28 TESTED METHODS FOR MAKING EXTRA MONEY

No. 1JS

PIONEER HOME STUDY RADIO SCHOOL

NRI

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28 Tested Methods for Making Extra Money

1. HOW TO FIND RADIO JOBS

Right now you are looking forward to a long line of radio jobs which are going to give you valuable experience, increase your income and lead to something really big later on.

Of course there is the old saying that "the beginning of anything is hard," and you are possibly wondering where that first job is coming from, how you are going to get it, and whether you'll be able to make good on it.

In this book you will be given information which will enable you to handle a number of jobs after you have completed just a few lessons of your course. With this information you can make good on these jobs all right; and what we want to do now is to see how we are going to get our first jobs—break the ice, as it were.

Whenever a man starts out in business, what is the first thing he does? He lets as many people know about it as he can. He talks about his business every chance he gets, and he lines up all his friends and relatives so they will be his future customers.

You are starting into business—and believe me, it's a great business. The first thing you want to do is to let your friends know that you are studying Radio and that you are in a position to handle a certain number of radio jobs. Then, when a friend's Radio goes bad, he will automatically think of you, call you up and have you look at it.

This job well done, you will get a good deal of free advertising, for your friend will tell his friends about you. Then, when they need some radio work done, they'll think immediately of you, and you'll get the job

Talk Radio whenever you get a chance. When you meet a man on the street, or anywhere, for that matter, gradually bring the conversation around to Radio, ask him if he owns a receiver, what make it is, how he likes it, etc. Of course, this must be done carefully—it isn't usually advisable to ask a chance acquaintance for his radio work directly; you may frighten him off by appearing too anxious to sell your services. It is much better just to let him know you are in the radio game, and indicate by your conversation that you know your business. If he gets the idea that you're a good fellow, he'll think of you when he wants some repair work done.

Then later on, when you want to branch out and do more service work than your friends and acquaintances can provide, there are many things you can do to increase your business. You will be sent business cards by the N. R. I. later on in your course. These are real business getters, as hundreds of students have learned.

Among the other things you are urged to do is to advertise in the newspapers; use display signs on your porch, or in some other prominent position; use the telephone, especially in cases where you hear of someone indirectly, whose Radio is not performing satisfactorily; and use advertising letters.

It isn't necessary to run large "ads" in your local newspaper, or to run an "ad" every day. A small "ad," well worded, inserted on the radio page once a week, should bring you in a nice lot of business. A small "ad" in the business directory of the telephone book is also very valuable.

As for your advertising letters, it is advisable to build up your own list of names and addresses. Often you can get the names of set buyers from stores which sell Radios but which do not have their own servicing departments. Keep a record of the names and addresses of your customers; occasional letters to them will do a lot of good. If a customer mentions a friend who has a Radio, get his name and address and put it on your mailing list. Keep your list up-to-date. Don't send letters to people who have moved away or died.

Another source of profit that must not be overlooked is the radio stores in your vicinity. Get in touch with them, try to arrange to handle their service work, or, if they have a regular service man, to handle the overflow at rush times.

So you see there is much that you can do, and you can start making some contacts right now. Don't forget that you have your Institute back of you; remembering this will give you confidence to make a start and keep going!

2. HOW TO INSTALL AN AERIAL FOR MINIMUM INTERFERENCE

Local interference such as would be picked up by an aerial from high voltage supply lines, motors, generators, etc., where correction cannot be made at the source, may be greatly reduced by using special lead-in wire. In localities where there is considerable local interference, an ordinary lead wire would pick up the interfering noises. The use of special shielded lead-in wire may often prove the solution to this problem. Of course, where shielded lead-in wire is used, the ground lead must also be shielded.

Shielded lead-in wire can be purchased from practically any of the large Radio supply companies. In this wire the conductor is stranded copper wire well insulated, and over the insulation is a shielding braid. When this kind of wire is used for the antenna and ground leads, the shielding braid of both leads must be grounded. The same ground connection can be used for both.

In this case a separate ground must ordinarily be provided for the radio set. If the shields are grounded to a water pipe, the separate ground for the set can be obtained by driving a metal rod into the earth.

If it is impracticable to use two grounds, the shields can be connected to the same ground as the set, through a 10,000 to 100,000 ohm resistor. See Fig. 1.

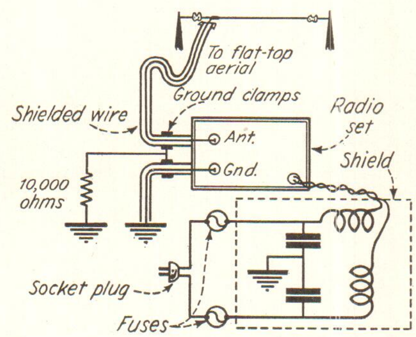

Fig. 1

It has been found by many service men that, in installing an aerial on tall apartment houses, the use of shielded lead-in wire helps materially in giving a fair degree of selectivity. When shielded lead-in wire is used, the aerial on the roof of the building can be from 40 to 50 feet long, as the shielding braid prevents the lead-in from picking up excessive signals.

In all cases the aerial proper should be erected at right angles to power and trolley lines, and the lead-in should be taken from the end farthest away from the source of interference. If the source of interference is not apparent, the point of minimum interference can be found by experiment—with one end of the antenna permanently fastened, move the other end around and note the noise picked up at as many positions as possible. Fasten permanently where noise is least.

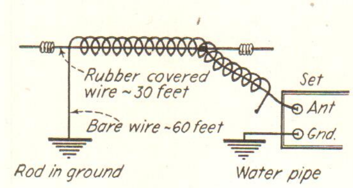

Fig. 2

There are various other means of partially eliminating interference. One is to construct a two-wire aerial, the two wires being at least 10 feet apart, and connecting the leads from one wire to the ground post of the receiver and the lead from the other wire to the antenna post. The secret of success with this type of installation lies in the twisting of the two down-leads.

Then there is another type of aerial that has been used by many service men successfully. The regular inverted L type of antenna is erected, using No. 10 rubber covered wire. Around the flat top of this aerial is wrapped a suitable length of regular antenna wire, the turns being spaced about 2 inches apart. One end of this wire goes directly to the ground as shown in Fig 2; the rest of the wire is wrapped around the flat top erection and continues to within 6 inches of the receiver. There must be no direct electrical connection between the two wires.

Of course none of these special installations will eliminate the interference that comes into the receiver through the A.C. power supply. This is best eliminated or reduced by the use of a filter, as shown in Fig. 1. It consists of two radio frequency chokes and two condensers in series with each side of the A.C. line. When this filter arrangement is used, a double fuse block must be used between the light socket and filter. Use 5 ampere fuses.

The chokes are placed at right angles to each other. They consist of 70 turns each of No. 16 D.C.C. wire, wound on a 2 inch bakelite tube. The condensers are 2 microfarads each and are rated at 600 volts.

The filter should be enclosed in a copper or metal container which may or may not be grounded. When a metal shield is used, the two chokes should be placed on wooden blocks to prevent them from touching the shielding.

3. UNDERGROUND ANTENNA INSTALLATIONS

Underground antennas are desirable in some instances where extreme sensitivity is not wanted but where it is desired to reduce static and interference. An underground antenna system is not a cure-all, but it will improve the reception in many cases, even though it does reduce the sensitivity of the receiver.

Lead covered wire should be used. Directional effects are obtained by laying the wire in a trench about 18 to 24 inches deep, 75 feet long, in one continuous direction as shown in Fig. 3. Where the wire is cut at the far end, it should be dipped in hot pitch several times, then wrapped with rubber tape and dipped in pitch again. This prevents the wire from making contact with the earth and the lead covering. The wire used should be No. 14 solid or stranded, insulated with a rubber covering with the lead shielding over that. This wire can be obtained from most large electrical supply houses.

Where space is limited the wire may be placed in a spiral form as shown in Figs. 4 and 5. This type should be buried in a pit or hole in the ground about 4 to 5 feet deep and about 3 feet in diameter.

The spirals should be made with the turns of wire 3 to 4 inches apart, and the smallest diameter should be about 6 inches. A space of 6 to 8 inches should be left between each of the spirals. This type is not directional and is much easier to lay. Its pick-up is much smaller than that of the horizontal type, and, as a rule, it is not to be depended on except for reception of nearby local signals.

