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RADIO PROGRESS

"Always Abreast of the Times"

IN THIS ISSUE:

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PUBLISHED TWICE A MONTH

RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 11

Contents for

AUGUST 15, 1924

We all know that static and fading are worse in summer time. But the question is, Why? An article by Langley in the next issue gives the best discussion we have seen of this subject. He tells why fading is usually worse around 80 to 100 miles away from a powerful broadcasting station. See "STATIC AND FADING IN WARM WEATHER."

The Neutrodyne is a very popular set, but do you know why it is never reflexed? In the September 1 copy Wexler and Seplain not only tell why this has not been done before, but explain how to do it—"REFLEXING THE NEUTRODYNE."

By all means don't miss "WHEN RADIO CONTROLS ITSELF," by Goldsmith, the head of the Research Department of the Radio Corporation.

There are dozens of different kinds of phone jacks on the market. Some are much better than others. By changing a connection you can operate your phones and loud speaker at the same time. Read "JUDGING JACKS FOR REAL RESULTS," by H. V. S. Taylor.

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RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 1, No. 11 AUGUST 15, 1924 15c PER COPY, $3 PER YEAR

Real Reasons for the Rheostat

When to Use and When to Omit This Necessary Unit

By HORACE V. S. TAYLOR

AMONG the various pieces of apparatus which might be classed as accessories in a radio set the one used most is probably the rheostat. There are a good many conflicting opinions held about this unit. For instance, some builders will employ no less than six of them in a six tube set, whereas other manufacturers cut the number down to two or one, or perhaps even omit it entirely.

Probably everyone is familiar with the way a rheostat looks. A side view of a popular style is shown in Fig. 1. T1 and T2 are the terminals. It will be noticed that T1 is connected by a metal strip, S, to the arm A, while T2 runs to the start of the wire winding. This would apparently make the two connections not alike. However, although the construction is different for the two, in practice they give exactly the same results, so no attention need be paid in connecting up the set as to which is which. The arm A rubs over the wire which is wound around a fibre strip bent in the shape of a crescent.

Using a Filament Switch

The conventional symbol for joining a rheostat is shown in Fig. 2. T1 again represents the rotating arm and T2 the terminal attached to the wire. The whole theory of connections for this unit is explained by this picture. When the arm is swung around to the left to the position shown by dotted lines, then the circuit is open and no current can flow. This use of the rheostat as a switch is quite common, particularly on the older sets. Some of the newer radios have a filament switch connected in series with the "A" battery and when this is shut off of course the entire filament circuits for all the tubes are dead. The advantage of this construction is twofold. First, the individual rheostats can be left set to the position of best operation and when the switch is turned off it is not necessary to shift them. Second, there is no danger of forgetting to turn off all the tubes as is sometimes done when an

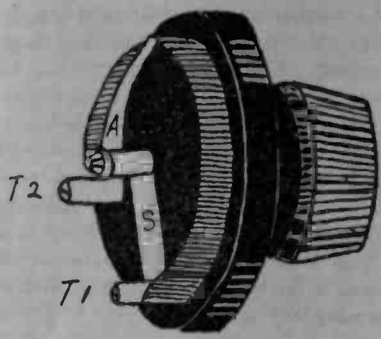


Fig. 1. Connections of Rheostat

individual control must be operated for each bulb. The single switch in this case turns on and off the lot.

Referring again to Fig. 2, when the arm is turned to the right it cuts down the amount of resistance wire in circuit between the two binding posts. This naturally reduces the resistance, and so allows the current to increase. When turned to the full-on position the arm rests directly against terminal T2 in the better built units and this cuts out all resistance, which allows full voltage to be impressed on the tube filaments. The advantage of this construction is evident when using the dry battery tubes Take the WD-11 or 12, for instance. These operate on 1.1 volts filament pressure. When the dry cells are new they have a pressure of 1½ volts, but as they run down the potential keeps dropping and finally they get as low as 1.1 volt. If the rheostat were a poorly constructed one, so that all the resistance could not be cut out in the "on" position, then the pressure on the tube could not be correct since the rheostat would take up one or two-tenths of a volt.

Drawing Your Morning Bath

Resistance, in an electric circuit, works exactly the same as in a water pipe. There are two cases which will readily come to mind of such an effect. If the pipes in your house are quite old it may happen that as time goes on the water pressure apparently falls as you try to draw a tub full for your morning bath. This will quite likely be caused by the fact that rust and sediment in the pipes have caused a partial stoppage. In other words, they have introduced resistance into the pipe line. The more this resistance is, the less the flow of water. Of course, it is the same principle exactly as that which governs the electric current in your filaments. Another thing,—notice that if you have a long pipe, which is partly clogged, then it cuts the water supply down a lot more than a short length. Here again the same analogy holds. A long resistance wire has a great deal more effect than a short one in reducing the flow.

As a matter of fact, the ratio between

the voltage absorbed by a long resistance wire and a short one is just the same as the ratio of the length of the wire itself. Thus, if we have a piece of wire a foot long and run, say one ampere through it, it will take up a certain voltage. If we have the same size of wire two feet long with the same current, it will take just twice the voltage. That is why the rheostat changes the current as we swing the arm from side to side.

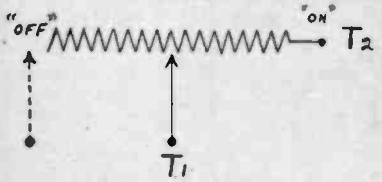


Fig. 2. Rheostat Symbol

When it is over at the left it leaves a long piece of wire in circuit, but as we move it to the right it keeps cutting out turn after turn and so reduces the length of wire which the electricity has to traverse. Way at the right in the "on" position all the resistance is out of circuit. The fact that the wire is still connected (since it is all one piece) does not have any effect, as no current is flowing through it. In other words, a resistance is effective in cutting down the current only if there is a current to cut down.

How the Current Varies

Another point to notice is the way that the area or size of the pipe affects the operation. If we have a large pipe it naturally carries more water than a smaller one. The amount carried depends on the area, not on the diameter of the pipe. In Fig. 3 we see two pipes; one has a one-half inch inside diameter and the other a one inch. Since one is twice as big as the other, it might be supposed that it would conduct twice as much water. But it must be remembered that the area of the circle varies as the *square* of the diameter, and since one pipe is twice as big, it will have four times the area. As a matter of fact, such a pipe really will carry water four times as fast.

Exactly the same thing holds true in regard to the electric conductors if they work on direct current or ordinary alternating current. For such cases the resistance goes down as the area increases, just as illustrated. For instance, compare a No. 30 copper wire with a No. 24. The former has a diameter of .01 inch, while the latter is just double,—.02 inch. That means that the resistance of the No. 24 is one-quarter of the other, or if each one is connected up to a battery the latter will pass four times as much current as the former.

Silver Better Than Gold

Another thing that affects the resistance of the wire is the material of which it is made. Silver is the best conductor that is known, but it is only a trifle better than pure copper. Gold is about the same as copper. Iron and brass have seven or eight times its resistance, depending on the purity of the metal. If copper were used for the resistance wire of a rheostat it would require a very great length or else a very small diameter. The first would be objectionable because there would hardly be room on the rheostat to wind it all on, and the small diameter would not do because the wire would be weak enough so that it would be very likely to break, owing to the small size. On this account rheostats are always built of special resistance wire, which is from 15 to 60 times as effective as the same amount of copper. Such wires contain nickel and chromium as their principle ingredients. The further advantage of such alloys is that when they get red hot they do not oxidize, whereas copper and iron corrode badly at such temperatures.

Sometimes when several tubes are operated from the same rheostat it will be found that this device gets pretty warm and oftentimes the user gets somewhat worried about it. This need cause no alarm however, as a good rheostat will stand a fairly high temperature without causing any trouble.

Rheostat Uses Volts

The whole purpose of a rheostat is to absorb voltages so that the tubes will have the proper pressure applied to them. The battery usually gives out a higher pressure than required by the tubes and the difference must be absorbed in the rheostat. For instance, if we are using a 200 or 201-A tube a pressure of five volts is required on the filament. The storage battery which operates the set gives out six volts; that means that the rheostat must absorb one volt. If UV-199 tubes are employed, they will require a potential of three and since the three dry cells each give 1½ volts, or a total of 4½, then the rheostat must take up 4½ minus 3 or 1½ volts.

It may be asked, How many ohms are needed to absorb one volt? This question cannot be answered until it is known how much current is flowing. The rule is that the volts equal the amperes times the ohms. For instance, 8 volts will be absorbed by a rheostat having a resistance of 2 ohms with 4 amperes flowing, or 4 ohms with 2 amperes or 6 ohms with 1 1/3 amperes. The reason for this may be grasped by looking at Fig. 4. This represents a river in spring flowing over a dam which backs up the water. In the springtime a large current is running and the resistance of the dam causes a big disturbance in the stream. This is shown by the eddies and ripples just beyond the dam. Fig. 5 shows the same stream and dam in the autumn. The current flowing is now small, and as a result the effect of the dam is so little that it can hardly be noticed. The water trickles over the obstruction and continues on its way without any very great amount of disturbance being seen. It is this same action exactly in the rheostat which requires the amount of current to be known before the voltage drop can be calculated from the resistance.

Current Needs of Tubes

We are now in a position to decide on what value of resistance to use in various installations. The first step is to find out how much current will be used to light all the filaments. The values of the ordinary tubes are as follows:

UV-200—1 ampere.

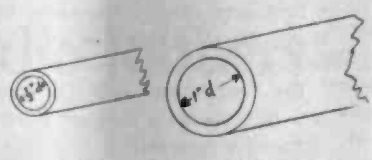


Fig. 3. Wires Like Pipes

UV-201A, WD-11 and WD-12—¼ each.

UV-199—1/16 ampere.

As an illustration, a five tube neutrodyne using five 201-A's would require 1¼ amperes. If a UV-200 is used for a detector, then the current will be increased to two.

The six tube superhet of the Radio Corporation uses 199 tubes, which will require 6/16 or 3/8 ampere all told.

The next thing to do is to find how

much voltage must be absorbed in the rheostat when the batteries are fully charged or new. A 6 volt storage battery gives about 7 volts just after taking it off the rectifier and a new dry cell runs 1½ volts. Three dry cells in series will then give 4½ volts. The tubes use 5 volts on the UV-200 and UV-201-A; three of the UV-199 and 1.1 on the WD-11 and WD-12. By subtracting these later values from that of the battery the work to be done by the rheo-

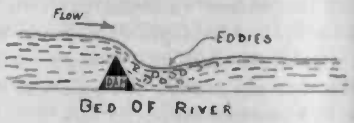


Fig. 4. Springtime Flood

stat is obtained. Thus for the neutrodyne 7 — 5 = 2 volts in the rheostat. In the superhet we have 4½ — 3 = 1½ volts at the rheostat. For the ordinary set using WD's the figures are 1.5 — 1.1 = 0.4 volts.

To get the resistance which the rheostat must supply, divide the volts as just found, by the amperes which the rheostat will control. Assuming that only one of these units is used for the neutrodyne, we shall need at least 2 volts divided by 2 amperes equals 1 ohm—obviously a six ohm rheostat will be ample. For the superhet we have 1½ volts divided by ⅜ which equals 4 ohms. Here a six ohm rheostat would do, although many would use ten ohms. Other cases are calculated in the same way.

Using Separate Rheostats

All the above calculations were made with the idea in mind that one rheostat would control all the tubes. This is oftentimes done in the latest design of radios. But if the set you are going to build has separate controls for one or more tubes, then the same principle of design will be used, but instead of using the current carried by all the tubes, just use the amperes which will pass through the rheostat in question.

When it comes to deciding on how many rheostats to use there is some disagreement among engineers. The number varies all the way from six to eight on a set with as many tubes down to a single control for all the filaments. Some manufacturers use three—one for radio amplification, one for detector and one for audio. However, the general tendency is to reduce the number of controls. It has been proved again and again that the temperature of the filament does not affect the amplification of radio or audio steps, provided it is within 10 or 20 per cent. of the correct value. Furthermore, all tubes of any certain kind are near enough alike so that they require the same voltage on the filament to get best results. This applies to amplifiers of all kinds. That is, a radio step works at the same temperature that an audio one does.

Tuning on Electric Lights

For this reason it is absurd to have an individual control for every tube. The same thing applies to your house lights. They are all designed for 110 volts. What would you think of an architect that specified a special resistance in each lamp circuit which you were supposed to adjust every time you turned on your electric light. As a matter of fact all your light bulbs are built for the same voltage—110. The manufacturers could have built them just as well for 115 volts, and in fact they do build that size for use on special circuits. But if you ask for 110 volt lamps you get them, and there is no occasion at all to use individual adjustments on each socket.

The same people who build the electric lights are the ones who construct the vacuum tubes and they use the same kind of engineering on the filaments. If you have a bulb which rates at 5 volts it means that it will work best for all around service at that pressure. As a matter of fact, such a tube will give good results anywhere from 4½ up to 5½ volts. The filament adjustment on these modern units is not at all critical. How foolish, then, to imagine that each one has to be separately controlled!

Tuning with Rheostat

When we take up the matter of the detector there are some who think they have to get their tuning by varying this unit. This is really a mistake. The detector should be adjusted to rated voltage for the same reason as that applied to the amplifiers. For instance, a UV-199 tube will give best detector action at 3 volts. But it is undoubtedly true that by varying the current through the detector filament, stations can sometimes be tuned in or out. For this reason the inexperienced operator often thinks that it is worth while to have a separate rheostat for the detector.

This reasoning is not right. The fact that the tuning *can* be changed by the rheostat is a poor argument for making it adjustable. By the same token the tuning can oftentimes be changed by bringing your hand up to some coil in the radio set. Using the same line of argument, it would be desirable to have a hand attached to a swivel arm so that it could be stuck in and out of the cabinet to get these changes. Anyone can see how foolish this idea is. Or put it in another way. If you are out in an auto, which is rolling along at 25 miles an hour, and you wish to slow down, it is easy to put your foot on the brake a little, while you are still stepping on the gas. To be sure you *can* do it this way. Most people prefer, however, instead of putting on the brake, to let up a little on the accelerator and so accomplish the same result.

The Manufacturers Ought to Know

From this it may be seen that in radio it is a poor argument for putting on additional controls to say that they can be made to work. Every bit of tuning which can be accomplished by the detector rheostat can be done better by the variable condenser or variometer which is already in the set. If all the tubes are hooked up to the same rheostat, and it is adjusted to the rated voltage, as found out in countless tests of the manufacturer, then the best results will be had. If you have no voltmeter to find out this exact pressure, no harm is done, since as mentioned above, the adjustment is not at all critical and anything from 10 to 15 per cent. above or the same amount below the designed pressure will give perfect performance.

