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How to Wire Your Hook-Up

Kinks that Sharpen Tuning and Increase Your Range

By HORACE V. S. TAYLOR

THERE are two big problems in building a radio set. The first of these is what sort of a hook-up to use. Of course, part of this last question is answered at once by your bank roll. We do not advise building an eight tube superheterodyne if you have only $7.50 to spend on parts.

But after you have got some idea of the number of tubes you are going to have, there is still the question of which way to connect them. If you have followed the advance of radio for the last year or two you will know that there are a few good hook-ups and about 3952 variations on them which are not as good as the original. There are some very good reasons for the magazines continuing to publish a lot of foolish circuits.

Why the New Hook-ups?

One of them is that the public wants a lot of new hook-ups and so the radio editor sits down in his private office and tears off a few. Another excellent reason for the new schemes is that many of the editorial writers are heads of companies manufacturing sets, and it is a very inexpensive way of advertising to crack up your own set in the article which you write and then collect money for it from the publisher.

When you have finally made up your mind what kind of a set you mean to build there is still the question of putting in the wire. In a general way this may be obtained from published details in the better radio journals. For instance, see the "Hook-up Number" of RADIO PROGRESS (January 15, 1925) containing fifteen worth-while hook-ups which have been in use for a long while and have been found by the radio fans to produce good results.

Laying Out the Parts

Such diagrams usually do not show the exact location of every unit. As a matter of fact, it is probably better that they do not. If you are building your set it is for one of two reasons. Either you are doing it for the pleasure and enjoyment which you get from "rolling your own," or else you wish to save money and so assembled it yourself instead of paying a factory to do that work.

Fig. 1. Sharp Bends in Arrester

If you are going into this construction work for the pleasure of creating something, then there is infinitely more satisfaction in arranging the parts and laying out the connections and units, than there is of making a Chinese copy of some other person's design. And if you do it to cut down the cost, it will be much cheaper to follow a general plan or hook-up than it is to copy line by line and wire the diagram drawn by some interested person who has parts to sell.

How the Units Vary

Take for instance, such a simple thing as an audio transformer. Some manufacturers bring the leads out at the side and some at the top. The primary connections will be at the left in some makes, while in others they will be located at the front and rear. It is impossible in making a sketch of the wiring of a set to show exactly how these leads go unless the particular brand of transformer is specified. And in following such a diagram the builder must buy the same kind of unit if he wishes the leads to be correct. That is where the factory man with an axe to grind gets in his deadly work. He will show a picture of a transformer with the primary leads at the bottom and the secondary at the top and tell you to buy "Blink's Best Bargain" transformer. Since you are following this construction you will have to invest in Blinks, even though it may not be a very good unit.

The best way out of this difficulty is to use hook-ups which show that one side of the primary of the transformer goes to the plate of the detector tube and the other side to the "B" battery. This information should be enough for you. You are now ready to put on your thinking cap and knowing that a straight line is the shortest distance between two points you are ready to run a wire as described.

Knowing How in Wiring

If you decide to follow this "intelligent" method, rather than the "copycat" scheme, it will be well for you to know some of the tricks of the trade and the wiring kinks, which will add miles to the range of your set.

In the first place, it is necessary to use lots of wire in a wireless set. There is a choice of bare, spaghetti covered or ordinary insulated conductor for hooking-up the various parts. Furthermore if you wish to use insulated wire there is a choice between the solid copper center and the stranded or braided

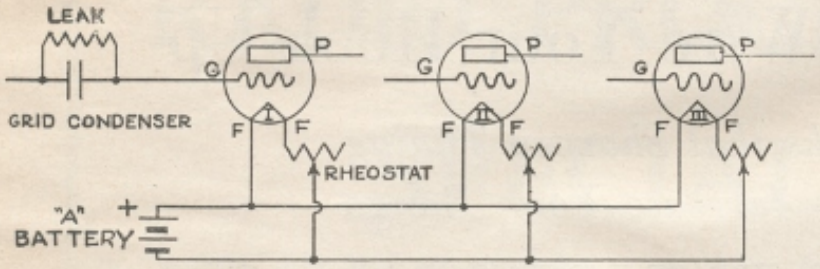

Fig. 2. Individual Rheostats Control Each Tube

cable, which is quite flexible. After you have done considerable wiring on a set you will agree with the manufacturers that solid wire is the only thing to consider. It will stay put when you have once bent it to shape, whereas the stranded cables are so very flexible and easily bent, that they quickly lose their shape and flop all around the set.

