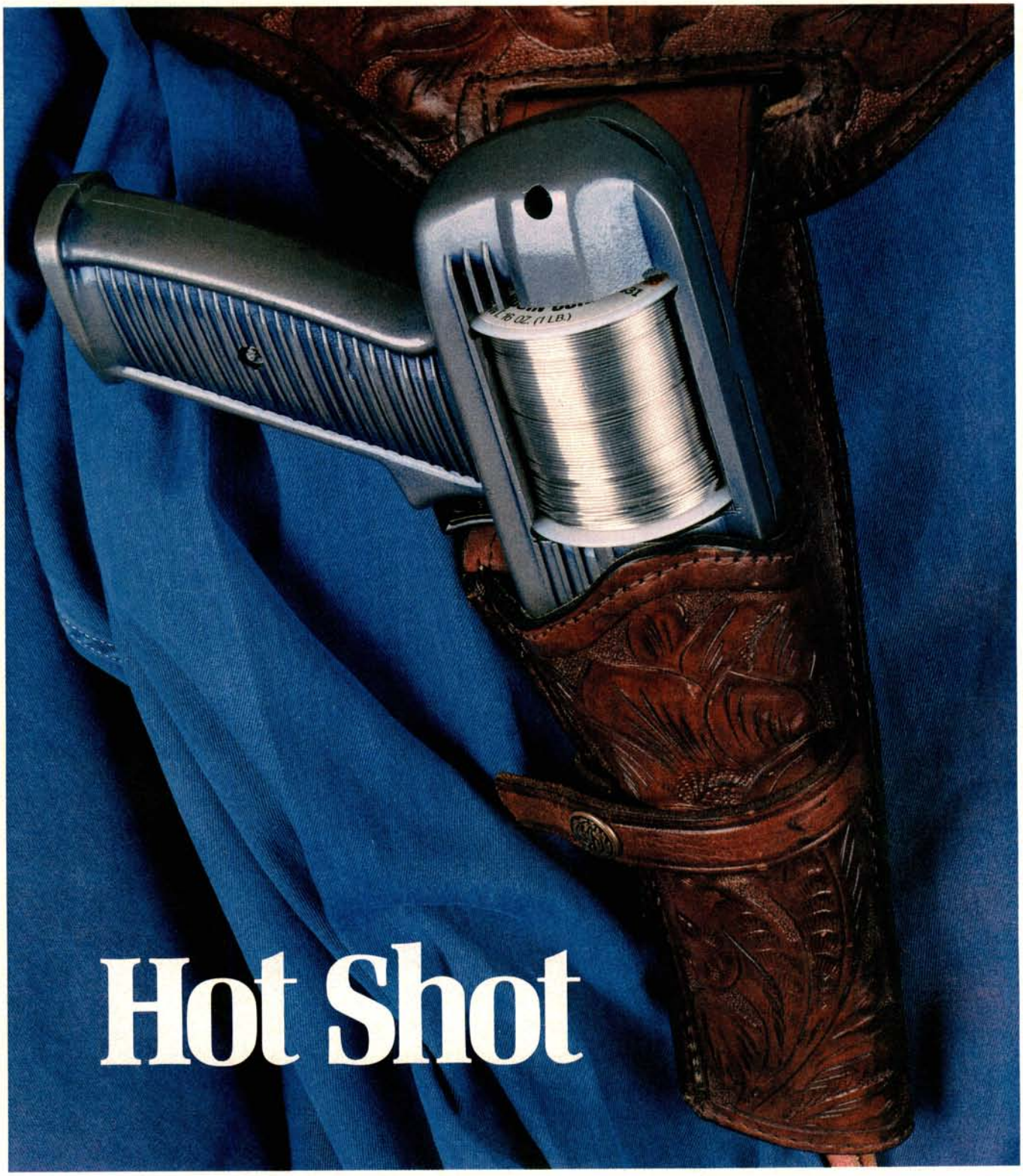


Hot Shot

It's getting harder and harder to find a car that doesn't have some type of on-board electronics. In past articles, we've discussed computers and sensors, and many of the ways they interact. But we often forget the importance of the wires which connect them. Wiring and wire harness connectors are the weak links in the car's electronic communication system. They are exposed to heat, moisture, corrosive chemicals, and maybe even physical abuse.