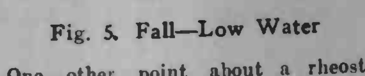


Fig. 5. Fall—Low Water

One other point about a rheostat which is sometimes brought up is that it is not safe to leave it adjusted to the correct point and then turn on the current with a switch. This is nothing but a superstition. Do you turn on the current on your electric lights through a rheostat or do you snap them on all at once? The same kind of filament exactly is used in a UV-200 as that which is in the ordinary bulb and in the other styles of

Continued on Page 28.

Some Sending Station Stories

WGY SANG TO SOUTH AFRICA

This most extraordinary reception was reported by N. Grant Dalton, an amateur at Johannesburg, Transvaal, South Africa, who received, through 2XI, the entire performance of "The Mikado," broadcast on the evening of May 22. The Johannesburg Star, to which Mr. Dalton in his delight reported his reception, doubted the young amateur (strange to say) but the management of the publication was interested to such an extent that they cabled the General Electric Company prepaying reply to check the claims of Mr. Dalton. He heard 2XI from 2:45 to 5:30 A. M., his time. (You know the early bird, etc.)

Mr. Dalton stated: "It is the best reception I have ever had. It was the best I have yet experienced both as regards clarity and strength. To be sure, the spoken word sounded a bit muffled or mushy. The same also applied to the choral singing, but the solo and duet voices were particularly good. Throughout we could distinguish the text." The Johannesburg man also picked up 2XI April 22 and May 15. He used a four tube set, one high frequency amplifier, detector, and two low frequency steps, but the absence of static was so marked that he was able to add another radio frequency tube to build up the incoming signal.

Johannesburg is 8,043 miles from Schenectady. This is a record distance for the station. The reception was the more remarkable because of the warm weather at the transmitting end and the heavy static that had to be penetrated to reach southern Africa, now experiencing the winter season.

FOR CLASSICAL MUSIC LOVERS

During the month of August, WGY, Schenectady, will have a special musical treat for its audience. A series of 11 concerts by the New York Philharmonic Orchestra and eight by Goldman's Band will be broadcast. This will be good news to the thousands who plan to spend their vacation period in the playgrounds of New York, New England and eastern Canada.

Programs of both these organizations will be presented in New York, the former at Lewisohn Stadium, College of the City of New York, and the latter at The Mall, Central Park. WGY will be connected to New York by wire and will present the concerts in co-operation with WJZ.

This will be the seventh season of stadium concerts for the Philharmonic Orchestra, which this season has been augmented to 105 players under the direction of Willem van Hoogstraten, with Fritz Reiner, conductor of the Cincinnati Orchestra, as guest conductor. With few exceptions the personnel of the orchestra will be the same as that engaged for the regular Philharmonic concerts next season. Stadium concerts do not follow the tradition that summer concerts must consist chiefly of light, popular music. The only limitation on the programs will be the fact that they are played out of doors. Most of the standard symphonies and symphonic poems are listed for performance, as well as many unfamiliar works by classic and modern composers.

CONVENTION CALLER BEATS "DOUG"

Our friend Douglas Fairbanks can't claim to be the most popular idol any longer.

Bushel baskets of mail, telegrams and even packages are being received by Graham McNamee as a result of his announcing through eighteen stations scattered in twelve cities during the Democratic National Convention at Madison Square Garden. Some are pathetic, others amusing, and they abound in invitations to week ends, social functions and every form of amusement that can be imagined.

Skunks Delighted at This

According to a communication from Ramona, Oklahoma, Graham McNamee's announcing was so entrancing that, "when Smith passed McAdoo at the eighty-third mile post, one of my listeners, Ezra Thumpkins, got so excited he rolled off the log backwards and fell into eleven feet of water, so you see the race almost cost the life of the best skunk hunter on Possum Creek."

Many of the fair ones (at least we hope they are) have written in asking about our hero—the color of his hair and eyes, and most particularly, whether or not he is married.

The answer to this question and thousands of others who have presented it in various ways disposes of more than half the letters which he has received. So here is the dope—McNamee's hair is a medium shade of brown; keen blue eyes that are always alert, even though he is a married man.

HOUSEHOLD EQUIPMENT COUNSEL AT WJZ

One of the foremost writers on women's subjects in the country, Miss Ethel Peyser, will deliver a talk every Wednesday afternoon which will be a regular feature from station WJZ hereafter, under the title "Counsel on Household Equipment." Miss Peyser is a recognized authority on practically every household subject from music to plumbing, and is a featured contributor to the country's leading periodicals. She writes for a reading audience of approximately 15,000,000 women a month, and her radio audience numbers at least 5,000,000 within the same period, making her remarks and ideas probably the most discussed of any woman's in the world.

HEARING THE MUSIC DOUBLE

Automobile tourists who visit Central Park, at Schenectady, N. Y., Sundays during the month of August may enjoy the novel experience of listening to a concert direct from the instruments at the same time they hear the same concert by radio.

The Schenectady Little Symphony Orchestra will play at the tourist park Sunday afternoons, August 17 and 31, and the music will be broadcast by WGY. At Central Park and within 500 feet of the orchestra is the new induction loud speaker invented by Dr. C. W. Hewlett, of the research laboratory of the General Electric Company. A description and hook-up for this new type was given in the July 15 issue of RADIO PROGRESS, page 25. By means of a loop aerial the radio waves of WGY carrying the orchestra music will be picked up and reproduced by the loud speaker.

When Should a Potentiometer be Used?

Why Do Some Hook-ups Show One and Others Leave It Out?

By VANCE

IF you look over the diagrams and hook-ups of radio sets of several years ago you will notice that most of them contain at least one and sometimes two or more potentiometers. Yet, to-day's diagrams almost always leave them severely alone. Can we lay this to a change of fashion, like bobbed hair, or are circuits better known than they used to be?

At least part of the change is undoubtedly due to styles. If you look over the various articles in the radio press, you will be surprised to notice the great similarity of many of the hook-ups. Some one has an idea at first and good or bad, publishes it. This is copied by another paper and that by another, and all without much checking up to see if the various parts are really required and are correct. There have been cases on record where a mistake was made in a formula or diagram, and this was repeated time after time without correction, one just coyping crudely from another.

Tubes Much Better Now

At least part of the vogue of the potentiometer may be laid to this cause, but there used to be some excuse for it. The vacuum tubes of two years ago were not as good as they are now. For one thing, they were a lot more critical. That is, they had to have just the right plate voltage, or they would not work very well. Of course, a "B" battery varies in steps of one cell. Each cell has a potential of 1½ volts.

The taps on a "B" battery come at 16½, 18, 19½, 21, and 22½ volts. There is no chance of getting 21½ say, or 22.1 volts. In the attempt to split these intervals a potentiometer was often shown. By connecting the two ends the wire resistance across the terminal to the "A" battery and hooking up the minus of the "B" to the adjustable arm, then the steps of the "B" battery could be broken into small parts as desired and fractional pressures could be easily obtained.

Big Range is O K

As a matter of fact, it is rather doubtful whether such fine steps really amounted to very much because in most cases, at any rate, other adjustments in the set like changing the "A" battery rheostat or one of the condensers would make the tube operate just as well as by fooling around with the potentiometer, but with the present tubes there is no excuse at all for using such an instrument in the "B" battery circuit. The UV-200 tube is the most sensitive to plate voltage, but even it will stand a change of two or three volts of "B" battery without causing any trouble. When we get to the hard tubes like the UV-199 for instance, they rectify fairly well with a "B" battery voltage, varying from zero to 50. The reception at zero is not very loud and it is somewhat difficult to make the tube oscillate, although it can be done, but even a few volts of "B" battery will cause good operation.

In other plates where a potentiometer or "pot," as it is sometimes called, used to be shown is in the grid return of the audio amplifier tubes. Here again it is really useless. There is no occasion for adjusting the voltage on the grid in steps any smaller than 1½ volts. With a pressure of 45 on the plates all that is needed for a grid bias is that the grid return be connected direct to the minus lead of the "A" battery.

Even when using as high as 90 volts this is often done. Such a connection for a three-step audio amplifier is shown in Figure 1. If best results are wanted then a "C" battery of about 4½ volts can be inserted between the grid returns and the "A" battery, minus toward the grid and plus to the potentiometer. But whether 4½ or 6 volts are used, it makes no real difference, and that is why a potentiometer at this place is superfluous.

Pot is Needed on High Frequency

When we come to the *radio* frequency amplifier, however, we find a different story. Such amplifiers have a tendency to oscillate and cause squeals and dis-

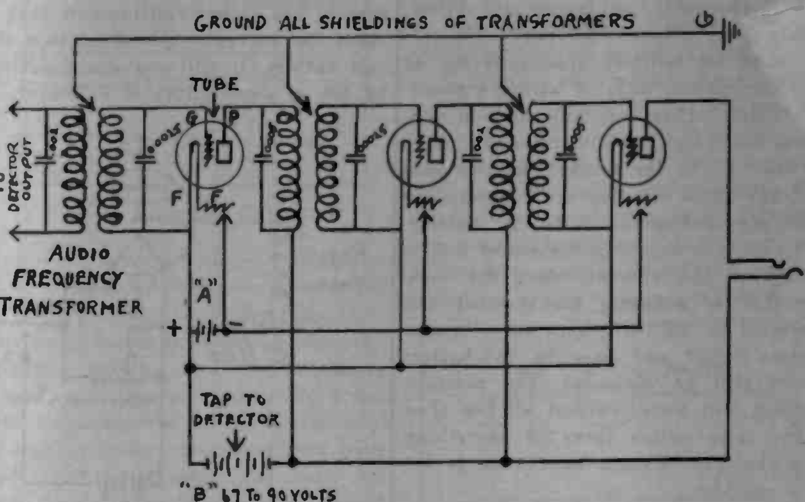


Fig. 1. Hook-up of Three Audio Steps

tortion. One way of curing such trouble is to use a neutrodyne hook-up. That will give the best results, but is expensive and somewhat complicated. A good method which works well is to bring the return lead from the secondary of the radio transformer back to the sliding arm of the potentiometer, as shown in Figure 2. By adjusting the "pot" the grid bias (voltage) of the tube is changed and by getting the right value

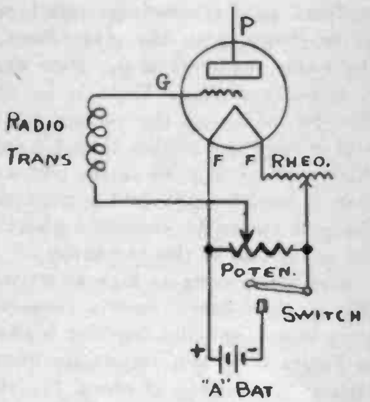


Fig. 2. Requires Filament Switch

the undesirable oscillations are killed. This point is found by trial.

Some set builders are inquirying as to the various ways of wiring a potentiometer. There are only two in general use, which are illustrated in Figures 2 and 3. In the former, the two ends of resistance winding are connected to the plus and minus of the "A" battery. A switch is shown in the minus line to turn off the current, since the usual method of swinging the rheostat arm around to "off" will open only the filament circuit, and since the "A" battery will still be connected, the potentiometer will waste current all the time. The same switch turns off everything, so that the rheostat handle can be left in one place.

Uses "C" Battery—No Switch

The other popular way of wiring this instrument is shown in Figure 3. Here we have omitted the switch, as it is no longer necessary, although, of course, it might be used if desired. The rheostat and "pot" are in series across the "A" battery as illustrated. That means that when the rheostat is turned to "off" it opens both circuits, and no current can flow. In either case the turning arm is connected to the radio transformer secondary. This is called the "grid return" since it is the way the oscillations get back from the grid to the filament. In this diagram a "C" battery is shown in the grid return lead. It is not necessary to use it when this particular hook-up is employed any more than with Figure 2, but if more than 45 volts of "B" battery are connected, it will cut down distortion and also lengthen the life of the "B" battery, as just explained.

If more than one tube of radio amplification is used, the hook-up will be like Figure 3, except that one potentiometer will do for all the amplifiers. Each radio transformer will have its grid return lead connected to the same point on the "C" battery. If more than one rheostat is used, the one shown should be in control of the detector.

200 or 400 Ohm Resistance?

A question that frequently is asked is what the value of resistance should be for a potentiometer. They usually come in two sizes, 200 and 400 ohms. They look just alike, except that the latter uses smaller wire in its windings. Practically speaking either one can be used in most any hook-up. The advantage of the higher resistance is that it takes less current. Connected to a six-volt battery, it will consume 6 divided by 400 or about 1-70th of an ampere.

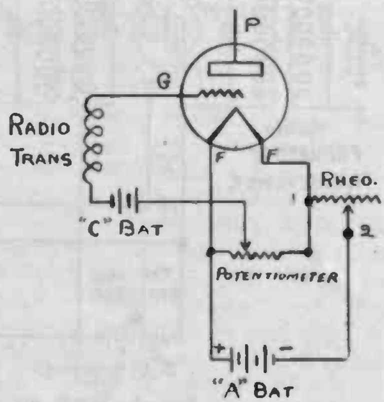


Fig. 3. No Switch Used

This value is so small as to be negligible, unless it is running twenty-four hours a day as would happen in Figure 2 if the switch were forgotten and left closed.

A 200-ohm instrument will use just twice as much current or 1-35th of an ampere on a six-volt battery. This again is too small to worry about. The lower resistance is supposed to be slightly better in that it gives a shade more volume to the amplification, but the difference is so slight that it is often doubtful whether it exists. If any question is raised on this point, there is a method of hook-up which removes the resistance of the potentiometer from the radio frequency circuit. This is simply to connect a small mica condenser .00025 or .0005 from the center connection of the "pot" to the plus of the "A" battery. In such a case the high frequency will run from the grid through the transformer and "C" batteries and then through this condenser direct to the filament. In this way some hundred ohms can be cut out of the grid circuit which sharpens the tuning to some extent.

If you are using radio frequency transformers on any set except a neutrodyne, it is worth experimenting with to see if a potentiometer will not give you clearer reception.

BAND BEATS BEEF FOR EDISON

Thomas A. Edison is Joseph Knecht's greatest admirer and an enthusiastic listener every evening when Mr. Knecht's orchestra broadcasts from the Rose Room of the Waldorf-Astoria. Furthermore, this music radiocast through Station WEAF is the one thing which insures his prompt arrival at home for dinner. Mr. Knecht learned of this one evening recently when the great inventor's daughter-in-law, who was dining at the Waldorf, came up between numbers to congratulate and thank the conductor and his orchestra.

For years the Edison family has despaired of getting the inventor home from his laboratory in time for 7 o'clock dinner, so great is his devotion to work. One night he listened in during dinner and heard the last number of a Rose Room concert. Upon learning that the concert had been going on since 6 o'clock, he gave orders that dinner in the Edison household would be served at 6 o'clock thereafter, and he hasn't been late to dinner since.

