Bus Wiring 1920's Battery Sets

A Tutorial by Gordon Symonds

For those of us who enjoy the radios of the '20s, there is noting nicer than a hand-wired battery set in an elegant mahogany cabinet with a polished bakelite front panel. The use of solid bus wire and black insulated tubing lends an air of distinction impossible to obtain with stranded hook-up wire.

Often, these radios are in very bad condition when acquired, and require partial or full rewiring in addition to the usual cabinet and panel restorations. While rewiring such a set with bus wire requires a not inconsiderable amount of work, it is a skill which is easily teamed and is quite enjoyable.

The simplicity of the early circuits, with their low component counts, means that the number of individual wires in a set is not excessive, although some multi-stage superhets can require a fair amount of work. The final result of such an effort will be a set in which the owner can be justifiably proud.

Materials Required

The 'special" tools required for bus wiring are inexpensive and few in number. To get started you will require the following:

- a set of cutters for the bus wire. These should have a shearing action to ensure a square-cut end for the wire (regular side cutters, which result in a cut like Fig. IA are not suitable). A good, inexpensive tool to accomplish shear cuts is the wire stripper listed below. The resulting cut has a square end, as in Fig. lB.

- a set of heavy duty (solid bus wire is hard to bend!) wire bending pliers with smooth, round jaws. The jaws should be tapered (have a variable diameter along their length), with a range of diameters to suit screw sizes from about #4 - #10.

- accurate, flexible steel, narrow, measuring ruler. A miniature steel tape measure with a width of 114" or so is excellent for this purpose.

- a small steel square, with a blade length of 4' or so. An accurately cut piece of rigid metal about 3" x 4" will also work for this purpose.

- a small V-shape file

- a single-edged razor blade (best) or small pair of sharp scissors

(OK) for cuffing the insulated tubing.

- a set of bending jigs. These will be made up as required from the bus wire.

- a good soldering iron of about 50 watts. The Weller constant temperature TCP series is excellent

- bus wire and insulated tubing. To wire or rewire a radio, you will use a lot of material, so be sure to estimate lengths conservatively.

- two soft wood blocks (preferably pine)

- rosin core solder some small tywraps

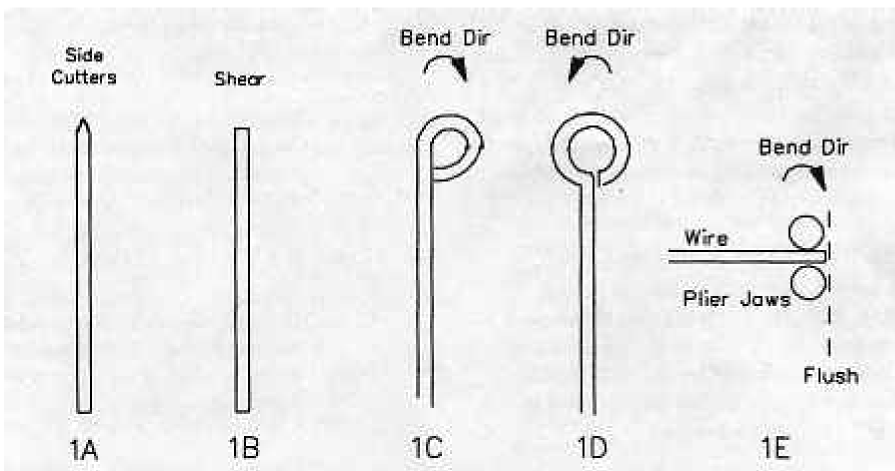

Figure 1. Cutting Wire and Forming Eyelets

<u>A Word About Accuracy and Neatness</u>

In this work, ACCURACY and NEATNESS are all-important. These concepts are related.

ACCURACY: When using 12 or 14 ga solid wire, the is very little room for error, as there is virtually no "give" in the wire to compensate for even small mistakes. Even if one could "force" the wire to compensate for inaccuracy, neatness would almost certainly suffer. Further, the wire is stiff enough to damage components if attempts are made to force it where it doesn't want to go.

NEATNESS: The human eye is relatively tolerant of some anomalies, such as absolute sizes or distances. It is, however, excruciatingly sensitive to others, such as parallelism and end-on alignments.

