August 1, 1924
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RADIO PROGRESS

"Always Abreast of the Times"

IN THIS ISSUE:

YOU WILL UNDERSTAND THIS MAGAZINE---AND WILL LIKE IT

PUBLISHED TWICE A MONTH

RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 10

Contents for

AUGUST 1, 1924

A Neutrodyne is a fearful and wonderful thing to many people. In our next issue will be given the hook-up of the Rice Neutrodyne, which is the simplest to understand and the easiest to neutralize of any set we have run across. To those who want to build their own sets, we recommend this article, which will show the actual construction.

A rheostat is such a simple thing that it is often overlooked when it comes to instructions for operating a set. Do you realize that improper use of this device will cost you money when it comes to buying new tubes? A discussion of the reason why some makers use six rheostats and some leave them out altogether, will be given in the RADIO PROGRESS of August 15.

What does a potentiometer do to radio frequency that it does not to audio? A clear discussion of this perplexing question is given by Vance in the coming magazine.

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RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 1, No. 10 AUGUST 1, 1924 15c PER COPY, $3 PER YEAR

Some Sets Squeal, Some Don't

Perhaps Something's Wrong with a Radio Which Won't Squeal

By HORACE V. S. TAYLOR

WHEN you tune your radio to your favorite station, one of these hot nights, perhaps you get a fine piece of music. Then, bang! In the middle of it comes a horrible howl from a nearby "blooper" or re-radiating set. At such a time one cannot see any good at all in a squeal.

As a matter of fact, there are two broad classes of radios. The first in point of invention, if not in goodness, is the regenerative set. The second is the set using radio frequency amplification. But regeneration is a wonderful thing when properly operated. It increases the range of a vacuum tube sometimes as much as 50 or 100 times. The general theory has been explained a good many times and is quite simple. It consists only of hooking the output or plate of the tube to the input or grid, so that some of the energy from the "B" battery is fed back to strengthen the weak signal coming in from the aerial.

The First Steam Engine

This calls to mind the first models of the steam engine invented by Watt. He designed an engine consisting of a piston, which traveled back and forth in the cylinder, and by its connected rod turned a heavy fly wheel. There was a valve in each end of the cylinder. When the piston got to the top of its stroke, a boy, who operated the engine, would open the valve and admit steam to push it down again. When it reached the bottom he turned off the top valve and opened the bottom, so allowing the steam to push the piston up again. Of course, it had to run at rather slow speed as it was limited to the quickness of the boy. This engine was made in several models until the idea was thought of to make the engine work its own valves. So the cocks controlling the steam were hitched up to the fly wheel in such a way that when the piston reached either end of its motion some of the energy of the fly wheel was fed back by a lever to the controls or valves, and so the motion was made self sustained.

There is the same difference between a regenerative and non-regenerative set. The latter, as illustrated in the hook-up in Figure 1, is very simple in operation, but it has a drawback. No very great distances can be covered. In fact, it is scarcely better than a crystal in this respect. Twenty-five to fifty miles is all that can be counted on in a real non-generative tube set. Sometimes we heard of longer distances being pulled in, but generally in such cases we find that as a matter of fact the set, while designed without a tickler coil, nevertheless, has the wires spaced in such a way that some feed-back action between the plate and the grid causes real regeneration.

Why Only Two Amplifiers?

It is this same idea of the proper spacing of the wires, which is often discussed in connection with audio amplifiers. Even on the most expensive sets, it is rare to see more than two audio frequency amplifiers. The reason is that when three of these units are hooked up one after the other, it is very difficult indeed to distribute the leads and connections in such a way that they do not react one on the other and cause a howl. Such a howl is evidence of this feed-back action, so the next time you hear a friend talk about getting several hundred miles on his radio, which he thinks has no feed-back, you can tell him that he is fooling himself.

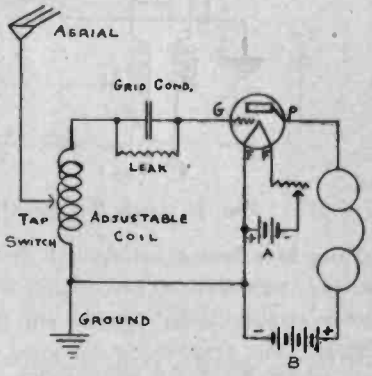


Fig. 1. Non-Regenerative Set

When Armstrong, or DeForest (they are still fighting to see which it was) first invented regeneration, it was hailed as being the most wonderful thing in radio next to the vacuum tube itself, but it has recently come into a rather bad name, owing to the terrible trouble caused by so many sets of this kind being improperly operated. As a remedy for this condition there have been several hook-ups invented which do away with it. These all depend on the basic principle of radio amplification. This latter differs from the audio in

this way. The audio waits until the detector makes music out of the incoming wave and then steps it up to make it a lot louder. It does not increase the range of the set very much, but does enable a loud speaker to be connected up instead of the phone.

Different with Radio Steps

Radio amplification, on the other hand, takes the waves just as they come from the aerial and increases their volume before feeding them to the detector. In this way the range of the set can be extended several hundred miles. If several steps are used, a loop aerial can be used in place of the ordinary outdoor wires. Such sets when properly constructed have no chance to squeal, as they do not oscillate.

Radio Amplifiers Don't Squeal

Most sets which use radio amplification do not offend in the way of squealing into the air. While the radio tube may not be entirely a one-way street to prevent oscillations going backwards, still it reduces them so much that they cease to bother other listeners-in in the vicinity. The only objection to these sets is that they are usually somewhat more difficult to build than those which have the detector for the first tube.

When a neighbor adjusts his set so that it squeals there is no way you can tune him out short of changing your adjustments to listen to some other broadcasting station. This is unfortunate but true. The reason is, if you want to hear, say, KDKA at 326 meters,

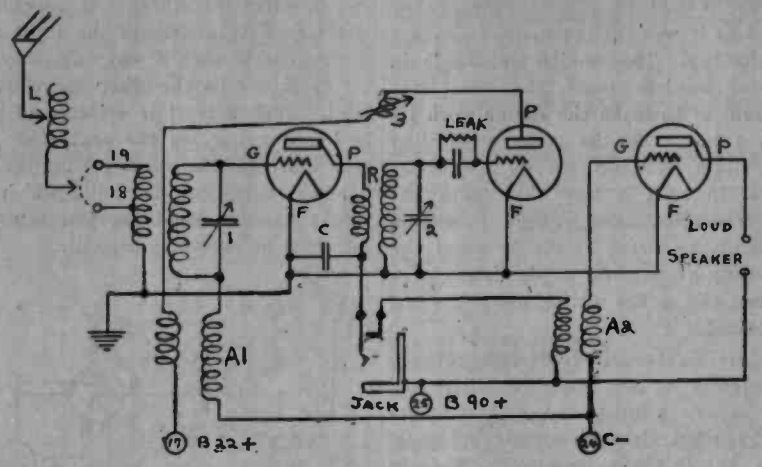


Fig. 2. Uses Regeneration and Radio Amplification

There have been a few designs which combine regeneration and radio frequency amplifications. Such a set, the Trirdyne, was described in our issue of July 1. The hook-up is shown in Figure 2. It will be seen that the incoming radio waves, after going through the tuner, reach the radio amplifier tube. From there they go through radio transformer "R" to the detector, but the plate of the detector is connected through Coil 3, which is an adjustable tickler, before they reach the audio amplifier. The second tube will oscillate and cause a squeal if the tickler is turned up too high. However, this squeal will be only in the ears of the user. It will not get on the line since the first tube acts in such a way as to block the squeals from running out backwards into the line.

then any one who works his set on 325 meters will interfere, and since the two waves are so close together, any one getting the one will get them both. No matter how good your radio may be, don't try to tune out your neighbor's squeals, as it is a waste of time since it *cannot* be done. The best cure for this condition is a sharp axe wielded by a Boy Scout. A few deft strokes on your neighbor's set will tune out the squeals completely.

Owing to the fact that regenerative sets have been put out in such large quantities in the past, and are so reasonable in price, it is conservative to say that fully 90 per cent. of the radios now in use operate on this principle. That being the case, it is necessary to take them into account.

For the benefit of those who use this type, but who have sets which are not working properly, the following description may be of interest:

How it Should Squeal

A regenerative set, if working properly, *can* always be made to squeal. It is very much like the brakes on an automobile. If they are properly adjusted by pushing hard on the brake pedal, both rear wheels can be locked so they will slip over an asphalt pavement. Naturally this is rather rough on the tires, and furthermore, the car does not come to rest quite as fast as it would if the brakes were put on with just the amount of pressure so that the wheels almost slip, but don't. Once they begin to slide, the tires don't grip the ground nearly so hard, and so the braking action is considerably less. But here is the point: if your brakes are not powerful enough, or not adjusted so that you *can* slide the wheels when you want to, then there is no chance that you can bring them to the point of *almost* slipping.

Applying this to our radio problem, we shall find that the tuner is most sensitive when the tube is just at the point of oscillating. That is, the plate is coupled back to the grid so as to give just the right amount of tickler action, so that when the aerial starts a signal the feedback will just keep it up. If the tickler coil is turned on any stronger, then the tube won't wait for the aerial to give it the signal, but will start something itself with the result that our neighbors hear the squeal.

Is Your Tickler Strong Enough?

But we shall not be able to get the tube up to the point of oscillating unless the tickler is strong enough to go a shade farther and make it actually oscillate. Here again it is not that we want it to break into vibrations of itself, but we want it to be *able* to do so. But some sets through one trouble or another will not work this way and so do not make good receivers.

One thing which often causes this trouble of not being able to oscillate is shown in Figure 3. This is an ordinary single circuit hook-up with a variocoupler and tap switch for coarse adjustments and a series condenser for fine tuning. Regeneration is controlled by turning the rotor of the coupler. The output goes from the plate to the tickler plate or rotor and then to the jack and "B" battery. Let us assume for an in-

stant that this is all there is to the set; that is, the audio amplifier shown on the right has not yet been added. In that case, the telephones will be connected into the circuit where the jack is.

By-Pass or Stopping Condenser

Now notice the condenser "C." It is called the by-pass or stopping condenser. It has a very distinct use in the circuit. The output of the plate "P" contains two parts—the high frequency, going about one million times a second, and the low or audio with a speed of a few hundred cycles. Both these go through the tickler, but owing to the low speed, the audio does not have any effect on it. It is the radio frequency which reacts on the grid to cause oscillation. But when these two vibrations reach the point "X" they divide. The higher is able to go through condenser "C" which usually has a value of .001 mfd. (microfarads). As a matter of fact, it can't go the other way through the phones because their impedance or electrical weight is so great that they can't be made to vibrate at such tremendous speed. But the audio frequency can shake up the diaphragm at its vibration without any trouble. Of course, the low pulsations are not able to go through condenser "C" as they are too slow to affect it.

It oftentimes happens that in one tube sets, especially those made at home, that condenser "C" is omitted. This causes no trouble for the reason that the telephone cord acts like a condenser itself. You see it is built of two conductors or wires which are separated by an insulator, that is, the silk of the cord. Now any two pieces of metal separated by an insulator will form a condenser. Such a cord has a capacity not quite as big as that mentioned for "C," but still large enough to enable the radio frequency to pass and so work the tickler to cause oscillations.

Adding One Step

However, we have decided to make our single tube set over to use a second one. After connecting up the one step amplifier, as shown in Figure 3, we find that the detector will no longer oscillate, and as a result we cannot get the distant stations the way we used to. What is the trouble? The answer is this: When the phone plug is inserted in the detector jack, it puts the cord in circuit and it acts as condenser "C" as just described, but when we pull out the plug, and so connect the primary of the audio transformer in its place, then we have suppressed the condenser. How then will the radio frequency get through? It can't go through the transformer, since the inductance of this instrument is about the same as that of the phones it replaces, and instead of having six foot leads to act as a condenser, its connections are made by wires only an inch long and separated some distance apart, so you can't blame the radio waves for dying in their vain attempt to get back to the filament.

This explains why a good many sets will not work as well with one step of amplification as they did on the detector alone. Of course, the remedy is very simple. A .001 or .002 mfd. condenser, costing fifteen cents, can be connected,

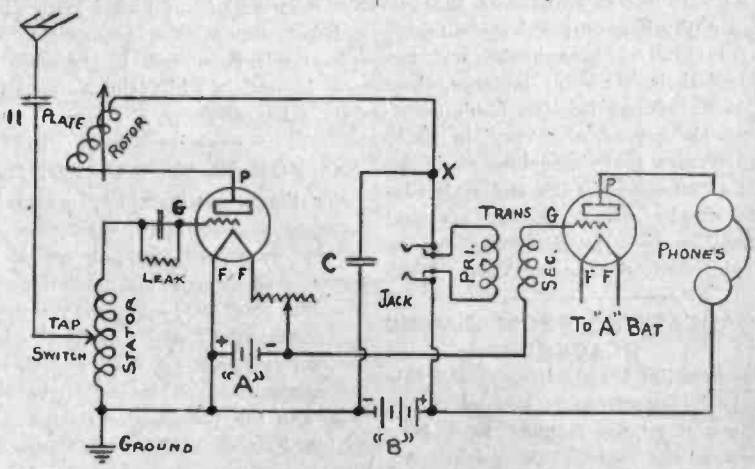


Fig. 3. How to Add One Audio Step

as shown in the diagram, and it will immediately restore the radio to its former efficiency. When the phones are plugged into the jack it merely puts the two capacities ("C" and the phone cord) in parallel, which raises the total value somewhat. But this does no harm since the value of capacity is not critical at all. Any reasonable figure is quite satisfactory.

Some Tubes Won't Squeal

In case your regenerative set will not oscillate when you want it to, and contains the condenser we have been discussing, then the next most likely place to look for trouble is the tube itself. Some tubes make much better detectors than others even of the same style. This can easily be proved by trying out several tubes in your set and noticing how far the tickler dial has to be turned to make the set start to squeal. With some tubes this action will occur at half the reading that others require. If you have only one tube to try then it is difficult to test to see whether it is at fault or not. In such a case it is well to borrow a neighbor's tube just long enough to see if it makes any difference.

If neither of the above causes are responsible, and a new set will not oscillate, it usually means either that there is a wrong connection or that the tickler leads are reversed. Try interchanging the two connections to the rotor of the variocoupler and if that is the trouble it will be easy to get the tube to squealing.

Just a word of caution here. In consideration to your friends the testing which has just been described should be tried late at night so as not to disturb other broadcast listeners who may want to enjoy the regular programs.

