do that. But to get 1000 miles while one or more local stations are going is something to boast about. There are comparatively few sets on the market at present which are able to obtain such results. A set which can do it is called selective.

There is a great deal of misunderstanding on this subject. Most people seem to think that it is some weird character of radio itself which is concerned. Instead of thinking of a complicated set having some mysterious ability to cut one or the other out, just imagine that you are the radio set and that you are receiving with your ears the conversation of several people in the room around you. If you stand in the middle of the room you will have no selectivity at all. Any two people talking in the same tone will be heard equally loud. Those that are shouting will be "received" louder than those whispering. Now make it selective by putting an ear trumpet in each ear and pointing these at some one person.

You are now a set which is selective to some extent. When you point your horns at Mr. A