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Big Connections . . . . Terminal Installations on Big Wires

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The last time I wrote for these pages, the topic was solderless terminals for small wires. I'll suggest "small" wires are those accommodated by ordinary hand crimping tools; 22 AWG through 10 AWG (AWG = "American Wire Gage" a measurement system that says big wires shall be known by their small numbers ? ? ?). Most light airplane wiring falls in the 22-10 AWG range. However, starter, hydraulic pump, alternator, ground power, and power distribution circuits are exceptions which require much larger wires in the 8 AWG to 2 AWG sizes.

Battery wiring carries starter current so both battery and starter circuitry are at least 4AWG and in most cases 2AWG wire. Alternator feeds are proportioned to the alternator's output rating. 40-amp or smaller can use 8 AWG, 50 to 75 amp machines are wired with 4AWG, 90 to 125-amp alternators are wired with 2AWG wire. Of course, the airplane's limits on consumption of energy are tightly tied to alternator capacity. So, main power distribution paths are wired with the same size wire used to attach the alternator b-lead to the rest of the system. A handful of high current, 30-50 amp loads like hydraulic pumps call for wire in the 8 AWG to 6AWG range.

Solderless, crimp terminals are available for all these sizes but you won't find them in the normal electronic and automotive parts outlets. Further, the tools to apply "fat" terminals are equally robust and expensive. If your heart is really set upon using top-of-the-line, solderless terminals throughout your project, by all means, check with local electrical contractors. Quite often they'll have both tools and terminals. They would probably install terminals on wire segments supplied by you and brought to their facility. Ideally, terminals should be installed right on the airplane because in some situations, "clocking" of a terminal is important. "Clocking" refers to orientation of a terminal on the wire when installation is completed; wires larger than 6AWG are difficult to twist. Proper clocking insures terminal alignment with its mating stud.

For the less discerning or more frugal builders, there is an alternative to the high-dollar termination of fat wires in airplanes. You can solder them on . . . . solder, SOLDER . . .? Yes, the dreaded "S" word. I don't know how many articles I've seen in recent years wherein readers are advised against using solder for wire joining and cite a variety of pitfalls including heat damaged wire or insulation, and rampant corrosion resulting from poor selection of materials. I believe most people's aversion come from lack of understanding of solder's limitations and capabilities. Soldering is an ancient technology for joining metals and will be the topic of a future article. In the mean time, please consider the following and trust me - it works!

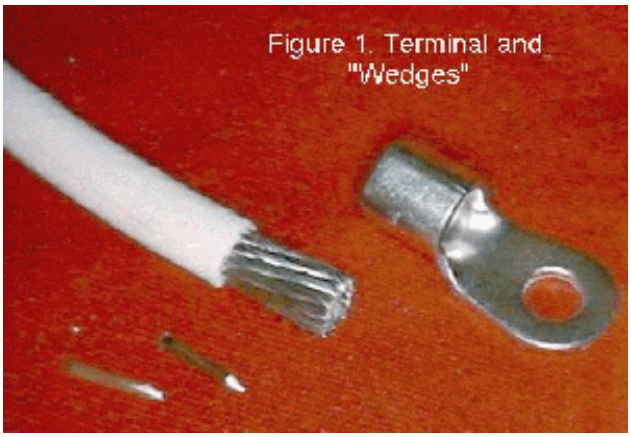

Figure 1

Terminals to be soldered must be all metal, un-insulated type as shown in Figure 1. If you have access to insulated

terminals but not the tools to apply them, you can twist the insulators off with a pair of pliers. The terminal barrel should be a snug fit over the wire. The best joint will occur if the strands can be fairly "packed" into the barrel. My favorite way to tighten a wire in a loose barrel borrows from the technique of using wedges to secure a hammer head to a wood handle. In this case, the material needs to be compatible with the soldering process so how about copper wedges?

The finished termination is going to get dressed up with a sleeve of heat shrink over the wire and terminal barrel. Now's the time to slide the heat shrink over the wire. With the heatshrink in place, strip back the wire to be terminated so that when the strands are just flush with the wire barrel, a .10" to .15" gap exists between end of insulation and the terminal's wire barrel. If the terminal you're about to apply seems too loose, get a short piece of 14 or 12 AWG house wire and strip off the insulation to get a bare strand of solid copper wire. Cut a piece of wire about a half inch long and use a file or sanding disk to sharpen the end. My favorite tool is a cutoff wheel in a hand- held hobby motor.

Figure 2

Push the wedge into the end of stranding - toward the center clear of the terminal barrel as shown in figure 2. If it's still too loose, you can try a second wedge, make bigger wedges from 10AWG or 8 AWG solid wire, or find the right size terminal! The only caution I'll urge with wedging is that some terminals are not brazed shut at the joint where the barrel is formed from the flat stamping. Aggressive wedging can spread the barrel open.

Now, you're almost ready to solder. Check the clocking of the terminal. This means that the terminal should be oriented with respect to twist on the wire so that the terminal will drop onto it's mating stud without twisting the wire. Oh yeah, you do know that the parts to be soldered need to be clean? If the terminals have been laying around in a junk box for 10 years or if the wedge wire is less than shiny, use Scotchbrite pads or similar to brighten things up before assembly.