Mr. Knecht has invited the scientist to prepare a request program of his favorite numbers, which will be played in the near future.

Building a Battery Charger

You Can Save Money and Bother by Its Use

By C. W. RAOS

A BATTERY charger has come to be almost a necessity for the home radio which uses a storage battery of one form or another. If no charger is employed one must disconnect his battery and carry it to a charging station, leave it there a day or two besides paying about a dollar. If a rectifier (charger) is used however, one may swtich it on for an hour or two each evening before listening in. This always insures a fresh battery and is a very economical method when contrasted with paying a charging station, besides causing no annoyance. It is easy enough to build a charger at a low price. The following rectifier is quickly and cheaply constructed.

Procure a six gallon crock (about 12 x 12 inside) and fill it with distilled water to within two inches of the top. The distilled water can be made by boiling off faucet water and condensing the steam, but considering the time and heat necessary, it is usually cheaper to buy the water. A five gallon carboy usually costs about $1.00 for the water, plus $2.50 for the carboy. This latter amount is refunded in full when the carboy is returned in good condition. Now add enough borax (20-Mule-Team is good) so that after stirring thoroughly some will lie on the bottom undissolved. This makes a saturated solution of borax (sodium tetraborate). A few tablespoonsful of household ammonia are next added, and the solution is complete.

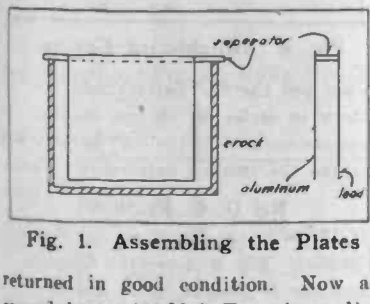


Fig. 1. Assembling the Plates

Making the Plates

Cut out a piece of sheet lead 11" x 10" and thick enough to hold its shape fairly well, about 1/16" is right. Obtain a piece of pure aluminum the same size and 1/8" thick. These two plates can be bought at a hardware store and will cost very little. Now take a piece of wood 14" x 2" x 1" and dip it in hot paraffine, laying it aside until it becomes thoroughly dried. Then fasten to it the two pieces of metal as shown in the sketch Fig. 1 with the 10" side fastened to the wood.

Be sure that the screws holding the two plates do not touch each other or else they would short circuit. Solder a wire at the top of the lead sheet and solder a lug to another piece of wire for the aluminum sheet. Fasten this carefully under one of the screws holding the aluminum, making sure that the joint is a good one. The reason for using a lug with the aluminum is that it is very difficult to solder this metal even with the right kind of solder and flux. Besides the difficulty of soldering, special materials must be used. Since the screw connection is just as good, there is no reason for not using it. Now immerse the two sheets of metal in the crock so that the wooden support will rest on the edges of the crock. The plates will now hang clear of the bottom about two inches which will allow a great deal of sediment to collect before reaching the plates. To prevent evaporating, a layer of heavy automobile oil is added on top of the solution. If desired a dust-proof wooden cover may be made with two binding posts for terminals.

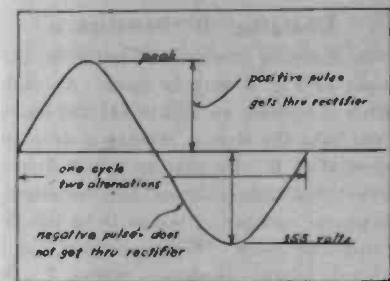


Fig. 2. Lighting Current

How A. C. Works

There are many ways of connecting a rectifier of this sort and so a few remarks on the theory might help the reader to decide which circuit is best for his particular needs. Fig. 2 shows an ordinary AC (alternating current) wave as it appears when used in house lighting circuits. When AC of this sort is passed through a rectifier as shown, the current can only pass in one direction, i. e., from the lead to the aluminum. So the first half of the cycle passes through from lead to aluminum. Now when the AC reverses and the second half of the cycle tries to return, it cannot pass from the aluminum to the lead and so is checked. During the passage of the first half cycle a gas film forms on the electrodes, the hydrogen on the aluminum plate and oxygen on the lead which checks the reversal of the current. This film can be broken down however, by excessive voltage and so we must be

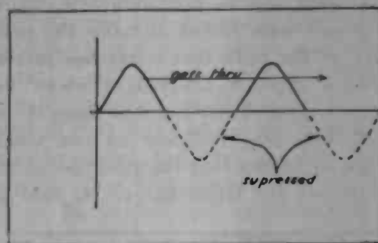


Fig. 3. What Rectifier Does

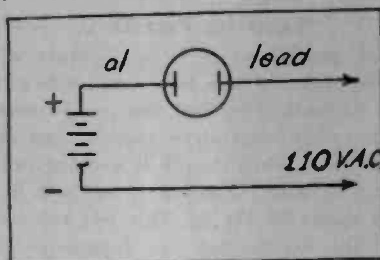


Fig. 4. Simple Connections

careful not to exceed this voltage. It is well to remember that the peak value of ordinary house current is 155 volts instead of 110 volts and that it is the maximum voltage which is more dangerous than the average (RMS 110 volts).

The reason for this difference is this: Direct current as supplied by a storage battery for instance has a steady pressure. For house lighting service this will be 110 volts and the potential will hold practically constant at that figure all the time. With alternating current, however, the pressure is changing all the time as shown in Fig. 1. If the maximum, which it reaches on the peak of the wave, is 155 volts, then the average value will be far below this figure. It would seem foolish to name the pressure by the peak that it reaches just as with a city—if the height above sea level is about 1,000 feet, but there is one hill that runs to 2,000 no one would think of saying that the elevation of the town was the latter figure. A good al-

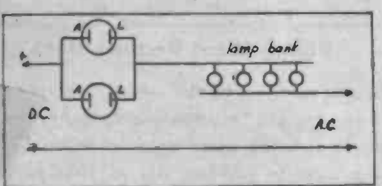


Fig. 5. Hook-up for Charging

ternating current wave, with a peak of 155 volts, has the same heating and lighting effect that a direct current pressure of 110 volts has. For this reason it is called a 110 volt AC supply.

Filter for Pure D. C.

A great increase in temperature will also cause the film to become conducting or at least cause flash over, so by using plenty of electrolyte this is guarded against. When the cell is working properly, a pulsating direct current will flow as shown in Fig 3. This lets one half of the AC through and suppresses the other half. All alternating current rectifiers give such an output. To give a pure direct current (DC) they require a filter. Such a filter consists of a combination of coils to prevent the pulsations from getting into the useful circuit and condensers which allow the pulsations to be drained off. But since for our purposes this is unnecessary we need not discuss it here.

A simple circuit for charging the "A" battery is shown in Fig. 4. This is suitable for a low resistance battery because

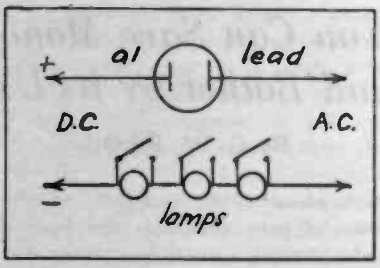


Fig. 6. Method of Control

a heavy current will flow. A modification of this circuit is shown in Fig. 5. Here we have two cells in parallel and also four incandescent lamps in series parallel. By screwing these lamps in or out different current values may be obtained. By leaving all four lit the battery will be charged at a maximum rate. By leaving only one lit, the battery will be charged at a low rate.

Charging "B" Batteries

For charging storage "B" batteries the circuit of Fig. 6 may be used. As each switch is opened, an additional 220 ohms is put into the circuit causing a drop in potential at E. By placing a 0-50 direct current voltmeter across the terminals the proper number of lamps to be left in circuit can soon be determined. An elaborate circuit is shown in Fig. 7. A sketch of the instruments on a panel is shown (Fig. 8). The lamps will be dim as only 55 volts is across each one instead of the customary 110 volts.

A pair of meters is very handy and costs but little. A good voltmeter reading 0-50 volts can be purchased for about $3.00. An ammeter reading 0-15 amperes charge and discharge should also be purchased for $2.00. Be sure that the plus side of the meter (marked +) is

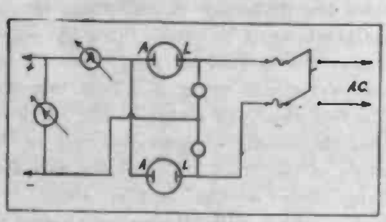


Fig. 7. Using Both Waves

connected to the positive side. An easy way to test is to put the two wires from the rectifier in a glass of salt water. The wires must be well separated. The wire from which bubbles (hydrogen) appear is the negative; the other is the positive. By using the two meters much information can be gained about charge and discharge of batteries. The values during the charge of an "A" battery should be from 2 to 6 amperes and at least 7½ volts at the end of charging. The values for a 24 volt "B" battery should be ⅛ to ¼ ampere and 30 volts. The charging voltage must never be lower than the voltage of the battery because then the battery will discharge back into the rectifier instead of charging. The current (ampere) rate should be preferably the lower one because the rectifier will not heat then. However, it takes longer to charge the battery. The name plate will usually give the desired information as to current values.

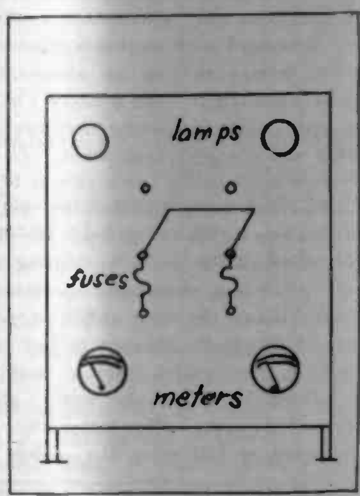


Fig. 8. Switchboard Lay-out

Do not put the "A" battery and the "B" battery in series on charge, because the excessive current of the "A" battery will overheat the smaller battery.

No D. C. Rectifier

If DC is in the house, no rectifier will be needed. Fig. 9 shows the diagram. If a rectifier is bought, there are two different styles of the manufactured article. One is the vibrating kind, which has a pair of contacts which are rapidly opened and closed by a magnet, which buzzes back and forth 60 times every second, keeping in step with the alternating current supply. The other works on the same general principle as a vacuum tube. The Tungar is a sample of

Continued on Page 16

Building the Rice Neutrodyne

Telling How It Can Be Built and Why It Works

By CHARLES R. WEXLER and ARTHUR SLEPIAN.

EDITOR'S NOTE. This is the second of a series of articles on the Rice Neutrodyne. The first article appeared in the last issue of RADIO PROGRESS, and dealt with the construction of the set in detail. In this second article, there is taken up the all important process of neutralization. In the third article will be discussed various modifications such as reflexing, the use of dry cell tubes, and trouble shooting.

Details of Mounting

The transformers may be mounted on the end plate of the condensers and tipped at an angle of approximately 55 degrees in approved neutrodyne fashion. However, a much better and preferred means is suggested and indicated in Fig. 7, whereby all coils are mounted mutually at right angles. The reason this is better than the tipping coil arrangement, is that the latter is oftentimes adjusted wrong for angle or for spacing. When all the coils are at right angles as shown, then there is no chance that the magnetic flux from one coil will affect another.

Preparing the Panel

Figure 8 shows the panel all drilled. The usual method of laying it out is followed. A Radion, Condensite, Bakelite, Formica, or Celeron or equivalent panel is to be preferred; and, since, a well made panel shows the builder's handicraft to advantage, great care should be taken at this stage. In laying out the panel, it is advisable and convenient to use dividers and a combination square in order that the dimensions may be accurately made. Engraving on the panel greatly enhances its appearance. It is noticed that only center holes are shown for the reason that since no trade names are specified, the reader may use the parts he prefers and be governed accordingly. Those having neutrodynes are so much more fortunate since their original panel layout may be retained.

Assembly and Wiring

Again we repeat, those building neutrodynes for the first time may very profitably follow approved layout; that is, the radio frequency tubes should be located between neutroformers. The audio frequency amplifiers may be located at one end as shown in the drawing, or may be located at the other end. This gives symmetry to the panel, as in one well-known commercial design, although

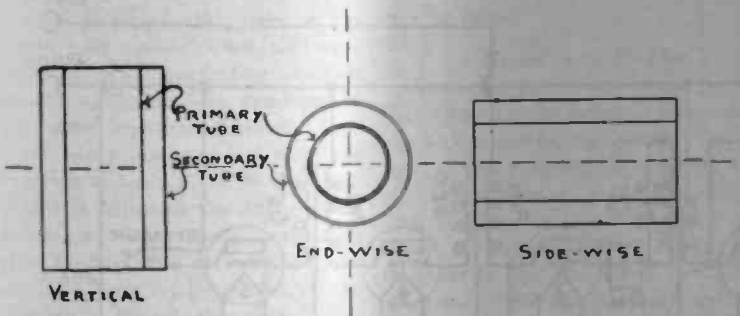


Fig. 7. Coils Not Tipped as Usually Necessary

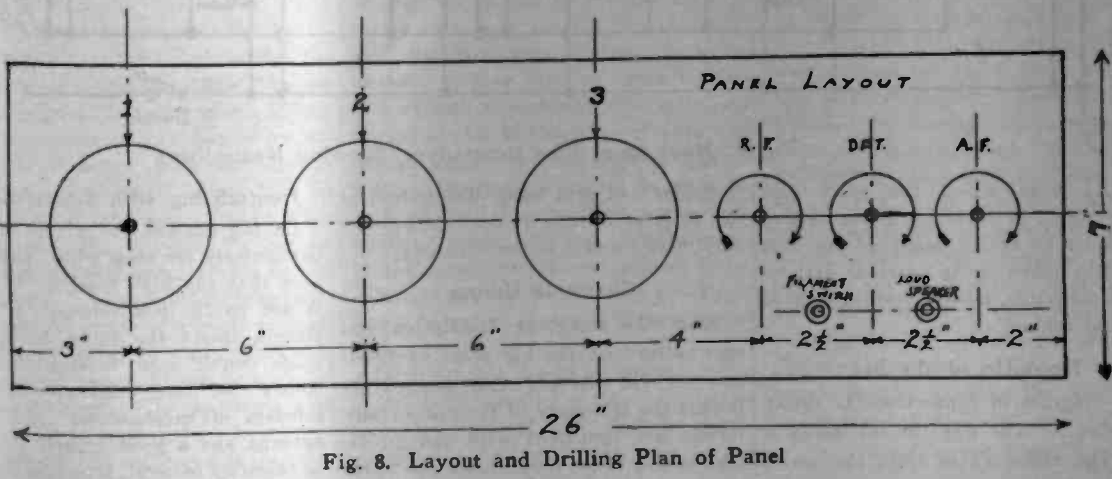


Fig. 8. Layout and Drilling Plan of Panel

it involves a more difficult construction. No intermediate or filament control jacks are used for the reason that they require difficult wiring and are apt to be a source of much trouble. In assembling the receiver, it is usually preferable and more convenient to mount the sockets and audio transformers on the baseboard which is fastened to the panel. Since the character of the wiring will have great influence upon the efficiency of the set, it is quite advisable to sketch out beforehand the mechanical wiring of the set on paper, with the purpose in general of keeping grid leads short, high potential plate and grid wires widely separated, and running as few leads as possible parallel for any distance. The old scheme of checking off each line on the hook-up diagram as it is wired is advisable, thus affording a check against possible omissions or errors. It is usually preferable to start wiring the low tension or filament circuits. When these are complete put all the tubes in place and make sure that the rheostats and switch control the brightness of the filament. After these circuits are found to be O.K., then finish the plate and grid wiring. In soldering it would pay the reader to review many of the tips and kinks taken up in previous articles in this magazine, making certain of good electrical contact.