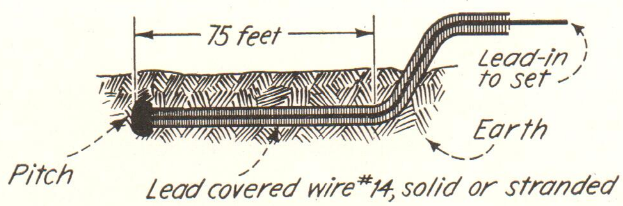

FIG. 3

4. THE ERECTION OF A GOOD ANTENNA

When called upon to install a good antenna, there are many points to bear in mind, as, for instance, the length, height, kind of wire used, its relation to other antennas and power lines, and where the receiver is to be installed. These are all factors which greatly affect reception.

For ordinary radio reception, a single wire outdoor antenna is recommended. Stranded wire, which has been tinned or enamelled, is almost universally used at the present time. The antenna should be from 50 to 75 feet long.

In cases where the receiver is especially sensitive—and this is true of most modern superheterodyne and screen grid sets—a very short aerial 15 to 40 feet in length, may be used. This has the added advantage that it will increase selectivity.

The position of the antenna wire is very important. It should be as high as possible and should not be in close proximity to any other object. Electric power lines close to the antenna may cause noise in the receiver. Closeness to a metal roof or other large metallic surfaces will decrease the efficiency of the antenna system. Under no circumstances should the antenna be run above or parallel with other wires carrying electric currents of any kind. If it is necessary to run the antenna over a metal roof, it should be at least 8 feet above the roof. The antenna should never be run parallel with another antenna unless there is considerable distance between the two.

The antenna lead-in should, in all cases, be part of the antenna itself; that is, the antenna wire between the two supporting points should be continued directly down from one end to connect to the receiving set. It is not necessary to cut the wire and then connect the lead-in to the antenna.

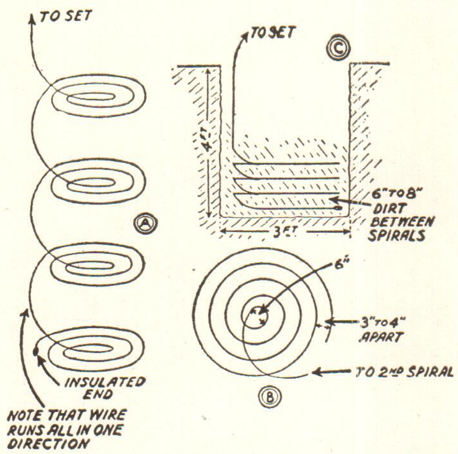

Fig. 4.—The illustration above shows how an underground antenna can be made with a minimum of labor.—Illustration Courtesy Cloverleaf Mfg. Co.

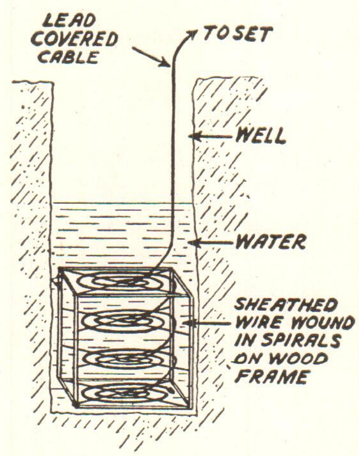

Fig. 5.—The spiral antenna may be used under water as well as under ground. Above we see an antenna installed in an old well.

However, if it is ever necessary to connect an extension to the antenna for lead-in purposes, the ends of both wires must be carefully scraped, twisted together, soldered and then taped. This is necessary to insure good electrical contact and maximum efficiency. Keeping the antenna and lead-in all in one piece eliminates the necessity of soldering.

The lead-in should be kept away from buildings, trees and other obstructions. The antenna lead-in, as it comes to the set, should not be run along the back of the receiver.

The antenna should be very carefully insulated. Insulators, porcelain cleats and insulated bushings should be used as shown in Fig. 6. The antenna may be supported either by wire or a stout rope fastened to the insulators as illustrated in Fig. 7a. About 6 inches of the end of the antenna wire should be passed through the free end of one insulator, turned back through the same eye once and wound tightly around the antenna wire proper, as shown in Fig. 9. Draw the other end of the antenna wire through the eye of the insulator at the other end, wind it tightly around the wire at that end also, and run the lead-in wire directly to the receiver.

If enough wire is left from the antenna to serve as a lead-in, it is only necessary to draw the surplus wire through the eye of the insulator, then twist the insulator half a dozen times or so, as shown in Fig. 7a. If it is necessary to attach the lead-in separately, the end of the lead-in, as well as the end of the antenna to which it is to be fastened, should be scraped carefully before the joint is made and the lead-in wound around the antenna as shown in Fig. 7b. This joint, as well as any other joints

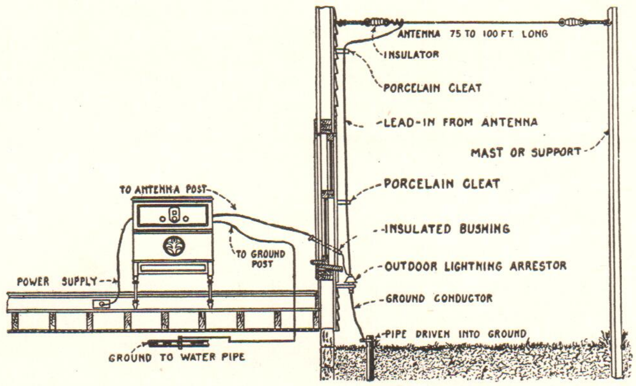

Fig. 6

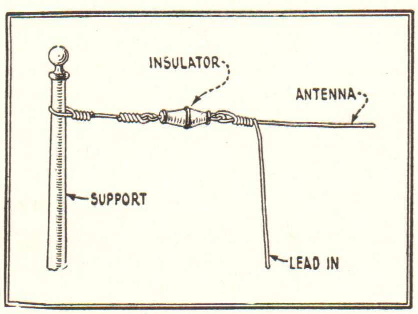

Fig. 7a.—Illustration showing how antenna wire and lead-in should be connected to insulator if wire is long enough.

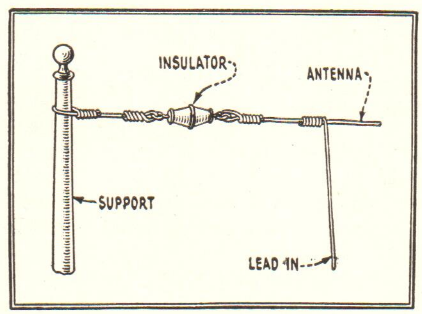

Fig. 7b.—Illustration showing how to attach a separate lead-in wire to antenna.

in the antenna system, should be soldered and wrapped with ordinary friction tape.

When the antenna is strung up, it should be pulled tight and fastened so that it does not sag and will not swing back and forth. Turnbuckles, pulley and cord or stiff springs may be used for this purpose. The antenna should be so placed that nothing will touch the aerial or lead-in. If the branches of a tree or any other obstruction touches the antenna or lead-in, the incoming signals may not only vary in intensity but they may be stopped altogether. This is especially true in wet weather. The main thing to keep in mind in putting up an antenna and its lead-in is to keep it well insulated and clear of obstructions.

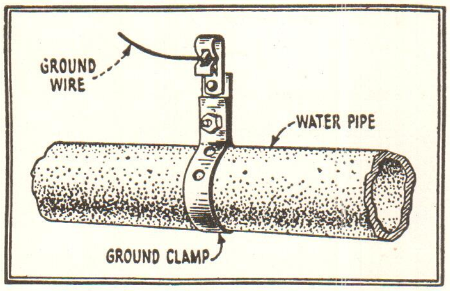

Fig. 8.—Ground clamp attached to water pipe.

If it is impossible to use one end of the aerial as a lead-in, as already explained, then the lead-in wire should be No. 14 rubber covered wire. The lead-in should be attached to a lightning arrestor as shown in Fig. 6. From the lightning arrestor the lead-in wire is run through an insulated bushing through the wall of the house directly to the receiving set.

In many radio installations, where the owners of the building will not allow the insulated bushing, a special window strip is used. This consists of a thin piece of copper, thoroughly insulated, which is placed under the window sash. One end of the lead-in is attached and soldered to one end of the lead-in strip and the receiving set is connected and soldered to the other end of the lead-in strip by means of a wire of convenient length. This eliminates the necessity of making a hole through the wall. The installation, however, does not meet with the requirements of the Fire Underwriters, and for this reason the insulated bushing placed in the wall as shown in Fig. 6 is preferred.

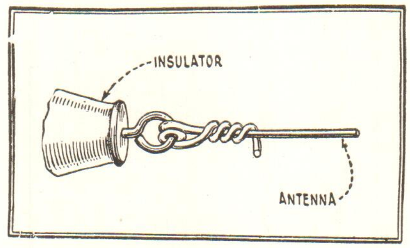

Fig. 9.—Illustration showing how antenna wire should be connected to insulator.