Figure 3

Now comes the fun part. You've got a range of choices for sources of heat to flow the solder. I've used an ordinary propane torch adjusted to a very small, inner blue flame of about 1/4". If your work area is VERY free of drafts (moving air cools your work rapidly) you can use one of those little butane torches that run on a throw-away lighter. You can also use a soldering iron with as few as 50 watts of heat capacity - IF it's a small 50 watt iron that gets all the heat out to the tip. My favorite is an Ungar handle (See Figure 3) with screw-in heating elements . . . we used to have similar tools for "wood burning" art when I was a kid. They may still sell these tools in craft shops. The solder you're going to use will be electronic grade 60/40 or 63/37 alloy with a rosin core. The ideal size is the .062" diameter stuff.

Poor torch technique can make it look like you tried to clone the Mona Lisa with a paint roller so listen up. If you use a propane torch, heat for this task is always applied on the back side of the terminal about even with the tongue end of the wire barrel (Figure 4). Angle of the applied flame should blow hot gasses away from the wire's insulation (If you're using a soldering iron or tiny butane torch, you can move the heat source around the barrel so that it's opposite where the solder is going in). About 10-15 seconds after initial application of heat, feed solder into the

space between wire strands and the terminal barrel. Start out immediately opposite the

flame. Molten solder is the conductor of heat from barrel to strands; after the first inch or so of solder has been fed into the joint, start around the barrel always pushing it into the space between wire and barrel until about 6" of solder have been fed into the joint. Now, you're almost done. Turn your attention to the other end of the barrel where we left a "window" between insulation and barrel; keep feeding solder in and watch for the appearance of solder which will flow by capillary action to the wire end of the barrel. Don't be surprised if it takes 10" or more of .062 diameter solder to finished the joint! Resist the urge to feed solder into the other wire end

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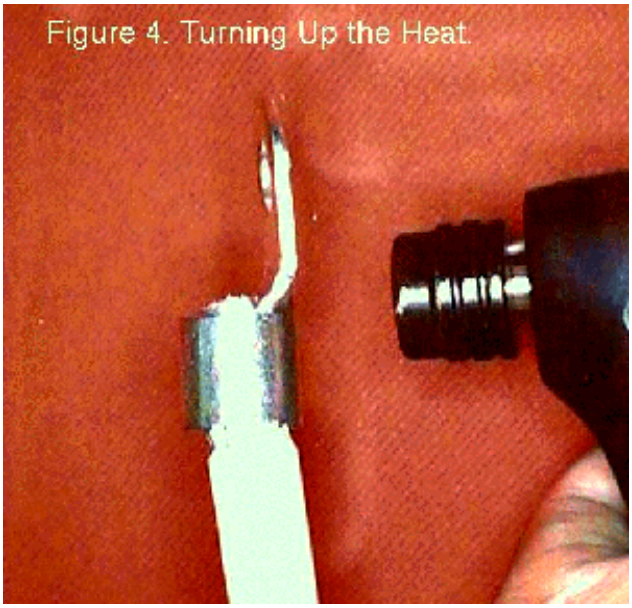

Figure 4

When solder first appears at the wire end, reduce the heat and see how the exposed stranding looks at the cut end. If the stranding matrix isn't filled with solder, you can now begin to feed solder directly into the stranding wherever the solder has not already flowed. As soon as the ends appear "covered" you can take the heat off. Your soldered on terminal should look something like Figure 5. A little "toasting" of the insulation may be unavoidable . . trim away the lumps with a knife and go to the next step.

Let it cool, wipe down with rag or paper towel wet with acetone or lacquer thinner. The insulation may pull back from the joint a little bit; put the heat shrink in place over the barrel and shrink down to finish the joint (Figure 6).Sources for materials and tools: Heat shrink tubing is commonly stocked by electronic and automotive parts houses. I prefer double-walled products with an inner-wall of melting sealant. Terminals should be tin plated solid copper. Electrical supply houses will have big'uns both insulated and uninsulated. Irrespective of what the supplier says the matching wire gage is for any terminal he offers, you're more interested in how well it fits before crimping. Take a piece of stripped wire with you when you

Figure 5

shop for terminals. Small quantities of electronic grade solder are available from Radio Shack, electronic supply houses will want to sell you a full pound. If you do invest in a pound spool, I recommend Kester Resin 44 in a 63/37 alloy and .032 diameter. This is a good all around size for OTHER soldering jobs. For soldering big terminals, take four, 12" strands of .032" solder and twist them together to make solder stock. The AeroElectric Connection stocks fat wire termination kits which include terminal, double wall heat shrink, wedges and solder.

Figure 6

A hardware variety propane torch can be used with care. An electric soldering iron is probably ideal and easier to control. Check with electronic tools supply stores and hobby/craft stores. You need the concentrated-heat 45-60

watt type tools shown in Figure 3. The little butane hand torch is also a good choice. It's slow but you're not in a hurry and It's very unlikely to over-heat the joint. This little guy does need a draft-free workspace to do the job. Check hobby shops for heat guns used to shrink model airplane covering. They cost about $20.