This month, we'll show you repair procedures which will help you make a lasting fix when a wire or wire end is damaged. Twisted or crimped connections may have gotten the lights working on your old International truck, but those days are gone.

Hot Shot

The Importance of Good Connections

Most of the wires in today's electronic cars are very small, and normally handle very small amounts of current. A poor electrical connection can greatly reduce the ability of the wire to handle the correct current flow.

Low current levels can be especially critical to the performance of sensor circuits. In fact, some sensor signals travel at such low current levels that the wire is shielded with a metal braid to protect it from electromagnetic interference (EMI). The braided metal covering is grounded at one or both ends. Correct repair of this type of covering is just as important as the correct repair of the damaged sensor wire it shields.

The Importance of Good Repair Techniques

Before we start, let's eliminate crimped connectors completely. The use of crimped connectors provides a mechanical connection between two ends of a broken wire. But too many times, this type of mechanical connection does not give us a good electrical connection. A crimped connection may look perfectly good to the naked eye. But our old enemies, vibration, moisture, and corrosion can ruin crimp connections very quickly. This could mislead us and have us believing that circuit components are at fault when the crimped connection is really the problem.

Save crimped connectors for emergency and temporary repairs.

The good news is that correct repair procedures are not difficult once you learn a few tricks. The minimal tool list for making solder repairs is small, although we'll show you a few special tools which will make these repairs even easier.

Hot Shot

So what are good wiring repair techniques? Solder joints on properly prepared wire ends are the best, most lasting repairs we can make. So heat up your soldering iron, and learn how you too can be a Hot Shot wire repair specialist.

Soldering supplies and tools used in this article were obtained from these sources:

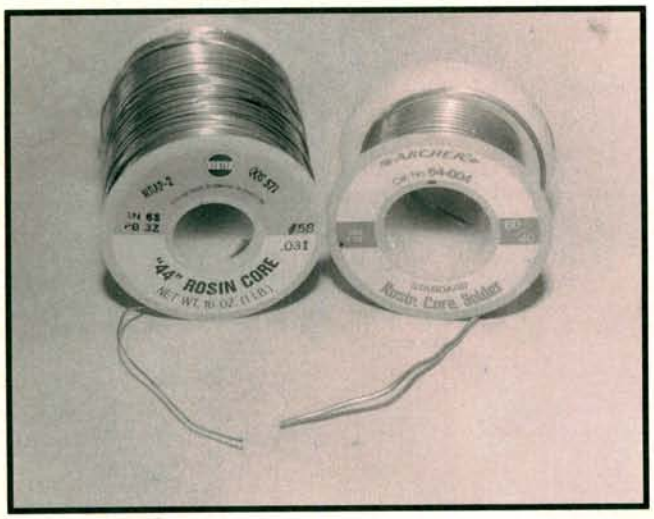
HMC-Hub Material Company
Circle No. 215

Radio Shack
Circle No. 216

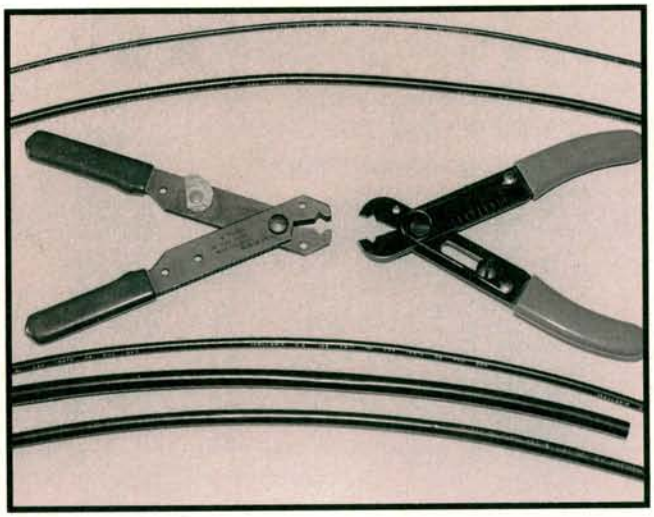
—By Vince Fischelli

1 A solder pencil rated at 30-35 watts is good for repair of small gauge wires. Replacement tips for this type soldering iron come in different sizes to suit the job at hand. This fixed-temperature Weller iron supplied to us by HMC, operates on 120 volts/AC. The iron heats slowly, and stays hot until unplugged, so be careful. Even after it's unplugged, it will take a few minutes for the iron to cool down. A good accessory for a pencil-type iron is a soldering stand like the one shown in our photo. The stand keeps the hot iron tip from burning the vehicle carpet or your fingers, and the sponge in the base is good for cleaning the iron's tip.