Whether to use insulated wire or not is a problem. Cotton covered magnet wire makes a very good connection. Some people object to it for one reason or another, but when you think that all your coils are wound of this material, it seems foolish to claim that a few extra inches in addition to the several yards in the coil will make any electrical difference in the set.

Busbar For Looks

The chief objection to ordinary magnet wire is that it is not very stiff. Of

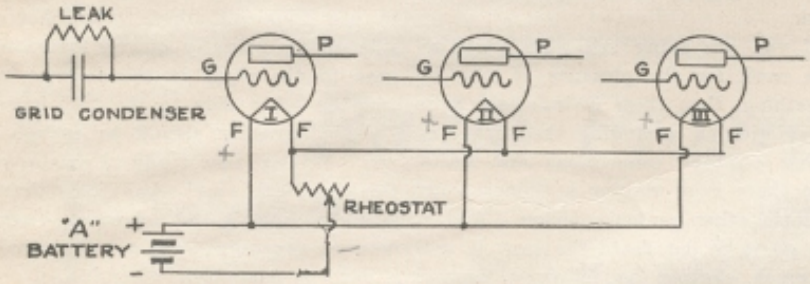

Fig. 3. One Rheostat Does the Work of Three

course, you can get such conductors up to very large sizes, but they are not usually used and are quite difficult to obtain. It is a better proposition to use a stiff heavier wire like busbar. This stays put and also looks very much better than the flimsy stuff which will not keep a straight line. When you are buying such busbar it is well to bend a piece in your fingers. If it is too stiff it means that the copper in it is not pure, and the resistance will be higher than it should be. Also it is difficult to make nice looking bends if the wire is too hard.

There is a choice of either round or square wire. The round is considerably easier to work with as no attention has to be paid to prevent twisting. For that reason many builders are using this style. A tin coating is a good thing on the outside of the bar, as it makes soldering very much easier. Of course, such a conductor has somewhat higher resistance because the high frequency travels mostly in the outside surface, (skin effect). The resistance of the connections is so low, however, that even if it were doubled it would still be lost in the shuffle.

The tinning on the wires makes solder stick fairly readily and so aids in making good joints. According to Hoyle, no soldering flux should be used, except resin. There are, however, two or three liquid fluxes on the market which are powerful enough so that you can solder to iron or steel and yet are really non-corrosive. As a test a bunch of No. 40 copper wire (which is much finer than an ordinary hair) can be dipped into the flux and allowed to dry for weeks and still show no corroding. With such a flux it is safe to speed up the operation of soldering.

Care should be taken that neither flux or resin flows over a surface which is supposed to be an insulator. For instance, it would be very bad to allow any flux, no matter how non-corrosive, to get on the insulation of a low loss condenser. Such a substance is partly conducting and would act like a high resistance short circuit between rotor and stator plates. The condenser would be "low loss" no longer.

Bending the Wire

Another well advertised point is that sharp bends in a wire are dangerous. This is all wrong. If you use a pressure of 75,000 or 100,000 volts, you will find that points or sharp bends allow such a concentration of pressure that

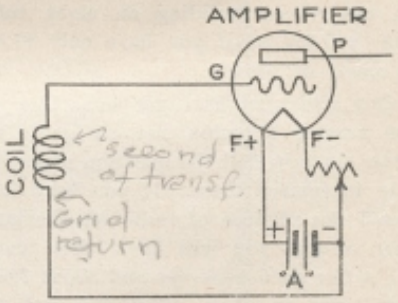

Fig. 4. Amplifier Grid Return

electrical leakage into the air will occur. Such high voltage power line will sometimes at night be seen to give off a bluish haze at sharp points or bends on the wire. For these tremendous pressures, it is necessary to use large radius curves.

When we come to the radio set with pressures under 100 volts, (under 1/1000th of a volt for radio frequency currents) then such effects absolutely do not exist. The sharpest needle point will not cause any losses at all.

When a fire engine is pumping water at high pressure through a fire hose, spectators are usually warned to keep away. If the hose should burst the high pressure might injure them. On the other hand, when a child is blowing soap bubbles it is foolish to think that the pressure through the pipe as he blows is likely to do any damage.