Hook-Up of the Set

The diagram of connections is shown in Figure 9. The way the set works is this: The radio waves from the aerial run through the non-adjustable primary "A" to ground. This circuit does not have to be tuned, and will respond to all wave lengths. The secondary oscillates from the grid, out the middle tap, to the filament. The secondary is tuned by condenser "C1." The upper half of transformer "A," while it carries the current which flows through condenser "C1," still has no effect on the plate to which it is connected. The reason for this is because neutralizing condenser "NC" just balances out the capacity of the grid-plate of the tube, as described in the first article of this series. When "NC" is adjusted in the way to be described shortly, there is no tendency for this circuit to oscillate.

The output from the plate goes through the primary of radio transformer "B" and over to the 90-volt "B" battery. The secondary of transformer "B" works tube No. 2 in the same way as just described for tube 1. The output of tube 2 runs through radio transformer "C" to the "B" battery. The secondary of "C" is connected from the plus of the filament to the grid through the grid condenser and grid leak. The output of the detector 3 runs to audio frequency amplifiers 4 and 5 in the usual way.

Circuit Is Unique

From the foregoing description you will notice that the big point of difference between this and other neutrodynes is that the secondary of the radio transformer are connected with the middle tap running to the filament and the upper end to the neutralizing condenser. The voltage of only half the secondary is impressed from the grid to filament, or putting it another way, the condensers "C1" and "C2" have double the ordinary voltage compressed on them. For this reason 11 plates are all that are needed.

Neutralization of the Set

We now come to the subject of neutralization. Since our coils are all at right angles, each to the other two, there will be no trouble from magnetic effects. The electrostatic action will be neutralized completely, as has been described.

We are now directly concerned with the actual process. Two methods have been developed for accomplishing this. One of these might be called an ordinary procedure, and the other be distinguished as a laboratory method. Although, they are the same in theory, in practice, the difference between the two is this; in the former method, pay no attention to the theory and test with local broadcasting; proceed as follows:

Neutralizing with Local Stations

Having checked the wiring of the set particularly for open wires, and making sure that the high tension "B" battery is not on the low voltage "A" battery circuit, insert the tubes, having again made doubly sure because tubes cost money and dead tubes are forceful reminders of carelessness. Now connect antenna and a good ground (these will be taken up in detail later) to the proper

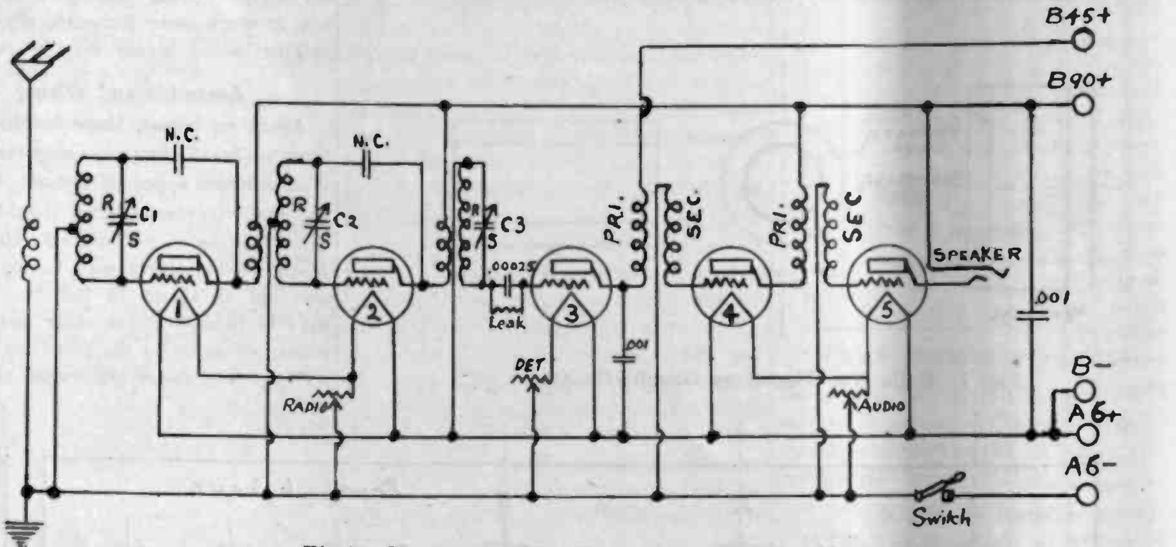


Fig. 9. Hook-up of Rice Neutrodyne, Showing Neutralizing

terminals, and insert either phones or loud speaker in the jack for this purpose. Now forget the fact that the set is a neutrodyne and tune in a good strong local station which is keeping up a running program. Of course, in tuning you may get the familiar carrier waves, oscillations, whistles, and howls of the so called "bloopers" or regenerative sets. If you do not get these in your first attempt at tuning, try all combinations of dials. If none of the above occur, you may consider yourself lucky, and the set is neutralized.

Since in all probability you will not be so lucky, you will have to balance out these oscillations. This is done very simply by moving the stabilizing condensers gradually and symmetrically (about the same amount for each) until all the undesirable noises and squeals disappear. The radiocasting should now come in clear at all wave lengths, and it should be impossible to get oscillations of any kind and, accordingly, no distortion resulting from it. Just a bit of caution is necessary here. Just because your set is properly neutralized, don't think that you won't hear the oscillations and squeals of other sets or the beat note that results when the wave channels of two transmitting stations overlap. Nothing has been developed to prevent these from being heard. Beat notes are easily distinguished from the other noises as their pitch or tone does not change in adjusting the dials; whereas, in the case of ordinary oscillations the pitch changes with dial adjustments. If you have been really careful in the construction of the set, this operation of neutralization is one of beautiful simplicity.

How the Laboratories Do It

The laboratory method, whereby the set can be neutralized without the use of actual signals, is an ingenious scheme of adjustment which was devised by Mr. Harold A. Wheeler. This method has been taken up in detail in previous issues of this magazine as applied to other neutrodynes. The following is but an application of this same device to the Rice circuit. An artificial broadcasting station or source of signals is used, consisting of (Fig. 10) an inductance, condenser and buzzer, known as a buzzer wavemeter circuit. The following procedure should be employed:

A. Prepare the set for actual reception, i. e., insert the tubes, connect batteries, etc., and connect to the artificial buzzer generator as shown.

B. Start the buzzer in operation, and with the condenser in the wavemeter circuit at some given value (say 50 degrees) tune the dials on the set until you can hear the buzzer loudest.

C. Remove the first radio frequency tube and by some means such as a piece of spaghetti over one of the filament prongs and a socket contact, prevent the tube from lighting when replaced. If necessary, readjust the dials on the set to get the loudest buzzer signal. Now adjust the first neutralizing or compensating condenser very slowly and carefully until the signal becomes weaker and weaker, and finally disappears. Then remove the paper or spaghetti and replace the tube. (Be sure the contacts have not been bent out of place in the above process). Poor tube contacts (or none at all) are a frequent and puzzling source of trouble.

D. Repeat C for the second stage of radio frequency.

E. It is not really necessary to neutralize the detector stage, although this may be done.

Better, but Harder

Comparing the two methods, it is seen that although the latter is the more exact and scientific, the former dispenses with all the necessity of juggling tubes, etc. If you have good luck the first way is quite satisfactory. But sometimes it happens that through some irregularity the two small neutralizing condensers, "NC," do not work well when adjusted to the same position. If such is the case, you will not reach the point of quiet on the set by turning them together. In case trouble is experienced in finding the exact location, the second method, as just outlined, since it takes care of each adjustment separately, will always be able to locate the trouble. Although the set is neutralized so that it will not oscillate, it should be made capable of oscillating by throwing the neutralizing condensers out of adjustment. In the event that the set refuses to oscillate at all, the trouble may usually be found in defective tubes, if not in the wiring.

Little trouble should be encountered in neutralizing the electrostatic coupling as just described if the electromagnetic coupling is negligible. It may be advisable at this time to say a few words in regard to electromagnetic coupling. Recently there have been proposed means of eliminating electromagnetic feedback by the use of "trick" windings on the neutroformers claiming that this removes the necessity of neutralizing the electrostatic coupling. This is a very wrong idea. To be sure, it will work once in a while, but it is like telling a bookkeeper when his accounts don't balance, that he should add $10.00 to the left hand side, because once before such an addition happened to get the right answer. Two mistakes can sometimes be found to neutralize each other, but it

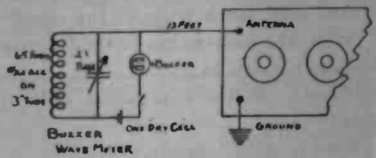


Fig. 10. Buzzer Connections

is much safer to find the first mistake and correct it, than it is to make another error on purpose with the hope that they will cancel each other.

Can Use Small Tubing

However, as a further precaution to eliminate electromagnetic coupling the neutroformers may be wound on tubing approximately two inches in diameter since such a coil has a very much smaller magnetic field than the usual size of coil used in the neutrodyne, and therefore, the feedback may be more readily neutralized. If this is done, the number of turns on the secondary must be proportionately increased to 80 turns, and those of the primary raised to 35 turns with the exception of the tuner primary which will now have approximately 12 turns. It is advisable, and may be found necessary, to shield completely the second stage of radio frequency, since this is very sensitive. This shielding is obtained by coating the panel in front of the condenser and coils, with copper or tin foil. In some cases it is even desirable to build a little copper box with four walls and place the coils and condenser inside. This gives complete shielding, but has the disadvantage that it introduces some losses in the circuit.

No doubt, by this time, the reader has observed that each stage of radio frequency amplification in the Rice circuit is "self-contained," and each stage is

Continued on Page 28.

Fone Fun For Fans

Quaint Russian Custom

Bright Boy: "In Siberia they don't hang a man with a wooden leg."

Innocent Boy: "Why not?"

Bright Boy: "They use a rope."—*The Continent (Chicago).*

Applied Mathematics

The old lady was timidly inpecting the stock of spectacles.

"How much are these?" she asked, selecting a pair.

"A dollar and a half, madam."

"And how much without the case?"

"Well, the case makes little difference. Suppose we say $1.45."

"What? Is the case worth only five cents?"

"Yes, madam," firmly.

"Well, I'm very glad to hear it; it's the case I want."

And, placing a nickel on the counter, the dear old lady took up the case and walked timidly into the street, while the optician gasped for breath.—*Pittsburgh Chronicle.*

Or Get "Bald" Out

"What can I do to avoid falling hair?"

"Jump out of the way."—*Carnegie Puppet.*

She (just introduced): "Somehow you seem familiar.

He: "Good heavens; I haven't started yet.—*Wesleyan Wasp.*

Walking Post

A colored soldier was walking post for the first time in his life. A dark form approached him. "Halt!" he cried in a threatening tone. "Who are you?"

"The officer of the day."

"Advance!"

The O. D. advanced but before he had proceeded half a dozen steps the dusky sentinel again cried, "Halt!"

"This is the second time you've halted me," observed the O. D. "What are you going to do next?"

"Never mind what Ah's gonna do. Mah orders are to call, 'Halt!' three times, den shoot."—*Everybody's Magazine.*

A Modernist

Teacher: "You'll have to stay in after school and work on your geography lesson. You didn't locate a single one of the cities."

Willie: "I can't locate them, but I know how to tune in on the whole blame lot."—*American Legion Weekly.*

'Snow Joke

Teacher (after lesson on snow): "As we walk out on a cold winter day and look around, what do we see on every hand?"

Pupil: "Gloves!"—*Cornell Widow.*

"What is a waffle?"

"A waffle is a pancake with cleats."—*Stanford Chaparral.*

BUILDING A CHARGER

Continued from Page 12

this latter type. It consists of a transformer, which reduces the pressure down to seven or eight volts, and the tube, which prevents current flowing in more than one direction. Either of these styles will cost in the neighborhood of $18.00.

Whether a rectifier is bought or made however, it will soon pay for itself in money and convenience.

One Day a Week

The most suitable way of keeping batteries up depends somewhat on the use of the set itself. If this averages three hours a day, it will amount to about 20 a week. A UV200 takes one ampere and a UV201A requires one quarter of an ampere in the filament circuit. A three tube set will then need $1 + 2 \times \frac{1}{4}$ or a total of $1\frac{1}{2}$ amperes. Twenty hours use a week will consume $20 \times 1\frac{1}{2}$ or a total of 30 ampere hours. Since most rectifiers charge at around two amperes, this will require $30 \div 2$ or 15 hours charging time if the battery were 100% efficient. As, however, there is some loss in it, it would need a minimum of about 18 hours charge to replace a week's use of current. If this is increased to 20 or 24, no harm will be done at all.

One of the popular ways of taking care of a charger is to turn it on once a week, say Sunday night, as soon as your last station signs off. Let it run for about 20 or 22 hours, until you are ready to listen in Monday night. By that time the battery will be entirely full. Of course, if you use four or more tubes in a set it will require somewhat longer time to fill it up if you run the set three

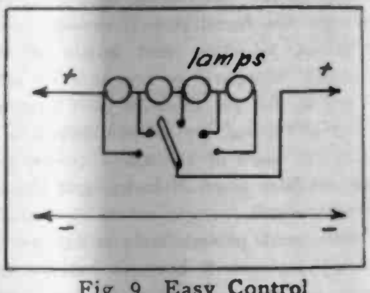


Fig. 9. Easy Control

hours a night, but once the principle is understood you can easily determine how long this should be.