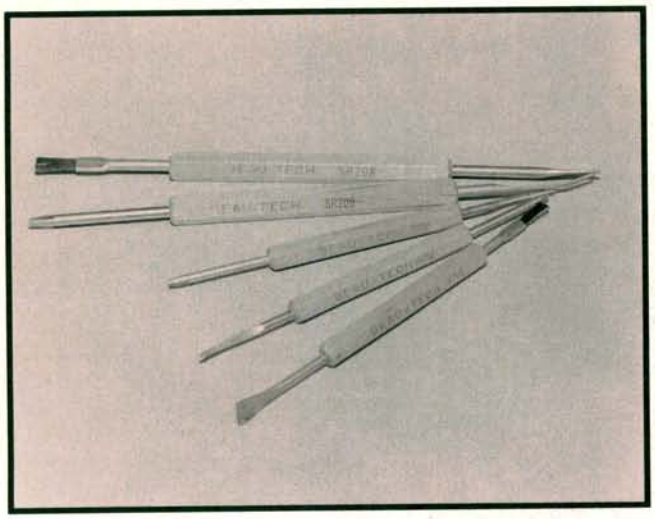
2 A pistol style solder gun rated at 100-150 watts is good for soldering fairly heavy connections. The gun shown is a Weller Soldering Gun, Model 8200. The pistol type trigger has two positions. Pull to the first click, and you have low (100 watt) heat. Pull the trigger in all the way, and the gun switches to 150 watt heat. The hotter range is very useful when you're soldering outdoors in cold weather. The solder tip is made of copper wire so it can easily be bent into various shapes and angles for soldering in hard to reach places. This iron heats up in a matter of seconds and cools quickly when the trigger is released.



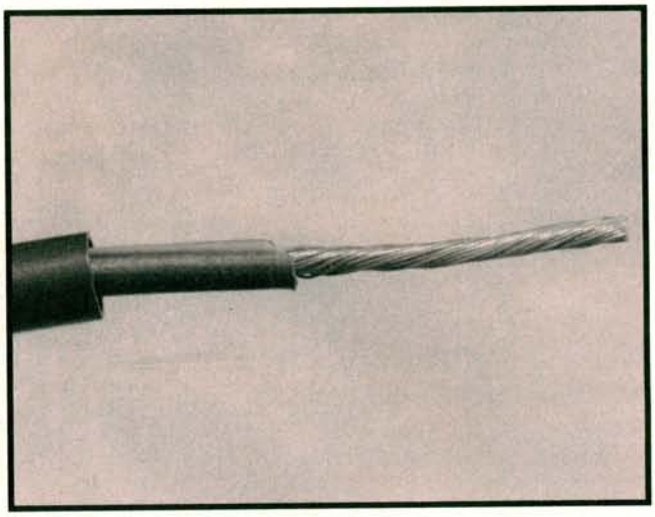
3 A spool of rosin core solder is the next requirement. Rosin core solder comes in different thicknesses and in different sized packages. The rosin core may be a single core, or may be made up of a number of alternating layers of rosin and solder. Solder which has a layering of flux and solder better ensures that the flux will be evenly distributed through the solder joint without soaking any one part of the joint. Heat from the soldering iron helps clean away any small amounts of tarnish on the wire, and the flux helps the solder get a better grip. The rosin core also makes the soldering action take place faster without the need for excess heat.