KEEPING IN THE SWIM

Westinghouse Station WBZ is playing an important part in the "Learn to Swim" campaign which was conducted recently in the city of Springfield (Mass.). The campaign was not only a timely one with the swimming season setting in, but much valuable information was imparted. WBZ radiocast several of the talks given by authorities on swimming and helped wonderfully in putting over the promotion. The broadcasts included talks on various swimming strokes, reasons why every person should learn to swim, and methods of resuscitation.

Some Sending Station Stories

LISTEN, MOTHERS, EVERY WEDNESDAY

After receiving the co-operation of several clubs interested in the welfare of young mothers, WEAF is now undertaking a regular weekly series of talks to be given each Wednesday morning. Among those helping are the Federation of Child Study, which includes in its numbers some of the country's most important psychologists, the Board of Health, the Speakers' Bureau of the New York Tuberculosis Association and the Board of Education of New York. They are assisting in order to make available to WEAF's listeners the best known authorities on problems of taking care of children through the first two years of their life. For instance, there will be an address by Mrs. Louis Jersawit, on the subject of "Fear," in which she discusses that important basic instinct as affecting the life and early education of the child. Another practical talk will be given by Betty McCann, on the subject of "Sewing for Your Child."

BROADCASTING FROM DIVERS PLACES

Since radio broadcasting took this country by storm, many strange things and many strange sounds have been broadcast, the roar of the mighty Atlantic's waves, the rattle of a rattlesnake, the voice of an aviator high in the heavens. Not satisfied with the novel idea of broadcasting the surf noises of the mighty Atlantic, the engineers of Station WIP, Philadelphia, looked for a stunt that would be even more thrilling.

So a deep sea diver will drop over the side of a boat, to the floor of the Atlantic Ocean, fifty feet or so below. In his diving helmet, he will have a special radio microphone, connected by lead cable to the boat and from there to the remote control pick-up station WIP, on the Steel Pier, Atlantic City, N. J.

C. O. Jackson, expert diver of the Philadelphia Derrick and Salvage Corporation, will have the distinction of being the first man to talk over radio from the bottom of the sea. The strange fish, and other sea creatures living at the bottom of the sea will be described. The appearance of the sub-sea foliage and mineral formations will be broadcast in full detail.

This will be the first time that any broadcasting station has sent a microphone to the bottom of the sea. Special cable, waterproof and flexible, is necessary to connect the diver to the boat. The voice will originate from the helmet of the diver, thence to the boat floating on the surface of the water above. The boat, in turn, will be connected by wire to the remote control station on the Steel Pier. Here the voice from under the ocean will be amplified many thousands of times, then transmitted over special telephone lines to the main station, located in Philadelphia, more than sixty miles away.

DO YOU PLAY THE PONIES?

For the first time since horse racing became a favorite sport, sports men will be able to follow the progress of the horses, even though they are miles away from the track. The international races at Belmont Park and Aqueduct will be run on September 4 and 27, and through the co-operation of Major August Belmont and the Westchester Racing Association, Station WJZ of the Radio Corporation will broadcast running descriptions of both races direct from the tracks.

Epinard, which in French means "spinach," the famous four-year-old which Pierre Wertheimer has recently brought over from France, is now in training for the series of three races scheduled for the early fall. He will be the star attraction of the first racing broadcasting in history, and the best horses of this country will be "seen" in competition with the foreign favorite by the radio listeners. J. Andrew White, who has described every kind of sport which the radio has so far carried to the distant fans, will talk to the microphone in the judges' stand, and direct Western Union wires, especially installed for the races, will carry his voice to the studio on West 42nd street, New York, where it will be put on the air.

The Belmont Park race on September 4 will be over the six-furlong (three-fourths of a mile) distance, and will see such American horses as Wilderness, Miss Star, Snob II, Baffling and Sun Pal pitted against Epinard (accent on the last syllable). At Aqueduct, on September 27, it is expected that Princess Doreen, Wilderness, My Own, Sun Pal, Little Chief and Snob II will race the French horse over the mile distance.

These international races are the result of the interest and enthusiasm aroused in racing circles both here and in France by the Zev-Papyrus race last year. They have awakened even more attention than before, for Epinard won't have the troubles that Papyrus had. He has arrived in time for much longer training here, so he can get used to our tracks. His jockey is Jasper Leigh, an American ex-horseman, who well knows our methods of racing. The three races which have been scheduled will let the French horse show his form at various distances and over three different tracks.

"AIN'T A-GOIN' TO RAIN NO MO"

Weather reports broadcast from WGY have sometimes saved farmers from heavy losses. On the other hand, a Malden, N. Y., resident recently informed the Schenectady station that he had suffered a loss because he put too much trust in the forecast. "After getting the weather report from you yesterday, predicting showers," he wrote, "I went out and set several thousand cabbage plants, knowing if we got rain they would be safe. Well, we didn't get a drop of rain, and it begins to look as though I am in for a loss, for the simple reason that I am big enough fool to believe anything that comes over the radio. After this, when the announcer says the weather report will now be given, I will switch off and get another station. It makes me tired."

High Frequencies and Their Application

Comparing Heat, Light, Radio and X-Ray Waves

By GEORGE LEWIS of the Crosley Radio Corp.

FREQUENCIES and their application to science are a very important subject to engineers. Of course, the word "frequency" is used in the technical sense, and means the number of times per second that electricity varies between positive and negative values. If we stand on the seashore and watch the waves roll in, we may count them and find that 20 waves break every minute. In that case they would have a frequency of 20 per minute. But the radio waves come in so fast that a minute is too long a time to use in measuring them. For that reason the frequency or speed of vibration is always specified as so many cycles per second. Each cycle is a complete wave consisting of a hill and a valley.

10,000,000 to Cigarette Paper

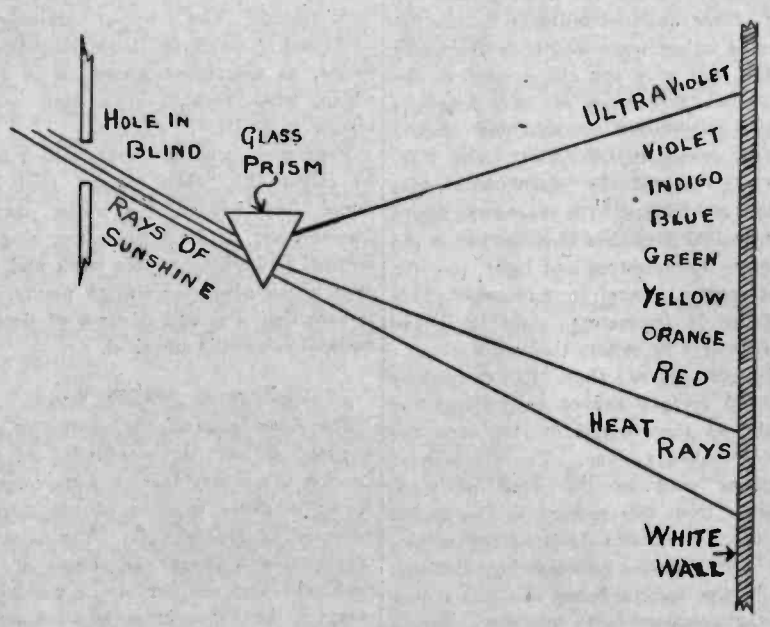
In one of the radio research laboratories a large chart has been prepared in colors which shows the different frequencies from the audible sound waves to those of the ultra X-rays. Comparison may be made between the speed of vibration of the powerful radio station in Annapolis and a piece of cigarette paper with a small quantity of radium on top of it. The speed is so slow in the first case that the waves are very long, long enough, in fact, so that it takes only about 250 of them to reach all the way from the broadcasting station to Europe. But the radium gives out waves of such tremendous high frequency that they are short enough to require 10,000,000 waves to go through the thickness of the cigarette paper from the top surface to the bottom. Comparing these two, that is, a few hundred to span the Atlantic, or a few million to penetrate a sheet of paper, gives the tremendous ratio between the quantities which we find in nature. The shortest wave lengths (highest frequencies) now detected are about one-million-millionth of a meter.

Colors We Never See

They are found by spectrum analysis. Do you remember how you have taken a glass prism and let a ray of sunshine through it in a darkened room? It broke the light up into seven colors, red, orange, yellow, green, blue, indigo and violet. But there were a good many "colors" beyond the violet which the human eyes cannot see, but which a camera can. By taking a picture of these spread out colors, which are called the "spectrum" of the sun, we find the seven which we can see and a great many more in the space which is called the ultra-violet. See Figure 1.

Tells Metals by Its Lines

If, instead of using the sunlight to make our spectrum of seven colors, we substitute a tungsten lamp, then the same thing will be seen after the rays of light have passed through the prism. But the arrangement of the colors will be somewhat different, and, if we take a picture of it, the ultra violet region, as shown by the film, will reveal a series of lines not like the sun. As a matter of fact, each element has its own arrangement of lines in the spectrum. By heating any metal red hot and then taking a picture of the light it is possible to tell immediately what kind of metal it was. The apparatus consisting of the prism and camera is called a spectroscope and is a very useful instrument in the laboratory.



Map of Location of Various Rays

It is with this same kind of instrument that the astronomers are able to tell what the ingredients of the stars are. This was the way that the gas helium, was discovered. It was found on the sun (called "helios" by the Greeks) long before it was discovered on the earth. The spectroscope shows that it is exactly the same in both places. Helium is used now to fill the big navy airships like the Shenandoah.

Squeaks Are Fast Vibrations

When we get to vibrations of the air it is known that sound waves have an audio frequency of from sixteen cycles a second for the lowest bass note up to twelve or fifteen thousand for the highest squeaks that can be heard. These high frequencies are very sharp, piercing and unpleasant to the ear.

Speeds below sixteen oscillations per second are so slow that the eye can see the separate movements, and so these are usually not called vibrations. The first band of frequencies then is considered as that of sound, from sixteen to, say, fifteen thousand. Of course, the exact limits are not at all sharp and vary considerably between the ears of one person and another.

Changing Meters Into Cycles

Here it might be remarked that it is easy to convert from wave length into frequency. Divide the number 300,000,000 (three hundred million) by the figures of either wave length or frequency and it will give you the answer in the other one (frequency or wave length); thus, 300,000,000 divided by 25,000 meters equals 12,000 cycles. Also 300,000,000 divided by 1,000,000 cycles equals 300 meters. The reason the figure 300,000,000 is used is because that is the distance radio waves and light, too, for that matter, travel in a second. This distance is in meters, since it is the wave length in meters that we use.

Longer waves than 25,000 meters (12,000 cycles) cannot be utilized for radio, as they would overlap into the audio-frequency zone. The commercial stations send in the band of wave lengths from 600 upward to the 25,000 meters. From 600 down to 200 meters are used by the broadcasting stations, while the meters below are given over to the amateur radio operator. But a conference is to be held which will probably give some of this zone to the better-class experimental stations.

Electricity and Medicine

Radio, as it is known to-day, is continually adding to the union between electricity and medicine, and affords an unexplored field for the experimenters. The medical scientists are just beginning to realize the possibility of using high frequencies in the treatment of disease.

The first action of human nerves of the body in detecting waves is found in their ability to feel the motion (or oscillation) of heat waves. The speed of the oscillation determines the temperature. A cold piece of iron differs from a hot one only in that its molecules are dancing around rather slowly, while in the latter case the little particles are jazzing at tremendous speed. The hotter it is the faster they go. When the metal gets red hot they go so fast, that is, the frequency of vibration is so high, that they shake up the ether and send waves of light to our eyes. A young scientist, Samuel Ruben, has worked out with great success a method of treating skin diseases with heat waves.

What Colors Really Are

Light waves have their frequencies, and each distinct sensation of color conveyed to the brain is but the registration of a different frequency or wave length. When they are all projected together, a white light results. The proof of this may be confirmed by painting the seven primary colors, as mentioned above, on a disc, which, when rotated at a high speed, results in white.

There is a band of waves, which may be called the "blue violet," that are found just beyond the violet waves. These waves or frequencies are used in medical and photographic work and the ones which also give life to plants. It is here that a second advance of electro-medical science is unveiled.

X-Rays at 200,000 Volts

The X-ray zone of frequencies is also a great servant of mankind. At the Crocker laboratory there is a tremendous X-ray machine capable of utilizing a potential of 200,000 volts. The rays are transmitted between the atoms of the flesh. The first chapter of the wonderful story of the X-ray in modern science is well known as applied to medical diagnosis and the treatment of diseased tissue.

The newest application of the X-ray frequencies is found in the destruction of bacteria in food, such as oatmeal. A far more important factor in this work was disclosed by the application of this high voltage X-ray to the lung of a person having pneumonia. A five-second application of this great energy was sufficient to not only dislodge the pneumonia bacilli, but to cause a hemorrhage. The experiment was successful, as have been several which have followed it. What the subsequent application of the X-ray will be can best be imagined by the results of the past astounding discoveries.

Science is familiar with frequencies some three hundred times smaller than the X-ray; for example, the electron, used in radio work. As progress is made in understanding electric waves, the small zone occupied by the radio art to-day will be very likely greatly enlarged.

Arrester with Unusual Guarantee

FOOLING THE LIGHTNING

A lightning arrester is somewhat like a life-preserver—it is called upon to work only in an emergency. No one knows to a certainty whether or not it will work until the excitement is over. So the D. X. Instrument Company of Harrisburg, Pa., issues for the Fil-Ko Lightning Arrester a special guarantee which provides that should lightning strike an aerial to which it is attached and damage the radio receiver, they will repair the set or pay the purchaser of the arrester $100.00. Thus the arrester protects the set, but if through accident it should fail, then the guarantee protects the owner.

Besides this extraordinary guarantee, the Fil-Ko Arrester has other attractive features. The body is made of Bakelite and is shielded by a polished aluminum "umbrella" that keeps dust, water and other conductive matter from causing leakage losses in that part of the antenna circuit. The instrument sells at $1.50, including the guarantee just mentioned.

Reactivation of Radiotrons

The UV-199 and UV-201-A Tubes Can Often Be Restored

By S. W. GOULDEN, Commercial Engineer, Member I. R. E.

WHEN either of the radio tubes are subjected to excessive filament voltages by the user, the electron emission may be reduced to the extent that the tube temporarily loses its sensitiveness and amplification properties. There are two ways that this high voltage may be applied. People who do a lot of experimenting and rebuilding sometimes have the misfortune to drop the "A" wire on the "B" battery lead. This puts a voltage of 10 to 20 times normal across the filament, with the result that it burns out if the contact is anything more than momentary. If it lasts even as long as one second, usually the tube will not light any more, but if it is only a fraction of a second, the filament may not be burned in two, but the coating of thorium on the outside of the wire will very likely be burned off. If such is the case, the tube will light as brightly as normal, but the current out through the plate and the phones will be reduced to a small proportion of its usual amount. This will result in a weak signal, or none at all, depending on how badly the filament was burned.