The same thing applies to the difference in pressure between 100,000 volts and 100 volts. The moral is bend your wire just as sharply as you like to make a good looking job.

Horn Gap Arrester

This principle of sharp bends is used in one of the simplest lightning arresters. Two large copper wires and bent sharply into horns as shown in Fig. 1. One of these is connected to the high voltage line, which will carry energy

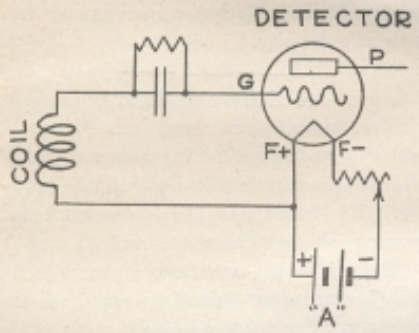

Fig. 5. Return of Detector

for perhaps hundreds of miles and the other is grounded. The spacing between the two horns is made great enough so that with ordinary voltages on the line no current passes. However, if a stroke of lightning should occur, so that the pressure increases to a point which might damage the line, then an arc will strike across the gap to the grounded terminal and this will pass the surge of pressure safely to ground without breaking down the insulation of any electrical apparatus.

The sloping, or upper part of the horn, is used to break the arc after it has been formed. Hot air tends to rise as you know when you examine an ordinary chimney. The powerful current jumping across the horns heats the air and this rising breeze blows the arc up the wire and so keeps increasing the length of the arc until it gets so long that it breaks and so is extinguished. But as already explained such an effect occurs only when the pressures are thousands of times greater than what you find on a radio set.

Omitting the Rheostat

Next let us take up the question of how many rheostats to use. Many diagrams, particularly the older ones, show as many of these units as there are tubes. Of course, such a hook-up will work perfectly, but you have considerable complication and expense in the wiring and also the set becomes so much harder to operate. The first tubes that came on the market a few years ago were very critical in their adjustments and were not at all uniform. That meant that each particular one had to have its own special voltage if it were to give the best results. Of course, in such a case individual control was necessary. The modern tubes on the other hand, are very much better. They are now built in such a way that there is a large factor of safety in the operation. An amplifier tube, designed for five volts, will work well all the way from four to six. Of course, when the pressure is run up above the rating, it shortens the life considerably, so it is an advantage not to exceed this figure. However, the potential may be dropped off by as much as 20% without causing any serious loss in the reception. With such a wide latitude it seems foolish to talk about the need for vernier rheostats on amplifiers.

A soft detector tube like the UV-200, is somewhat more critical. Even here, however, a variation of 10% may be endured without any trouble being heard in picking up the program. Since the latitude for the amplifier is so very broad, exceeding that of the detector, it is certain that when the latter has a rheostat adjustment which makes the voltage fall within the detector range, it will certainly be inside the correct amplifier band.

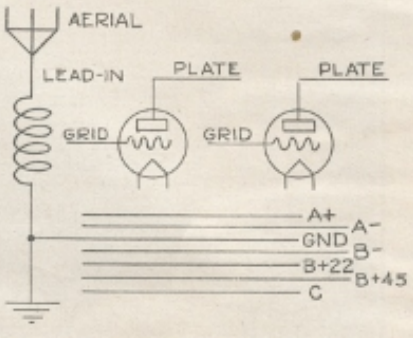

Fig. 6. These Wires Are Bunched

Changing the Hook-up

For that reason it is well to change a hook-up which calls for so many rheostats. Fig. 2, shows a typical wiring diagram for a three tube set using three rheostats. The grid and plate connections are not shown, as this discussion will apply to *any* kind of a set. Notice that the rheostats are shown in the negative side of the "A" battery. This is the better method of connecting them in case they are all used. However, if your hook-up shows them in the positive side the method of cutting their number down to one will be just the same. Fig 3 shows how the filaments are re-connected, so that they

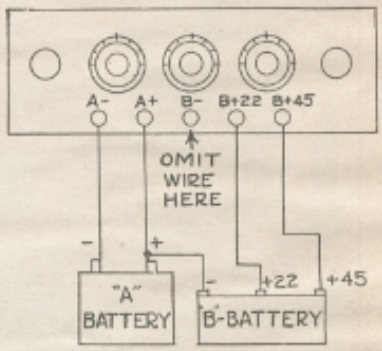

Fig. 7. Omitting the "B"— Wire

will all be controlled by a single unit. Here again this unit is in the negative line.