A lightning arrestor must also be connected as shown in Fig. 6 in order to comply with the Fire Undrewriters' rules. In aerial installations on apartment houses indoor lightning arrestors are used.

A good ground connection is essential. It is usually made by fastening a ground wire to a cold water pipe by the use of the ground clamp as shown in Fig. 8. There must also be a ground connection attached to the lightning arrestor. This may be a pipe driven several feet into the earth, or, if it is convenient, the ground wire may be attached to a cold water pipe in close proximity to the lightning arrestor.

5. HOW TO OPERATE MORE THAN ONE SPEAKER FROM A SINGLE RECEIVER

Fig. 10 shows how we may connect as many as thirty magnetic speakers or headphone sets to a single broadset receiver or any power amplifier.

The 2 mfd. blocking condensers are to prevent the direct plate current from flowing through the extension, while at the same time allowing the audio signal to be fed directly to the magnetic speakers connected in the extended line. As these speakers are connected in parallel, the maximum volume from each will be the same. The volume for each individual speaker or headset is controlled by the 100,000 ohm potentiometers. Don't run the two leads from the output of the receiver in metal conduit as the increased capacity may decrease the fidelity of reception. Good rubber covered wire is best. There is no fire hazard if the 2 mfd. blocking condensers are built to withstand a potential of 400 volts when using push-pull '45 tubes and 600 volts when using '50 tubes.

A single dynamic speaker can be connected directly across the output of the normal receiver by connecting to points *A* and *B* in Figs. 10, 11 and 12. Any dynamic speaker which derives its field power from the house lines and which is designed to be connected directly to the output of the power tube can be used. Generally, box type or mantel type dynamic speakers have incorporated in them either a dry metallic rectifier or a vacuum tube rectifier so that D.C. current can be fed to the field of the dynamic speaker. These portable dynamic speakers also have built in them a coupling transformer which means that they may be connected directly to the output of a power tube. When adding a dynamic speaker to a receiver, the additional magnetic speakers or earphone sets cannot be used, as they would put too great a load on the radio set.

The hook-up shown in Fig. 10 is intended for push-pull output receivers, but the same scheme can be used in receivers where there is only a single output tube. The connections are shown in Fig. 11 and Fig. 12. It is merely necessary to connect the extended line section shown in Fig. 10, which has terminals *A'*, *B'* to *A* and *B* in Figs. 11 and 12.

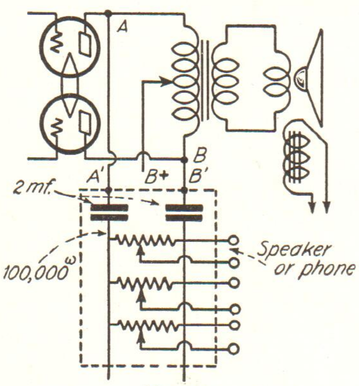

Fig. 10

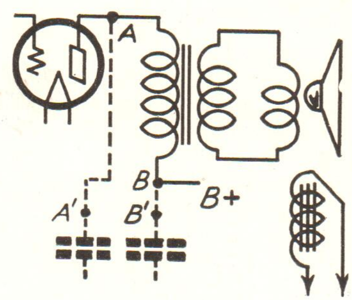

Fig. 11

6. HOW TO INSTALL TONE CONTROLS

Many customers would like to lower the tone of their radio receivers—the lower the better. Most of the new machines have tone controls built in, and many customers would like to bring their sets up-to-date by this addition. There is a very simple method of increasing the low frequency audio response by cutting down the intensity of the high audio frequencies. This particular phenomenon is thoroughly explained in the regular lessons of your course.

The addition of a tone control may have the disadvantage of bringing out any A.C. hum which might be present in the receiver.

Fig. 13 shows the method used when connecting the tone control to the output of a push-pull receiver. To make the desired addition, it is only necessary to solder two wires onto the grids of the push-pull output tubes. One wire goes to the variable resistor R_1 (500,000 ohms)—the other to a mica condenser C_2 (.005 mfd.). C_2 and R_1 are then connected together. The connection of these two lead wires to the two parts—namely, the resistor and the mica condenser—may introduce a howl into the machine if the new leads are run near the grids of the other tubes. This may be eliminated by properly placing the wiring so that it is not near the other circuits. You will have to experiment a little until the proper position is found.

R_1 may be mounted on the set panel and two which will cause hum. The same is true of the audio transformers and the speaker. If you suspect trouble of this type, try the speaker in various positions and at different angles with the receiver chassis. Sometimes a slight movement of the speaker or receiver chassis will eliminate hum caused by magnetic interaction.

15. ADDING A-B-C SUPPLIES TO BATTERY RECEIVERS

Any battery set may be made "all electric" by adding an A-B-C eliminator. The A eliminator must be a separate unit, while the B and C eliminators are made in one unit. The B eliminator supplies the C battery potentials. We may purchase the two units or construct them ourselves.

The most desirable type of B-C eliminator is one which will supply potentials up to 250 volts and as high as 100 milliamperes of current to any battery operated

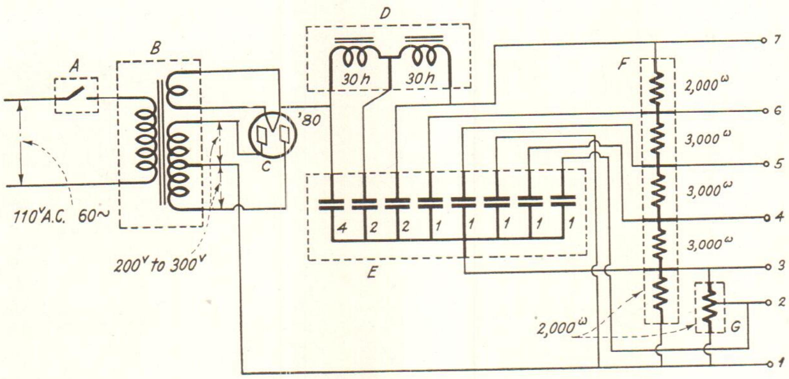

Fig. 25

receiver having up to nine tubes. Any smaller receiver may be supplied also. We recommend this B-C eliminator to you for construction.

A list of parts used in building the B-C supply shown in the drawing follows:

A. 1 line switch.
B. 1 power transformer.
C. 1 type '80 tube and socket.
D. 2 30-henry chokes (100 ma. capacity).
E. 2 2-mfd. condensers.
 1 4-mfd. condenser.
 5 1-mfd. condensers.
F. 1 13,000-ohm resistor with movable contacts.
G. 1 2,000-ohm variable resistor.
 5 feet of hook-up wire.

All of the apparatus may be mounted on a flat wood board measuring not less than 8 × 10 inches or the complete B-C eliminator may be housed in a metal or wood box, having a base of the same dimensions and at least 7 inches high.

Starting from the left of the picture diagram in Fig. 26, the transformer is shown in the upper corner. Following to the right at the top are the filter chokes. Filter condensers, arranged 4 mfd., 2 mfd. and 2 mfd., fill in all of the rest of the space with the exception of the resistor. The condensers may be obtained in one block if desired. The five 1-mfd. condensers may be placed at the end as indicated. The tube shown in the lower left corner should be placed as close to the transformer as possible.

The wiring of the parts is extremely simple and is shown in Fig. 25 and in Fig. 26.

The output terminals 1 to 7 should be binding posts or Fahnestock clips so that connections can be easily made to the receiver. There are 7 output terminals. Starting to the left of the resistor in Fig. 26, terminal 1 is the maximum C− terminal, the next is the variable C— terminal, the next is the B— terminal. Then there are 3 terminals for various plate voltages required by the receiver, and the last terminal on the right is for the power tube or tubes.

It must be pointed out here that all of the output voltages cannot be exactly correct for every receiver, because these voltages change when the receiver is connected to these terminals. This unit, however, is a standard unit and will furnish sufficient current for the average 1 to 8 tube receiver if the resistor contacts are moved one way or the other until a voltmeter indicates the desired voltage.

Tubes used in battery sets for radio frequency amplifiers almost invariably require $67\frac{1}{2}$ volts for their plate circuits, a great many require 90 volts, and some others even as high as 135 volts. The screen grid tube requires 90 to 180 on its plate, and from 45 to 90 volts on its screen grid. Detector tubes usually require 45 volts. Some detectors require $22\frac{1}{2}$ volts, but 45 volts can safely be used on them.

Under normal conditions terminal 1 will supply up to 30 volts negative potential, any part of which may be used by connecting to terminal 2 and a lower value of bias obtained by adjustment of the 2,000 ohm resistor.

Terminal 3 is the ground terminal, and is not intended to provide any potential but acts as the return terminal for all of the plate circuits.