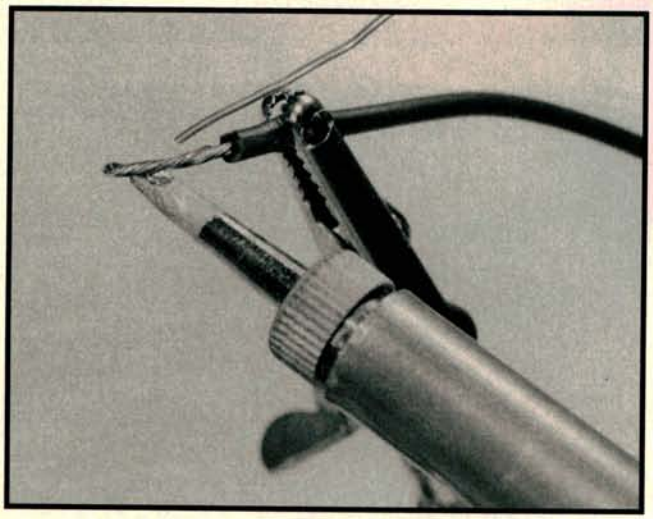
4 The next requirements for good soldering are an adjustable wire stripper and assorted sizes of heat shrink tubing. Pocket knives and razor blades are not good wire strippers. They can nick the wire. This can remove strands from strand type wire or weaken a solid wire. A good quality stripper should have adjustable jaws. That way you can remove the insulation without damaging the wire beneath. After finishing your repairs use the correct size heat shrink tubing to protect and insulate the finished solder joint. The tubing shown is from an assortment purchased at our local Radio Shack. It's easy to use, and one package seals many joints.



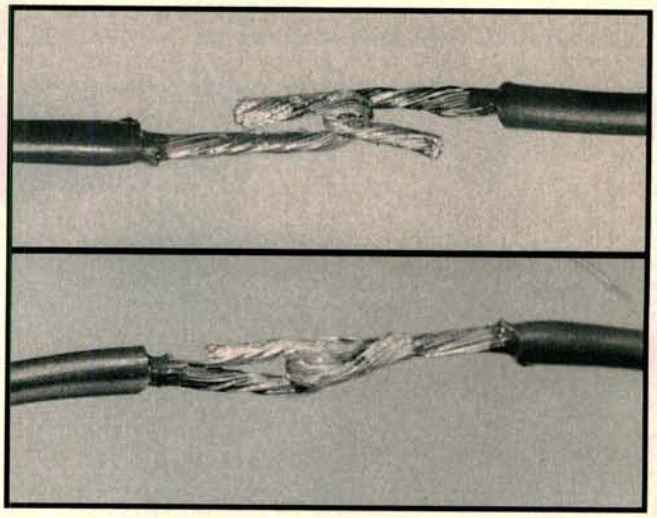
5 One accessory you'll want to add to your soldering tool list is an assortment of soldering tools (called soldering aids). These tools are chrome plated, and have different tips which can be used to clean and bend wire after it's soldered. Solder can't stick to the plated tips on the tools, so the tools won't stick to your finished solder joint. Pointed tips are useful for some circuit board repairs. Several stiff wire cleaning brushes are also included for cleaning terminal and wire ends. Slotted probe tips are used to make hooks on tinned wire ends prior to final soldering. We'll show you this technique in a moment.



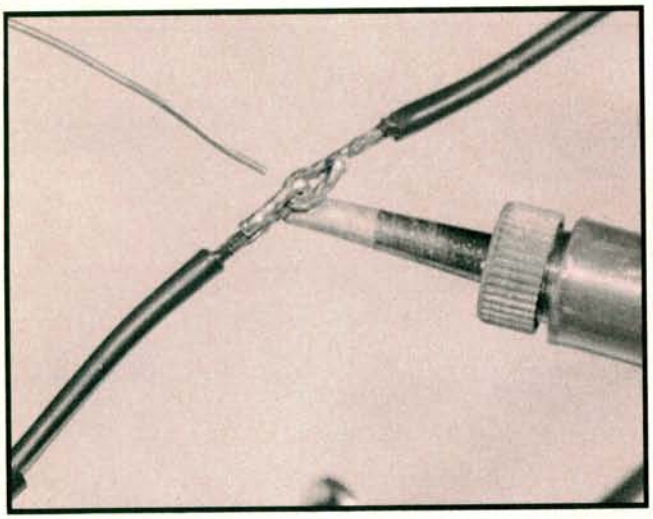
6 Now that you're familiar with the tools you'll need, let's get hot. Our first project is a simple repair of a broken wire. Remove about 3/4 inch of insulation from each wire end. Be careful not to nick the wire or cut away any of the strands. Removing strands can weaken the strength of the soldered connection. (Once again, don't remove insulation with a knife, side cutters, or hedge trimmers!) Slide a length of heat tubing over one end of the wire. Select a tubing diameter just large enough to fit over the finished solder joint, and place it far enough from the repair area so that the heat of the soldering iron won't shrink the tubing before you're ready.