This is so that the proper grid or bias voltage may be applied to the amplifiers by connecting the grid return, which is one of the output terminals direct to the "A" minus. This allows the — voltage drop through the rheostat to be impressed on the grid.

The connections for this re-design are very simple. First hook-up the "A" battery, rheostat and detector tube in the usual way. If your set is already wired, then there will be no change so far. Now run wires from each of the other tubes so that the filaments of all three are connected together. It does not make any difference whether the terminal, which is sometimes marked F+ on the socket is actually the plus or not. In other words, the filament terminal, which is at the right of the grid, may be either plus or minus without effecting the operation of the tube.

No Laziness Here

By this connection you will see that one rheostat does the work of three. So you have saved two of these units, a lot of wiring, and also made the set so much easier to operate. The brightness

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Rx DR RADIO PRESCRIBES.

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

Question. To pick up some stations, I have to turn the variable condenser entirely out, so that the plates are separated. Does that mean that the coil or condenser should be changed, and should it be made larger or smaller.

Answer. If the capacity has to be turned as low as possible (to zero on the scale) it means that the coil is too big. Usually fifty turns on a 3½-inch tube or sixty turns on a 3-inch tube with wire about No. 22 or No. 24, will be found plenty big enough. By taking off ten to twenty turns from your coil you will have to adjust the condenser so that the plates interlock or mesh part way to pick up the same station. This will give you room to turn it down to get the higher frequency (lower wave length) stations.

HOW TO WIRE YOUR HOOK-UP

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of all the tubes will rise and fall together and if one is right, they are all correct. The rheostat may get fairly hot, since it does all the work, but unless it reaches a temperature where it will carbonize a piece of tissue paper, there will be no trouble on this account.

Fig. 4 shows better how the grid return from the amplifier must be connected to get the best results. The plate circuit does not appear, since it has nothing to do with this connection. The coil attached to the grid will be the secondary of the transformer. This will represent a step of either radio or audio amplification.

The end of the secondary opposite the grid is called "the grid return." It is shown connected to the "A" minus and separated from the negative end of the filament by the rheostat. That is how the drop in voltage is applied to the grid.

Such a connection is not right for a detector. No negative bias is needed here. The grid return from the detector (Fig. 5.) comes from the coil, which will be the secondary of a radio frequency transformer provided such is used ahead of the detector, or else it will be the stator of a variocoupler, which is used as the tuner. This grid return is not run to the "A"— but to the *plus* terminal of the filament. This connection is correct for every kind of tube in any hook-up. That is why it is better to use it, and then if later on you want to change the kind of tube you use for detector it can be done without any alteration of the hook-up.

Those Parallel Wires

All directions say that wires in a radio should not be run parallel and close together. This is wrong as applied to some of the leads. Wires which carry radio frequency which oscillates about one million times per second (1000 kc.), should be kept away from other metal as if they are close together they act like plates of a condenser and a lot of the energy is lost. But the direct current lines, like the "A" and "B" battery wires and the low frequency or audio conductors are not affected by these small capacities.

Indeed in many hook-ups you will see a large capacity like a .1 mfd. condenser connected between certain pairs of these wires. How foolish to increase this capacity to a large amount and then make sure it is as low as possible. Fig. 6 shows a grouping of all the wires, which may be run parallel and so that they all but touch without causing any trouble at all. But notice, that the aerial and the grid and plate connections are kept far away from them.

Omitting the "B" Minus Lead

The negative side of the "B" battery will work equally well when connected to either the plus or minus side of the "A" battery. But when hooked-up to the "A"+ the voltage on the plate will be slightly greater than when the "A"— is used. For that reason it is usually shown with a wire connecting "A"+ and "B"—. Such a connection may be made outside the set, if the two batteries are placed together on the floor. Run a short wire as shown in Fig. 7, and then the "B"— lead may be omitted entirely. Two pairs of lamp cord will then take the place of five wires running to the batteries. Of course, if only two terminals of the "B" battery are used instead of three as shown, then three wires will do the entire trick.