It is precisely the latter which can make or break the final appearance a bus wiring job. If two adjacent wires are not parallel, or a right angle bend is a bit out, the human eye will register it instantly. This work takes time and cannot be rushed. Like any other learned skill you do get better as you go along. It is quite rewarding and can be done a few wire runs per evening over a period of time.

One interesting side effect of doing your own bus wiring is that you develop a very critical eye for the workmanship on other sets. In general, the work done by home-builders, and even some manufacturers, in the 1920's was not of a very high standard!

Types of Bends

There are three basic bends in bus wiring: the angle, eyelet and crimp. The angle (usually 90) is used to change direction, the eyelet is used under screw heads and for tee wire joins. For both of these bends, jigs are required to ensure the right angle or eyelet is accurately located. The crimp connection comes in many forms and will be mentioned later

An eyelet takes two bends, the first as in Fig. 1C and the second as in lD. For the first bend, the wire should be gripped so that it is flush with the edges of the plier jaws, as in Fig lE, then make the bend as in 1C. The direction of the bend is important - it should be clockwise so that tightening the screw head does not tend to open up the eyelet when the screw is tightened. To make the second bend, rotate the pliers 180 degrees inside the eyelet. regrip the wire and bend slightly in the counterclockwise direction to form a symmetrical eyelet. Make sure that the joint is tightly closed after each bend.

It is difficult to give any general description as to how to do crimped connections (as to component tugs, etc.), but be careful to ensure that they are neat, mechanically strong and have a good appearance. For appearances sake, the wire should approach the lug on its centre line. A typical crimp connection is shown in Fig 2.

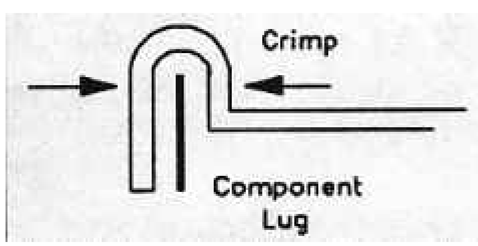

Figure 2. A Typical Crimp Connection.

Before doing any wiring, there are a few things to get out of the way

Calibration of the Bending Pliers

The jaws of the wire bending pliers must be permanently marked so that bends will be accurate and consistent. The object here is to locate the positions on the tapered plier jaws where the wire must be held to obtain consistent "inside" bend radii suitable for common machine screws. Some antique wire bending pliers were actually manufactured with "stepped" jaws, but I have never seen one of these except in a 1922 magazine ad. You will need a sample machine screw in each of the sizes you intend to use, usually #4, #6, and #8. For each screw size and wire size for which you wish to bend eyelets:

- estimate where on the plier jaw that the wire should be placed to give a circle which will just slip over the machine screw, and make a mark with a fine pencil.

- bend an eyelet as above and check the fit with the machine screw. This should be an easy slip fit, but not too loose, as the appearance will suffer.

- If the eyelet is the wrong size, cut it off, make a new pencil mark on the plier jaws and bend another.

- repeat this process until accurate eyelets are obtained consistently. Once this is accomplished, using the file to make a fine, permanent reference mark on the plier jaw. This mark should be filed deep enough so that you can just feel it as you slide the wire over the plier jaw.

- To make the mark more visible, fill it with white lacquer stick. The final result is illustrated in Fig 3.

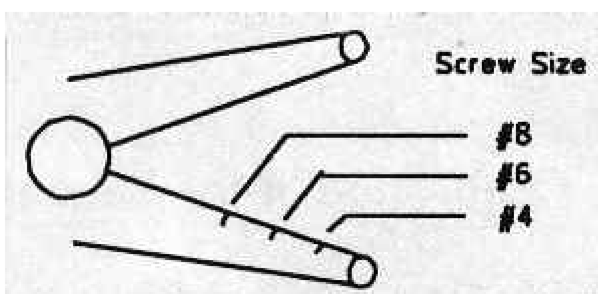

Figure 3. Plier Jaw Marking.