Charging Twice a Month

Since the average size of storage battery used with a radio set contains 90 ampere hours, it will be seen that in

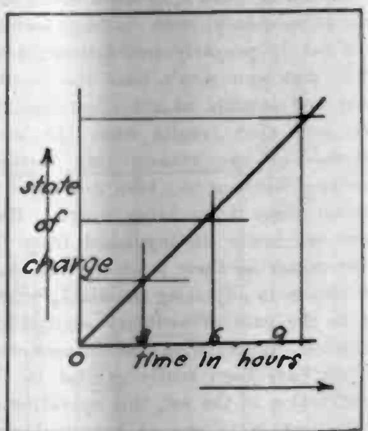


Fig. 10. Charging Curve

taking out 30, the charge is only one third gone. This means that if you should forget to put the charger on some Sunday night you could run the battery for two weeks in succession without charging and only use two-thirds of its available capacity. It would seem that this could be continued for the third week but it is inadvisable to run the battery down absolutely flat. For this reason it is better to charge at least every two weeks. Of course, when a charging period is omitted, as just described, the next week will need two days of operation instead of one to bring the battery up to full capacity.

What Makes a Transformer Work?

It Does Not Make Energy, But It Will Change It

By OLIVER D. ARNOLD

IF you are using a one tube set, then you will not be particularly interested in a transformer, as no such animal is included in your equipment. But if your set uses two or more tubes, then you will find that every audio amplifier tube has one transformer to feed it. The radio frequency steps usually require transformers also. A few hook-ups use resistance or impedance coupling instead of transformers, but these have not come into very great popularity.

The inventor of this piece of apparatus was Mr. William Stanley, whose portrait is shown in Fig. 1. He was the first electrical engineer employed by Mr. George Westinghouse, way back in 1884, and it was his invention of the alternating current transformer that made long distance transmission of electricity possible. All over the United States to-day you will find alternating current used, except in the immediate vicinity of electric generating stations. The reason is this,—direct current cannot be changed in voltage except by expensive and complicated machinery, which actually rotates, like a generator or motor. Alternating current, on the other hand, can have its pressure or voltage step up or down with the greatest ease by running it through the windings of one of these instruments. The beauty of this is that there are no moving parts whatever, and so there is no need of oiling the bearings or inspecting the shaft or armature, because there are no such parts.

A transformer can be tucked away in a niche that is good for nothing else, or can be hung from a telegraph pole or installed in a manhole and left for years without any attention at all. It is about the only piece of electrical equipment which can be forgotten when once installed.

When it is desired to conduct electricity over long distances, it is necessary to use high pressures. This is reasonable. If water is to be carried from a reservoir to a city 100 miles away it is easy to see that the water pipes will have to carry a pressure considerably greater than that required to supply a community from a reservoir near at hand. A rough rule for finding out what potential is needed is to allow 1,000 volts per mile of transmission. If we want to send power from Niagara Falls for a distance of 75 miles the pressure would be something around 75,000 volts. Of course, this is to be modified up or down to make it fit in with the existing transmission lines.

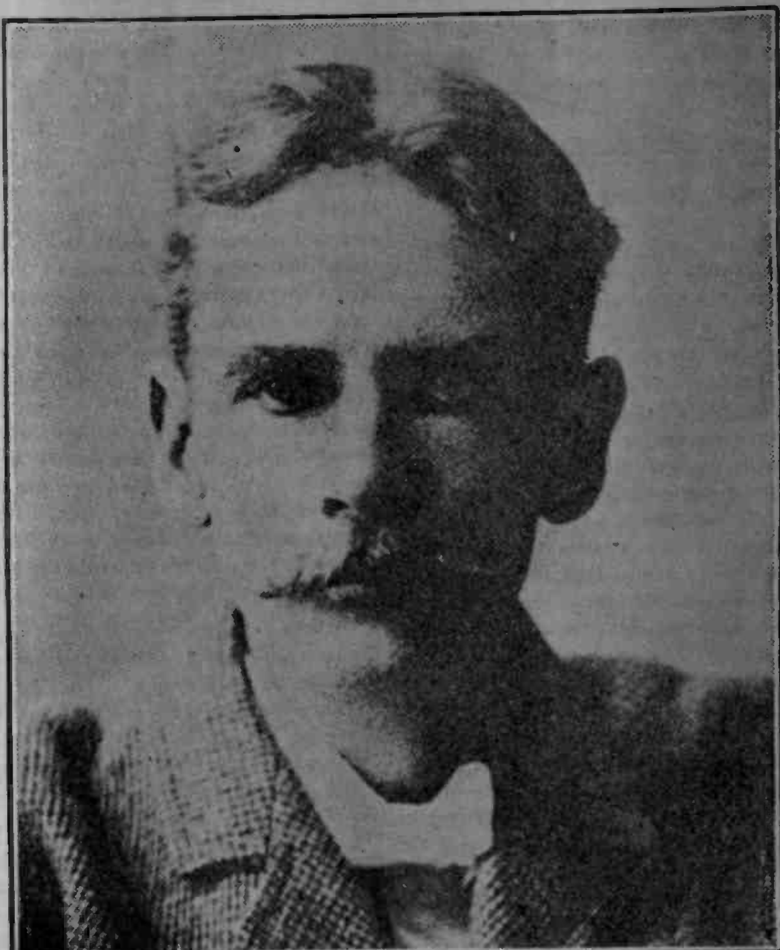


Fig. 1. William Stanley Invents Transformer

For most electrical devices direct current is more or less better than alternating in every way except one. That one is the possibility which the latter has of having its voltage raised and lowered by cheap, non-rotating means. And so, in spite of the fact that direct current would be nearly always preferred by the user, as a matter of fact, alternating current is almost universally used. Of course, what is referred to in the preceding paragraphs is the use of electricity for light and power.

When we get to radio we have one of the few cases where alternating current is required. It is the vibration of the telephone or loud speaker diaphragm which causes the music. And this vibration is the result of the electricity which reverses its direction back and forth several hundred times a second. The exact speed of vibration depends en-

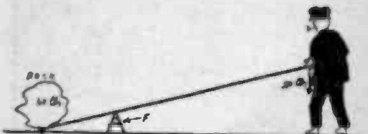


Fig. 2. Principle of Transformer

tirely on what note is being played. Thus Middle C is sounded when the telephone disk oscillates 256 times every second. The octave above it goes just twice as fast or 512 cycles. The next octave doubles that again, etc., as high as we want to go.

Since we are dealing with alternating current we naturally think of using a transformer. The question immediately arises, how much will it increase the energy? This is a mistaken question, as it seems to imply that the energy can be increased. Of course, that is not possible. No machine can increase the amount of energy it gets—it can only convert it into some other form. Thus a generator converts the mechanical motion which it gets from the engine into electrical energy, but the horsepower output of the generator is always less than the input which the engine supplies to it. It is less because the generator has some losses.

In the same sense a transformer cannot be said to increase the energy. All it does is change the voltage and the current. If it increase the voltage in the ratio of 3 to 1, it will reduce the current to one-third or less. It is exactly the same principle as a lever. See Fig. 2.

Here we see a man who is lifting a rock with a lever. The fulcrum F is one foot from the rock, and the man's hands are three feet from the fulcrum. This gives a 3 to 1 ratio, or advantage for the lever. Say the rock weighs 60 lbs. The question is, how hard will the man have to push to raise it? The answer is, that since the lever has a 3 to 1 ratio, then we must divide the weight of the rock, 60 lbs. by three, and it gives us the answer of 20 lbs. That is, a 20 lb. pressure on the right hand end of the lever gives a 60 lb. force up on the left hand end. Of course, if we take into account, the friction of the fulcrum, the man will have to press down, say 20½ lbs., as there may be one-half pound loss.

I think everyone will see that our conclusions so far are correct. Does that mean that the lever enables the man to do three times as much work as before? By no means. When you talk about work it contains two ideas. These are, first, force or pressure, and second, distance, through which it acts. It is the product of the force, *times* the distance, which give us the amount of work. As an illustration, take the foundations of a building. They exert a force upwards of hundreds of tons, and this force is exerted day and night. How much work are they doing? None at all, because they have not moved through any distance. If the building is about to be moved and it rests on jack-screws, when the jack-screws are turned to raise the building, then since they are moving through a certain distance, work has to be done. The men who operate the jack-screws will easily believe this.

Or take the other case of a colt scampering about a field without any harness on. He moves through a considerable distance, but does no work at all, because he is exerting no force or pull. If you attach him to a cart, then the pull which he applies to it, acting through the distance he moves, will do work.

This same principle applies to the electrical case. Suppose we are lighting an electric light lamp. Let us take an automobile headlight, for instance. The amount of energy supplied is the volts times the amperes. The answer is called watts. Thus for an ordinary headlight the pressure is taken from a six volt storage battery and the current is three amperes for each light. Then 3 x 6 equals 18 watts, which is the power consumed by the filament. A Dodge car uses a 12-volt battery. For this reason it requires a 12-volt light. This bulb takes only 1½ amperes. Its power is 12 x 1½ which equals 18 just as before, and it gives just the same amount of light. Don't forget though, that it uses a different style of bulb,—if a 6-volt bulb were put in a Dodge headlight it would be burned out very shortly.

Since the storage battery gives out direct current, a transformer could not be used, and so the proper bulb must be selected. If it had been alternating current, then a transformer could have been put into the line which would step the voltage down from 12 to 6 (a ratio of 2 to 1) and would increase the current in the same proportion, that is from 1½ to 3. The point is that whatever we gain in voltage we lose in current and conversely. When you read about a transformer stepping the voltage up from 110 to 2,200 (20 to 1) you know that the current has been reduced to 1/20 of what it was. Of course, this very small current will require only a small size wire to carry it, and that is why transformers effect a very great saving of copper wire in the transmission lines of the electric light companies.

When the other end of the transmission line is reached, another transformer reduces the voltage from 2,200 down to 110 volts and at the same increases the

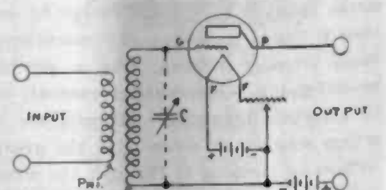


Fig. 3. Hook-up of Amplifier

current 20 times. This brings it back to approximately as it was at the generating station, but the losses in the line have been low owing to the small current. The reason the current is only approximately as great as it was is because each transformer has a small loss. That this must be small is shown by the fact that the modern, big transformers have an efficiency of 99½ per cent.

Getting back to the radio set again, look at Fig. 3. This shows the hook-up of an amplifier. It might be either a radio or audio frequency unit, as they are connected just the same. The difference would be that a variable condenser C is often connected across the secondary terminals to tune a radio frequency unit, but never an audio frequency. If the latter were tuned, it would mean that certain notes would be much louder than others, which of course is very undesirable.

The primary as shown in Fig. 3, is connected to the output of the previous tube, which may be a detector or an-

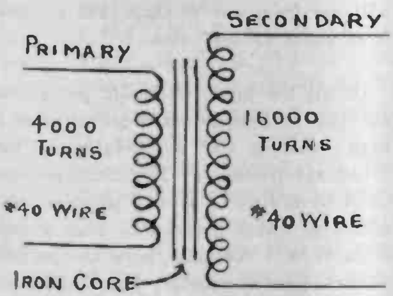


Fig. 4. Audio Amplifier

other amplifier. The current through the primary is supplied by the "B" battery and is comparatively large. The alternating voltage comes from the plate variations and is small. Since it is voltage that works the grid of the amplifier, it is essential to make it as large as possible. By putting this transofrmer in with a step-up ratio of, say, 3 to 1, it means that voltage output from previous tube is multiplied by 3 before it is fed to the grid. This, of course, gives a much louder signal. At the same time the current in the secondary is one-third or less what it was before being transformed, but this does no harm as we require practically no current to operate the grid. This is the principle on which the transformer works.

When we come to the actual construction of the unit it makes a difference whether it is to work at high or low frequency. The low or audio transformer usually contains 15,000 to 20,000 turns of No. 40 enameled copper wire as shown in Fig. 4. The reason for using this size is that the current is less than 10 milliamperes (.010 ampere) which is not enough to cause this small size of wire to overheat. Even a thinner conductor would be satisfactory from the electrical point of view, but this is the smallest size made commercially as diameters less than that are hardly strong enough to stand the pull of the winding machines. The wire is insulated with enamel, because that makes the thinnest coating possible, and where so many turns are used, the space occupied must be cut down to a minimum.

If this transformer is to have a ratio of 4 to 1, then the turns will be divided in the same proportion; that is, the primary will contain 4,000 and the secondary 16,000 turns. A 3,000 primary and 12,000 secondary would have worked nearly as well, but within reason the more turns the more efficient the transformer is. These turns will be wound on an iron core. This is used for two reasons: In the first place, iron conducts magnetism much easier than air (from 100 to 500 times as well) and so the magnetic core enables a much smaller coil to be used. In the second place, iron core causes the tuning to be much broader or not nearly as selective and as just explained audio vibrations should not be tuned to any one note.

A radio transformer uses very much fewer turns. This is because the high frequency of around one million a second is much more effective in operating than the lower speed a few hundred cycles per second. Also, since it is necessary to tune the radio as sharply as possible an air core will be used and wire with a low resistance. To meet this last requirement a fairly thick conductor is employed. No. 22 single cotton covered or double silk covered is a popular size. Twenty-five turns is often used on the primary of such an instrument. The secondary will have from once to twice as many turns, say about 50. High ratios of transformation cannot be used on radio transformers as the leakage losses for coils with a large number of turns are excessive. Such a transformer is shown in Fig. 5.

Speaking of the ratio of primary and secondary brings to mind the various claims by different manufacturers. One will state that a 3 to 1 ratio is the best and another will say that 5 to 1, or even 10 to 1, is the only thing to use. The question is, What is the best standard for ordinary use? If we take the theory of the thing and disregard all other considerations, then the higher the ratio, the better. But other factors enter in. In the first place, the losses of the high ratios are greater than those of the low. Another point is this: The space for winding the coil is limited. If you will notice, the great majority of audio transformers are about the same size. If they are built much bigger, it will run the cost up, and they could not be sold at a competitive price. If the number of turns is fixed at say not to exceed 18,000 or 20,000, then it means that the high ratios are obtained by sacrificing the number of turns in the primary. Thus a 3 to 1 ratio would be 5,000 to 15,000 (total 20,000). A 9 to 1 would consist of 2,000 to 18,000 turns (total 20,000). Thus we see that changing the ratio has dropped the primary from 5,000 down to 2,000. If we cut down the number of turns on the primary it reduces in some measure the amount of energy which it receives from the previous stage. That is why the higher ratio transformers oftentimes do not give any more volume of tone than the lower ones. Another disadvantage, which is sometimes found in using the 10 to 1 units, is that when more than one is hooked up in a set there is a pronounced tendency to oscillation at low speed, which is heard as a shrill howl. Such a howl can readily be identified because when the aerial is disconnected it still persists. Offsetting these disadvantages is the fact that in some of the better makes of instruments the 10 to 1 unit is a shade louder than those of lower ratio.