Terminal 4 will provide 45 volts for operating any detector and also for the screen on a D.C. screen grid set. Tap 5 will supply 90 volts for R.F. and 1st A.F. plates and the 6th tap will supply the power tube with 135 volts. For a receiver using a '71 tube, terminal 7 is used instead of 6 and, in this case, 6 is connected to the first audio frequency amplifier plate lead. The grid return of the first audio frequency amplifier tube rarely ever needs more than $4\frac{1}{2}$ to 9 volts bias. This is provided by the slider on the 2,000 ohm resistor. A type '12 tube or '71 tube requires more bias than this, which is obtained from terminal 1.

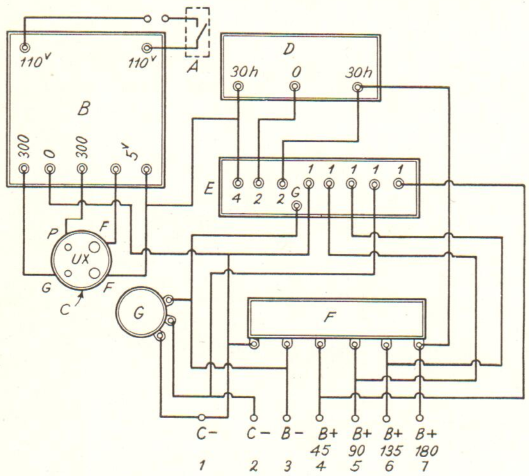

FIG. 26

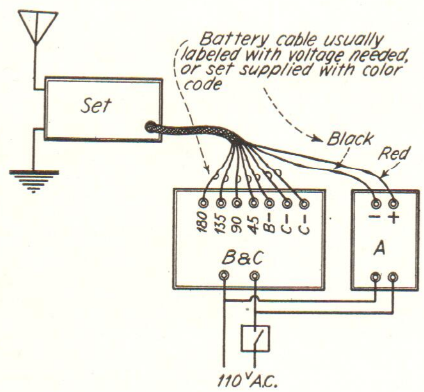

FIG. 27

A typical battery receiver correctly wired to the B eliminator is shown in Fig. 27. Notice that the A and B-C eliminators are wired to one switch.

The A eliminator is similar in many respects to the B eliminator. A transformer is required to reduce the line potential instead of increasing it, to the correct value (10 volts for all practical purposes); a rectifier to rectify the A.C. and a filter to smooth out the A.C.

A list of materials necessary to construct an A eliminator follows:

A. 1 power line switch.
B. 1 step-down transformer, 110 volts A.C. to 10 volts A.C. (5-ampere output.) (Bell ringing transformer, 75 watts.)
C. 1 full-wave dry disc rectifier.
D. 2 2,000-mfd. condensers. (Dry electrolytic type).

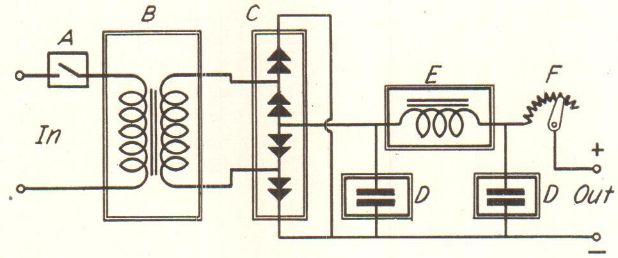

Fig. 28

E. 1 1½-henry choke (2½-ampere capacity).
F. 1 variable resistor, 10 ohms (5-ampere capacity).

The wiring diagram of this A eliminator is shown in Fig. 28 and the arrangement of parts is shown in Fig. 29.

The dry disc rectifier is made in the form of a set of discs with a bolt run through their centers, making electrical contact with each end disc. One end of the bolt provides the negative A terminal. The diagram shows that both ends are electrically connected. In practice the bolt itself is this connection. The positive lead is taken off the center point of the bolt and is connected to the filter circuit. The other two terminals on the rectifier are connected to the transformer leads.

The resistor is adjusted to supply the correct amount of current. From 1 to 8 tubes can be supplied with filament current through the use of a single A eliminator of this type.

There are, of course, only two output terminals shown in Fig. 28, in the arrange-

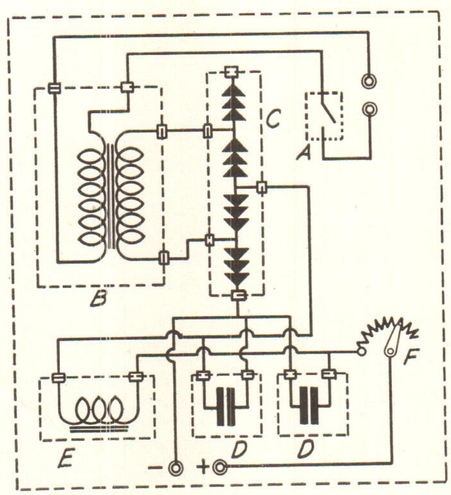

Fig. 29

ment of parts. Almost any arrangement will be found satisfactory, and one particular arrangement is shown for your help in constructing the device.

The A and the B eliminators may be mounted in the same compartment if desired, and they may be connected to the same line switch so that both of them may be turned on and off at the same time. This makes any receiver just like an A.C. receiver because the throwing of one switch will put the receiver in operation.

There are no batteries to run down or to be recharged, there are no liquids to spill or evaporate, and the only replacements necessary under normal operating conditions are the type '80 rectifier tube of the B eliminator and the dry disc rectifier unit of the A eliminator. It should never be necessary to replace either of these more than once yearly.

16. HOW TO REPLACE CHEMICAL RECTIFIERS WITH DRY RECTIFIERS

Chemical rectifiers used in trickle chargers and B eliminators have the disadvantage that they require considerable attention. The chemical solution and the electrodes need frequent replacing. It is also very difficult to keep the terminals of the units clean, as the chemical solution will "creep" and cause corrosion on the tops of the cells. If the solution happens to be spilled in any way, it will eat away the parts that it comes in contact with and will quickly damage any rug or furniture which it happens to touch.

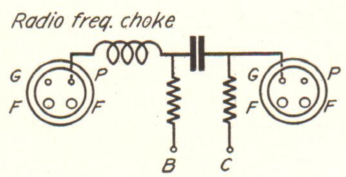

FIG. 30

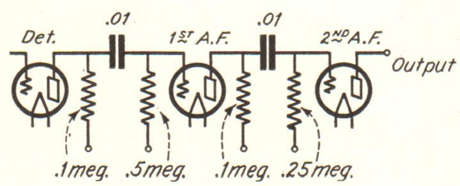

FIG. 31

When renewing the rectifying units in such types of rectifiers it is by far the best policy to use the dry type of rectifier. This rectifier has the advantage that, if properly installed, it will last considerably longer. It requires no attention and it will not cause injury to surrounding objects, since there is no liquid to spill out if the unit should happen to be tilted.

Various manufacturers make dry rectifier units specially designed for practically all types of trickle chargers, A and B eliminators. It is absolutely necessary to use those units designed for the particular model of charger or rectifier which you are repairing. These units can be obtained from any large Radio supply house at very attractive prices.

The units are easy to install. Generally it is only necessary to remove the old rectifying jar or jars and connect two, or sometimes three, wires on the new unit to the terminals on the charger or eliminator. In the case of trickle chargers the new dry rectifier ordinarily has two binding posts to which the battery is connected, just the same as the binding posts that were on the original charging unit. Complete instructions are always included with the replacement unit so that the Radio-Trician will have no difficulty in making the necessary connections. The two requirements to remember in making these changes are that the dry rectifier must never be overloaded and the unit must have plenty of ventilation so that it will not become too hot. If too large a current is taken from the rectifier, it will rapidly deteriorate and will not give the service life that it should. However, this trouble will not be encountered if the unit recommended by the manufacturers for the particular charger or eliminator that you are working with is used. The charger or eliminator should not be placed in a closed cabinet or box. The back of the container should always be left open so that there will be a free circulation of air around the unit.

17. MOTOR-BOATING AND HOW TO CURE IT

Motor-boating is a peculiar sputtering sound, often observed in receivers which are operated by battery eliminators. This trouble, however, is not confined to receivers operated in this fashion but occurs even in battery operated sets. It is called "motor-boating" because it resembles the "putt-putt" of a motor-boat engine. Motor-boating is really audio oscillation, and the frequency of re-occurrence may be anywhere from 2 to 30 times per second.

It is believed by many that resistance coupled amplifiers cannot be operated satisfactorily with B eliminators without motor-boating. This is not true, and the purpose of this chapter is to indicate ways and means of preventing this trouble.