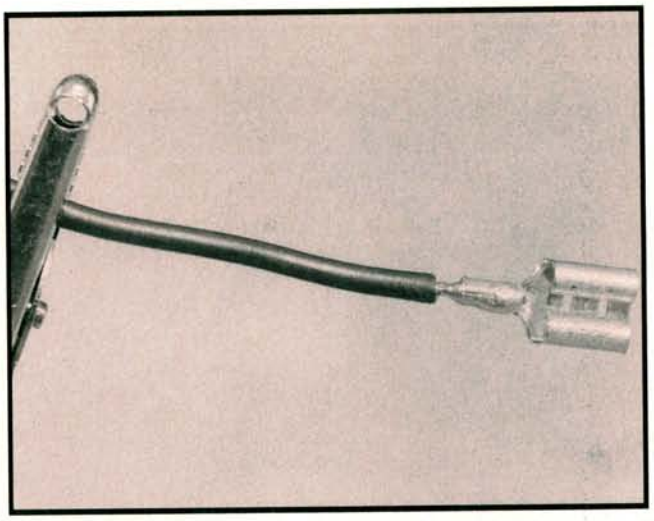
7 If you're soldering strand wire, twist the strands into a neat bundle. "Tin" both bared wire ends to apply a thin coat of solder to the wires. Hold the hot tip of the iron directly against the underside of the wire (heat rises). When the wire is hot enough, touch the tip of the solder to the point where the soldering tip meets the wire. This may take practice, but you'll be surprised at how fast you get the hang of it. The solder will flow over and into the wire. The flux in the solder helps the solder melt and flow evenly. Use only enough solder to apply a thin coating of solder to the wire. (The alligator clip is on a stand supporting the wire while we solder.)



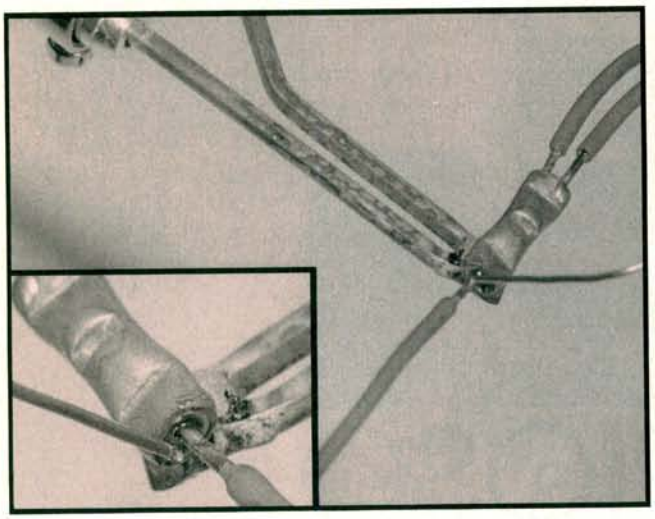
8 The next step is to prepare the tinned wire ends by using the slotted end of the solder aid tool to place a small hook in each wire end. (Use your needle nose pliers if you don't have the solder aid tool, but be sure the tips of the pliers aren't covered with oil and grease.) The point here is that we want to make a neat hook in the end of the tinned wire. Now clasp the hooks together, and squeeze them tight with your pliers (lower photo). This gives us a strong mechanical bond. Once this joint is soldered, it will be stronger than the original wire. No solder connection should be made without first making a good mechanical bond.



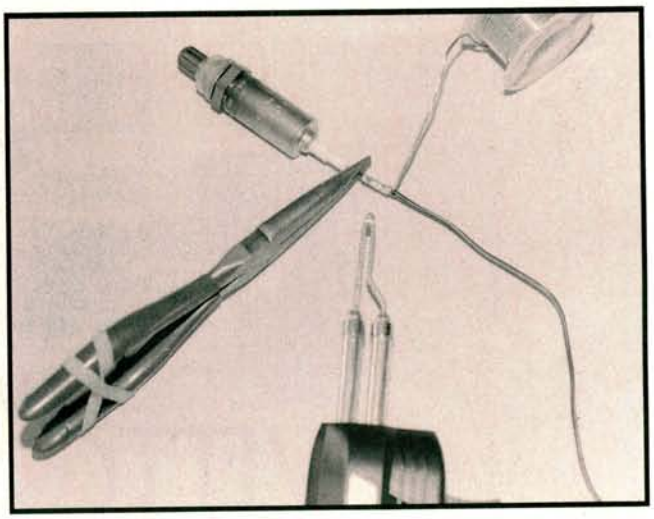
9 Now finish the joint. Electrically seal the connection by soldering the wires together. Once again, apply heat at the base of the connection. With the joint hot, apply a small amount of solder to the top of the joint. Heat will rise through the joint until it melts the solder. Don't use too much heat or too much solder. Use just enough heat to get the solder in the tinned joints flowing and also melt the new solder. Apply only enough new solder to lightly cover the joint. Do not allow the joint to flex or move until the solder cools enough to solidify. We don't want a "cold solder connection" due to cracking of the solder joint before it has cooled.



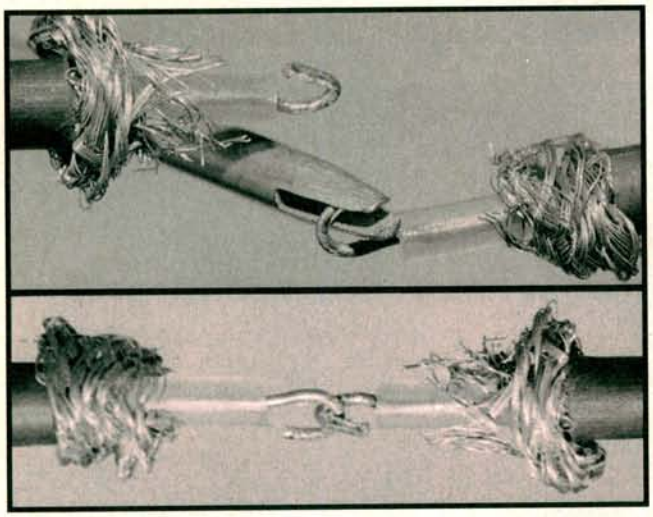
10 Wire repair isn't the only use for your new soldering skills. Instead of simply using a crimp style terminal end, a combined mechanical crimp and solder connection will give you a lasting repair. After cutting off an old corroded terminal end, remove just enough insulation from the wire to install it in the new connector. Clean and tin the wire. Insert it in the connector, and crimp the connector barrel over the wire. Then heat the terminal barrel from below as you did with the wire we repaired, and touch the solder to the top of the terminal as shown. Don't use too much solder.



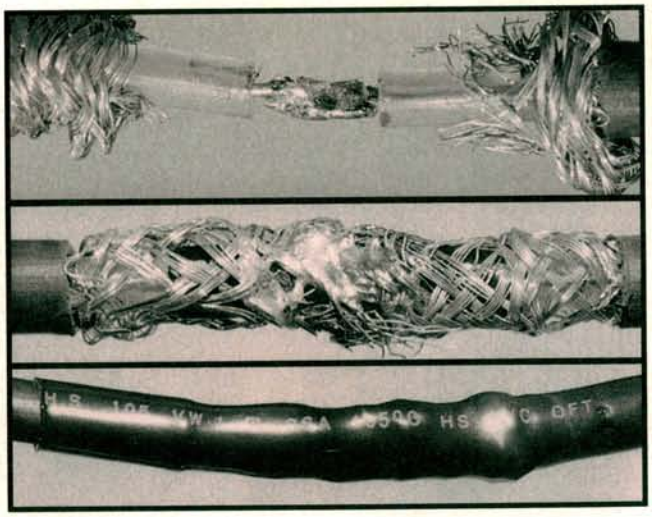
11 If crimp style connectors aren't as good as soldered connections, then why do OE manufacturer's use them? We're not sure. But crimp connectors hidden inside taped wiring harnesses can and do fail. One way to repair these connectors is to heat the crimp connector with a slightly higher than normal heat. This extra heat will burn away tarnish and corrosion. Then apply solder to the heated area, and let the heat draw the solder into the joint. This will clean and restore the connection in one easy step. If you've ever done any sweating of copper plumbing fittings, you'll understand this procedure.



12 Universal 0_2 sensors are a good use for your soldering skills. These sensors won't have the terminal end you need to connect them to the ECU harness. You'll be expected to reuse the connector from the old sensor. One example is this Bosch replacement oxygen sensor. It comes with a factory installed crimp connector on a very short wire lead. Due to the fact that the wire is so short, we're concerned that the heat of the soldering iron may damage the sensor. We install a "heat sink" to absorb some of that heat. (In this case, our heat sink is a needle nose pliers held closed by a rubber band.) Then we tin the wire, crimp it, and flow solder into the connector.



13 Repair broken shielded cables as follows:
• Slide a length of heat shrink tubing over one end of the broken cable.
• Cut back the insulation without damaging the braided shielding. Push the shielding away from the repair area. The braided cable will compress as you slide it back.
• This cable has a plastic tube which separates the copper core wire from the shielding. Cut away about 1/2 to 3/4 of an inch of the tubing to expose the copper core wire.
• Tin the wires, and make your hooked ends using the slotted end of the soldering aid tool.



14 • Join the hooked ends of the wire and squeeze them together with your pliers. Then solder them together.
• Cover the solder joint with a good quality electrical tape.
• Push the braid back together until it just barely overlaps, and solder it in two places. The braiding is thin gauge, and solders easily at a low heat. If the braiding is too short to completely cover the repair area, solder a couple of small jumper wires to connect the two ends of the braid.
• After the solder on the braiding cools completely, slide the heat shrink tubing into place and heat it.

Answers to Soldering Questions:

1) *Why do we use rosin core solder? Won't acid core work?*
Acid core is too corrosive.

2) *Will the rosin clean away small amounts of corrosion?*
No, but the heat from the soldering iron will clean away small amounts of tarnish.

3) *How much heat is "enough" when I solder? Is it possible to use too much heat?*
Applying too much heat during the soldering process can burn away the insulation on the wires being repaired. Also be careful about high heat when soldering a wire which is close to a sensitive electronic component. The use of a heat sink may be required to protect the component.

4) *Do I need to perform any maintenance on my soldering iron?*
Re-tin the tip of your soldering iron before each job. Heat the iron and melt a small amount of fresh solder over the tip before each repair job. Tips can be cleaned while still hot with a wet sponge.
Finally, on pistol type soldering irons, tighten the screws or nuts holding the tip to the gun on a regular basis. A loose connection at the tip causes a voltage drop, and a reduced heating of the tip.

5) *Are there any situations where I need to add additional flux to a joint?*
No.

6) *What is the safest, best way to heat the heat shrink tubing?*
In many cases, a cigarette lighter or a match will do. If you're working around highly flammable substances, a heat gun is a safer choice.

7) *Is it okay to just twist the two wires together and solder them without tinning them first?*
While this approach may be successful in some cases, it does have a drawback. Since the wires are not pretinned, it'll take more heat to bring the two wire strands to temperature than it does to heat and tin them separately. This extra heat may damage the insulation.

Additional Soldering Tips

1) Use the smallest wattage possible to get the job done. Overheating the wires can damage the insulation.
2) Always use rosin core solder for wiring repairs.
3) Apply heat, then solder. Let the solder ride on the part of the wire closest to the heat. Leave it there until the solder flows. Remove the solder. Then remove the heat.
4) Don't let the soldered connection move until it cools. If you move the connection before it's "set" you can crack the connection. This may lead to an intermittent connection later on.
5) Properly secure any repaired wires, and route them as they came from the factory. If the wires aren't positioned properly, they can be infected with electromagnetic interference. Keep all wires as far away from secondary ignition wires as possible.