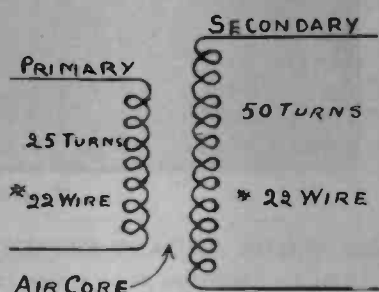


Fig. 5. Radio Amplifier

We might sum up this situation by saying that ordinarily a 3 to 1 or 4 to 1 ratio is most satisfactory for all around use, but where special results are wanted a 9 to 1 may be preferred, especially in the first step.

Continued on Page 22

Miss Ruth Arden

BEATS THE TRUANT OFFICER

Little boys suffering from strong impulse to wander away from the front-porch or back-yard, in search of adventure, must nowadays take radio into account, when making plans for a safe get-away. Otherwise radio upsets everything.

Little Marcel Plourde, 5½ years old, left his parents' home in Montreal, at 11 a. m., July 15th. The police were duly notified and CKAC, La Presse, of that city, broadcast a description of the diminutive adventurer that evening. Less than an hour later he was spotted on a street corner by a radio fan, who was putting out some empty milk bottles at his door. After twelve hours of unalloyed freedom and bliss, Marcel was restored to loving arms.

Marcel is an "experienced wanderer," according to his parents, and his disappearance from home "is a thing to be expected, every now and then, when the weather is fine."

PORTRAITS *of* POPULAR PERFORMERS

No matter how good a concert is it usually gets to be a wee bit tiresome, if the same kind of music is repeated for an entire evening. That is why most instrumental programs have interspersed between numbers the songs of some good singer. The Kudisch String Ensemble, which broadcasts from WJZ quite regularly, has been particularly happy in selecting the well known soprano, Ruth Arden. When next time you hear this silvery toned artist you will see from our picture that her face is as sweet as her voice.

Of all the kinds of music put on the air the orchestra continues to hold a high rank in the appreciation of the broadcast listeners. The Knickerbocker Grill Orchestra is a very popular organization, which broadcasts once a week from WJY. We show here the portrait of its genial conductor, Leonard Nelson. With a smile like that it is no wonder the music makes us feel good. Next Friday evening at 7:30 tune to 405 meters and you will hear a good program.

Mr. Leonard Nelson

American Radio Relay League

EXPRESS USES INSIDE AERIAL

Experiments with the reception and transmission of radio signals from a moving train have been carried out here successfully by a number of radio amateurs connected with the Radio Society of Great Britain. On a run from London to Newcastle, a distance of 276 miles, messages were exchanged with station 6XX, London, and amateur stations along the route.

6XX is the official station of the Radio Society of Great Britain and through prearrangement with Philip R. Coursey, secretary, it was made available for the experiment.

A special car was attached to the "Scotch Express" through the courtesy of the London and Northeastern Railway Company. This was fitted up with an amateur transmitter and short wave receivers. Unlike most experiments of this kind the aerial, instead of being strung along the top of the coach, was located inside. There were two antenna wires stretched through the car from end to end.

Only a Few Watts Used

Some of the two-way communication with amateur stations was carried on over a distance of 100 miles. The power used was very small and consisted of only a few watts. Although a complete record of the tests has not been made public, it is understood that railway officials are much impressed with the results.

Station 6XX represents the best in English amateur sets and is operated with more than the customary power of 10 watts through a special permit obtained from the British Post Office. The circuit used is the loose-coupled Hartley. During the transatlantic tests of last year the signals of this station were heard more than eighty times by amateurs in America.

NO SILENCE BELOW 80 METERS

Upon the urgent application of the American Radio Relay League, the Bureau of Navigation, Department of Commerce, has authorized supervisors of radio to amend amateur licenses (on application of owner) to permit the use of special bands of short wave lengths without quiet hours. This action removes many of the objectionable restrictions put upon the transmitting amateurs because of the necessity for cooperating with the broadcast listeners, and at the same time reduces rather than increases the interference problems affecting both classes.

Within a few weeks, many amateurs who have been using the wave lengths from 150 to 200 meters will have adjusted their stations to operate on one or more of the new bands below 80 meters, which will result in a further separation of the general broadcast and amateur wave lengths and a substantial decrease of amateur radio interference with broadcasting. The new wave lengths assigned to amateurs are: 75 to 80 meters, 40 to 43 meters, 20 to 22 meters and 4 to 5 meters. The use of these bands is restricted to CW transmitters exclusively.

The amateurs for whom the recent extension of "quiet hours" has proved irksome will find in these shorter wave lengths a solution of their problems, as concerns the hours of operation, for the order to supervisors specifies that "quiet hours" need not be observed on any of the bands below 80 meters, although they must of necessity be continued in full force on the regularly assigned amateur waves of 150 to 200 meters. Amateurs are advised to take particular note of this fact.

Saves the Silence

For a number of months officers of the American Radio Relay League have realized that the continuation of silent hours for an indefinite period would be likely to increase the tension existing between amateurs and listeners, and complete harmony could be brought about only by the assignment of shorter waves for amateur use. The Department of Commerce also appreciated the situation and relieved the condition to a certain extent by issuing experimental licenses which permitted certain amateurs to operate on 100 meters or lower. The present order of Commissioner Carson, however, opens up the short waves to the rank and file of the amateurs which, with the elimination of silent hours, conforms to the desire of the amateur organization.

While the new regulations are designed to simplify interference problems, much confusion can result by an incorrect interpretation, and so amateurs desiring to take advantage of these new privileges are advised not to make any hasty changes in their wave length until they know what is expected of them. They must first make application to the radio supervisor of their district to operate on any one or all of the new wave lengths, and get their licenses properly amended. They are also asked to take note of the fact that they must use a coupled circuit in the transmitter. A provision is made that silent hours will be required if the station is situated so as to produce objectionable interference with "other services."

The old regulations stated that special amateur stations must not use wave lengths above 200 meters and quiet hours must be observed between 8:00 and 11:30 p. m., daylight time.

SPANISH HAMS ON 150 METERS

Fernando Castano of Madrid, Spain, in a letter to the American Radio Relay League informs that organization that there are now about 100 amateur radio transmitting stations in his country, following decision of the government to permit amateurs the use of wave lengths below 150 meters and up to 100 watts power. The leading radio organization is the "Radio Club de Espana."

MUST USE TUBE TRANSMITTERS

Aside from the fact that no amateur spark stations are permitted in Cuba, regulations regarding amateur transmitting stations are very liberal and somewhat similar to those in the United States, according to F. W. Borton of Havana. In a letter to the American Radio Relay League, he says that amateurs are allowed use of wave lengths from 75 to 200 meters.

RADIO SUITS BILL TO A "TEE"

This portrait reveals Broadcast Bill,
Who's perfect at putting the pill
When out on the links
He beats other ginks,
And follows the ball with a will.

When friends said they wanted to know
He explained how he kept on the go—
"Don't go with a caddy
That did for your Daddy,
Just carry a good Radio."

—*By Del.*

Hogan Secures Summary of Reception Troubles

THE last talk of the series by John V. L. Hogan, consulting radio engineer and Past President of the Institute of Radio Engineers, recently given before WEAF's microphone, ended with a request for data about receiving troubles of WEAF's listeners. The answers sent in have given some valuable figures about certain live radio problems.

The greatest interference came from spark code signals, as reported by 39 per cent. of those who answered Mr. Hogan's request. Whistles from neighbors' sets came second with 31 per cent., and cross talk (that is, interference from other broadcasting stations) 30 per cent.

Radio listeners were also requested to indicate their second and third choice as to the most troublesome sources of interference. Whistles and cross talk again won the places of honor (or dishonor).

All Agree Code is Worst

The consistency of these figures is quite notable, spark interference holding first place. Steps are being taken to reduce this trouble as much as possible. Although whistles hold only second place, still, they are very objectionable.

There are only two ways that this difficulty can be removed. One is to get all fans using single-circuit regenerative sets to scrap them or change them over into non-squealers (one method of doing this was shown in our July 1 issue on page 15). The other is to educate them to operate their radios without the tickler turned on so hard as to cause the tubes to oscillate. That is why RADIO PROGRESS and all other magazines keep harping on this point.

When the first changes in wave length were made, cross talk was, perhaps, the most serious difficulty, but improvements in the design of sets and increased experience on the part of those operating them have made this trouble rank third.

Arrangements are being made with the principal radio telegraph companies for reducing the amount of traffic on wave lengths which interfere with broadcasting. Considerable progress has been made. The wave-length conference in Washington several months ago put into effect a plan of giving out wave lengths, which has resulted in a great improvement in the interference situation.

This is a summary of over 5000 individual votes, the letters having come from practically the entire eastern half of the United States.

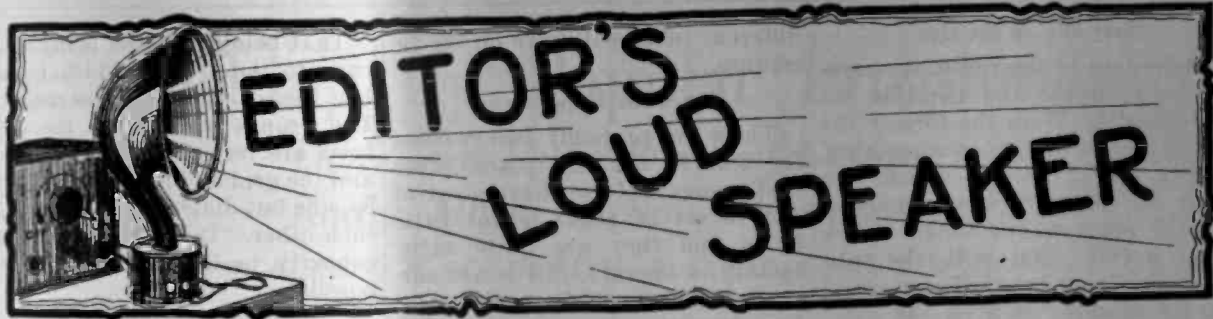
WHAT MAKES A TRANSFORMER WORK?

Continued from Page 19

Notice that all this discussion hinges on alternating current. Occasionally some one proposes a scheme for a direct current transformer. Unfortunately "there ain't no such animal," if there were, then 99% of all alternating current power circuits would be swept out of existence and direct current would be substituted. This because of the basic idea of a transformer. The stepping up or down of voltage and current is the result of an electric vibration. A steady pull has no such effect at all. As an illustration of a similar effect, it might be mentioned that an electric vibrator will oftentimes relieve a bad case of headache. This is because the motion is back and forth. If the same amount of motion were applied in a straight line it would push a person's head out the window, and this would not do his headache much good.

Another case is that of the undesired lossening up of nuts and bolts on an automobile. Everyone realizes that it is not the miles traveled in one direction (direct current) which casues the nuts to unscrew. It is the vibration which brings about this result and it would be just as effective if the machine were held off the ground by a crane while the engine were running and the wheels revolving, provided only it was jarred in such a way as to give the same vibration as before.

The alternating current in the primary causes magnetism to oscillate back and forth through the secondary, and it is this *oscillation* of the magnetism which generates the secondary voltage. Steady magnetism induces no voltage at all. This must necessarily be the case, otherwise we could stick a horseshoe magnet into a coil and leave it there and draw off enough current out of the coil to light the house without its costing a cent.



MUSIC WITH YOUR MEALS

Sometimes in laying out a new house the modern architect will provide a place for a lead-in from the antenna in the parlor and living room and also another in the dining room. This is to enable the broadcast listener to take his set with him into the dining room when it comes meal time. This is not a bad idea, as the doctors say that music has an effect on the mind which is apt to aid digestion. For this reason we suggest that those who weigh a little bit more than they wish they did should abstain from radio at such a time.

But there is a better way of getting the music in one room or another than that of taking the radio set around with you. It is very easily arranged, too. All that is needed is about 50 feet of double conductor insulated cord. Ordinary lamp cord, costing three or four cents a foot, is very good for this purpose. A telephone plug should be fastened to one end, and the other should connect to the loud speaker or telephones. Of course this scheme works better with the former, since it is not so satisfactory to sit through a meal with head phones on.

When the cord has been attached at both ends as just described, then plug into the jack in the regular manner and the program will be heard just as usual. The set will be left in its accustomed place, and all that is necessary to get one or another station is to carry the loud speaker to the set and then tune in until you hear what you want. Without any further change of the dials the loud speaker may now be taken into the dining room or upstairs and it will furnish music just the same as before.

How About Short Leads

Many of our readers will probably be horrified at such a scheme. "Where are the short leads you are always preaching about?" they will exclaim. Of course, it is true that inside the set some of the leads should be as short and straight as possible. This applies particularly to the grid connections and in a lesser degree to the plate leads. The reason is that such wires carry radio current at high frequency. The loss between wires varies as the frequency; that is, if we have a thousand times the speed of oscillation, we get 1000 times the loss. Now the speed of vibration of the audio current averages about 1000 cycles a second, while the radio frequency is about 1,000,000 cycles. You will notice that the ratio between the two is around 1000 to 1. This means that the small losses which occur in the telephone cord are negligible, but when multiplied one thousand fold they are so large as to destroy the goodness of the reception.

If you think that 50 feet of telephone cord are going to cause any trouble in the music, just recall to mind the fact that when you pick the telephone off your desk and talk to your friend your voice will have travelled perhaps several miles before it reaches him. The audio frequency which is sent over an ordinary telephone is not different in any respect from the same frequency which comes from the amplifier of an ordinary radio set. As the total cost of this suggested change amounts to only $1.00 or so, you will be pleased at trying out an experiment which is 100 per cent. sure of working perfectly.

FEEDBACK ON A CRYSTAL

As the crystal set is one of the most popular radios there is, it is not surprising that many experimenters are at work on it all the time. Since it is well known that regeneration, or feedback, is a very great improvement in operating a tube set, it is quite natural to ask why it has not been tried out with a crystal.

Bicycle and Auto

As a matter of fact, it has been tried innumerable times and always with the same result—complete failure. To understand why this is bound to be the case, suppose we compare the operation of a bicycle and an automobile. The bicycle has one rather serious failing. It has to be pushed. Suppose some chap should come to you and tell you that by some wonderful new combination of bearings, wheels or whatnot, he was able to get surprising new results from a new bicycle. Do you think this would interest a car owner? By no means. In the back of your mind all the time you would be saying to yourself, "Well, anyway, I would have to crank it all the time myself." And of course you would be quite right.

In the auto, on the other hand, all the labor the driver has to perform is to operate the controls and to think (this last seems to be hard for some drivers). When you step on the gas it isn't the physical labor you do that speeds up the car—you are merely allowing the gasoline to give up its energy, and it does the hard work.