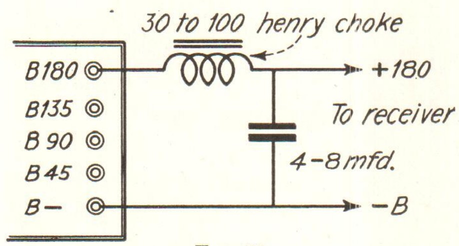

Fig. 32

Motor-boating should not be confused with the familiar 60 cycle A.C. hum, which is noticeable to a certain extent in all receivers that are operated from the power line.

Let us consider the causes of motor-boating. If the eliminator is poorly designed or defective, motor-boating will result. The use of small chokes or insufficiently high capacity by-pass condensers in the filter section will cause motor-boating. Defective resistors and slow leaking condensers (condensers not able to retain their charges) are another source of trouble. Fluctuating power supply, which is quite noticeable in smaller distribution systems, may also cause this trouble.

Now that we have listed the possible causes of motor-boating, let us see how it may be corrected. For fluctuating line voltages a glow lamp such as the UX-874 connected across the B negative and the B + 90 volt terminals which supply the R.F. tubes, will help to stabilize the plate voltage and prevent motor-boating.

Another effective remedy for motor-boating is to connect an R.F. choke coil in series with the detector plate and the plate resistor in the case of a resistance coupled receiver as shown in Fig. 30; and between the detector plate and P terminal of the first audio transformer, in the case of a transformer coupled audio system.

Substituting a 1 or 2 megohm resistor for the usual 0.1 megohm leak in the plate circuit of the detector also serves to reduce motor-boating. The proper values to use in a resistance coupled amplified circuit when using a high mu tube are indicated in Fig. 31.

Still another method of eliminating this fault in amplifiers is to connect a 30 to 100-henry choke coil and also a 4 to 8 mfd. condenser across the B negative and highest B positive terminals of the eliminator as shown in Fig. 32. A still better method is shown in Fig. 33, where a number of chokes of approximately 100-henry inductance are connected in series with each plate supply lead from the eliminator to the receiver.

We have a special treatment for motor-boating in the case of a superheterodyne receiver or receivers equally sensitive. In this instance, we make use of a separate B battery to supply the second detector plate voltage. It is true that the use of a 45 volt B battery prevents the receiver from being entirely operated from the power line, but in some instances we have to do this.

If, after trying the various "cures" already mentioned, we still do not overcome the difficulty, the fault may be in the receiver itself. Incorrect grid bias is a common fault and the receiver should be carefully gone over and all the biases checked. Correct C bias is especially important in the power stage. As a general rule, radio frequency and audio frequency tubes require a negative bias while a detector tube requires a zero or slightly positive bias. It is a good idea to connect a variable resistor such as a Clarostat in place of the bias resistors or in parallel with them so that proper adjustment of voltage can be made. Too much grid voltage is liable to cause motor-boating, and with the aid of the

Clarostat excessive voltage may be taken care of. See Fig. 34.

Another cause of motor-boating is a defective grid condenser which is not capable of holding its charge. A defective condenser may be determined by disconnecting it from the circuit, applying 45 volts to its terminals for a moment, disconnecting the battery and discharging the condenser through the headphones. A click will be noticed if the condenser is Okay.

Motor-boating may be caused by reversed primary windings of the first audio transformer. It may be that in the process of manufacture the leads from the transformer windings were incorrectly brought out to the terminal strip.

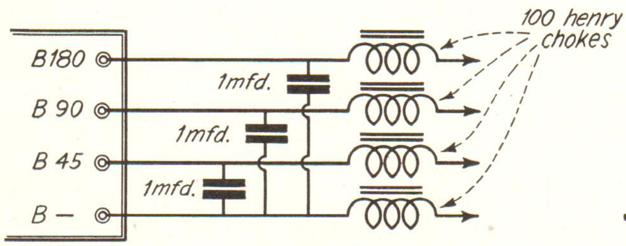

Fig. 33

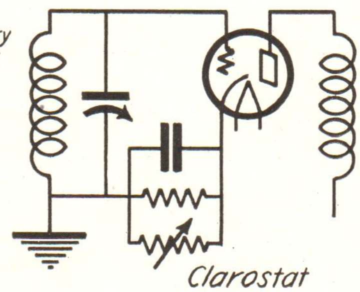

Fig. 34

18. HOW TO OPERATE ANY BATTERY OPERATED SET ON A 32-VOLT LINE

Many American homes are equipped with 32 volt farm-lighting plants. Such voltage supplies can be utilized to operate battery receivers conveniently and economically.

The entire filament voltage can be obtained and part of the "B" supply from these lighting plants. The voltage needed for the filaments of a normal battery set is 6 volts and the usual drain is 2 amperes. By a fixed or variable resistance connected to one terminal of the supply, and using the other end of the resistor and the other lead of the power supply, a suitable filament voltage is obtained provided the resistance is of the correct value. A fixed and variable rheostat can be used in series. It is best to use a low range voltmeter connected across the filament supply of the set so that the voltage may be correctly adjusted.

Fig. 35 shows all connections and parts needed for operating a receiver on the 32 volt line. The voltmeter is connected between A– and A+. All tubes should be in their respective sockets. Now turn on the switch and advance the rheostat arm until the voltmeter reads 6 volts. Never remove a tube from the set without cutting off the switch or the filament voltage will rise above the rated amount and burn out the other tubes.

Referring again to Fig. 35, as many "B" batteries may be connected to the B+ 32 volt line as are required. This figure shows three 45 volt "B" batteries used to give a total of 167 to 177 volts, which is enough to operate all types of battery operated power tubes.

If you wish to calculate the value of fixed resistances for any set—that is, to reduce 32 volts to the proper filament voltage—it can be done as follows: First, add up the filament currents of all tubes. Next subtract the filament voltage from 32 volts. Now, after obtaining the latter, divide it by the current drawn by the tubes. For example, suppose we have five '01A tubes and one '71A. Each tube draws 0.25 ampere. Six tubes would draw a total of 1.50 ampers. Subtracting 6 volts (filament voltage set is designed for) from 32 volts, we have 26 volts. $\frac{26}{1.5} = 17.6$ ohms approx. This resistance should have a power value equal to the current through it (1.5

amperes) times the voltage difference (32 minus 6). This is 26 × 1.50 = 39.0 watts. Therefore use a 50 watt resistor.

It is impracticable to use a variable resistor that will handle this amount of power, so for this reason it is advisable to use two resistors—one fixed, the other variable. Both resistors must carry maximum current. It is recommended that one-fourth of the total resistance be in the rheostat. In this case use a 15 ohm fixed resistor and a 5 ohm rheostat. Note that a variation from 15 to 20 ohms is possible.

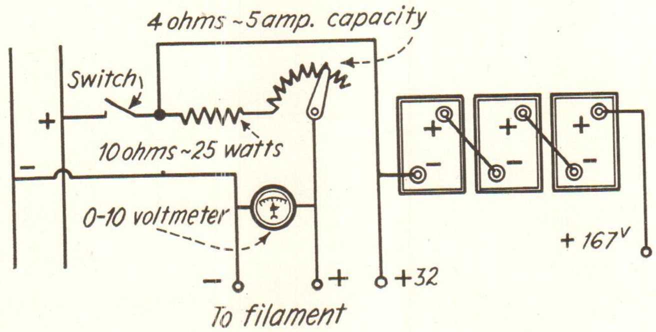

FIG. 35

19. ADDING A LINE BALLAST TO PREVENT OVERLOADING

A device to regulate line voltage to receiving sets is needed more than most people realize. Accurate measurements have been made on supposedly 110 volt lines over a period of twenty-four hours, and it was found that on some lines the voltage varied from 95 to 130 volts at different times of the day.

A resistance connected in one side of the line will overcome this in the case of a steady high line voltage; that is, if the set is intended to operate at 115 volts and checking with an 0–150 A.C. voltmeter shows that the line voltage is 120 or 125 volts. Many older A.C. sets were designed to operate on either 110 or 115 volts, and no special adjustment was provided. When a set designed for 110 volts is operated on 115^v it will be overloaded and the tubes and power pack will very likely be damaged. A 5 ohm-10 watt resistor connected in series with the line will take care of this. Or you may use special adapters manufactured for this purpose.* Always operate on the tap

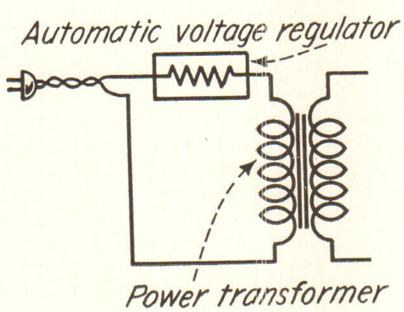

FIG. 36

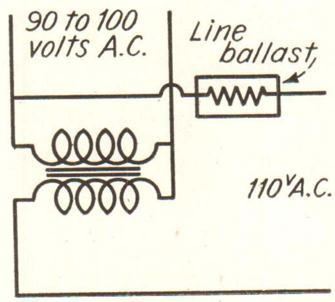

FIG. 37

* In most modern receivers a three-point switch is provided so that the set can be adapted for use on 100, 110, or 120 volts.

equivalent to the steady line voltage, or, if in doubt, at a setting above the rated line voltage.