<u>Making Up Eyelet Bending Jigs</u>

The amount of added wire required to form an eyelet depends on the radius of the hole and the wire gauge. If an eyelet is to be formed at the end of a wire run (ie one end is already fixed), the wire must first be sheared to the correct length and then the eyelet formed. The purpose of an eyelet jig is to permit accurate determination of where to cut the wire so that the formed eyelet will end up in the right position at the end of the wire. If the location is not accurate, the wire run will have to be redone. To make an eyelet jig (one required for each eyelet and screw size):

(1) Cut (shear off square) both ends of a piece of wire about 3" long.

(2) File a fine reference mark on the piece of wire exactly 1.00" from the end on which the eyelet is to be formed.

(3) Bend the eyelet for the screw size using the correct position on the jaws of the "calibrated" pliers.

(4) Measure the distance between the centre of the eyelet hole and the reference mark from step (2). Subtract this measurement from 1.00" - this is the amount of extra material required to form the eyelet on the end of the wire.

(5) File a file reference mark on the wire, exactly the distance determined in step (4) from the wire end opposite the eyelet, and fill with white lacquer stick. The eyelet thus formed is handy to identify the jig and to hang it up on a small board. One eyelet jig will be require for each wire size and machine screw size. Test the jig by bending a few eyelets as below.

Making Up Right Angle Bend Jigs

The thickness of 12 and 14 ga wire is such that it must be taken into account when making 90 degree bends. In bending angles, select one bend radius that you like from those marked on the jaw of the bending pliers and use it consistently. A right angle bending jig can be used to accurately indicate where the wire should be gripped so that an accurate right angle results. The jig is used to indicate the distance before the bend that the wire should be gripped.

To make an angle jig (one required for each wire size):

(1) Bend an eyelet into one end of a 3" piece of wire (to hang it up!)

(2) Make a reference mark in pencil about 1/8" from the end opposite the eyelet Bend a right angle as described below. If the centre line of the wire does not fall on the intended path, adjust the mark and try again.

(3) Once the reference mark is correct, mark the jig with the file.

This completes the tool kit. Next, we will look at how to use the jigs we have made up.

Bending Eyelets and Angles

Bending an eyelet at the end of a wire run:

> (1) Accurately mark on the wire (with pencil) the location of the centre of the screw head which is to receive the eyelet. See Fig. 4.
>
> (2) Align the reference mark on the jig with the pencil mark from (1), and make a second pencil mark flush with the end of the jig on the wire to he cut. Cut the wire and bend the eyelet as already described.

Making a right angled bend along a wire:

> - Accurately mark the wire at the centre line of the new path. See Fig. 4.
>
> - Align the end of the jig with the mark from (1), and make a second mark on the wire to be bent at the jig reference mark. Grip the wire at this second point and make the bend.
>
> - Check the accuracy of the bend angle with the small square and adjust as required.

The above will work equally well with square bus wire if you are fortunate enough to find any!