Burned by the Rheostat

The second way that the coating is lost is by wrong use of the rheostat. If it is turned around too far toward the full-on position, then too much voltage will be fed to the filament. This will not cause any apparent damage for some little time, but the use of excessive filament voltages over extended periods will gradually cause a decrease in emission which may not be noticed immediately, but which will become evident after several hundred hours of use.

Whether these conditions come about rapidly or slowly depends upon the filament temperature employed which, of course, in turn, depend upon the voltage applied from the "A" battery. The safest way to tell where to set the rheostat is to use a volt meter. A small size suitable for this use costs about $1.25, and while extreme accuracy will not be expected at this price, still the meter will read near enough to the true value, so that a good adjustment of the rheostat can be made. If no volt meter is obtainable, probably the best way is to turn up the tube pretty bright and then tune in on a distant station. Now reduce the current a little by the rheostat setting, and *after* retuning see if the volume of music has fallen off at all. It is important to run the test after retuning, since changing the rheostat may affect the best position of the tuning dials, and if these are not readjusted the volume will decrease, owing to their wrong setting. If, then, the program is as loud as before, try cutting the rheostat still further. Repeat this operation until a falling off in the tone is noticed, then increase the current slightly back to where it was just before the decrease was found. Since this gives full volume, there is no advantage of burning the tube any hotter.

How to Restore Life

When a decrease in electron emission occurs from improper use, as just described, the normal sensitiveness and amplification of radiotrons UV-199 and 201-A can often be restored by a simple process known as "reactivation," as follows:

(1) Place the tubes in the sockets of the radio set, disconnect the plate battery and apply a voltage to the filament terminals 10 per cent. in excess of the normal rated voltage (use accurate voltmeter).

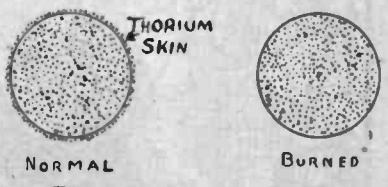
(2) This means that 3.3 volts should be applied to radiotron UV-199 and 5.5 volts to radiotron UV-201-A. These values may be had by turning the rheostat around too far for normal operation.

(3) The application of this voltage should extend over a period of from 2 to 15 hours, depending upon the extent to which the electron emission has decreased.

(4) To determine when the sensitiveness of the tube has been restored, the filament voltage should be reduced to normal and the tube connected in a standard radio set in the usual way. This may be done at the expiration of 5, 10 or 15 hours, and if at the end of any of these testing periods the tubes operate satisfactorily, a continuation of the reactivation process is no longer necessary.

Rapid but Dangerous

The filaments of radiotrons UV-199 and 201-A may be reactivated instantaneously, but the process is not recommended by the Radio Corporation for the reason that the filaments might burn



Filament Before and After

out. It may be accomplished, however, by applying instantaneously from 15 to 18 volts of a standard "B" battery directly across the filament terminals of the tube—the briefer the period the less the danger of burning out the filaments. After this has been done, normal voltage should be applied to the tube filaments for one hour with the plate battery disconnected. This last process should only be resorted to where speed is an important factor.

The reason for this treatment may be understood by referring to Figure 1, which shows a cross section view of the filament magnified several hundred times. The filament consists of an alloy

of metals which conduct the "A" battery current, but do not give off many electrons to carry the electricity from the "B" battery; alloyed through the mass is a small proportion of thorium, which is one of the rare but not precious metals. This metal is the same as that used in incandescent gas mantles to make them give off so much light. The thorium is not only distributed all through the body of the wire, but also forms a coating or skin on the outside, as shown in the sketch labeled "Normal." It is this thin skin that increases the radiation of electrons several hundred thousand times. That is why the filament can be run at a dull red heat and still give louder signals, while the UV-200 and the old UV-201, which have no thorium, will not work unless operated white hot.

How a Burned Tube Looks

When the filament has been overheated the layer is burned off, as shown in the sketch "Burned." The treatment, which has just been described above, by running the temperature too hot for normal, allows the thorium through the mass of the filament to come to the surface, where it slowly collects into another film. The reason the "B" battery must be disconnected in this process is because it causes such an attraction from the filament to the plate that the small particles of thorium are boiled off and drawn bodily over towards the plate before they have had a chance to collect in any quantity.

While this process of treatment will restore the tube practically to its former goodness, still, of course, it cannot be repeated indefinitely, and a better way to do is to make sure that the radiotron is not abused in the first place.

In case the user has diffiulty in making this repair himself it is well to take the tube to any reliable radio dealer who will be able to fix it up if the damage has not gone too far. If the trouble is that the tube is defective at the start then it should be returned at once and credit will be given for it after it has been returned to the laboratory of the manufacturer.

HE GETS THE OF-FISH-AL RETURNS

When Broadcast Bill has a holiday
He sets right out for the pool;
Altho its awfully hot in town,
He knows out there it is cool.

He arranges to carry a picnic lunch
Wherever he plans to go,
With fishing tackle, and then, of course,
His reliable radio.

—*By Del.*

WHEN FLORIDA VISITS BROADWAY

Radio is building up its own list of "places to see" among the out-of-town listeners. This was strikingly illustrated during the recent broadcasting by station WJZ of the Sunday evening concert of Nathan Abas' Pennsylvania Concert Orchestra direct from the Main Dining Room of the Pennsylvania Hotel. A waiter approached the announcer and told him that a gentleman at a neighboring table would like to see him as soon as possible. After signing off the concluding number of the concert, announcer AON went to the table indicated and introduced himself to the man. The gentleman proved to be a resident of a small town 15 miles south of Jacksonville, Florida, who listens to the WJZ broadcast of the Pennsylvania Concert Orchestra every Sunday evening, and who had arrived in New York just a half-hour before the concert began that night. Although he was supposed to go immediately to a friend's home in the city, he stopped off at the Pennsylvania Hotel in order to see the orchestra and the announcer whom he liked so much over the radio.

HERE'S YOUR CHANCE, GIRLS

A radio fan from Elgin, Illinois, certainly has been misled as regards radio broadcasting and its purpose. A request has been received from this gentleman requesting KDKA to broadcast the following: "I am a widower, 38 years of age, height 5 feet 7 inches, weight 160 pounds, light hair, blue eyes, a cabinet maker by trade and looking for a good wife." It is to be regretted that KDKA has not established a Lonely Hearts' Club which might be of service to our friend from Elgin in locating a wife for him. Many similar requests, however, might tempt the directors of the station to form such a club and devote a part of the broadcasting time in assisting the lonely ones.

This reminds us that many a girl listens to a radio set because she thinks it will "tickler."

Building the Rice Neutrodyne

Telling How to Build and Why It Works

By CHARLES R. WEXLER and ARTHUR SLEPIAN.

EDITOR'S NOTE. A great deal has been written about the Neutrodyne, but few people seem to understand why it works. If this were generally known there would be fewer sets which do not work. This article is the first one we have seen that gives a clear explanation of the principle on which the Neutrodyne is built. There are several makes of Neutrodyne and most of them are very difficult to balance correctly so that they are really neutralized.

The Rice Neutrodyne uses the same basic principles as the others, but it gets results in a very ingenious way. Fortunately the method is easy to understand and in practice it is not difficult to balance one of these sets completely. The following account, not only explains the action, but also describes the method of building the set. It is quite selective and sensitive; will not squeal nor reradiate, and taken all in all is perhaps one of the best sets that can be built.

IN general, cascaded, that is, using two or more tubes, radio frequency amplification is limited by the tendency of the tubes to oscillate. If they vibrate at a slow frequency, a howl is heard in the phones, while if it is high or radio frequency, the signals coming through sound very mushy and distorted. Unfortunately, feed-back action, which is the cause of this undesirable oscillation, is proportional to the amplification for a given degree of back-coupling, therefore,

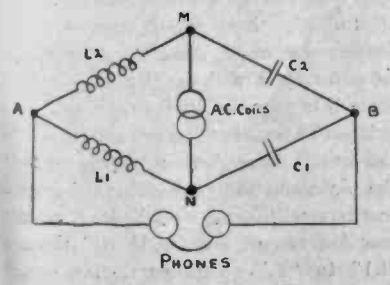


Fig. 1. Testing with Bridge

in multitube sets, where large amlipfication is obtained, the tendency toward oscillation is increased in proportion.

Naturally, what we are aiming at is to reduce the feed-back or tickler action so as to prevent the tubes from oscillating, but to retain the highest amplification possible in order that we may get a loud volume even when receiving on a loop.

Two Kinds of Feed Back

Various means to minimize or eliminate this feed-back have been suggested and employed. There are two different kinds of feed-back that cause trouble. One is magnetic—that is, the action of one coil on another, such as is found in the ordinary regenerative sets when the tickler coil is turned more or less in line with the stator or varicoupler. The other is entirely electric or electrostatic, as it is often called. This is the action of a condenser. The wire from the output of the amplifier acts upon the grid wire just as one plate of the condenser acts on another. In this way electricity is transferred across the air gap between them and feed-back action is accomplished. But while in the regenerative receiver the feed-back is wanted and is controlled by the tickler dial, in the present case the regeneration is harmful and has no dial to cut it down.

The electrostatic feed-back is in all probability, the more difficult to minimize, since we cannot eliminate readily the capacity feed-back in the tube itself. But in the case of magnetic action we may minimize feed-back by shielding or arranging the coils as they are commonly used in the Neutrodyne.

Rice Reverses Regeneration

The Rice Neutrodyne method to be described is one of a number of practical applications of the general principle that electrostatic or capcitive condenser coupling between circuits may be reversed in direction or polarity and if desired may even be reduced to zero. In the actual set, that is accomplished by balancing one capacity against another as we shall see later.

The underlying theory of the Rice method is very simple, and, although it is probably little known among radio fans, it is very much used by electrical engineers. The idea may readily be grasped by anyone who, having this knowledge, will understand the operation of the Neutrodyne and so is prepared to construct and operate a set more efficiently. The arrangement is called an impedance bridge (Fig. 1).

It consists of two coils, L1 and L2 and two condensers, C1 and C2. When this

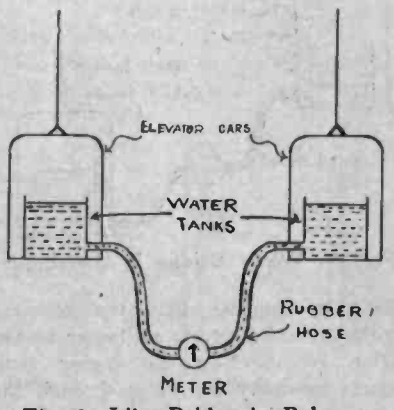


Fig. 2. Like Bridge in Balance

bridge is balanced the inductance or electrical weight of the two coils will be equal and the capacity of the two condensers will be just alike.

Balance Out the Hum

It can be easily seen and can be proved by mathematics that when L1 equals L2 and also when C1 equals C2 then the two halves of the system are equal or balanced. This is tested ex-

perimentally by listening in the phones. Across the points "M" "N" some kind of alternating current is connected. This source of current may be 60 cycles, 110 volts of your electric light circuit, or it may be a radio coil, which is excited by a tube oscillator. In the receiving set itself its place is taken by the tuner, which gets its electric waves out of the air through the aerial. But no matter how the alternating voltage is obtained, when it is applied across "M" "N" no hum will be heard in the phones, since, as just described, the system is balanced. If, while experimenting with the setting, C1 is made either larger or smaller than C2, right away a buzz will be heard in the phones.

This idea of balance may be better understood by referring to Figure 2. Two elevator cars are shown, each with a large tank of water in it. The two tanks are connected by a flexible rubber hose, and a water meter is in the middle of the hose line to show whether there is any flow of current. Since the two cars are the same height, it follows that the level of the water in the two tanks is the same and so the meter will show no current flowing in either direction.

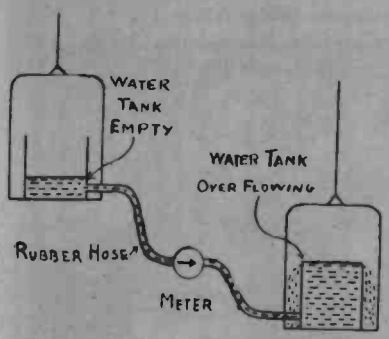


Fig. 3. When Bridge is Unbalanced

But now suppose that the elevators move so that they are no longer at the same height. Now the higher tank starts to empty its water through the hose into the lower tank, which, of course, overflows as Figure 3 shows. The meter immediately indicates that a current is passing through the line.

The explanation of this analogy is no doubt clear. The meter which shows the flow of water represents the telephone of Figure 1, which also indicates the flow of current. When the two elevators are balanced at the same height, then the meter shows zero, and in the same way when the two circuits of Figure 1 are balanced the telephone is silent, which shows zero current. Notice also that the height of the elevators in the building has nothing to do with it. If they are both at the first floor, no water flows. Then they both start going up. Still no water flows as long as they are balanced at the same level. Perhaps they both stop at the tenth floor. Still no current is indicated by the meter. The same thing is true of the circuit. As long as the two halves are alike, that is, they are *balanced*, the phones will be quiet. If the capacities C1 and C2 are changed, it will have no effect on the meter (phones) provided they are both changed alike. It is only when one capacity is different from the other, so giving the circuit of equal electrical height, that the phones indicate a current is flowing.

Actually, in the case of the Rice circuit (Fig. 4) the inductances consist of a double coil, which acts as the secondary of the radio frequency transformer and is tapped at the center; one-half of this coil acts as L1, and the other as L2. They have the same number of turns. In the diagram C1 represents the plated-grid capacity of the tube, while C2 is a small variable condenser known as the neutralizing or compensating condenser.

A Capacity You Can't Kill

C1 is shown in dotted lines, because it does not represent a real condenser which may be adjusted. The capacity is there just the same. It consists of the leads and terminal wires of the vacuum tube. It is the capacity between the grid and the plate which counts. This is often called a leakage capacity, not in the sense that it really leaks, but because it is unavoidable, and allows the high frequency current to leak through. This is the action which causes an ordinary amplifier set to have two defects, first, that it distorts the music, and second, that it allows oscillation to feed back into the aerial and so annoy the neighbors.

The amount of leakage capacity naturally varies with the kind of tube used. The UV-201A has the greatest amount and then in order the WD-12 and WD-11, while the UV-199 has the least. This last tube was designed especially with this trouble in view and so the manufacturers have been able to minimize it.