In cases where the line voltage fluctuates continually, a device is needed that will change its resistance as the voltage changes so as to take care of overloading. Fortunately, several commercial regulators are available that in fact do change in resistance value as the voltage changes. These are called automatic line voltage regulators.

The current drawn by the receiving set determines the type of regulator to use on a given receiver. Manufacturers of these regulators (line ballasts) will furnish charts which specify the type of regulator to use with any receiving set. You will find the advertisements of these manufacturers in all radio magazines. The two best known devices go by the name of Clarostat and Amperite. Fig. 36 shows how these regulators are connected in series with one side of the line of the power transformer.

Where the line voltage is high at all times it may be reduced to 110 volts by the insertion of a line ballast as shown in Fig. 36.

Where the line voltage is always less than 110 volts and a low voltage tap to the power unit is not provided, the voltage can be built up by using a small stepdown transformer. In some localities the line voltage may be as low as 90 to 100 volts all the time. Should this be the case, a small variable step-down 110 to 20 volt transformer connected to the line properly will bring the voltage to normal value. Connect the transformer and line ballast as shown in Fig. 37.

20. USING DEFECTIVE AUDIO FREQUENCY TRANSFORMERS BY SUBSTITUTING IMPEDANCE COUPLING

A receiver which has become inoperative because of a defect in the secondary of an interstage audio frequency transformer of the conventional type can be made to operate by disconnecting the defective secondary winding from the circuit and by connecting a .01 mfd. fixed condenser from the grid of the tube to the plate end of the

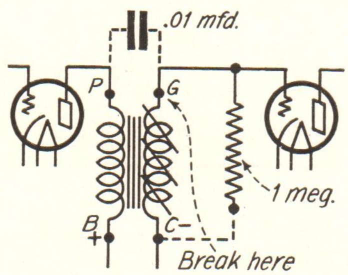

FIG. 38

primary. A 1 to 0.1 megohm grid leak is then connected from the grid to the portion of the circuit which originally connected to the C− end of the secondary. If you are sure that the secondary is open, it need not be disconnected from the circuit. Fig. 38 shows the method to use.

If it is the primary of the transformer that is open, it should be disconnected from the plate of the tube and from B+. Substitute in its place a resistance of 0.1 megohm and connect the B+ to 180 volts if it is in the plate circuit of an audio tube or to 90 volts if it is in the plate of a detector. A coupling condenser must again be used between the plate and the following

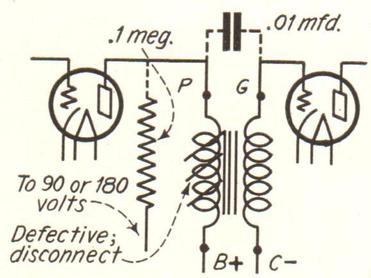

FIG. 39

grid. A condenser of from .01 to 0.1 mfd. will be found satisfactory. Fig. 39 shows the hook-up. A 30 to 100 henry choke may be used in place of the 0.1 meg. leak, in which case the connection to a different voltage is not recommended.

Repairs may be effected when only the secondary of a push-pull transformer is defective by using a 0.1 or 0.25 megohm grid leak between the grid and C— of each tube and by connecting two .01 mfd. condensers from each end of the primary to the grid of each tube. This is only used when the receiver has a high turn ratio transformer ahead of the first A.F. tube. The method is shown in Fig. 40.

All of these repairs decrease the amplification of the receiver but they do add to the tone quality, especially in sets in which poor transformers were used. In modern receivers the decrease in amplification would not be very serious. These methods may be used in emergency cases until new transformers are secured.

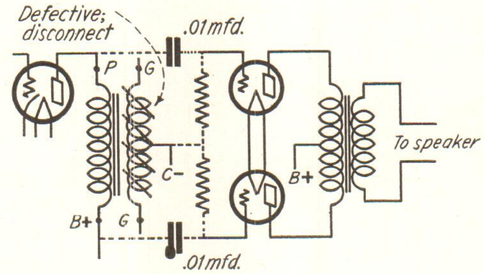

Fig. 40

21. HOW TO OPERATE 25 CYCLE APPARATUS ON 60 CYCLE CURRENT

Many owners of radio receivers designed for 25 cycle A.C. current move into localities where the only available current is 60 cycle. These people are usually told that their sets can't be operated on 60 cycle current and they are advised to purchase new sets. However, we are going to show you how to make the few minor adjustments needed to adapt a 25 cycle receiver to 60 cycle operation.

The first thing to do is to measure the line voltage. If it is very high—that is, between 115 and 125 volts—it will be necessary to place a resistance in series with the line.

The average radio receiver draws approximately ¾ to 1½ amperes. Current consumption, of course, depends entirely upon the design of the set. The resistance to be used in reducing the line voltage will be between 10 and 15 ohms and should carry 2 amperes. Ordinarily it is advisable to use a rheostat of this current capacity rather than a fixed resistor.

Place a low voltage A.C. voltmeter across the power tube filaments and adjust the rheostat until the voltmeter reads slightly under the rated value for the tube —about 4.8 for a '71 A. This adjust-

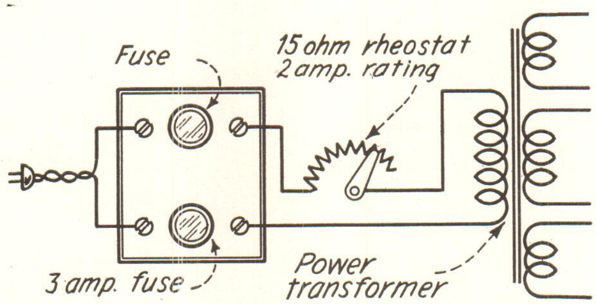

Fig. 41

ment may be made with the rectifier tube out of the set.

In cases where the line voltage is not over 100 volts, and the set has several input voltage taps on the primary winding of the power transformer, a series resistor in the line may not be necessary. This is because you can connect the input voltage leads to the 110 volt tap on the primary. This will serve to reduce the voltage so that it will not be excessively high for receiver operation.

It is because of the design of the power transformer that a reduction of input voltage is necessary when we operate a 25 cycle set on a 60 cycle line. Twenty-five cycle transformers have approximately twice as much iron in their cores as the 60 cycle transformers. Because of this there is less leakage and the secondary voltage is greater.

The chief difficulty in operating a 25 cycle set on a 60 cycle line is that, should a short occur in the secondary winding of the power transformer, the primary winding is very likely to burn out. It is wise, therefore, to place a double receptacle in the input circuit and insert 3 to 5 ampere fuses. Any overload will immediately blow the fuses thus opening the primary circuit. The complete circuit is shown in Fig. 41.

Where 25 cycle sets are operated on 60 cycle A.C. in the manner described above, it will be found that the set is decidedly free from hum. This is because of the design of the filter circuit, for larger chokes and larger filter condensers are used in 25 cycle sets than in ordinary 60 cycle sets.

22. HOW TO OPERATE 110-VOLT A.C. RECEIVERS ON D.C. LINES

In some of our older American cities, the electric current is D.C. People purchase A.C. receivers and often move to sections of the city where 110 volts D.C. is used. A.C. receivers cannot be used on this current and the owners are without radio reception or must trade in the A.C. set on a D.C. set, which would entail an expense they often do not want to incur. Also there are others in rural communities who obtain electric current from 110 or 32 volt D.C. farm-lighting plants.

Rotary converters are available to change D.C. current to A.C. current, which are reasonable in cost. Many service men are installing them so as to adapt A.C. receivers to D.C. line operation.

Converters can be purchased for as low as $49.50 list that will operate practically any A.C. receiver on the market. These are available to operate from 32, 110 and 220 volts D.C. at the same price.

It is a simple job to install one of these converters. Simply connect the D.C. line to the D.C. posts on the converter and connect the A.C. receiver to the A.C. posts. Then turn on the current of the D.C. line and the receiver is ready to operate. When a converter is used, the power input voltage to the receiver is controlled at the converter.