Stepping on the Gas

Referring to the radio, the crystal is a bicycle and the tube an automobile. With the former the aerial has to do its own pushing. Every bit of energy which you hear in the phones was carried by the ether waves which struck your aerial. But with the tube set this is not true. These aerial waves merely "step on the gas," which in this case is the "B" battery current. The power to run the tube comes from this source, just as the horse power of the machine is obtained from the gasoline. All that the aerial has to do is to work the throttle or the brake. In other words, it is the brains which control the output from the battery.

Now when we get to regeneration we use up some of the energy from the "B" battery to help us operate the controls. Suppose on our car the foot brake were very stiff and so we had the motor pump some oil into a tank to help us work the brake bands. As a matter of fact, this very thing is done on some models of heavy trucks. In this case we would be using regeneration. But on the other hand, if it is a bicycle we are riding how absurd it would be to consider attaching a similar contrivance to help us put on the brake. It would be like trying to lift ourselves by our bootstraps. To be sure we *could* run the pump to force the oil pressure, but it would be our pedaling that worked the pump and in the end we would lose a lot of power.

Don't Try It

If this principle is clear then you will never waste any time at all in trying to make the crystal climb up itself in regeneration.

USING TUBE ADAPTERS

In experimenting with various radio hook-ups it is interesting to try out combinations of different condensers and different coils. Also a variety of hook-ups is often experimented with. But one thing that most amateurs leave severely alone is the testing of the effect different tubes will have on the reception.

Few Tube Experiments

There are probably two reasons for this. In the first place, tubes cost money. If you have a set of one to six of these useful little bulbs and they are quite satisfactory in operation, it is not surprising that you will hesitate before investing four or five dollars apiece in an entirely new set. The other main reason for not experimenting is the fact that in general the tubes are not interchangeable. Thus the UV-199 will not fit any other UV socket, and the WD-11 cannot be used in a WD-12. Each needs its own special support.

This does not apply to the UV-200, 201-A, and WD-12, which are interchangeable, in the so-called "Navy standard" socket. This means that if at present you are using any one of the three tubes it is possible to try out the effect of the others. However, don't ever try to use the WD-12 as a radio amplifier or the UV-200 as either radio or audio amplifier, as they are not suited for such purposes. The latter tube is intended for just one thing, that is, a detector. If you are using this in your set you have about as good a unit as you can get for that service and no change will be any improvement.

Leads Brought Out Wrong

When we come to the subject of radio frequency amplifiers then a different situation appears. The UV-201-A was originally designed for such service, but unfortunately it had to be made to fit the old style sockets. For this reason the grid and plate terminals are brought out side by side since that was the way the original tubes happened to be constructed. Back in those days it was not realized that having the two so close together was a disadvantage. But now it is well known that such close spacing decidedly increases the internal leakage capacity of the tube itself. This is a disadvantage and causes loss of selectivity.

That being the case, many fans turn to the UV-199 which is the last word in tube construction. The prongs which form the contacts are very short in this model and the grid and plate are not side by side but diagonally across from each other. This cuts the leakage capacity to the smallest amount possible.

Don't Use Adapter

But now we come to trouble. Since this new tube will not fit in the old socket what could be more natural than to use a base adapter which enables the new tube to be used in the old socket? This, however, would be a bad mistake. Since one of the chief reasons for making a change in the tube is to cut down the capacity, it will be seen that anything increasing this value will be a step in the wrong direction. And unfortunately, this is just what will happen. By using the adapter we not only retain all the leakage of the old base, but besides this we add the capacity of the adapter and this later value is quite large. As a result we are a lot worse off than when we started.

The only way that advantage can be taken of the good characteristics of the new tube is by taking out the old socket and substituting a new one. This is not a difficult job. The only thing to be looked out for is that the arrangement of the terminals is different in the two cases and care must be taken in hooking up the four leads.

Look Out for Voltage

One other point should be noticed. The voltage for the 199 tube is considerably lower than that for the 201-A. Either the "A" battery should be cut to two cells of storage (or three dry cells) or a resistance of 50 ohms or more should be inserted in series with the "A" battery.

Even with the lower voltage it is necessary to use a thirty-ohm rheostat if only one tube is employed. If two or more are used then 20 ohms is enough, while with a four-tube set a six-ohm rheostat will work nicely.

Picking Up Popular Programs

There Are Three Ways of Getting Radio Music to the Transmitter

By ALFRED N. GOLDSMITH, B. S., Phd., Fellow I. A. E.,
Director of Research, Radio Corporation of America

THE human ear is a truly marvelous instrument. Few people recognize all the amazing feats which the ear and brain in combination can perform, and therefore how difficult is the task of the broadcast device which aims to pick up for the listening radio audience exactly what is happening in a concert hall or studio.

To begin with, the ear hears a tremendous range of differently pitched sounds from the lowest notes to the highest. The deep boom of an organ pipe lies at the lower end of the gamut of notes which the listener wishes to have reproduced. At the other end of the long range lie the overtones of the violin and piccolo in all their interesting and tart shrillness, and the high pitched harmonics which alone make the spoken consonants "s" and "f" sound natural. Actually the necessary frequencies range all the way from the ponderous tone of about 30 vibrations in a second to the piercing sound of 10,000 or more oscilations per second. If the lower frequencies are not correctly picked up, the piano sounds "tinny," the baritone becomes a tenor, and the speaking voice while understandable, sounds thin and unnatural. On the other hand, if the high frequencies are left out or partly lost, the violin sounds like a flute, orchestras give a jumbled and incomplete impression, and the voice, particularly of the feminine speaker, sounds muffled and indistinct.

A Whisper to a Roar

The ear is also capable of hearing and appreciating a wide range of loudness in sound. One can hear and understand a faint whisper and also an almost deafening shout. In broadcasting, so extreme a range of loudness is hardly required, yet it is necessary that the expression of a piece of music be preserved by subduing appropriately the softer parts, and accentuating fully the more forceful portions. It is not easy to find a suitable telephone transmitter and vacuum tube amplifier that will preserve the relative loudness of tones accurately. It becomes necessary to use vacuum tubes in somewhat extravagant fashion, most of the time working them far below the output they might give in other service in order to avoid distortion when really loud notes are to be correctly reproduced.

Another characteristic of the human ear, or it may be, of the brain, is the ability to concentrate on a strain of melody or a particular part of a musical composition. This is especially noticeable in connection with orchestral compositions. It is well known that the ear and mind can pick up and follow the melody played by the violins of an orchestra although the remainder of the orchestra is also contributing its full quota to the total of sound. To some

Fig. 1. Control Room Amplifier

extent this can be imitated in broadcasting by properly placing the transmitter so that the instrument carrying the melody is nearest to the transmitter and thus is accentuated in the resulting broadcast music. This, however, is always done at the risk of exaggerating this instrument unduly, or of suppressing other important instruments, and thus doing what is known as "throwing the orchestra out of balance." In fact, a good musical critic is a necessary element in every broadcasting station that has any pretensions to sending out really artistic productions.

Tiny Currents Omit Hiss

Having mentioned the problems in picking up music for broadcasting, it is desirable to give some of the various solutions for them which have been found. "The telephone transmitter which is used must be a very different device from the ordinary transmitter used on the usual telephone system." While the ordinary transmitter suffices for speech under comparatively uncritical conditions, it would not do at all for broadcasting. In the first place, it would be far too noisy. That is, "the average transmitter produces a certain amount of hiss and crackle which would be intolerable in high-grade broadcasting." So that, when carbon grain transmitters are used, they have to employ a special grade of carbon and to use very small currents so that they will produce a minimum of such objectionable noise. Otherwise the desired velvety silence when the artists are not singing will be missing, and the audience will be distracted and annoyed by the hiss of the transmitter.

"A second objection to ordinary telephone transmitters is that they exaggerate certain frequencies of the voice or music very markedly because the vibrating diaphragm or sheet of the telephone transmitter responds more vigorously, or "resonates," to certain frequencies or pitches. This is not acceptable in sending out music. The effect of such partiality for certain notes would be particularly dangerous if such transmitters were used for sending out an orchestral selection. Some instruments would be partly suppressed and others exaggerated, thus spoiling the

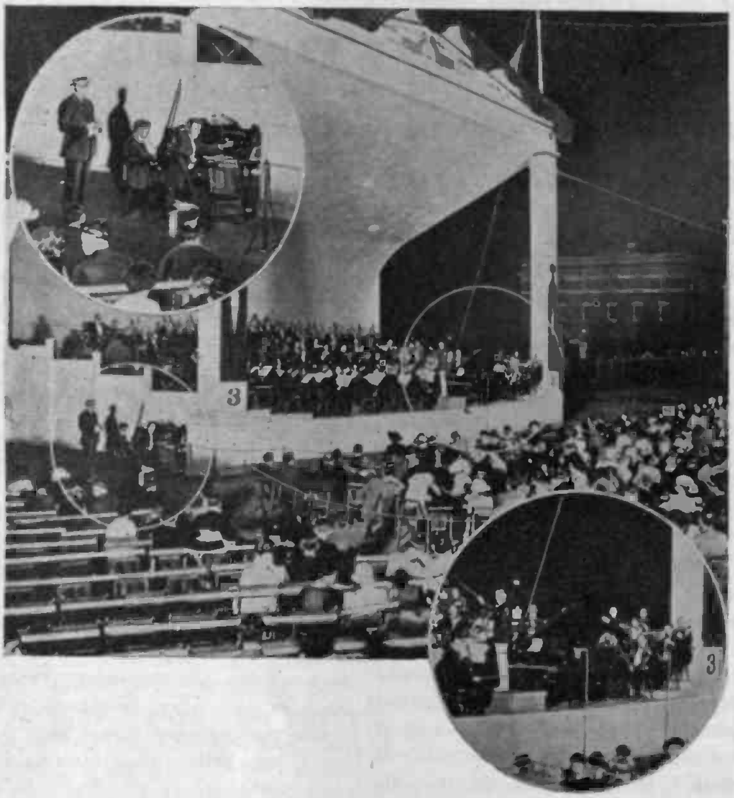


Fig. 2. How Pick-up Transmitter is Located

effect. So that it becomes necessary to use a telephone transmitter which has a diaphragm which responds as evenly as possible to notes of all pitches. One way of doing this is to use a thin and powerfully stretched diaphragm of steel or some other strong material which will respond equally to all usual tones. Another way is to use the so-called "glow microphone," which has been recently described, where the vibrating element is a small column of glowing gas through which a small electric current is passing. Yet other methods are available, but most of them not particularly simple.

Stepping Up the Signals

The amount of power which it is possible to get from these high-grade telephone transmitters is nearly always very small, and it becomes necessary to increase it by means of a powerful amplifier. This unit must also be free from noise-producing tendencies, and must amplify notes of all pitches equally. Both these requirements are very difficult to meet. Either resistance-coupling must be used, or else the greatest care has to be taken in the design of the special transformers used in a transformer-coupled amplifier for this work. Ordinary instruments would not serve at all, as is sometimes evident when listening to the "music" emanating from a badly designed broadcasting station. A good idea of the elaborate nature of a suitably designed amplifier is obtained from Figure 1, which shows some of the control room apparatus of Broadcast Central, Stations WJY and WJZ of the Radio Corporation of America at Aeolian Hall, New York City. This is really two amplifiers, one at the top of the case, and the other at the bottom.

Special relays permit either unit to be used at will so that there is always a spare available in case a tube burns out, or some other defect develops in one of the amplifiers. The control room engineering attendant at these instruments must stick right to his post during the entire performance, listening to every note that goes out, through special "monitoring sets," and maintaining loudness and quality of the music by the suitable controls which are provided. He also has a number of special colored signaling lamps before him on the control room amplifier, so that he knows just what is going on in the studio, and whether the transmitter which he controls is actually "on the air" (that is, transmitting) or not.

Clearly, carelessness and crudeness have no place in either the design or the supervision of the pick-up transmitter and control room amplifier of a satisfactory broadcasting station. The radio listener would do well when he is especially pleased by the clarity and excellence of an evening's performance to remember something of what has been done by "brain and brawn" in reproducing in his home the intricate and yet delightful melodies and sounds which make up the broadcast program.

Broadcasting from Outside the Studio

The long arm of broadcasting is reaching out further and further—both to gather the program and then to scatter it again. Although broadcasting is a young art, it has already changed radically from the conditions which the radio listeners of a few years ago can remember. In the early days of broadcasting, the programs all originated in the studio of the sending station, and every artist or speaker had to come to the studio in order to send his message to the world. This was an inconvenient plan since it required important persons and famous artists to leave their homes or places of business and travel to the broadcasting station, wherever it might be located, sometimes at an inconvenient hour. Nowadays, broadcasting studios which are wisely planned are located at the musical and artistic center of their city, and this has made it easier for the performers to be at the station in person.

There are, however, many types of current events which should be broadcast but which cannot be brought physically to the studio. For example, a theatrical performance or a musical comedy is generally unavailable for studio broadcasting. So also are church services, a dinner given to a world-famous celebrity, a great concert given outdoors or in an auditorium, meetings of legislative assemblies, athletic and sporting events, and the like. In other words, there are many occasions of intense interest to the broadcast listener, which, nevertheless, are not transferable from their place of usual occurrence. Fortunately broadcasting has found the means of gathering them into the station and then scattering them to its million listeners in unimpaired form.

The most common way of bringing the desired event to the broadcast station is by means of what is termed "wire line transfer" or, as it is sometimes called, "remote control." This consists in using a telephone line to connect the concert hall, for example, to the broadcasting station, and then sending the concert over the wire before broadcasting it. To do this, suitable pick-up transmitters have to be placed in the hall at carefully chosen locations. The music is picked up by these, and the corresponding telephone currents are amplified or strengthened by a "line amplifier." This is a carefully designed vacuum tube amplifier, somewhat like that in a high-grade radio receiver except that extreme care is taken to maintain the quality of the music perfectly, and to get a suitable amount of power out of the unit before sending the telephone currents over the wire from the concert hall to the broadcasting station. When these currents, which carry the music, arrive at the station, they are again strengthened by the control room amplifiers (Figure 1) of the station, and are then used to control the radio telephone transmitter in just the same way as if the concert had taken place in the studio of the station. In other words, instead of operating the radio broadcasting transmitter by telephone currents coming over a short wire line from the studio at the station, it is controlled by currents, which, when amplified suitably, have come over a long wire line from a distant hall. This is why the process is called "wire line transfer" of events originating at distant points, since it is carried from the distant auditorium to the broadcast station over a wire line.