Each Coil Its Own Generator

Now compare Figures 1 and 4. You will notice that as far as the coils and condensers are concerned, they are just alike. We have L1 and L2, which have the same values. Also, C2 is adjusted so that it is equal to C1. (This is done by trial.) That gives us the same balance as before. Instead of a special coil across "M" "N" to generate an alternating current in L1 and L2, we have the transformer action of the radio frequency coil in the set itself, which makes the coils L1, L2 generate their own alternating current. Then, connecting the points A and B, you will notice the phones. Of course, in Fig. 4 the "B"

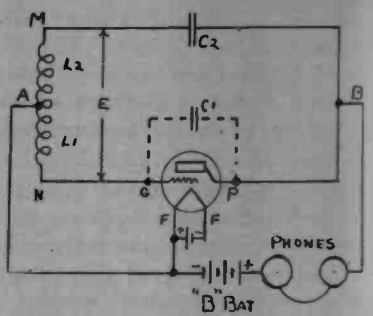


Fig. 4. The Rice Idea

battery is also included in the circuit, but this gives out direct current only, and so does not cause any sound in the phones.

If you have grasped the principle of Fig. 1, that when the two condensers are made alike the phones will be silent, you will readily see that the same thing applies in the radio set. But notice further that we are talking about the circuit from A to B, which connects the plate and the grid. This is balanced so there will be no feed-back. Consider now the circuit from grid "G" through "L1" to "F." This particular circuit has nothing to balance against it, and so any voltage which is induced in coil "L1" will be impressed on the grid-filament circuit. This will give the regular action for the tube input, and the output will flow from the plate through point B, phones, and "B" battery back to the filament in the ordinary way. The result is that, although the tube is balanced for oscillation and for feed-back, it behaves normally for amplification.

Neutralized for All Frequencies

Any tendency toward oscillation set up in the plate circuit is balanced through the action of the compensating condenser, which is adjusted so that the feed-back is eliminated when the condition of bal-

ance is reached. Since any neutralization method is really a means of controlling regeneration, any amount of regeneration may be had at will. Unlike other neutrodynes, the Rice circuit when properly constructed is neutralized over its entire range and will not oscillate or be thrown out of balance at either the upper or lower wave lengths. In fact, this method has been used by radio engineers, because of its very stability and independence of wave length, for recording the phenomena of fading and other allied problems.

Very often the highest priced parts are not the best, and it pays the careful buyer to investigate.

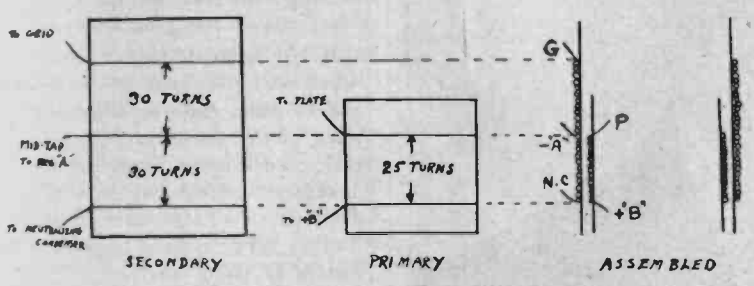


Fig. 5. Details of Transformer

Construction of the R. F. Transformers

For those who already have neutroformers, the construction of the transformers will be greatly simplified; neither should those without neutroformers encounter any difficulty in the manufacture. The secondary of the neutroformer is identical with that of the regular neutroformer except for the location of the tap, and consists of the usual 60 turns with a mid-tap. (See details in Fig. 5.) Therefore, those readers already possessing neutroformers need only rewind them, bringing out a mid-tap and doing away with the old tap. Those building for the first time should follow as closely as possible ordinary commercial construction, i. e., drilling two small holes for anchoring the winding, winding on 30 turns, twisting a tap, and then continuing for 30 more, finally anchoring the end of the winding in two small holes as before. It should be noted at this point that experiments show the mid-tap on the second stage of radio frequency (neutroformer "C") is optional, and the detector may be connected across the entire secondary as shown later, or the mid-tap may be used if desired. The primary consists of 25 turns (Fig. 5) wound on the smaller tubing to fit inside the secondary. The winding is wound in the same direction as the secondary, and is placed in the lower half of the secondary, as shown in Fig. 5, being held in position by any suitable means, such as stickers, tape, etc.

Construction of the Tuner

The construction of the tuner secondary is identical with that of the transformers previously described. The primary consists of eight turns wound on the smaller tubing (Fig. 6) in the same direction as the secondary, and is placed inside this coil, so that the primary winding affects the entire secondary winding. The mid-tap of the secondary should come directly over the center of the primary winding.

From the electrical diagram of connections (next issue) it may be seen that this circuit contains two stages of capacity tuned radio frequency tubes 1 and 2, a vacuum tube detector 3, and two stages of audio frequency 4 and 5, using a total of five tubes. Tuned radio frequency is used because a set so sensitive demands extreme selectivity. This is especially desirable in view of the super power stations now operating. It will be found that in a carefully constructed set the two stages of tuned radio frequency will be sufficient for reception throughout the United States. Tuning is not difficult, although the set is very sharp. The usual feature of logging stations by means of the dials (as in the neutrodyne) is retained.

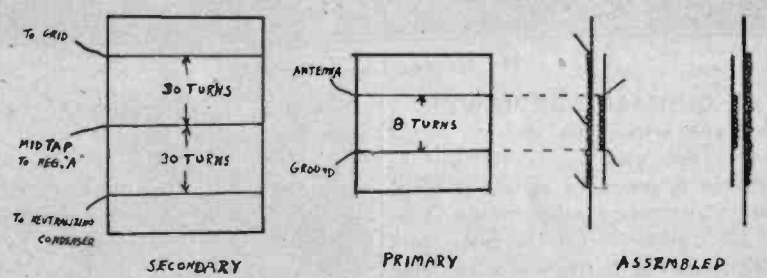


Fig. 6. Winding of Tuner

List of Parts Required

Now for the actual consideration of the set. The following material is required:

Parts

One 7x26 in. panel.
One 7x26 in. cabinet.
One base board.
Five sockets.
Two 6 ohm rheostats for amplifiers.
One 20 ohm rheostat for detector.
Three 11 plate (.00025 mfd.) variable condensers.
Two neutralizing condensers (Chelton is a good make).
Two good audio frequency transformers.
Three 4-in. dials.
One filament switch.
One open circuit jack.
One good gridleak.
One .00025 (grid) condenser.
Two .001 condensers.
Three sets of neutroformer tubing.
One-half pound double silk covered No. 22 wire.
Miscellaneous, such as binding posts, spaghetti, No. 14 tin copper wire, screws, nuts, bolts, etc.

Accessories

Five 201-A tubes.
One 6-volt storage battery.
One 90-volt "B" battery.
One "C" battery.
One loud speaker.
Antenna and ground.

In purchasing parts, don't seek to be penny-wise and pound-foolish, yet don't be extravagant. By this I mean, buy parts whose performance is well known.

The next issue will continue this article, giving the methods of mounting, assembling and wiring the set and the details of neutralizing the capacities.

Mr. George L. Chesterton

AN UNBIASED REVIEWER

All who attend the theatre or the movies (and who does not?) will be interested in getting a review of interesting plays before going to the show. But the trouble is that the newspapers which print the description of the play also carry the theatre advertising. It is human nature to favor the person who pays you real money, and so the theatre reviews are apt to be a trifle biased. We even remember seeing a series of plays by a summer stock company in which the reviewer stated every single week that this was the best show the company had put on. It seemed a little remarkable that the manager could work up to such a climax at the end of the season.

Realizing this condition, Station KYW, Chicago, has planned to radiocast descriptions of all the various shows which are given in the Chicago district. Since they collect no money at all from the theatres in question, it is safe to say that press agent stuff will be omitted.

The Truth About Plays

Theatrical reviews of musical comedies, plays and vaudeville acts performing in Chicago theatres will be broadcast twice each week from this station. The purpose is not to compete with the newspapers, but to give thousands of listeners who seldom read the dramatic criticisms in the dailies an opportunity to learn all about the good bits of entertainment around town.

It is believed that thousands who never read the criticisms in the dailies are at some time or other anxious to learn of the merits of some play, musical production or vaudeville bill. The newspaper review may have passed unnoticed. Here is where Westinghouse Station KYW expects to perform a real service to radio fans.

The reviews will be put on twice each week. They will be officially known as "Around the town with KYW in Chicago." Competent reviewers will pass on the productions and will give an honest opinion as to the attractions reviewed. The "highlights" of the production will be told to the radio audience and the listeners can decide for themselves as to whether or not they care to see that particular offering.

The directors of KYW feel that they are well within the scope of their station in reviewing attractions, as theirs is the pioneer radiocasting station of the West and the only station to radiocast musical comedies, dramatic plays, revues, comedies and the opera direct from the stage in the theatre as well as from their studios. The thousands of letters received from in and around Chicago, as well as every part of the United States and Canada, attest the popularity of these features.

Letters have been sent all producers in the United States telling them of the plan.

Station KYW is very powerful and runs on 536 meters. If this is a higher length than you can reach on your set, no doubt it will be an advantage to increase the size of condenser or make whatever change is necessary to bring it in your range.

PORTRAITS OF POPULAR PERFORMERS

Not many men have served in both the Army and Navy. When such a warrior turns to civil pursuits, what line will he enter? We show a photograph of Mr. George L. Chesterton, who, after his discharge as a soldier and sailor, went into the newspaper game. He wrote so easily that he became an author and his pleasing voice took him one step further to becoming a minstrel. If you tune in on 455 meters to listen to WJZ you have probably heard him, as he has delivered about thirty-five addresses from that station.

A New 94-Meter Sending Station

No Wires Are Used in the Aerial When Broadcasting

WHEN transmitting several thousand miles it is found by experience that wave lengths of 5,000 or 10,000 meters are the most efficient. But when distances of a few hundred miles up to a couple of thousand are required, then the advantage seems to lie with the shorter wave lengths. The reason is this: the short lengths correspond to high frequency or speed of vibration, and the faster the waves oscillate, the more effective they are in operating a receiving set. Unfortunately they are also more effective in operating undesirable receivers, such as trees, mountains, trolley and electric wires. In other words, all these obstructions steal more of the shorter waves out of the air than they do of the longer ones. If the receiving station is reasonably close to the broadcaster, then these higher losses are not important and the short waves are better because of their efficiency, but if we are talking to Europe then there are so many unwanted receivers as just mentioned that only a small proportion of the waves sent out ever reach the receiving station, and so the higher efficiency of these waves is wasted.

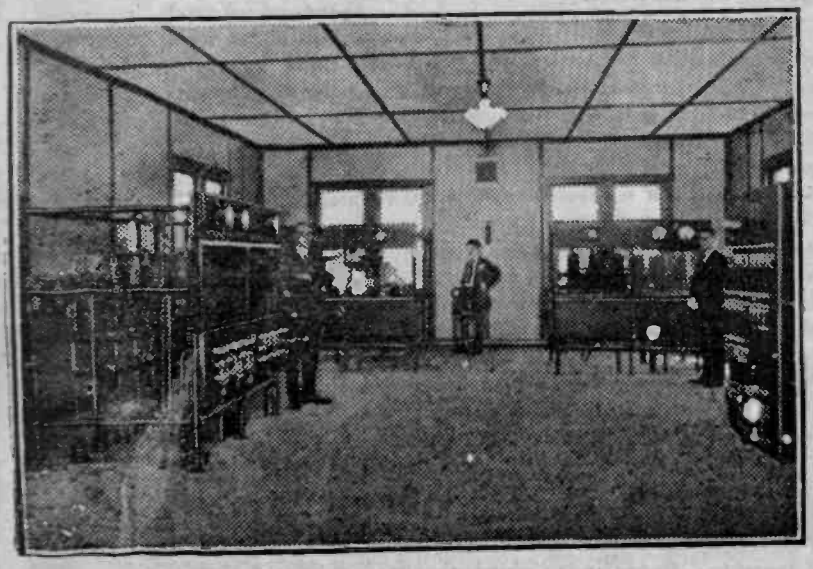


Fig. 1. Inside of Model Short-wave Station

Short Waves Popular as Short Hair

The Westinghouse Electric Company is convinced that for radiocasting in the United States the advantage lies with the short wave. With this idea in mind they have completed and have been operating for several months a new specially-designed radio experimental building, erected at a cost of several hundred thousand dollars.

The new building is a one-story concrete and brick structure located about a mile east of the Westinghouse Company's East Pittsburgh works. The site chosen is within a few feet of being the highest spot in Allegheny county, and is one of the few level tracts available on the hills which dot the locality.

Before building the new station a good deal of experimental work was done with the 94-meter wave. The programs, which were sent out by KDKA, on 326 meters to the listening public, were also transmitted at 94 meters and practically every night these were received by the Hastings, Nebraska, station and also in England. The transmitter was formerly located on the top of a nine-story building directly in the heart of the East Pittsburgh Works. Steel buildings, known to have a decided absorbing effect on radio waves, completely surrounded the set, and in addition, it was located in a valley with hills on three sides. As a matter of fact, the main transmitter of KDKA is still located in the same place and it is a matter of radio history that all of KDKA's transmitting achievements have been accomplished from this set. However, there is a probability that the 326 meter transmitter will be moved to this very desirable new position.

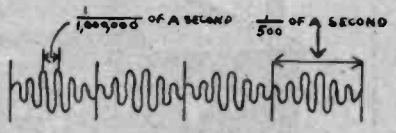


Fig. 2. What Modulation Does

The new radio experimental building has been designed so that all apparatus contained within it is located symmetrically.

Heavy Parts in the Basement

The basement is divided into several rooms. The main basement chamber contains the high-power transformer plant, motor-generator sets, filters, chokes and other apparatus. One of the rooms houses a transformer station of the Duquesne Light, the local electric company. The remainder of the basement is occupied by the battery room, furnace room and storage space. Power is brought into the basement through underground ducts from two separate sources, both of which are 4,000-volt, 60-cycles. This current supply may be

stepped up or down as required. The available power supply is in the neighborhood of 250 kilowatts, which can be increased, however, should it be necessary.

With this basement arrangement all bulky apparatus is located out of the transmitting room and is never in sight.

The main apparatus room on the first floor of the building in which are located the oscillator, modulator and rectifier panels is large and spacious and having windows on all four sides is well lighted by day.

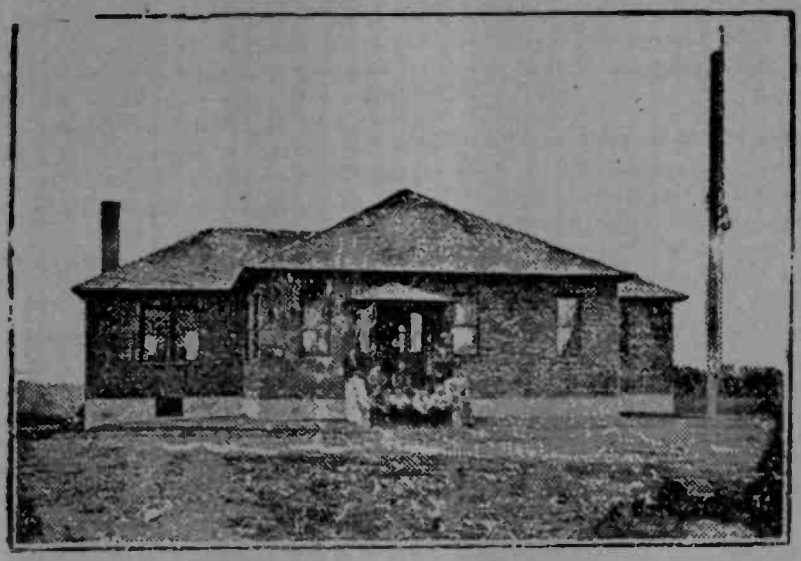


Fig. 3. Outside Station, Showing Special Aerial

This is clearly shown in Figure 1. Notice the neat appearance of the room and the absence of crowding.

Rectifier Uses Six Tubes

The rectifier which furnishes high-voltage to the plates of the water-cooled tubes is mounted in a specially designed frame so that every part of the apparatus is accessible. Replacements and observations can be conveniently made because every part of the unit is in full view of the observer. The rectifier has a capacity which can be pushed to 150 kilowatts, if it were necessary, and is the result of the several years experimenting and pioneering of the Westinghouse Company in short-wave broadcasting. The rectifier is of the three phase type, having a tube on each side of the line or a total of six water-cooled vacuum tubes. In front of each tube is a coil of rubber hose to permit the use of city water to cool the tubes. On the front of the panel is a row of knife switches used to regulate the voltage of the transformers, thus governing the output of the rectifier. This arrangement may be seen on the panel at the right.

The oscillator panel is of the same general construction as the rectifier panel and makes use of Westinghouse, high-power, water-cooled, copper-anode transmitting tubes. The anode is where the current runs into the oscillator and is called the "plate" in a receiving tube. You see these on the left. They are not ordinarily subjected to maximum capacity, but are usually connected in parallel, that is, the grids connected together, and the same with all the plates and all the filaments. Thus each tube is subjected to about half its rated capacity and an unusually long life in tubes results. Another reason for paralleling tubes is that operating on the high-frequency waves causes unusual strains to be developed, not encountered in the ordinary radiocasting wave lengths, and some factor of safety is desirable. Immediately behind the tubes is the tuning inductance. In the front of the panel are located the various indicating meters. As in the case of the rectifier every part of the oscillator panel can be observed and replacements made without difficulty. The modulator panel, using the same general type of tubes, has a switching arrangement whereby the number of tubes used and the amount of power can be regulated. Indicating meters are mounted on the front of the panel and there is also a modulation meter which shows how strongly the energy generated by the oscillator is being modulated.

What Modulation Does

The carrier wave is modulated by breaking it up into groups corresponding to the audio frequency. Figure 2 shows a modulated wave. Carrier waves oscillate a million times a second and this is chopped up into series of waves as shown. This series is repeated 500 times a second since the artist is singing note C on the piano. The modulation is 100% when the carrier wave is reduced to zero at the end of each group. In Figure 2 the carrier wave dropped to about one-quarter its maximum and so the modulation is 75%.

Antenna Plays No Favorites

Since there is no horizontal part this aerial is entirely non-directional—it sends its messages North, South, East and West alike.

Adjoining the main room and extending a few feet into it is the control room. The front and projecting sides of this chamber have glass windows so that every part of the apparatus room may be constantly seen by the operator. This compartment is equipped with amplifying apparatus consisting of two units, one using five watt, the other 50 watt tubes. The start and stop control switches, line terminals, amplifying connections, etc., all are located in this room. Thus the engineer at his desk can control everything in the station. He also can listen in and hear the signals, thus judging them for quality.

Other rooms on the floor include the main office, sleeping room and shop.

Antenna Is Remarkable

One of the most distinctive marks of the station is the extremely unique short-wave antenna, a special type perfected by Frank Conrad, assistant chief engineer of the Company, and the man who made most of the present records possible through short-wave development. This aerial is a copper tube erected vertically with respect to the ground and supported from a pole about

Continued on Page 22

What Aerial Do Radio Waves Prefer?

Explaining Why Some Antennas Are Better Than Others

By A. K. LAING

DOUBTLESS you have had the experience of taking a set from one location to another. As first set up it worked wonderfully well, but after moving, results were not nearly as good. It was the same set, the same batteries and loud speaker. Then why did it disappoint you so? Of course, the answer is the aerial and ground were different. Assuming that the ground in each case had a good connection to your cold water pipe, the only thing left is the antenna.

While the action of antennas, and of radio waves, is still partly a matter of conjecture, the similarity between an aerial system and a regular condenser shows that the action of an antenna depends at least partly on its capacity. Therefore, if the same principles are applied to the design of an aerial as are as in the ordinary 23-plate variable condensers or mica as in a Micadon or even a paraffined paper, like the cheap phone condensers. If such a condenser is connected to a source of potential (voltage) such as a dry cell, it will receive a charge of electrical energy. When the condenser is well made, it will hold this charge even after the wires from the battery have been disconnected. Then if a wire with a suitable meter is connected across the condenser, the meter needle will give a kick just when the wires are first touched. This shows the discharge of the energy which has been stored up. Of course, the volt meter drops right back to zero again, because the condenser does not *generate* a voltage the way a battery does, but merely stores up a small amount of energy. It is all the difference between a river and a tank of water.

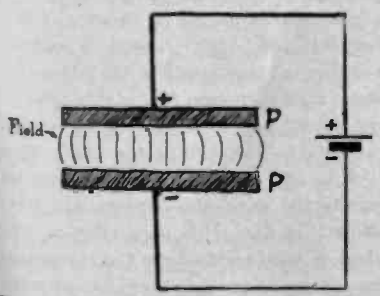


Fig. 1. The Action of a Condenser

used in the calculation of a condenser, a corresponding increase in efficiency, both in radiating and in absorbing radio waves, will be noted.

It will be the purpose of this paper to present the capacity action of an antenna, and to show just how this condition may best be brought about by proper attention to certain details of construction.

What a Condenser Is

Figure 1 shows the simplest type of condenser, formed of two metal plates separated by an insulating air space. This non-conductor between the plates is called the dielectric. It may be air

This simple experiment may be performed by connecting a radio condenser of .001 or .002 microfarads across a "B" battery, removing it, and then touching the terminals of a pair of phones to the terminals of the condenser. A sharp click will be heard. The efficiency of the condenser may be tested roughly by noting how long it will hold this charge. In trying this experiment, be careful not to touch the terminals of the condenser with your fingers, as your body is conducting and will to some extent discharge the energy.

Testing Out Your Condenser

A perfect condenser would hold it indefinitely. A poor one will lose it in a few seconds. The average condenser for a radio receiving set should hold such a charge for more than a minute.

It can be shown by using a condenser with solid dielectric, such as a sheet or glass, and with plates that may be removed, that the "charge" of a condenser is in the *dielectric*, and *not* in the plates. Thus if a condenser composed of two metal plates separated by a sheet of glass (like Fig. 1, except pane of glass inserted between P-P) is charged from a source of high potential and then disconnected from the battery, the plates may be removed from the glass and touched together, grounded, etc., but when they have been replaced upon the dielectric the condenser will discharge in a normal fashion. Different plates may even be substituted without causing any diminution of the discharge.

This proves that the charge of a condenser sets up an electro-static strain in the dielectric, which may be air, or some solid material as described. If we consider the aerial as the upper plate of a condenser, the ground as the lower plate, and the air in between as the dielectric, then the action of an antenna system on a basis of charge and discharge may be likened to that of any condenser. Of course, the value of the capacity of an aerial is rather small. The average size is about .0002 mfd. This represents the size of a single wire

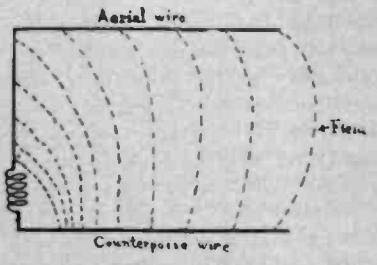
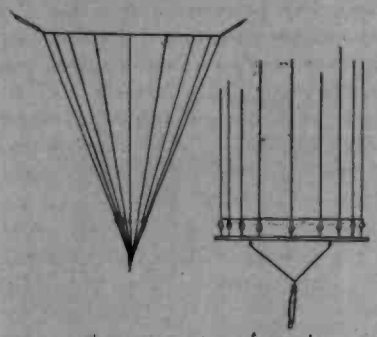


Fig. 2. Aerial As Condenser

aerial about 75 or 100 feet long and the ordinary mounting height. If a much longer wire is used, naturally the capacity will be increased.

Figure 2 shows such an arrangement, with a counterpoise substituted for the ground, as is done in most sending stations. Now let us suppose that a train or series of electro-magnetic waves, (a radio message, for instance), passes through the space between the aerial and counterpoise.

These waves will result in giving a high and then a low electrostatic pressure to the dielectric. This alternate up and down action will occur about one million times a second, depending on the frequency or wave length of the station which is broadcasting the message. The effect of this alternating electric pressure across the dielectric is to make the condenser (aerial and ground) charge and discharge through the lead-in wire and radio set. It is this charging current which operates the receiver. It will be noticed that this action is the reverse from what we considered in Figure 1. There the dielectric was put



showing proper spacing of wires to compensate for skin effect, and provide for equal distribution of current.

under a strain, as a result of the current flowing through the condenser wires, while in Figure 2 the strain is caused by the radio waves and the ether, and this strain is *relieved* by the current flowing through the connections.

How Inductance Interferes

At this point the consideration of the radio wave as the cause of a simple flow of current must cease, as we notice the result of inductance (or electrical weight) as well as capacity in every antenna. When inductance and capacity act together they behave like a weight on the end of a spring, and so have a certain time of vibration or period which depends only on the values of the inductance and capacity.

But up to and including the point at which varying stresses of dielectric, produced by passing waves, induce a flow of current in the antenna wires, we can consider its action as a pure condenser.

Obviously, as the antenna depends so largely upon its capacitative action (like a condenser) for the reception of energy in electric waves, for best efficiency it must be made as perfect a condenser as possible without destroying its other essential qualities.

What Makes a Perfect Condenser

In a simple statement which may be made on the subject, a condenser to be perfect must have:

1. Plates or conductors of zero resistance.

2. A dielectric or insulator of infinite resistance—that is, which will not conduct any current at all.

As neither of these qualifications can be entirely met, they resolve in practice into the following requirements:

1. The plates and the wires connecting to them must have a negligible resistance to currents of any frequency.

2. The dielectric must have as high a resistance as possible.

3. The dielectric must be uniform throughout. It must not have a lower resistance at one point than at others.

4. Any mechanical supports must be well out of the electrostatic field (where they would have an electrical effect) and must have maximum resistance.

In addition to the above points, which apply mainly to the condenser aspect of the antenna, the following general rules must be observed:

5. The distance between antenna and ground must be as great as is possible in a given location (for the desired wave length).

6. Multiple wire aerials should be designed for a fairly uniform distribution of current per wire.

7. For transmission, an antenna should be designed so that its natural, or fundamental wave length, is slightly lower than the actual wave length which will be transmitted. The coil which is inserted in series with the lead-in, and which acts as the secondary of the oscillation transformer, increases the wave length enough so that it comes out to the figure assigned by the government. Of course, the shorter the aerial, the larger must be the coil to get the right frequency.

8. Directional effects should be considered in advance.

How Does Your Aerial Point?

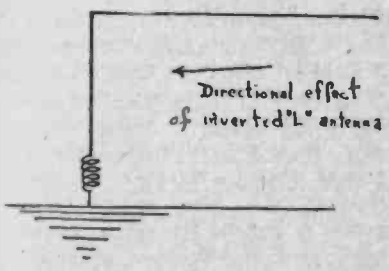
For broadcast receiving in general, no particular station is wanted more than any other and so directional effect is not wanted. By directional effect is meant that waves coming in from say the North are much stronger than those from the South. The direction from which the receiving is loudest is determined by the way the aerial points. With the ordinary aerial, which is at least thirty feet high, the directional effect is very small even though an **L** aerial is used.

It will be well to consider the aspects of each of these points in order. (1) Low resistance at all frequencies can only be had by using wire of large surface area, made from a metal of high conductivity, with a clean smooth surface. Heavy solid copper wire, and copper ribbon, are good for the purpose. A type of braided tube antenna wire now offered is satisfactory. Stranded wire has the advantage that an equivalent high frequency resistance may be had with it at a saving in weight over the solid wire. Phosphor bronze and aluminum have a low conductivity and are no longer recommended for antennas. The fact that the surface of a wire is bright when it is erected is not reason enough to think that the "clean surface" clause has been complied with. Clean surface means a smooth surface that will *stay* clean and smooth. In ordinary climatic conditions, copper soon corrodes, forming a film of semi-conductive material very detrimental to efficient operation. It might be thought, despite the fact of high frequency currents traveling on the surface, that these currents would choose the highly conducting layer under the corroded surface, but this is not wholly the case. When a film of very low conductivity surrounds the wire, the current will travel below this film with high efficiency, but when a semi-conductive film is present, the current passes through it rather than through the metal underneath. Therefore, it is very advisable to use insulated wire for the antenna system. Ordinary enameled wire has the lightest, and perhaps the best, insulation for the purpose. Number twelve or fourteen enameled copper wire makes a good antenna system, as the wire resistance is small.

(2) High resistance of dielectric. This point does not find serious application in antenna design, as it does in small condensers, for the only dielectric available is air, which has tremendous resistance.

Don't Put It Over Trees, Etc.

(3) Uniform dielectric. While no choice of dielectric is allowed one, a mixture is often encountered, and should always be eliminated when it is at all possible. By mixed dielectric is meant the presence of wood, stone, or other material in the space between the two "plates" of the antenna. If a normal ground is used, and the aerial



stretches above a region broken by part of a house, some trees, a fence, etc., the electric field between antenna and ground cannot be uniform. Many objects such as those mentioned form imperfect insulation, which causes absorption losses, and all of them tend to have a higher dielectric value than that of air, thus distorting the electrostatic field and causing an uneven distribution of potential. To remedy this, the antenna should be stretched over the most unbroken space available. When there is no such space, a counterpoise should be used. This is another wire or set of wires placed below the aerial in such a manner that there will be a perfectly clear space between the two systems. The counterpoise is connected in place of the ground. It usually makes the tuning much sharper than it is with the regular type of ground connection. When a counterpoise is used with a transmitting antenna, the point of zero potential on the inductance (near the middle of the coil) should be grounded as well.