The switch which turns the converter off and on may be mounted and insulated on the receiver panel and wires run from the switch to the converter. The set is shut off by turning off the converter.

Fig. 42 shows a typical rotary converter. It has a filter built on the unit to filter out any interference caused by the operation of the converter.

Full information and prices concerning rotary converters can be obtained from most wholesale mail order houses.

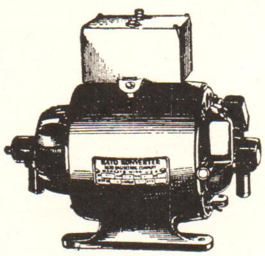

FIG. 42

23. INCREASING POWER OUTPUT BY CONNECTING TUBES IN PARALLEL

When more undistorted power is needed from a radio receiver or power amplifier which uses a single power tube, it may often be obtained by connecting another power tube, similar to the one already in use, in parallel with the original tube. We say "often" because we are not always sure that the power supply will furnish additional current without a drop in voltage. The following scheme is worth trying, and service men claim it is a good way of decreasing distortion. Do not expect to get louder signals; only expect clearer signals.

The type of circuit employed does not affect the hook-up in the least. Fig. 43 shows schematically how the connections are made. Four stiff insulated wire leads are connected from the contacts of the original socket (always a 4-prong socket) to another 4-prong socket.

The grid of the additional tube is connected to the grid socket terminal of the old tube. The new plate connects to the old plate and the filaments connect to the old filaments. When A.C. operated, the new filament leads must be kept as short as possible. If they are run any distance, the two new leads should be twisted together. If stiff enough wire is used, the new socket will support itself. A permanent installation can be made by mounting the extra socket on the chassis with connections made under the panel.

If you try this on a push-pull output, which consists of two power tubes, an additional socket will be needed for each. This scheme works well on battery sets and A.C. sets using low power output tubes, such as the '20, '31, '12A, '71A. Usually distortion appearing when '45 and '50 tubes are used can be traced to a defect in the set.

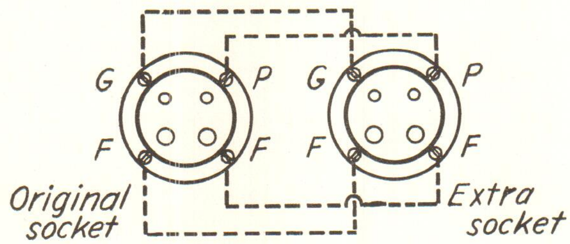

Fig. 43

24. SHIELDING SET FROM LOCAL INTERFERENCE

Shielding is used in receivers to accomplish two distinct purposes:

First, to prevent local interference from signals of nearby transmitting stations caused by the direct pick-up of the coils and the wiring of the set.

Second, to reduce the effect of interstage coupling between the radio frequency stages in the receiving set itself.

To accomplish the first result the receiver chassis can be placed in an all-metal box, thus efficiently shielding the set from local broadcast signals. Doing this is the only practicable way when the receiver is built in a large console cabinet.

In table model receivers, the same results can be obtained by lining the inside of the cabinet with 12 ounce gauge sheet copper, or aluminum, or, in fact, any non-magnetic material. Heavy tinfoil can be used for this purpose, although it is not as good as copper, which is the best material that can be used. The tinfoil should be securely fastened to the sides, top and bottom of the cabinet and also the panel.

If the shield consists of several different pieces, they should all be connected together and the entire unit connected to the ground binding post of the set. It is of course extremely important that the aerial and various battery connections, if it is a battery set, do not touch the metal shield in any way. Likewise, it is important that the different parts in the receiving set or on the panel do not make contact with the ground shield.

In order to prevent interstage coupling between the coils in a set it is necessary to place each coil in a separate shield. Shielding cans may be obtained from practically any large radio supply house. This scheme can only be used when the coils are small and not too close to any other apparatus. Quite often a small copper or non-magnetic metal plate can be placed between all the radio frequency coils and the shield connected to ground.

25. INSTALLING SIMPLE INTERFERENCE ELIMINATORS (CHOKES AND BY-PASSES)

The reproduction of the very best receiver made can be marred by interference. This interference may be in the form of a series of steady clicks or there may be just an occasional click. Again, it may be a loud steady buzz or hum. In some cases the interference is picked up by the aerial; in other cases it reaches the set through the 110 volt power line.

In section 2 of this book we learned how to erect antennas for minimum interference. In this chapter we are going to learn the part that filters play in interference elimination.

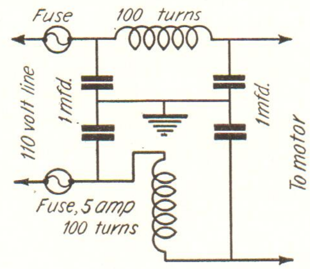

Fig. 44

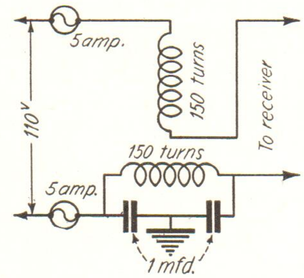

Fig. 45

utility devices—all may cause interference. Special filters are designed and made by several manufacturers to eliminate this interference.

A filter of this kind is nothing more than an arrangement of chokes and filter condensers. The chokes can be built up by the service man, in which case fairly large wire, not smaller than No. 16, should be used. The wire should be well insulated. Fig. 44 shows the type of filter that can be used on small motors. It consists of two coils and four condensers.

The coils are wound on a 2 inch form, with No. 14 or No. 16 wire—75 to 100 turns. The coils should be placed at right angles to each other.

The condensers are .5 to 1 mfd. each. A filter of this sort is most effective when shielded. It may be installed in a box of copper or aluminum, but the shielding must not touch the filter. This is to prevent short-circuiting.

First, we must make sure that the defect is not in the receiver itself. If the hum or buzz is loud and does not vary in intensity, a defect in the receiver is usually indicated. It will be heard with the aerial and ground disconnected from the receiver. If the noise is not present at all times and if other people in your vicinity get the same noise in their receivers, it is safe to assume that there is some outside source of interference in the locality.

If the source can be located, it is always best to install a filter directly at the source. Refrigerator motors, elevators, sewing machines, washing machines and household

In cases where the source of the interference cannot be located or corrected, and where it is definitely known that the interference is coming through the 110-volt line, a simple filter connected in the line will eliminate many of the clicks and ground leads to the broadcast receiver must be disconnected. If you use the converter shown in Fig. 46, connect the lead marked "antenna" to the antenna binding post of the receiver and the lead marked "ground" to the ground binding post of the receiver. If you use the converter shown in Fig. 47, connect only the lead marked *A* to the antenna binding post of the receiver.

Set the tuning dial of the broadcast receiver at some point where no broadcast station will be received. Use that portion of the dial where the set is most sensitive. In older sets this will be at the high frequency end. In the very latest sets sensitivity is practically uniform throughout the dial range.

If the broadcast receiver is of the type that will tune to frequencies slightly higher or slightly lower than the broadcast band, set the dial for less than 550 or more than 1,500 kc., depending on which end is the more sensitive.

To tune in short wave stations, rotate the tuning dial of the converter *slowly* until signals are heard in the loudspeaker of the broadcast receiver. Remember that a great deal more patience must be used in tuning to short wave stations than in tuning in broadcast stations as it is very easy to tune over a short wave station.

For best results and to eliminate the effects of hand capacity, the converter should be enclosed in an aluminum box. Or, if you prefer, line the inside of a wooden box with 12 ounce sheet copper and place the converter in this box.

Make sure that no portion of the converter makes contact with the shielding. The exceptions to this are that in Fig. 46 the negative side of the filament, at point *Y*, is connected to the copper shield, and also in Fig. 47, point *Y* is connected to the shielding.

No grounds are necessary with either of these receivers.

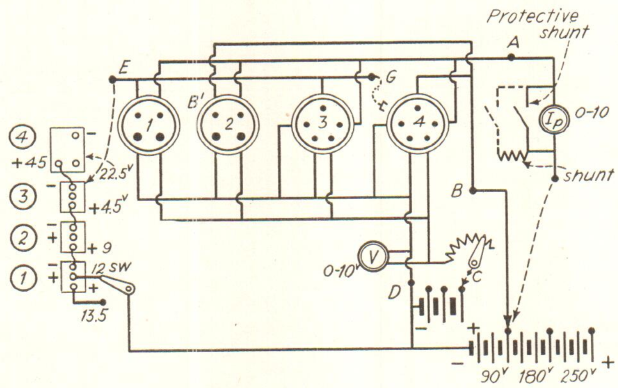

Fig. 48

27. A SIMPLE TUBE TESTER

There are a number of tests to be made on vacuum tubes about which you will learn in your main course. One test, however, and the test we are interested in here, is the "figure of merit test" usually referred to as the "mutual conductance" test. We aren't going to consider the theory of mutual conductance at this point, but we are going to learn how to make mutual conductance tests so that we can determine the value of a tube.