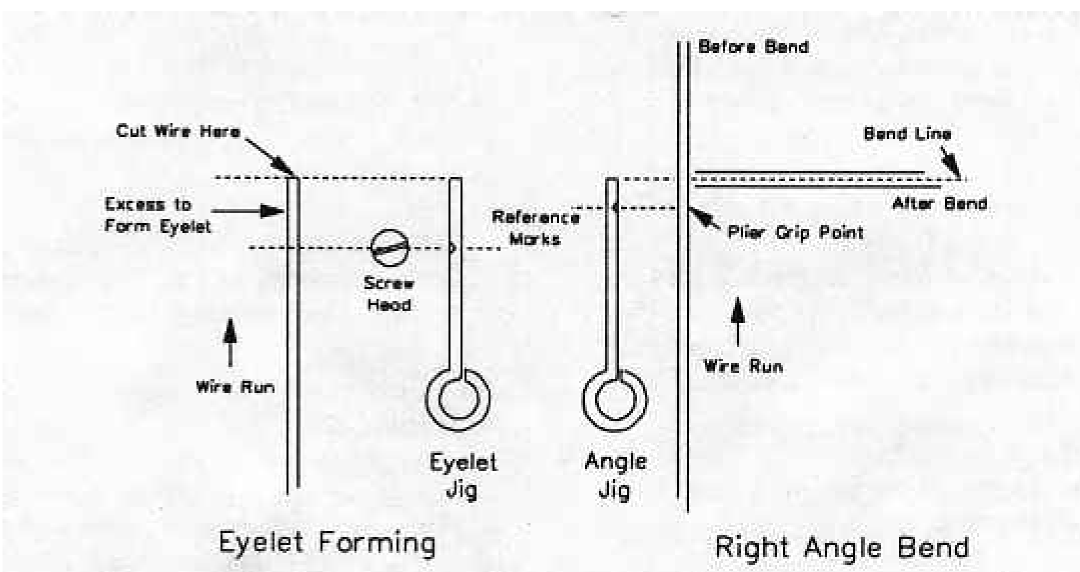

Figure 4. Using Wiring Jigs.

Getting Down to Work

After the above preparations, it is time do some actual wiring! Before starting a wiring job, a little planning will be helpful. This will require research to determine the correct appearance of the original set (many sets have suffered the indignity of several amateurish rewiring jobs), or at least to find out what was usual for the vintage of the radio. If this is a repair (only a few wires are to be replaced) try to match the existing as closely as possible. When you remove old wiring, save any insulated tubing.

- Determine the wire size from existing wiring, publications, etc. For example, the early Leutz superhets (1922 - 24) used 12 GA wire. If you are building a 'new" set, 12 GA wire looks nicer but costs a bit more and requires more work. Estimate the amount of wire required, if you are not sure, start with a 100' roll of 12 Ga.

- If the set used the snazzy black insulated tubing, estimate the amount required. If you are not sure, use the tubing. Start with about 50' of insulated tubing to suit the wire used.

- If the set used solder lugs. you should use them too, If you are not sure, leave them out.

If this is a repair job, remove the offending wiring, saving any insulated tubing. Make a note of each wire run as you remove it

If this is a complete rewiring job or a new" set:

- make up a wiring diagram (a drawing showing the routing of the wire runs) from the existing wiring, blueprints or from other documentation of the set

- if you do not have a schematic of the set, make one up wire-by-wire as you disassemble it

- remove all components from the baseboard and front panel. Clean and/or restore the baseboard and panels as required (now is an ideal time to do this, as they are easy to work on). Do the same for the components. (Re)assemble the baseboard, front panel and components. All components must be mechanically secure. If this is a 'new" set, decide on the component layout.

Wire the set in a logical sequence:

- busses: ground, filaments, B+, screen voltages

- other long or complicated runs

- the remainder

Preparing the Wire

When 12 and 14 GA bus wire comes from the manufacturer, it is inevitably wound on a small spool. After being unwound, it must be straightened before use. To accomplish this, secure one end of the wire to a fence post, unroll the entire length of the spool (or as much as you can), and repeatedly draw the wire between two soft wood blocks (pine is good) over its full length until it is smooth and free from ripples and small kinks. Do not use too much pressure on the blocks and wear gloves to protect your hands. Once the wire has been straightened, recoil it using a diameter of 2 or 3' and secure with a tywrap. Once recoiled, handle carefully.

Wiring Hints

(1) Use right angled bends if at all possible. Point-to-point wiring is obviously better from an RF point of view, but this isn't the way it was done. Even a 1/2' jog should be done with two right angled bends.

(2) If you are using insulated tubing, it must be cut to size and slipped on the wire before the next bend, eyelet or crimp. Allow about 1/8' of clearance from the crimp, eyelet or right angled bend. Cut the tubing cleanly and squarely, using the single edged razor blade and a wood block.

(3) When making solder joints, appearance is very important as they are there for all to see. Joints should be bright with a good solder fillet. Clean the flux from each solder connection using alcohol and 0-tips. Work in a well ventilated area.

(4) When making a tee connection to another wire, bend as small an eyelet as you can (you can make a jig for this if you wish), open it up enough to slip over the wire being connected to, and then crimp it tight and solder. This gives a nice symmetrical appearance to the joint

(5) When starting a wire run, estimate the length of wire required and cut an adequate length from the coil of straightened wire. Do not attempt to work directly from the coil itself!