Kind of Insulator is Important

(4) Leakage at the insulators is a common fault of nearly all aerials. Moulded "mud" insulators are not to be recommended, as in damp weather they almost always are covered with a conducting film of moisture. Glazed porcelain and glass insulators are two wholly satisfactory ones now available. For transmitting antennas, the long eighteen or twenty-four-inch glazed porcelain insulators are ideal. For reception, shorter ones of the same type will do. Any supporting framework, such as masts, guy wires, etc., should be separated by at least a few feet from the aerial proper, and should preferably be distant about one-third of the space between the antenna and counterpoise that they support.

(5) The theoretically ideal antenna is a single vertical wire in the center of a metal disk of large area, like the handle and cover of an umbrella. The wave length of such a system is too low unless the wire is unreasonably long. Therefore, the more common "T" and "L" types are used, as they have a much higher wave length for a given amount of wire, due to greater capacity between the wire and the ground. But for high efficiency, and absence of directional effect. the single vertical wire is ideal. A vertical cage is a modification which has been used but little, but which proves very satisfactory.

How to Space the Wires

(6) When a number of wires are used, as in a fan or flat top antenna, they should be concentrated at the extremities of the system, as shown in Figure 3, or else arranged in regular circular cages, to allow the "skin effect" to distribute the current as evenly as possible. This "skin effect" is caused by the fact that when alternating current reverses at a high rate of speed, that is has a high frequency, the different parts of the current stream repel each other and try to get as far separated as possible. This is accomplished by their hugging the shore, so to speak, and not venturing out into the center of the conductor. If it is a single wire, practically all the current runs in the outside layer or skin, and the rest of the wire carries no electricity. Where there are several wires in parallel, as shown in Figure 3, most of the current will be found in the wires near the edges and only a small amount in the center. This accounts for the peculiar spacing shown.

What Wave Length is Best?

(7) There is considerable advantage in operating with nearly the fundamental wave length on an aerial. As the formulas for calculating this in advance are difficult, and, furthermore, some of the constants in the circuit, like the depth to a permanently conducting layer underground, etc., are not well known, it is difficult to predict the wave length of an antenna and ground in advance closer than 25 to 50%. For this reason, perhaps the best way in general is to erect an aerial which seems suitable from past experience, and then try it out. If the wave length is too low, more wires can be added, or if too high, then shorten the wires.

(8) The directional effect of the "L" antenna is shown in Figure 4. The "T" and fan types are not appreciably directional.

(9) The lead-in has not been mentioned, but, of course, this must be well insulated and care must be taken not to run it very close to the ground wire. At least a foot away is not too distant.

When all these points have been given careful attention, you will have an aerial that is probably considerably better than the majority of those in operation.

WAS THE WARDEN RIGHT?

A convict in a Middle Western State penitentiary wrote to a Willard Storage Battery dealer in his home town to ask for a second hand radio battery to attach to a receiver that he has built and set up in his cell, paid for out of his meager earnings of a dollar and a half a month, saved during the four years of his imprisonment.

He told in the letter of his shut-in life and how the little radio set he built brought him his first touch with the outside world. He related how it cheers him and builds hope in his heart that he will be able to live clean when his release comes. He told of the comfort and encouragement, entertainment and education he gets from the box full of wires, coils and apparatus. He explained that radio is a force in reformation that no reformer could hope to be.

It was a human letter and reached the heart of the dealer, a practical business man. He was disposed to comply with the prisoner's request with a brand new battery instead of a second hand one. But before doing so, he considered it wise to get the consent of the warden before making the gift. He wrote the prison for permission.

The warden replied by asking that the gift be withheld and the request denied, because, as he stated it, "Radio within prison walls has not yet been put through the experimental stage."

Was the warden right? If you had been warden, what would your reply have been?

Fone Fun For Fans

The Pot and Kettle

The Janitor's little boy, very black, was named "Midnight" by his white neighbors. He didn't mind their calling him that, but one day when one of his own race exclaimed, "Hello, Midnight!" he retorted indignantly, "Shet up, you'se jes about quarter to twelve yo'self."—Crosley Radio Weekly.

One Toot Here

The fresh brakeman approached the lunch counter jane with a look of tenderness in his eye.

"Little dear," he began, as he started to encircle her waist with his arm.

"Down brakes, kiddo," she interrupted. "'You're going around a dangerous curve."—Radio Merchandising.

Instructions Followed

"John did you deliver my message to Mr. Smith?"

"No, sir," answered John; "he was out and the office was locked."

"Well, why didn't you wait for him?"

"Because there was a notice on the door to 'Return at once;' so I came back as quick as I could."—S. S. Messenger.

"She Done Gone"

A salesman, bringing his bride South on their honeymoon, visited a hotel, where he boasted of the fine honey.

"Sambo," he asked the colored waiter, "where's my honey?"

"Ah don't know, boss," replied Sambo, eyeing the lady cautiously. "She don't wuk here no mo'."—Sour Owl.

Paid in Advance

A youth with a little too much lead in his foot was speeding through a small town in Indiana recently and when arrested was fined $15 by the judge.

Hurriedly the young man laid down $30 and made for the door.

Judge—"Here, young fellow, wait for your change."

Speeder—"Never mind, I'm leaving this town faster than I came in."—H. Krause.

Practising

A hired man was standing in front of Einstein's door as a funeral went by.

"Whose funeral?" he asked of Einstein.

"Chon Schmidt's," replied Einstein.

"John Smith!" exclaimed the hired man. "You don't mean to say that John Smith's dead?"

"Vell, py golly," said Einstein, "vot you dink dey is doing mit him—bractising?—Radio Merchandising.

VOTING TWICE FOR PRESIDENT

You will soon have the chance to do this without the risk of being arrested for a repeater. One ballot may be cast in the ordinary manner and the other one according to the scheme just announced by Station WBZ, Springfield. Only recently they conducted a similar radio poll to determine who was the popular choice for Democratic presidential choice. A large number of radio listeners responded with votes and the entire ballot proved satisfactory. The news of this radio ballot was given to many newspapers and no doubt reached the delegates attending the Democratic convention. The poll was closed just before the convention met for its first session so that the delegates would know in advance what popular opinion wanted.

The presidential plebiscite vote by radio will be a much larger promotion. The power of the Springfield Westinghouse station enables it to be heard in every State in the Union, and so will enlist the sentiment of every voter in the country who is also a radio owner. The whole nation will be allowed to ballot in the WBZ unique radio vote, and there is no question that every State in the Union will be heard from before the poll is closed.

The contest will be conducted in much the same fashion as the one just closed. Various champions will be given the stand in front of the microphone and allowed to speak in behalf of their choice for limited periods. This practice will continue nightly. Persons of political fame in and around Boston will speak into the microphone and conduct the vote generally. Complete arrangements have not as yet been made, but within a short time the names of the master of ceremonies and each champion will be announced, together with the plans for each night and the methods of compiling and announcing the results of the voting. WBZ is the only station in the country that is putting radio to such an interesting use.

A NEW 94 METER STATION

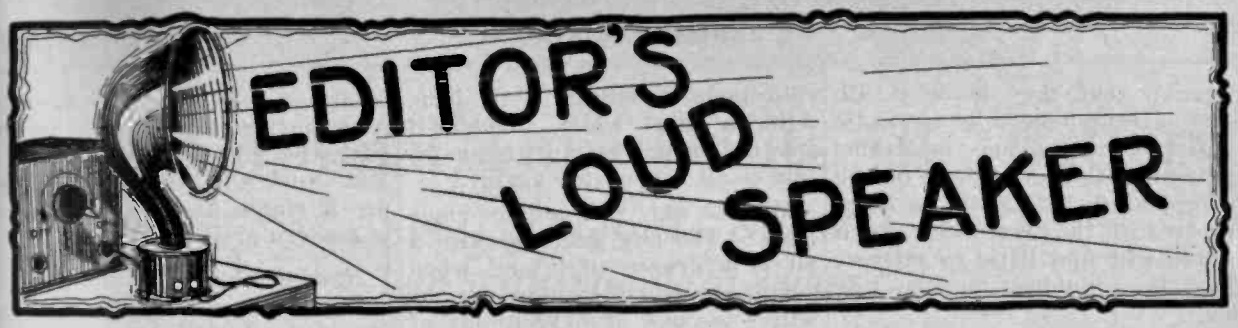
Continued from Page 18

50 feet high. The antenna has a ball on its upper end, and is quite rigid to prevent its swaying. Extremely fine results have been obtained from this perpendicular type of antenna. Though only one is now installed there will be several erected at various points about the station. The reason for using a tube is because the skin effect at this high speed of vibration, (slightly over a million a second), is very marked. Ninety-nine per cent of the current is carried in a copper film at the outside of the tube, only a few thousandths of an inch thick. If the copper were made a solid bar instead of a tube it would be tremendously heavy, as well as being quite expensive, and would not be a bit better. Figure 3 shows the outside view of the station and also the aerial.

To Hastings in Daylight

Wonderful results have been obtained from broadcasting from the new site. As an example, it is only necessary to state that daylight transmitting was successfully carried on between this station and station KFKX at Hastings, Nebraska, in order to repeat (from Hastings) the Republican convention proceedings at Cleveland and the Democratic convention proceedings at New York. Such a feat of daylight broadcasting would not have been believed possible on any wave length by radio experts a year ago. It is quite safe to say that there is no other station in the world now capable of doing such work.

With the new building and the latest apparatus, new and wonderful feats in transmitting may result this winter which will be far beyond that accomplished the past winter. Perhaps the scheme of world-wide broadcasting, first outlined by H. P. Davis, vice president of the Westinghouse Company which makes use of short-wave stations may become a reality or at least it may be started.



TEACHING DEAF CHILDREN

Probably the worse physical misfortune which any one can have is to lose his sight. There is no one so unsympathetic that he does not pity a blind man, but next to this affliction would probably come that of a child who is born deaf. It is bad enough to lose your hearing when you get old, but the poor child who has never heard misses a great deal that we never realize.

The young boy or girl gets a great deal of his education through his ears. Before learning to read or write the child has already picked up a large part of his vocabulary and has learned to think, and all this was acquired orally. As a matter of fact, it has been found by the various institutes for the deaf that many patients who are called "deaf and dumb" are really only deaf, and the reason they cannot speak is because they have never learned how to shape their mouths to make sounds, which, of course, they cannot hear.

To such unfortunates a great benefit is oftentimes given by radio. If the deafness is caused by absence of the ear drum or the vocal nerves, of course there is no hope; but where the trouble results from a thickened drum or some similar trouble which causes the patient to be very hard of hearing rather than completely deaf, then radio will be a great help.

There are two reasons why deaf people can hear radio when they cannot get what people are saying ordinarily. The first lies in amplification. If you have a two or three-tube set you will have noticed what a tremendous difference in volume of sound results from plugging the phones into the detector jack or the first or second stage of audio amplification. The music is the same in any case, but the first step makes it a great deal louder, and the second often yells so that it almost breaks your ear drums, if the phones are tight on your head. Of course, this step is really intended only for a loud speaker. By using this amplification on the phones of the deaf subject, enough volume reaches his ear so that he is able to hear quite well. It is different from shrieking conversation up close to him, because when a man starts to yell it changes the character of his voice very markedly.

For instance, if you hear a person way down the street yelling, you never could mistake it for some one talking near by in an ordinary tone of voice. The quality is quite different and the enunciation isn't the same. But let a person talk into the microphone of a sending station in a natural tone of voice, and you can tell that it is his ordinary voice, no matter how loud it comes through your amplifiers.

The other reason why the subject is able to hear radio better than conversation is not so well understood, but is concerned with the fact that the phone receiver seems to set the whole ear drum in motion more than a speaking voice does. This action can sometimes be noticed by a deaf person on a train. Perhaps he cannot hear you at all when you talk to your friends in the railroad station. But when you get on the train and speak to your neighbor's as before, he is able to hear every word. Doubtless you are talking louder than before, but in neither case louder than necessary to make the ordinary man hear. That is, in the first case his hearing is much worse than other people's, but, in the second, he is like the rest.

Following out this idea, some of the advanced schools for the deaf have installed radio apparatus with separate phones running to the desk of each of their school children. Amplifiers are inserted in the line in such a way that the volume of tone or loudness can be controlled for each individual child. The instructor has a microphone on her desk and she teaches the class in an ordinary tone of voice, just as she would in any grammar school. The boys and girls follow perfectly what she is saying. With such instruction it is found that they are normally bright and get along in their studies just as fast as any other children.

A WELCOME COMPLAINT

Most people like to be praised, and we are no exception. But once in a while some one puts in a complaint, which is also pleasing. This happened recently. One of our readers objected to the magazine because, as he said, it was too easy to understand, too elementary. We were glad to hear this because it shows in some measure, at any rate, we are succeeding in what we aim to do. The idea was to conduct a magazine which would appeal to a certain class of radio fans—those who are intelligent, but have not studied radio engineering.

You sometimes meet fellows who have a rather superficial knowledge of electricity, and as a result they try to give the im-

pression that they know it all. This is rather hard along radio matters, for the science is advancing so fast that even those on the firing line find difficulty in keeping up with the procession. Such people will find little to interest them in a publication like this one.

If you who now read this article are a radio fan who has not studied electrical engineering (that you are intelligent is proved by the fact that you bought a RADIO PROGRESS), then our articles, we hope, are interesting to you. If you have any suggestions to make as to what you would like to have discussed, or how you would like to improve the descriptions, we are glad to give you this invitation to write us just what you think.

THAT DIABOLICAL RAY

We have been hearing a good deal lately in the press about the ray consisting presumably of some kind of radio waves, which has been recently invented by an Englishman. It seems that he has sold his invention to the French government for use in war. Although the Americans do not seem very much excited, the news has upset Europe quite a little, and there is all sorts of inquiry as to what the ray is and what it can do.

We must confess that we are very skeptical about the matter. So far in the history of the world you can't get something for nothing, and while this applies quite forcibly to fake oil stocks and the like, the scientist feels so strongly about it that it has become one of the two great laws of nature. The first of these is that matter cannot be created or destroyed. When you burn a hod of coal it changes to carbon dioxide (unless it is slate), and the weight of this gas is exactly equal to that of the coal, plus the oxygen it took out of the air. Even gases are not destroyed. When you turn on your gas stove and put a cold flat-iron over the flame, you will notice that first of all a lot of water collects on the bottom of the iron. After a short while, though, it gets hot enough so that this moisture is all evaporated again.

Where did the water come from? The city gas has quite a lot of hydrogen in it and when burning a pair of hydrogen atoms will seize one of oxygen out of the air. Together they form a molecule of water, or since it is very hot, steam. When this steam strikes the cold surface of the flat-iron, it immediately condenses, just the way dew forms over night, but when the iron is hot, of course, it goes into the air as moisture, and raises the humidity of the room a little.

The second great law of nature says that energy cannot be created or destroyed. It is only changed from one form into another. The energy in coal when burned is changed to heat, which under the boiler is converted to that of steam. This passes over into mechanical energy of motion in the steam engine which is further turned into electricity by the generator. This changes into chemical energy when fed to a storage battery and on discharge is converted into heat and light by the electric lamp. So all through nature the primary source of all our power goes back to the heat of the sun.

Now, when we come to talk about a deadly ray which will stop magnetos, burn airplanes, kill men, and even destroy armies, we wonder where the energy is coming from. It takes a lot of power to accomplish such results. Here is an interesting fact. Lots of inventors work on various electrical cannon which will replace gun powder in war. It is a fact that while the amount of energy needed to fire a modern cannon is comparatively small (a few hundreds pounds of powder will do it) still, the *power*, which is the speed of giving off energy, is enormous. You see the shell is in the barrel of the rifle for such an infinitesimal instant that ordinary power simply has not time to give it a kick before it is gone. As a matter of fact, all the power generated by all the dynamos in New York City is not enough to fire a single high powered piece of modern artillery.

Now the laws of radiation, of heat, light, electricity, X-rays, etc., are all well known. There may be all sorts of improvements in sending these rays and also in receiving them, but no chance of changing the oscillations themselves. What would you think of any one who told you that he had invented a new kind of ocean wave, which would set fire to ships? You would laugh at him because the laws of ocean waves have been known for years.

Did you ever use a so-called radiant heater in your bath room during the winter time? If so, you know that the effect is small except on your light bill. It uses 500 watts of power and keeps the meter busy. It shoots a ray of heat across the room, which feels quite warm to the body, but just try to heat your bedroom with it. It would take a flock of them to make much impression on the temperature of a good sized room. Now consider increasing this ray so tremendously that it would actually set something in the room on fire. Even then when you pointed it out the window at a distant tree, if it were, say one-half a mile away, the tree would hardly feel it. Think of the energy necessary to ignite an airplane, which has been fire proofed, and which is circling around a mile overhead dropping bombs.

Perhaps you may say that some new kind of ray will be used. It is very doubtful whether there are new kinds, since the whole field of radiation has been pretty well explored, but even if a new kind *is* discovered, again it will be question of energy. A horse power of steam is not a bit more *or* less powerful than a horse power of electricity. So while it is only a fool who will say, "It can't be done," still we venture the prediction that the diabolical ray will be its own victim.

Five Terminal Tube Omits "B" Battery

Similar Results can be had with Standard Tubes

By OLIVER D. ARNOLD

IN a radio set there are only two kinds of parts which have to be renewed. These are the tubes and the batteries. Now, the tubes are a kind of necessary evil, and while many different circuits are being experimented on to reduce the number, still at least one or two remain. But efforts along these lines have resulted in the various reflex circuits, which make a single tube act both as radio and also audio frequency amplifiers, and so cut the number in two. Another result of this tendency is substituting a crystal instead of a tube detector, which is done in some of the reflex hook-ups.

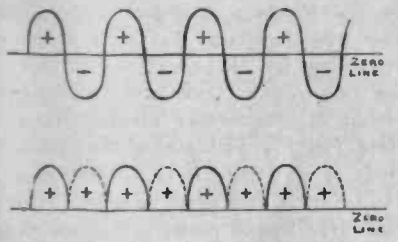


Fig. 1. Current and Heating

When it comes to the batteries, however, the hope is always expressed that they may be left out entirely. Batteries are not now used for many places where they were thought indispensible a few years ago. Even for such a thing as ringing door bells they are not employed as much as they used to be. Many people will remember the time when two or three dry cells were installed in the cellar and hooked up to the push buttons at the front door. But in modern wired houses they are no longer tolerated. Instead a small bell ringing transformer is connected to the electric light wires and its binding posts are used in the same place as the old batteries. This transformer has the advantage that once bought it costs nothing to operate, since the current consumed is so small that it will not register on the electric light meter. Furthermore, it never has to be renewed and is always in order.

Two or Three Batteries Used

It will be remembered that there are two different kinds of battery used in the ordinary set, and some of the newer ones are employing three. The "A" battery heats the filament by sending current through it in just the same way that the current from the central station makes your electric lights glow. That is all the "A" battery does—just supplies heat. If the filaments could be heated by gas without destroying the vacuum they would work just exactly as well.

The "B" battery has nothing to do with heating. Its mission in life is to supply electricity to the plate circuit of the tubes. In doing so it forces current through the telephone or loud speaker. The "C" battery does not give up any appreciable amount of current. It merely is used to put a certain amount of pressure on the grid. This is called the "grid bias." Only a few volts are used here—three to six—depending on how much "B" battery is connected.

Why a Transformer Won't Work

Attempts to dispense with the "A" battery have been made for a long time. The ideal way would be to connect the filament up to a low voltage transformer like the bell ringer, just described. This has been done, and if the tubes are used for sending wireless telegraph messages in code, then they are quite successful. But the trouble is that a transformer gives out an alternating current which drops to zero twice for each cycle. As the ordinary current supplied in the United States vibrates back and forth 60 cycles a second, this means that there are 120 times every second when no current is flowing through the filaments. This is shown in the upper curve of Figure 1. Of course, the heating varies up and down the way the current goes, except that, when the current reverses, the heating is just the same. In other words, a positive loop of current gives exactly the same amount of heating as the negative one does. This is shown by the lower half of Figure 1, which shows the amount of heat given off in the filament. The full lines show the heat liberated by the positive halves of the waves and the dotted ones by the negative halves. You will notice that they are all just alike and are, of course, all positive heat, as there is no such thing as negative.

Temperature vs. Current

To be sure, the *temperature* of the filament does not fluctuate up and down nearly as violently as the heat does. The reason is that it takes quite an appreciable time for the filament to cool off after the heat has stopped being supplied. You know that a soldering iron will stay hot quite a time after you pull it out of the flame. For this reason the temperature of the filament rises and falls, as shown in the upper curve of Figure 2. It does not drop to

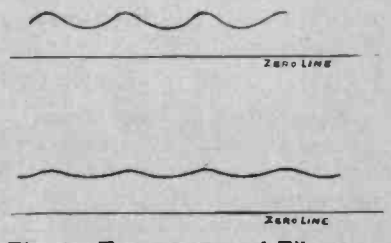


Fig. 2. Temperature of Filament

the zero line until several minutes after the current is turned off. You will remember that a big soldering iron cools a lot slower than a small one does, and for that matter takes a lot longer to get hot. So a thick, heavy filament will not fluctuate in temperature nearly as much as a thin one. The lower curve of Figure 2 shows this.

Of course, when you are operating a radio set, if you turn the rheostat up and down it causes the light to flicker and changes the volume of sound and sometimes the tuning. Suppose you jiggled the rheostat 120 times every second and got a temperature effect like that shown in Figure 2. You can easily see that it would interfere with the smoothness of the music. That is just what happens when the filament is excited by a transformer. A hum corresponding to 120 vibrations per second is heard continuously throughout the program.

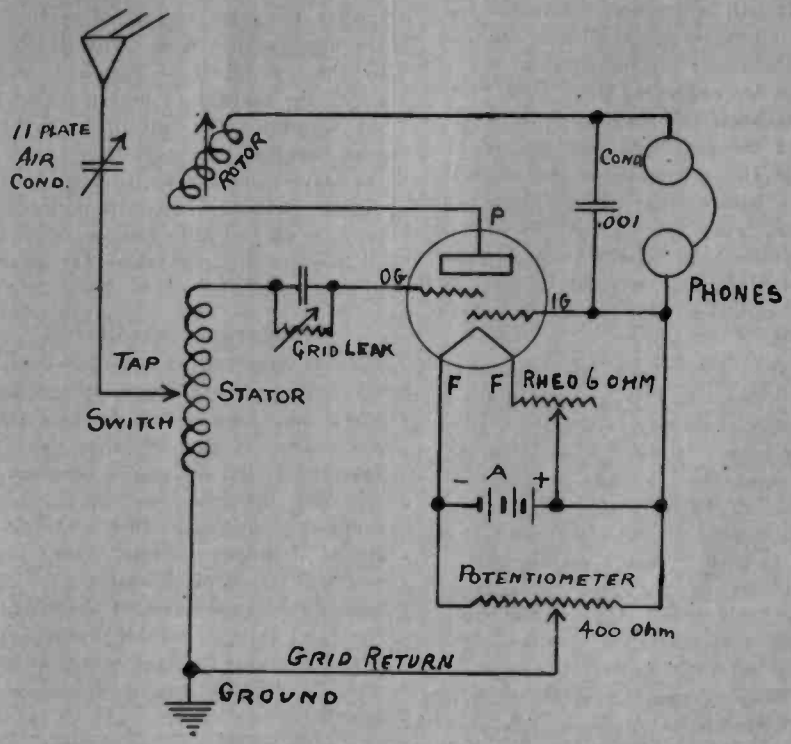


Fig. 3. Double Grid—No "B" Battery Used

Same Effect in Plate Circuit

Instead of using "B" batteries a rectifier can be substituted for the "B" batteries in your radio set. But here again the same trouble appears, i. e., a bad hum is heard all the time. This can be reduced by using condensers and coils in series, but this requires a lot of extra apparatus, and furthermore does not completely get rid of the hum, so this is hardly a satisfactory solution of the problem.

Another way of getting results has been known for several years, but has just recently been given considerable publicity. It consists in using a tube with five terminals instead of the customary four. The two filament and the plate leads are standard, but there are two grid—one is connected to a prong in the base to fit the ordinary socket, and the other has a terminal which comes out just above the brass shell on the face of the tube. The arrangement inside the tube is like that of the UV-200 except that one grid lies nearer the filament than standard, and the other grid is around it and separated from it by only a small distance.

Connecting Two Grids

In connecting up the set the hook-up of Figure 3 may be followed. A single circuit regenerative tuner is shown. The primary consists of the aerial and an 11 plate adjustable condenser for fine tuning, and the stator of the variocoupler which is tapped off with the right number of turns, as a coarse adjustment. The secondary runs from the outside grid, O.G., through the grid condenser and adjustable leak, stator, and grid return to the potentiometer. The plate circuit runs from the rotor of the variocoupler, through the phones and back to the *plus* of the "A" battery. This is like the standard connection, except that the "B" battery is omitted. The inside grid, I.G., is connected direct to the "A" plus.

To understand the theory of this circuit it is necessary to show just what the "B" battery ordinarily does. The filament, being very hot, shoots out large quantities of little particles of negative electricity, called "electrons." These fill the whole space inside the cylinder of the plate, to a greater or a lesser degree. In electricity, like repels like, and all these little electrons, since they have the *same* polarity, that is, they are negatively charged, naturally repel each other. Any new electrons being shot off from the filament have all the repulsion of all the other particles to contend with. This effect is called the "space charge." Because of it, many of the newly liberated particles are sent right back into the filament again, and only a relatively few can make their way out into the cold world, namely, the space near the plate.

Explaining a "B" Battery

Here is where the "B" battery exerts its influence. It is always the *plus* of the "B" which is connected to the plate. This positive charge has a very strong attraction for the negative charges of the electrons. Therefore, all those within a considerable distance of the plate feel the pull which the opposite kinds of electricity have on each other. The result is that great swarms of them rush over to the plate, and when they strike it they become the plate current, which runs through your telephones. An electric current is nothing more than a procession of electrons, the same as a parade is a procession of marchers.

If this explanation is clear, it will be seen that with no "B" battery the number of particles of electricity which strike the plate will be comparatively small, and that the more voltage there is applied to the plate the more they will strike. This action will keep on increasing up to the point where the plate voltage is high enough so that all the minus charges are attracted across, and, of course, any further increase above this voltage will not have any more effect.

Omitting the "B" Battery

It may be a surprise to know that many tubes will operate without any "B" battery in any standard hook-up.

Continued on Page 28.

American Radio Relay League

MacMILLAN'S RADIO RECORD

Now that a year has passed since Captain Donald B. MacMillan on board his "radio-rigged" schooner Bowdoin left Wiscasset, Me., on the first leg of his Arctic journey, it is interesting to review the extent of his radio contact with amateur operators of the American Radio Relay League. Out of this period, including the complete cycle of Arctic daylight and darkness, positively reliable communication was maintained for nearly seven months, while intermittent contact was had at various periods the remainder of the trip.

Much information regarding radio conditions in this region has been gathered that will be of use in future expeditions of the kind, but some of the phenomena experienced cannot be explained with present knowledge of the effect of the aurora on radio transmission. The most surprising condition encountered was the directional shift of the Bowdoin's signals as the little ship went farther north. The belief that once the explorer's ship reached winter quarters its signals would be heard equally well on either coast was not borne out.

Why Do They Reach the West?

While the vessel was on its way up the coast of Greenland, Donald Mix, radio operator, was in good two-way contact with radio amateurs in the eastern part of the country, but just as soon as the most northerly destination was reached, signals, instead of being heard in New England, were picked up on the west coast. This peculiar condition continued all through last winter, except for brief periods when the barrier was lifted temporarily and short messages from Mix were picked up at widely distributed points all over North America.

From the latter part of June last year up until July 28 while the Bowdoin was working its way up north, except at certain times when the ship was underway, regular communication was maintained with Irving Vermilya, operator of amateur station 1ZE at New Bedford, Mass., and R. B. Bourne, operator of station 1ANA at Chatham, Mass. From July 28 until August 27, when MacMillan was making a concerted effort to dodge the ice floes, moving southward, there was a period of complete silence. This was a cause of considerable concern until Bourne, who had been keeping a regular early morning vigil, picked up WNP's signals and copied a message saying that the Bowdoin had passed Etah, Greenland.

Barnsley Acts as "Central"

Although this place is within a few miles of Refuge Harbor, where the expedition spent the entire winter, this incident was practically the last time that an amateur in New England was in direct two-way contact with Mix. From that time until the early part of this year, signals from the Bowdoin have persisted in their westernly direction. and Jack Barnsley of Prince Rupert. British Columbia, has been the most reliable relay operator between MacMillan and the United States. Practically all press dispatches from MacMillan and messages destined for the Bowdoin were sent by way of Barnsley's station.

All through the months of September. October, November and December of 1923 communication with WNP was everything that could be asked, and thousands of words of press matter were received and scores of private messages were sent in both directions. Several broadcast stations were heard by MacMillan's crew, while WNP's signals were picked in such places as Minot, N. D., Evanston, Ill., Des Moines, Ia., Hanover, N. H., Avalon, Catalina Island, Cal., Fairmont, Minn., Glenside, Pa., Jamestown, N. D., Alaska, Fort William, Ontario, and in Texas.

Beginning the latter part of January. signals from Mix began to straggle, and they have continued to fall off with the approach of daylight in the Arctic, except for an occasional short message containing the information that "All's well." MacMillan will soon start for home, and it is expected contact will be renewed again.

RADIO ON THE BIG BILL

E. C. Page of Evanston, Ill., radio operator for the auxiliary ketch, "Big Bill," which is making a two-year trip to the South Seas in the interest of the Deep Waterways Commission, before leaving Chicago was presented with an official relay certificate by R. H. G. Mathews, Central Division Manager of the American Radio Relay League. This makes him an official A. R. R. L. relay operator and requires him to forward all amateur radio messages that he receives during the long voyage.

Being himself an amateur of considerable experience, Page has announced his intention of communicating on short wave lengths. As the "Big Bill" will eventually travel around the world, he will have the unusual opportunity of being able to converse in code with amateurs in practically all of the foreign countries. His trnasmitter has a wave length range of from 80 to 700 meters.

This set was designed with three important aims—that of low losses, commercial efficiency, and finally, its adaptability for hard usage on board a ship at sea. The Hartley circuit is used, employing two 50-watt tubes connected in parallel.

A Dynamotor for 1500 Volts

The power supply is obtained from a 1500-volt dynamotor. This is a machine for changing the direct current from the lighting system, which operates at low pressure, up to the high voltage required by the plates on the vacuum tube. It consists of an armature very much like that of an ordinary generator, except that it carries two entirely separate windings insulated from each other. One of these is connected to the 32-volt line and the other gives out the 1500 volts. The difference in the windings is that the first has only a few turns of heavy wire, while the second is wound with many thousand turns of fine wire. There is a commutator at each end of the shaft, one connected to the high, and the other to the low pressure windings. The ship is equipped with a 32-volt light system and this lights the filaments through a series resistance. Copper bus bar wiring is used throughout and spe-

Continued on Page 29

FIVE-TERMINAL TUBE

Continued from Page 26

For instance, experience was recently tried with a UV-199 tube, although other styles would show a similar result. When using this as a detector in a

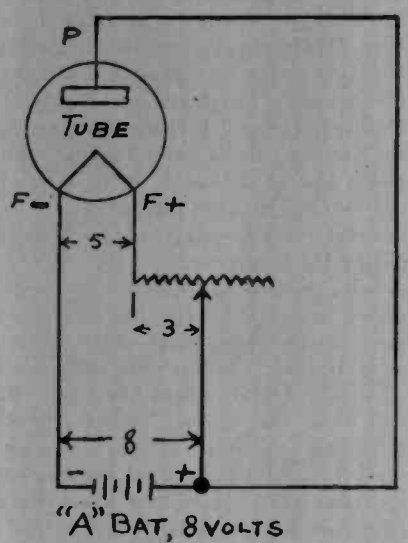


Fig. 4. "A" Battery Gives Plate Volts

single tube hook-up, the music was very good on any plate voltage from 20 up to 45. When this was cut down as low as six, the volume fell off somewhat, and at three the music was perhaps only one-half as loud. When listening to a local station the volume was still fairly good with the "B" battery entirely cut out and the lead which had run to it connected to the "A" plus. When this lead was switched over to the "A" minus it put a negative potential on the plate, and so this repelled some electrons which would otherwise have struck. The result was that the music could be heard only faintly. Notice, however, that it could still be heard. Distant stations in the test described were lost at five or six volts of "B" battery. The reason was that with low plate pressure a greater tickler effect is needed to cause the tube to regenerate. The coils used in this set were not big enough to cause more than the normal amount of feedback. If a tickler coil of 60 or 70 turns had been substituted for the ordinary one, then regeneration could have been continued to a lower voltage and distant stations would still have been brought in.

Needs Large Tickler Coil

With this idea in mind it is easy to see why the hook-up in Figure 3 works. Before the inside grid is connected to the "A" plus, the hook-up is just as described above. If the stator consists of 50 to 75 turns wound on a 3½-inch tube and the rotor contains about 50 turns, then the tube will oscillate and distant stations can be brought in. Single cotton covered wire of about size 24 is right for the winding.

Now let us connect inside grid IG to the "A" plus, as shown. This puts a positive potential into the space much nearer the filament than the plate is. For that reason it is much more effective in getting the electrons started on their journey across to the plate. This grid is wound with very fine wire, which leaves big spaces for the negative particles to shoot through on their journey. The operation of the set is just the same as before except for this additional assistance in building up the plate current.

Uses a Variable Leak

It will be noticed that it shows a potentiometer and also a variable grid-leak. With some experimenting one of these can usually be omitted, as they are both used for the same thing; that is, to control the grid bias or voltage on the grid. Since the output from this hook-up will not be nearly as great as from the ordinary style, it is worth while adjusting everything to the best possible point, and that is why these two extra controls are used here, while they may be omitted on a standard set.

Another point of interest in regard to the plate circuit is this: Sometimes an audio transformer is shown connected—the primary in series with the phones and the secondary in parallel with primary and phones. Of course, such a hook-up is absurd. A transformer does not increase energy. It merely changes the voltage and current of a circuit. Either one may be increased, but always at the expense of the other. The idea of using a transformer for such a purpose is crude.

Like Automobile Tire

After experimenting with the above hook-up it will be found, if the inside grid is disconnected and a "B" battery inserted in the usual manner, that the operation of the set is considerably improved. Even one cell of dry battery makes the music a lot louder, and two or three cells is a further improvement. What we are really doing is operating under unfavorable circumstances. It is like driving an automobile with only five pounds of air in the tires. Such a machine will run, but that is all you can say for it. Ten pounds of air will make it work better, and 15 still better. The more you put in the more satisfactory will be the operation of the tires until you get in the right amount.

Instead of using a "B" battery it is possible to employ an "A" battery with a higher voltage than necessary. See Figure 4. Here we have a tube like the UV-200, which uses five volts on the filament. The "A" battery has a pressure of eight volts. That means that three volts will be absorbed in the rheostat. Notice that the pressure of the rheostat (three volts) is connected right in series with the line between the plate P and the filament F. This is just as good as using a three volt "B" battery. The phones are not shown in this diagram so as not to confuse the circuit, but they are inserted right next to the plate. As we have already mentioned, three volts on the plates is enough to get fairly good reception if a powerful tickler coil is used. That is why the ordinary hook-up will work without a "B" battery, provided a high voltage "A" battery is connected.

Of course, this is a very expensive and inefficient method of generating the plate voltage, since one cell of "A" is a great deal more expensive than a cell of "B" battery; 22 volts of "B" usually cost a couple of dollars, while even six volts of "A" will run around $15 or $20.

In conclusion, for those who wish to experiment, we advise trying out the hook-ups just described, but, of course, if what you want are results, then it will be necessary to use some form of voltage on the plate circuit.

WGY

A new weekly feature has been added to the WGY program, starting July 28, something which should appeal to every lover of motion pictures. Quinn Martin, motion picture critic of the New York World, will give a series of movie talks or "Movie Notions" every Monday evening.

Rx 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.

MACMILLAN'S RADIO RECORD

Continued on Page 27

cial attention has been given to the construction of the set to make it sturdy and efficient.

Porcelain and Hard Rubber

Porcelain insulators are used wherever possible and, in such places as they are not practical, hard rubber has been substituted. Both of these materials are uneffected by salt water. No moulded material of any kind is found in the equipment. The dielectric losses have been minimized through careful design and construction. Loading inductances have been provided to bring the wave length up to 700 meters to allow for communication with commercial ship and land stations. These are nothing more than coils wound with several hundred turns, one of the plate, one for the grid, and one for the aerial circuit. They are inserted in series with their respective lines and slow the time of oscillation down until the wave length has increased to the value desired.

The tuner is a low loss type and embodies all of the advantages of a careful design. It was built in the Chicago Radio Laboratory. This receiver has a wave length of from 50 to 200 meters and will be used entirely for picking up short wave amateur sending stations. The ground consists of a two-foot copper strip around the hull.

A second tuner of the standard Zenith 3R type with a wave length range of 200 to 600 meters has been installed. This is provided with a special loading arrangement to allow for reception of signals on wave lengths of 2,000 meters and up. A complete set of "spares" including rheostats, tubes, condensers and sending telegraph key are carried.

Inasmuch as the receiving set uses three "B" (22½ volt) and a "C" battery, a number of sets of batteries have been sealed in evacuated air-tight metal containers that have been packed carefully in a cool spot below the water line of the ship. The complete aparatus was donated by the Zenith Radio Corporation.

Question. Please give more information in regard to size of coils, etc., for the superhetrodyne, using the second harmonic, as shown in your issue of June 1?

Answer. The set described is that of the standard Radio Corporation. Unfortunately, they do not allow the details of this set to be published. They take the position that the excellence of the operation is due in no small part to the accuracy of the various condensers and coils. Such testing can be done only in a very well equipped radio laboratory. Even though they told the number of turns on the coils and plates in the condensers, still the average amateur would not be able to put it together correctly. The various stages each tune so sharply that they must all be exactly alike, or else nothing comes through. In this respect it is something like the neutrodyne, but only more so. In this latter set you realize that all three dials must be adjusted correctly to get results. With this superhetrodyne the need of all stages being exact is even more marked.

For this reason we are unable to give the winding details of the set. The reason the account was published is because so many people did not understand what the "Second Harmonic" meant, and how it was used in a set.

Question. What is the difference between a moulded and a wood variometer?

Answer. If both are well built, there is no difference at all in the operation of these two kinds. Dry, impregnated wood is a very good insulator and the same is true of a good moulded composition. Oftentimes the wood construction is cheaper, but the moulded material is usually better looking. In selecting a variometer, we recommend picking out one that uses a copper shunt to conduct the current in and out of the rotor. Some makes depend on a spring contact. If properly made, such a construction is quite reliable, but, of course, a sliding contact introduces one possibility of trouble.

Question. What is meant by an *untuned* primary?

Answer. Practically every circuit which carries radio frequency, has some natural period of vibration. This means that if left to itself it naturally wants to oscillate so many times a second. The fact that we do not know how fast it tries to go and do not adjust for it, doesn't mean that there is no such time of vibration. It is like a pendulum. If we see a stone tied to a string and hung up on a nail, it would be foolish to say that the stone and string had no special time of vibration, merely because we did not happen to know how fast it would go. When we set it swinging we would soon find that it made two beats every second, or five, or whatever the figure happened to be. If we wanted to make it go exactly five times a second, by adjustment of the length of the string we could accomplish this result But to say that it was untuned in the sense that it had no particular timing would certainly be wrong.

Whenever the primary of the tuner in a radio set is made non-adjustable, that

is, has no taps running to an inductance switch, then it is untuned in the sense that we can not ourselves adjust it for any certain frequency. But, of course, it has some particular wave length—there is some special wave length to which it will respond louder than any other. If the tuning is very broad, or in other words, the coil is not at all selective, then it can be used for the entire broadcasting field much the same as a fixed focused camera will take pictures of most any distance with satisfactory results.

Question. Is it important to get the polarity right for the tips on the telephone cord?

Answer. This depends somewhat on the amount of "B" battery used. If 90 or more volts of "B" battery are installed, and especially if no "C" battery accompanies them, then the direct current drawn through the phones will be comparatively high. It is this direct current flowing through the large number of turns in the winding of the phones which either weakens or strengthens the flux which comes from the permanent magnets. Strictly speaking, the music should be reproduced louder when this extra force helps rather than hinders the magnets, but practically it is very difficult to hear any difference. If the change is so slight that when you try it out you cannot detect it, then it is foolish to split hairs as to which way to connect the two cord tips. If you can notice any difference, of course the louder connection is the right one.

Question. What is the difference between silk-covered and cotton-covered wire?

Answer. The insulation on a radio set is not very important between turns. This may sound extraordinary since you have no doubt heard a great deal about using good insulation. There are three different places where insulation is necessary. The first is on the "A" and "B" battery circuit. Here we have real pressures up to as much as 90 volts in some sets. Of course, this requires insulation of good strength to prevent the voltage from jumping across. The second class is that on the radio frequency circuits, like the variocoupler and variable condenser. Here the pressure is very low, oftentimes less than 1/1000th of a volt. Naturally, any kind of insulation at all will withstand this pressure so that it will not break down, but there is another quality which must be looked for here—that of high resistance. If the amount of energy coming in is so very small, then it is doubly necessary to save all we have. That is why it is undesirable to use fibre for such places. Fibre will stand a high voltage, but it does allow some leakage, and that means that our tiny bit of energy will be partly wasted. Bakelite, condensite, hard rubber, and the like, are the only things to use for panels and condenser ends.

The third kind of insulation is that on the wires themselves. Its only use in this place is to separate one turn from the next. Here, of course, the voltage is so low as to be hardly measurable and there is no real danger of leakage. The necessity of the insulation on wires is pure mechanical, that is, it must keep them spaced apart. Practically any kind of fibrous material will do this, cotton, silk, or what-not.

The advantage of cotton is that it is cheap, but the threads are coarser than those of silk. The latter is a better insulator for high voltages, but such a requirement is not needed here. The advantage of silk in radio work is that it occupies so little space that the turns of wire can be closer together and so more wire can be got into a small space. For the rotor of a variocoupler, this is sometimes an advantage. However, if there is lots of room on the spool or tube, then silk is no real advantage and cotton will do just as well at a lower price.

GOING 38,000 MILES FOR RADIO

All work and no play might have prevented the Convention of Crosley Jobbers from being so successful, and so it was decided to include a little fun in the form of a mileage guessing contest. Every delegate was asked the number of miles traveled by all those present, the one guessing the closest to receive a Trirdyn Special Radio Receiver. A large map was placed before the jobbers and each placed a mark on the city he came from. Then the distances were added and it was found that 38,565 miles were covered by the visitors in coming to the convention, only one way and not a round trip being considered. H. P. Tozier, of Portland, Maine, won the prize by guessing 38,364½ miles, while G. H. Thaubald of Cincinnati was second with his guess of 38,885. Estimates ranged everywhere from 300 miles to 1,000,000,000,000, the persons entering these evidently being of the opinion that some valuable "booby" prize was to be awarded. They certainly deserved it.

RADIO PROGRESS
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