Every tube has a specific mutual conductance (g_M) which isn't difficult to measure. The average mutual conductance of a tube is given in the tube manufacturer's chart. If the measured mutual conductance is 25 per cent below the rated g_M, it is advisable to replace with a new tube.

The tester we are about to describe is totally battery operated, and is easily set up by a service man with the ordinary bench equipment. Every service bench should be equipped with a 6 volt storage battery, about four blocks of 45 volt B batteries and three 4½ volt C batteries, one of which should have a 1½ volt tap. In addition to these you will need two 4-prong socket bases, two 5-prong socket bases, a control grid cap for connection to screen grid tubes, a 0–20 ohm rheostat capable of carrying 2 amperes, a two-point switch and two meters.

You can use your own judgment in regard to the meters. Of course the better they are the more accurate will be your measurements. Yet for ordinary service work, simple inexpensive meters made by Beede or Readrite (sold by wholesale mail order houses for $.75 to $1.50) will do. A 0 – 10 milliammeter and a 0 – 10 voltmeter (both D.C.) are needed. You will also need three battery clips.

Mount all four sockets and the rheostat on a baseboard. Connect all the socket terminals as shown in Fig. 48 and bring their leads to binding posts *A*, *B*, *C*, *D*, *E*, and *G*. Note that the connection *G* is for the screen grid cap. The flexible wire should be long enough to reach socket 2 when testing battery screen grid tubes.

Connect the batteries as shown. The dotted lines represent flexible wires. All are provided with battery clips except the lead to the control grid of the screen grid tubes. In this way various voltages from zero to maximum can be obtained merely by changing the clip position.

Connect the milliammeter and voltmeter as shown. Also the two-point switch. It would be wise to put a shorting switch across the milliammeter, especially if you use an expensive meter. Then by closing the switch you can prevent excessive current flow through the meter. Always keep the switch closed, opening only when ready to read the meter. Then, if the meter reads off scale, close switch at once to prevent damage to meter. A shorted tube may be in the test socket.

When testing, every tube must have the proper voltage applied to the filament, across the filament and plate, across the filament and grid, and in screen grid tubes across the filament and the screen grid. These voltages are better known as the A-B-C and screen voltages.

Every tube is designed to work at certain voltages and as we want our measurements to indicate how the tube acts when in actual operation, measurements must be made at the operating voltages. Take for example, the '27 tube. The A voltage is 2.5, B is 180, C is 13.5 volts. Turn the rheostat so that all of its resistance is in the circuit; insert tube in socket; adjust rheostat until the voltmeter reads 2.5 volts.

Clip the B voltage leads to the 180-volt battery terminal and with the switch (S_W) on the lower contact, connect the clip from *E* to the upper end (–) of the third small C battery. This will furnish the 13.5 volt C bias.

The tube is now supplied with the same voltages it is supplied with in the set and the plate current should be about 5 ma. if the tube is normal. If the plate meter shows that the current is 20 per cent or more below 5 ma., the tube should be discarded.

This is a simple test but not quite as conclusive as the mutual conductance test. From a tube chart we see that the g_M of this tube is 1,000 micromhos with the above voltages (this is explained in the main course). Change the setting of the switch S_W from the 13.5 to the 12 volt C battery post. If the batteries are fresh and have never been overloaded, the C bias will decrease by exactly 1.5 volts. If there is any doubt about your batteries, check with a voltmeter.

Now read the plate current again and record it. The difference between this reading and the first reading is important—it is the change in plate current for a known change in C bias. The ratio of these two changes is the mutual conductance of the tube. Multiply the result by 1,000 to get the mutual conductance in micromhos.

Stated as a formula, this is:

$$g_M = 1{,}000 \times \frac{\text{change in plate current}}{\text{change in C bias}}$$

where the current is in milliamperes and the C bias is in volts and the B voltage is constant.

As a quick check, using the apparatus shown, the g_M will be 666 times the change

TABLE 1

Tube	Use Socket No.	E_f	Cells of a 6V Battery	E_p	E_g	E_{sg}	I_p	G_m
'99	1	3.3	2	90	4.5		2.5	425
'20	1	3.3	2	135	22.5		6.5	525
'30	1	2.0	1	90	4.5		2.0	700
'31	1	2.0	1	135	22.5		8.0	875
'32	2	2.0	1	135	3.0	67.5	1.5	550
'01A	1	5.0	3	135	9.0		3.0	800
'12A	1	5.0	3	135	9.0		6.2	1600
'71A	1	5.0	3	180	40.5		20.0* use a shunt	1620
'40	1	5.0	3	180	3.0		0.2	200
'22	2	3.3	2	135	1.5	67.5	3.3	480
'26	1	1.5	1	180	12.5		7.4	1170
'27	3	2.5	3	180	13.5		5.0	1000
'24	4	2.5	3	180	3.0	90.0	4.0	1000
'45	1	2.5	3	250	48.5		34.0*	2000
'10	1	7.5	3+1 dry cell	250	18.0		10.0	1330
'50	1	7.5	3+1 dry cell	250	41.0		28.0*	1800

* A shunt having a resistance one-third the resistance of the milliammeter will increase the range from 0-10 ma. to 0-40 ma. The meter manufacturers will give you the required information, or supply a suitable shunt.

in plate current in milliamperes. For example, if the current was originally 4.7 ma. and dropped to 3.3 when the C bias was reduced by 1½ volts, the difference will be 4.7 – 3.3 or 1.4. Then the g_M will be 666 × 1.4 or 932 micromhos. As this is within 20 per cent of 1,000 (the average mutual conductance) we can assume that the tube is O.K.

The data in Table 1 includes all necessary tube information for use with this type of tester, and shows how many cells of the storage battery should be used. When testing 7½ volt filament tubes, connect one 1½ volt dry cell in series with the 6 volt A battery.

28. REPAIRING BROKEN CONE SPEAKERS

The cones of magnetic speakers vary widely in shape and size, the material of which the cone is made, the manner in which the cone is held at its edge, and the manner in which it is attached to the armature at its apex. The cone may be circular, elliptical or egg shaped and the size may vary from a few inches to 36 inches. The material of the cone is generally special "Alhambra" paper. Common manilla paper specially treated to withstand atmospheric conditions is sometimes used for repair work.

Small metal or fibrous, circular or star shaped clamps are generally glued with some kind of moisture proof cement to the apex of the cone. The pin attached to the armature unit is generally threaded at the free end and is held to the apex of the cone by a small nut. See Fig. 49. This sometimes becomes loose and will cause the signals to be very distorted. The apex of the cone should be very thoroughly fastened to the armature. In making this adjustment see that the cone does not exert any pressure on the armature; the armature must be perfectly free to move easily. On some speakers there is a screw adjustment which may be turned slowly back and forth until the best response is obtained.

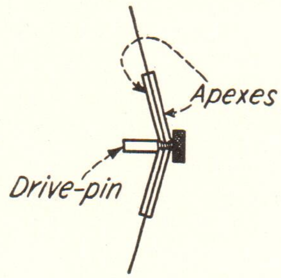

FIG. 49

Poor, weak or no response from the speaker is often due to the weakening of the cone at its apex. The best remedy for this is to strengthen the center of the cone by means of a collodion solution. This is a liquid solution which can be obtained from any drug store and which should be freely applied to the cone immediately around the apex. Or a small cone can be cut out of manilla paper and cemented inside and outside of the metal apex. Allow to dry thoroughly before testing speaker. In drying, it will stiffen the center apex of the cone and bring back good performance of the unit.

As the material of the cone is fragile and as the paper is usually very thin, it damages very easily and holes may be punctured in the cone. A complete replacement of the cone is expensive and troublesome. If the damage is not too great, the hole may be mended by carefully cementing a small piece of paper over it. By using good Dupont or Ambroid paper cement, and care in patching, the damage can be fixed up and the cone will sound as good as new.

It sometimes happens that the paper cone will become dented. Even though this dent is very small it may cause distortion on certain notes. The dent can be smoothed out by very carefully holding the dent over the steam coming from a tea kettle. Care must be used in doing this, however. Only the paper immediately around the dent should come in contact with the steam and then only long enough to become slightly moist and hot. Do not let the paper become wet. As soon as the paper is moist and hot, it can be very carefully smoothed into its original shape. Do not allow the steam to come in contact with any portion of the speaker which is glued together. If any portion of the speaker that is glued becomes loose, it may be reglued with Ambroid cement.