(6) For each eyelet, bend etc. as you progress along the wire run, reinstall the wire each time you do something, then remove it completely and perform the action. Attempting to work on the wire while it is in place is not really an option.

(7) Do not solder anything until the wire run is completely installed for the last time

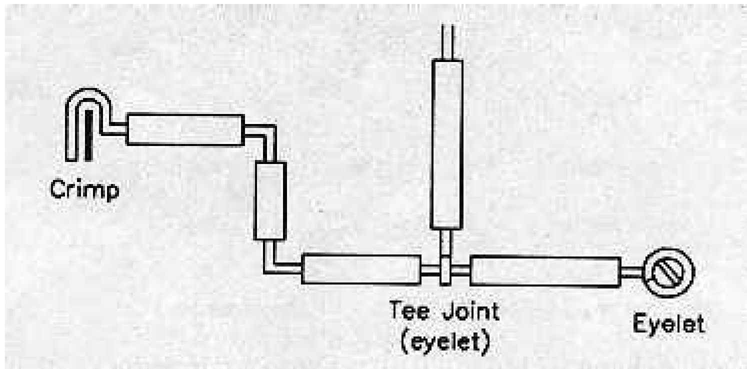

Figure 5 A Typical Wiring Run

The wiring method described above may seem overly complex on first reading, but don't let this discourage you from trying it out. As you gain more experience and practice, you will find that things go quite quickly, and that you will develop a very good eye" for gauging wire lengths, etc.

Eventually, you may be able to dispense with some of the jigs entirely, and do most things from experience. I am sure that in the old days, the people who wired these sets for a living could probably do the work in their sleep!

I can personally assure you that, if you take the time to do an A-1 job rewiring a battery set in the manner described, it will become one of the most appreciated radios in your collection. In a way, it was kind of sad in the mid to late '20s when bus wiring gave way to stranded hookup wire, wire harnesses and finally printed circuits.

A sample of the finished product which you can expect using the techniques described above is show in Fig 6.

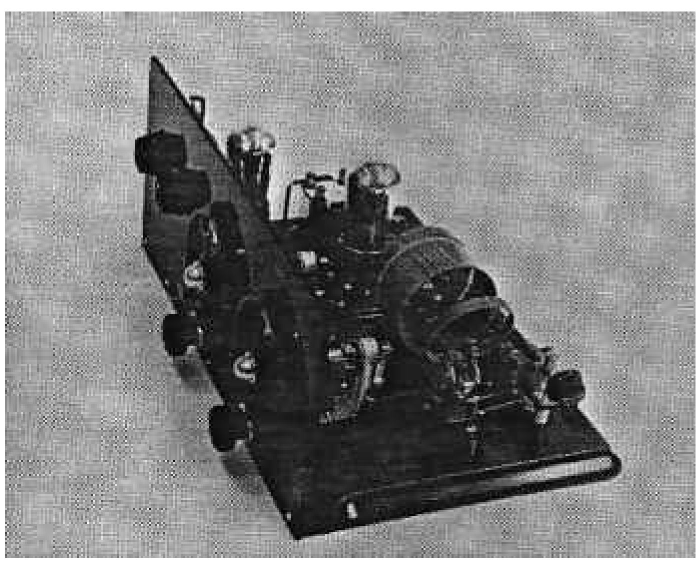

Figure 6: A Receiver Wired Using the Techniques Described

Bus Wiring Materials and Sources

Item	Part Number(s)	Approximate Cost
Wire Stripper/Cutter	Miller 101-S	$7 (Electro Sonic)
Bus Wire, 14 ga.	Birnbach #1410 Belden 8012	$80/m (US direct) $34/c, $275m (Electro Sonic)
Bus Wire, 12 ga	Bimbach #l4V6 Belden #8011	115/m (US direct) $50/c (Electro Sonic)
Tubing, 14 ga	Birnbach #B130-14	$15/c (US direct)
Tubing, 12 ga	Birnbach #Bl30-l2	$20/c (US direct)
Sources:	Bimbach 81 Schmitt Boulevard Farmingdale, NY 11735 (516)420-0400 Minimum direct order $100	Electro Sonic 1100 Gordon Baker Road Willowdale, Ontario M211 3B3 (800) 567-6647