It is very necessary to locate the pick-up telephone transmitter in the concert hall with great care, the problem of a proper position for it being even more serious than in the studio at the station, where conditions are more readily controlled. If an orchestra is playing, the transmitter must be placed so that every instrument will be heard in just the right proportion of loudness and that the orchestra will stay "balanced" when its playing is reproduced for the listener. If a sermon is being broadcast, the preacher, the choir, and the

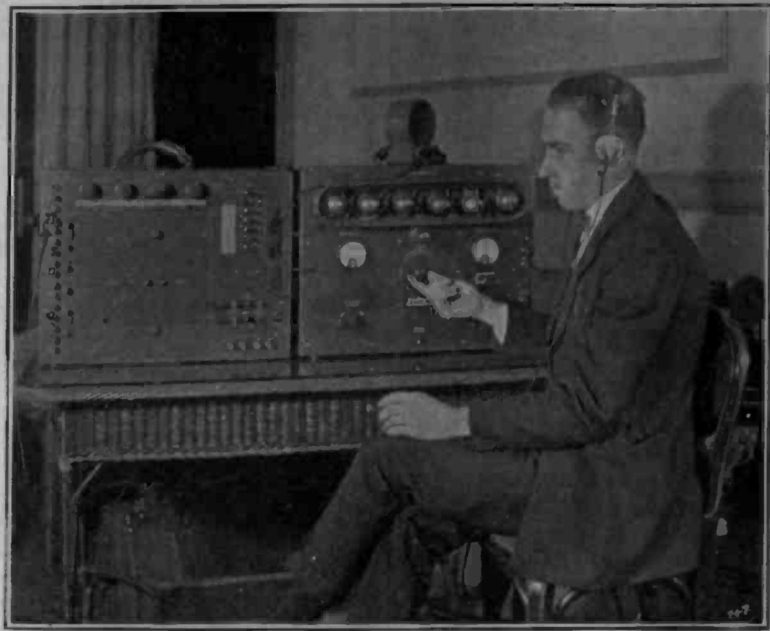


Fig. 3. Operating the Line Amplifier

organ must be reproduced correctly, and this may require several pick-up transmitters skilfully placed and appropriately used by a supervising engineer. Theatrical performances are still more difficult to pick up because the actors move around the stage, do not face the transmitter except by accident, are interrupted by applause, and by the frequently serious echoes which are found in theatres. Many hours of experimentation are generally required before an important event can be properly picked up for wire line transfer to the broadcasting station.

Figure 2 shows the location of the pick-up transmitter at the Lewisohn Stadium, New York City, from which the concerts of the famous Philharmonic Orchestra were broadcast by station WJZ of the Radio Corporation of America at Aeolian Hall, New York. The two inserts are enlarged views. Such important performances as these bring the best entertainment of the day to every listener.

The line amplifier is a specially designed piece of equipment, as can be seen from Figure 3. This is the type of amplifier which was designed by the Research Department of the Radio Corporation for use at stations WJY, WJZ and WRC. The left hand box contains the batteries and some of the individual transmitter controls. The right hand one contains the tubes and amplifying apparatus, as well as the important "gain control" which enables the supervising operator to regulate exactly the strength of the telephone currents which he places on the wire line to the broadcasting station. It also contains the "volume indicator," which is an instrument that visually indicates the strength of this same current and thus shows that the transfer is taking place correctly.

Exceptionally good wire lines must be used for this sort of work. If they are noisy, or if they do not transmit equally all tones, of whatever pitch, they will fail to give satisfaction. Consequently facilities for securing such lines and for testing them to determine their characteristics are needed if acceptable wire line transfer of outside events is required. The broadcast listener to a church sermon, faultlessly transmitted, will often fail to appreciate the elaborate process whereby his favorite preacher's words are being carried to his home by radio.

Describing the Radio Relay

There is another way of broadcasting outside events which is known as the "radio relay" method, and which has been experimentally tried with considerable success. This involves sending the material from the concert hall, for example, to the broadcast station by radio on a special wave length, and then receiving it at the studio, and automatically re-transmitting it on the usual wave length of the broadcasting station. More specifically, a small radio transmitter working on the unusual wave length of say 100 meters is placed at the concert hall and sends out the program. The average broadcast listener will not be able to receive this. But the sending station will pick up this concert on an excellent receiver, amplify it in the control room amplifiers, and send it out again at full power at the usual wave of say 400 meters. This latter wave length will be readily received by the listeners. The radio relay method, which may be used more in the future for certain types of events, simply replaces the wire line from the hall to the studio by a radio telephone connection.

In this modern aspect, broadcasting not only flings out entertainment, but also actually draws it in. From all points it takes the best and most entertainment material, draws it to the station by wire line transfer or radio relay, and then sends it out powerfully to an expectant audience. The outside event supervisors are literally musical "reporters," who carry their "news" to the station, where it is published widespread for the benefit of the listeners.

RADIO EDITORS TO RUN WEEI

WEEI, the new 500-watt broadcasting station of Edison Light, Boston, Mass., will open with a bang early in September. It will transmit on a wave length of 303 meters. Two Boston radio editors, who for many months have been telling broadcasters how to run their stations, will now have an opportunity to practice what they have preached, for they will have complete charge of the policy and operation of WEEI.

Edison Light's official initials, E. E. I. for Edison Electric Illuminating Company, are incorporated in the call letters WEEI. The new studio, fast nearing completion, is on the fourth floor of the Edison building at 39 Boylston street, Boston.

"THE LIAR"

A fool there was and he spent his dough
(Even as you and I)
For a wonderful new fangled radio
That was built for two hundred miles or so,
But the fool thought he ought to get Tokio
(Even as you and I).

Oh, the money it cost
And the sleep he lost
And the wonderful lies he planned
To tell to the fellows who hadn't got wise,
And unless they are bugs they'll never get wise,
And never will understand.

So the fool stayed up all the night and tried
(Even as you and I)
To get the stations away outside
His natural zone just to swell his pride
When he said he got them we knew he lied
(Even as you and I).

Oh the stations he got
And the ones he sought
Are always one and the same
To the radio bug who has learned to lie
And all of us know that it's easy to lie
If he's in the radio game.

S. W. Leaver, in "The Town Crier."

RADIO IN JAIL

A great deal has been said about the effect of radio on the world. Its future depends on the results of broadcasting, and directors who have the development of the art at heart are careful to put out only such programs as will please the largest number of persons without offending anybody.

While studying the effect of radio on society at large, a great deal of attention might well be diverted to its effect on that portion of society which is not at large—those who have broken the laws and so been put in jail. Here radio stands as perhaps the greatest single blessing for those unfortunates.

The following letter of applause from a convict tells the story better than volumes written by an outsider on the subject. It was written in appreciation of programs from WTAM, the radio station of the Willard Storage Battery Company, Cleveland, but it applies with equal force to any station:

Like Carpet of Bagdad

"Radio rivals the famous 'Carpet of Bagdad.' It enables a man serving 20 years in prison to 'listen-in' on programs broadcast from every part of America. One hears only good things over the radio; talks, lectures, speeches, sermons and music; matter that is interesting, educational and timely. Radio has its part to play in the reclamation of prisoners, and I, through my radio set, mean to do my part to help my fellow-inmates of this institution, Great Meadow Prison of New York State. The few dollars I have saved during the 10 long years that I have been confined have all gone to pay for my radio outfit."

REAL REASONS FOR THE RHEOSTAT

Continued from Page 7

tubes the same principle applies. It is often stated that the resistance of the filaments when cold is considerably less than when they are hot and this is quite true. For this reason they will take more current just at the instant when the switch is turned on. But just as soon as they get hot the resistance increases and since the wire cannot be hot and cold at the same time there is no chance of overheating it because it is so cold.

THE RICE NEUTRODYNE

Continued from Page 15

neutralized all by itself without reference to any of the other stages, i. e., the customary connection from the grid of one tube to the tap on the secondary of the adjoining tube is not used. This makes each stage independent of every other stage. This method affords a positive means of neutralization and should be a godsend to those who have neutrodynes that won't "neut."

The final part of this article will appear in the next issue. In it are directions for operating the set, hints for hooking it to the aerial and ground, and a discussion of the possibility of reflexing the audio amplification.

℞ DR RADIO PRESCRIBES.

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

Question. I noticed in one of the radio magazines that all the equipment of a set was mounted on a sub-base so as to eliminate body capacity. How does that result obtain?

Answer. This is a mistake. Body capacity has nothing to do with the kind of supports used for mounting the equipment. It is only a question of leakage capacity and shielding. The more a set is shielded the less the disturbance from this cause. Furthermore, the farther away the units are from variable grounds (represented by your hand) the less the effect.

Question. Why is a wooden variometer inferior?

Answer. A wooden variometer is not necessarily a poor one. If the wood is properly dried and then impregnated with a suitable insulator it will be found that it is a very good instrument. The only trouble is that wooden spools are cheaper than those of bakelite and in cheap instruments the manufacturers sometimes slight the materials, with the result that the unit does not work well. This fact has given wooden variometers a bad name.

Question. Why is it that various socket aerials will prevent static while bringing in the distant stations?

Answer. By socket aerial is meant the various devices which screw into the electric light socket and take the place of an antenna. They oftentimes work very well. However, the advertising that has been done recently that owing to shielding of the electric wires in your walls by the iron conduit, you will eliminate static, but not the signals, is incorrect. Whistles which come in from your nighbors *are* radio signals and no aerial of any kind is intelligent enough to think to itself that one kind of noise at 360 meters is caused by a neighbor and must be suppressed, while another kind at the same wave length comes from Station PDQ and is wanted. If the aerial is shielded enough to reduce the undesired waves it will also reduce the others in the same proportion. This is not saying that socket aerials are not good but it is stating that they are not any better than a good outside antenna.

Question. When are the silent hours for sending code?

Answer. During the summertime they are from 7:00 to 10:30, Standard Time, every evening. This, of course, corresponds to between 8:00 and 11:30, Daylight Time.

Question. When using transformers for lighting the filaments why does a "C" battery reduce the hum?

Answer. The "C" battery does not have any direct result in cutting down the noise, but it is necessary for another reason. Since the alternating current reverses its polarity once every cycle it is not possible to connect the wire running from the gird coil (the so-called grid return) to the negative of the filament. Each side of the filament is alternately negative. Instead the grid return is hooked up to the arm of a potentiometer which is set at the middle position. The other two terminals go to the two sides of the filament. With this connection there is no negative bias on the gird. To take care of this it is very desirable to use a "C" battery with the negative toward the grid and the positive to the potentiometer.

Question. Why do some transformers have four terminals and others five?

Answer. All ordinary transformers, both audio and radio frequency, use windings with four leads. The only style which has five is that designed for use in a push-pull audio amplifier. The middle point of one of the windings has to be brought out in such connections and the extra lead on the transformer takes care of this.

Question. Why are transformers and sockets often mounted at an angle?

Answer. The reason for placing the transformers out of line is to prevent magnetic leakage. When they are lined up one right after the other, if there were any stray magnetism which runs out of the iron of one it might influence the one nearby it. But when they are installed out of a straight line, the magnetic leakage does not have nearly as powerful an effect. The only reason for twisting the position of vacuum tubes is to make the wiring easier. Sometimes such an arrangement allows straight leads from one post to another, where bent wires would be needed if the tubes had the usual position.

Question. What is the advantage of the loud speakers which have square horns rather than round ones?

Answer. It seems to make very little difference what the exact shape of the horn is. This can be easily seen when all the various entirely different shapes of horns on the market are considered. Each one of these is really the best. The manufacturers tell us so. It is mostly a matter of taste whether we prefer one shape or another.

Question. What is meant by the resistance of a condenser being 0.1 ohms?

Answer. The resistance of a condenser has to be measured at high frequency as with direct current its resistance is zero. Also, the resistance varies with the wave length. The short-

Continued on Page 30

Remarks Received from Readers

EDITOR RADIO PROGRESS:

Providence, R. I.

DEAR SIR:—Re your Editorial, p. 23, in the August 1 issue of RADIO PROGRESS, "A Welcome Complaint," I have noticed your very evident attempt to make explanation of causes as well as to state effects, and to give explanations without gaps or use of words requiring a Radio Dictionary for definition. As most radio fans have "picked up" their knowledge as they went along without opportunity for coherent study in a school devoted to radio science, your method is bound to suit the vast majority. The limitations of language are such that one can hardly be too clear in discussing radio theory.

Yours,

H. A. NICKERSON.

We are glad to know that our efforts are appreciated, but we would like to hear from readers who have not understood any of our articles. If you find the style of any description is difficult to follow, please let us know, and we will try in the future to make such matters plainer.—*Editor.*

EDITOR RADIO PROGRESS:

Since I am at the old mill, I am going to take a crack at the circuits you present, and I hope not without effect. If you operate a set yourself, you are either in the class of those who use regenerative receivers capable of radiation or those who are abreast of the times and use a set which helps keep the air clear. If you do not personally own a set, you have at least heard the howling, squealing ten-cent store variety of radiating transmitter that makes radio fans miserable. This variety of interference is wholly unnecessary. There are any number of sets which hardly radiate or are incapable of interfering at all, whether properly or improperly operated. The single, two and three-circuit regenerators clutter up the air, are broad in tuning, comparatively inexpensive and rapidly being replaced by other circuits giving equal DX, selective tuning, comparative low cost and *no interference.*

Why, therefore, should RADIO PROGRESS go *backward* with the article on page 11 and the construction article on page 29 of the June 1 issue? Those who build that receiver will in all probability not know how to tune it and will make life miserable for their neighbors. There is no tickler shown, but it is quite capable of putting out one hundredth watt or more.

For the good of radio, therefore, may I plead that no further articles be allowed to appear in your magazine concerning the construction of these nuisances. Let me state once and for all time that the Armstrong principle was a great advance in its day, but that the ranks of the BCL's who will not learn to use it correctly will be better satisfied with other substitutes of equal DX value which will clear the air.

Sincerely yours,

RICHARD SIDDALL.

We agree with the author of this letter. There is no doubt about it. The squeals from radiating sets are perhaps the worst feature of radio at the present time. There are a good many different styles of sets which do not offend very much, if at all, in this matter. The only trouble is that such hook-ups almost invariably make use of radio frequency amplification, and many amateurs seem to have rather poor success in building them.

Undoubtedly the general tendency is away from these squealing sets or bloopers, and we are glad to throw our influence on the right side of the question.—*Editor.*

DR. RADIO PRESCRIBES

Continued from Page 29

er the latter is, the greater the resistance. You will always notice that the frequency or wave length at which the latter was taken is mentioned when giving such condenser data. This resistance value includes more than just the current losses in the condenser plates. Besides this are contained the losses through the dielectric or insulating ends. The figure as given represents a fictitious value. If a real resistance of that amount were inserted in series with a perfect (no loss) condenser then the total losses would be the same as they actually are.

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8 Temple St. (P. O. Box 728)
Providence, R. I.

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RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER