

# How to Fabricate an Ignition Lead

by Mark Howards

**R**adios giving you static? Rpm drop excessive during pre-takeoff runup? Spark plug terminal wells dirty? When was the last time you took a close look at your ignition cables?

A variety of ills can beset ignition leads, of course. The most common problem is damage to the shielding (or even the cable itself) where it exits the plug, at the cigaret. Over the course of many plug removals, you (and others) may not always have held the ignition lead motionless while unscrewing the terminal hex from the top of each plug. The wire twists and flexes and eventually frays through the shielding. Cables also get damaged through vibration (inadequate clamping), placement too close to hot exhaust manifolds, or routing over sharp edges without proper protection.

There are several ways of dealing with damaged ignition leads. Probably the most expensive way is to replace the affected magneto's ignition harness *in toto*. For a four-cylinder engine this will run you anywhere from \$90 to \$180, depending on whether you want a half-harness or a full harness. The other solutions are to make up individual replacement leads as necessary, or—if the damage is localized, at one end—using replacement parts to build up a new end for the existing lead. Naturally, this is a good bit less expensive. But you have to know the ins and outs of ignition-wire fabrication (and you may well have to borrow some specialized tools—more of which in a minute).

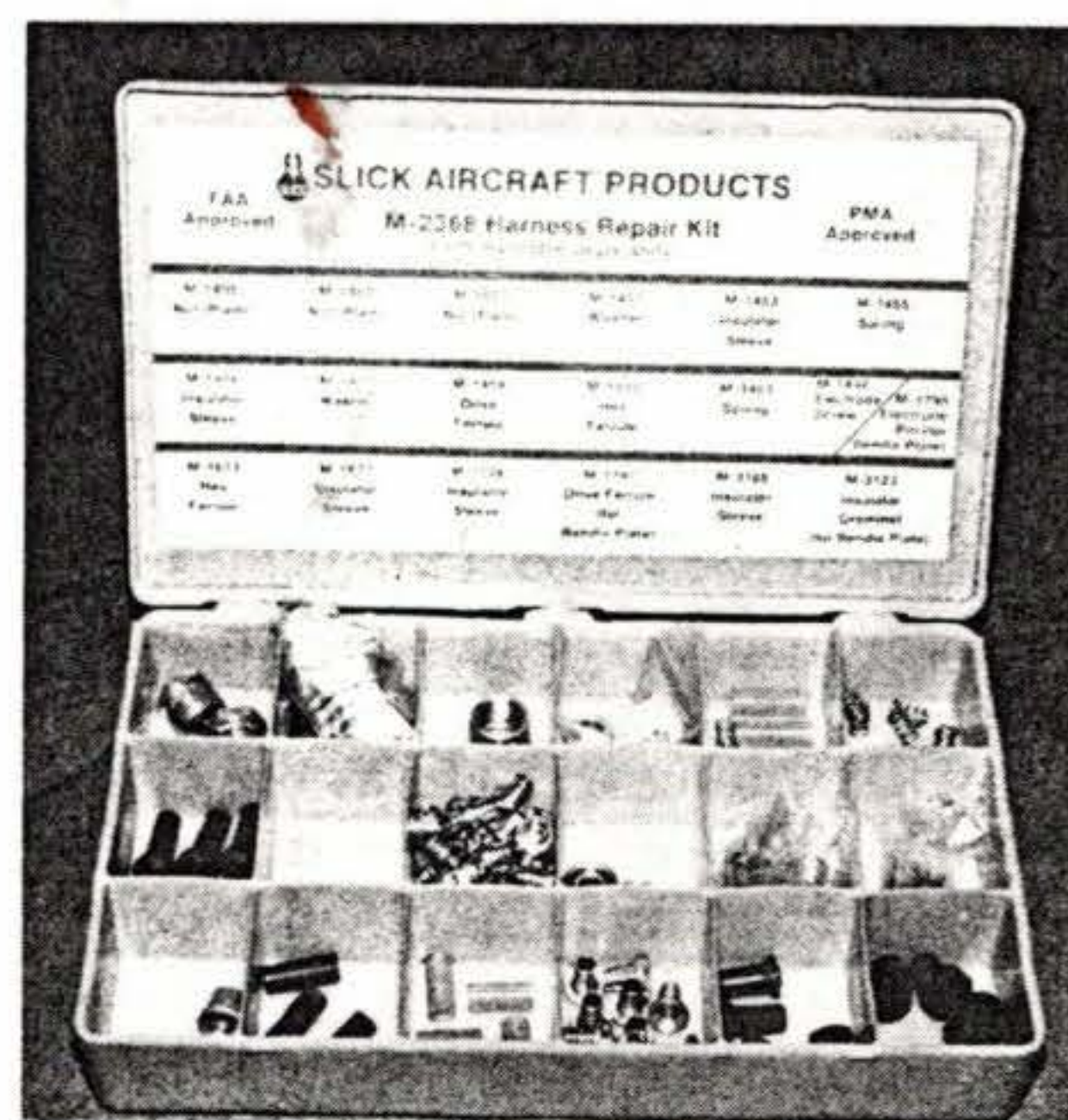
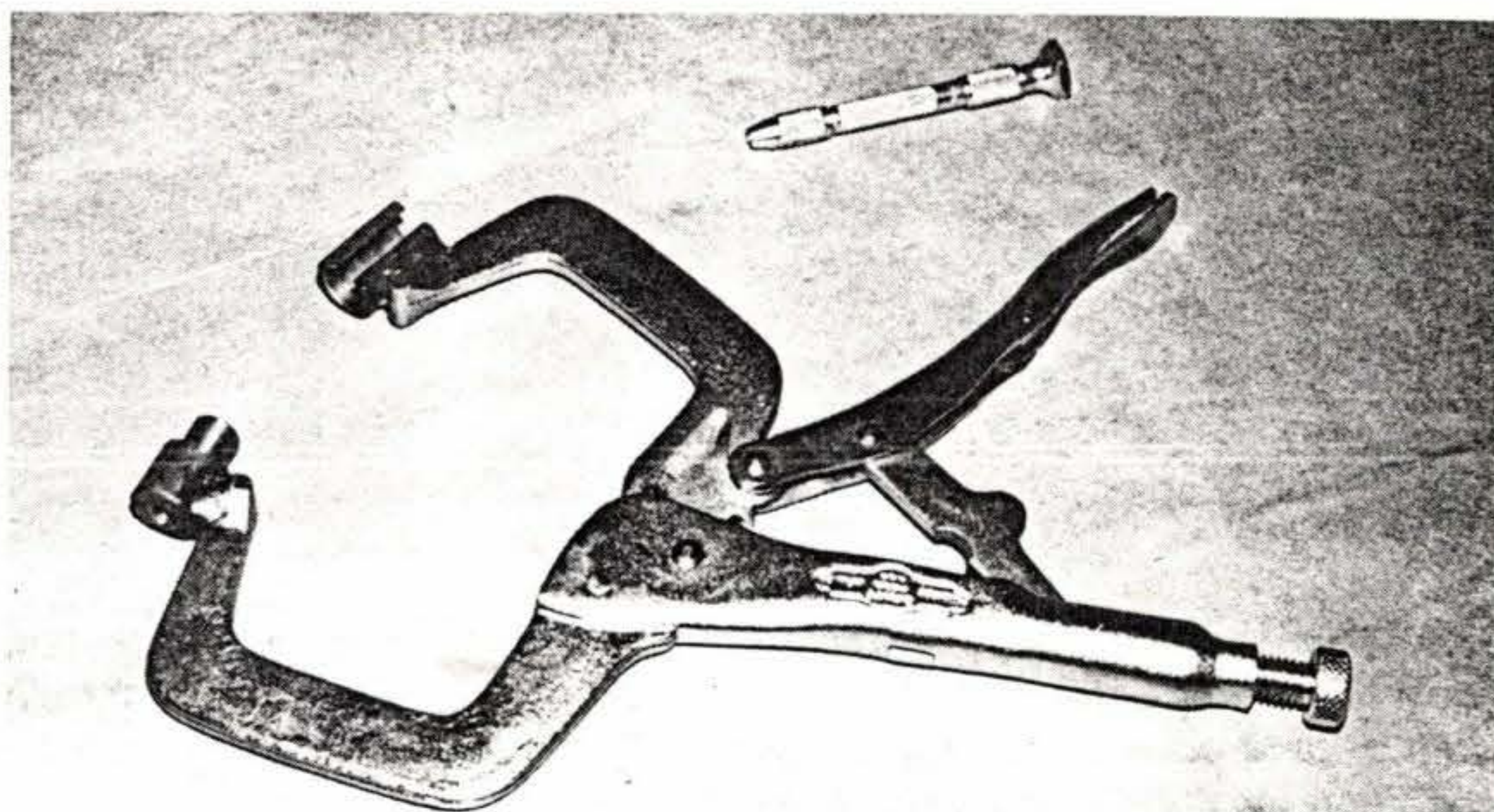
## Supplies

Unison, Electrosystems, and others supply ignition leads either as custom kits or as universal kits, the difference being that in the latter case you have to custom-trim your cable to final length. (Obviously, parts suppliers prefer to carry just the universal-type kits, since it cuts down on stocking requirements.) The single-cable kits come in various lengths—15-in., 18-in., 21-in., etc.—and, at least in the

*The Slick M-2368 repair kit contains a wide assortment of ferrules, screws, and hardware items, all of which are available separately. Special tools (above) include T-109 pressing pliers and T-111 vise pin. If your FBO won't let you borrow these, they can be bought for under \$50.*

case of Electrosystems (formerly Airborne) kits, may already have the spark-plug end made up, in which case you'll need to specify 3/4-20 all-weather ends or the old-style 5/8-24 ends. To make matters even more confusing, the spark plug end may incorporate a 90- or 120-degree elbow, or it may be perfectly straight. It's perfectly legal (so far as we know) to install a 3/4-20 all-weather-ended plug lead on a harness whose other wires end in 5/8-24 terminals (as long as you use the right spark plug—one end takes REM-type plugs and the other takes RHM), but people generally upgrade to all-weather leads all at once, at harness-replacement time. Intermixing styles on a piecemeal basis is likely to make your A&P look at you as if you've got a screw loose.

For this article, I had Chris Wray and Lance Drew of Wiggins Airways (Norwood, MA) show me how to make up both ends of a lead. We used a Slick M-2368 harness repair kit, which includes a variety of hardware (grommets, ferrules, etc.), 50 feet of ignition cable, and all necessary tools. This particular kit is intended for FBO use and is rather expensive,



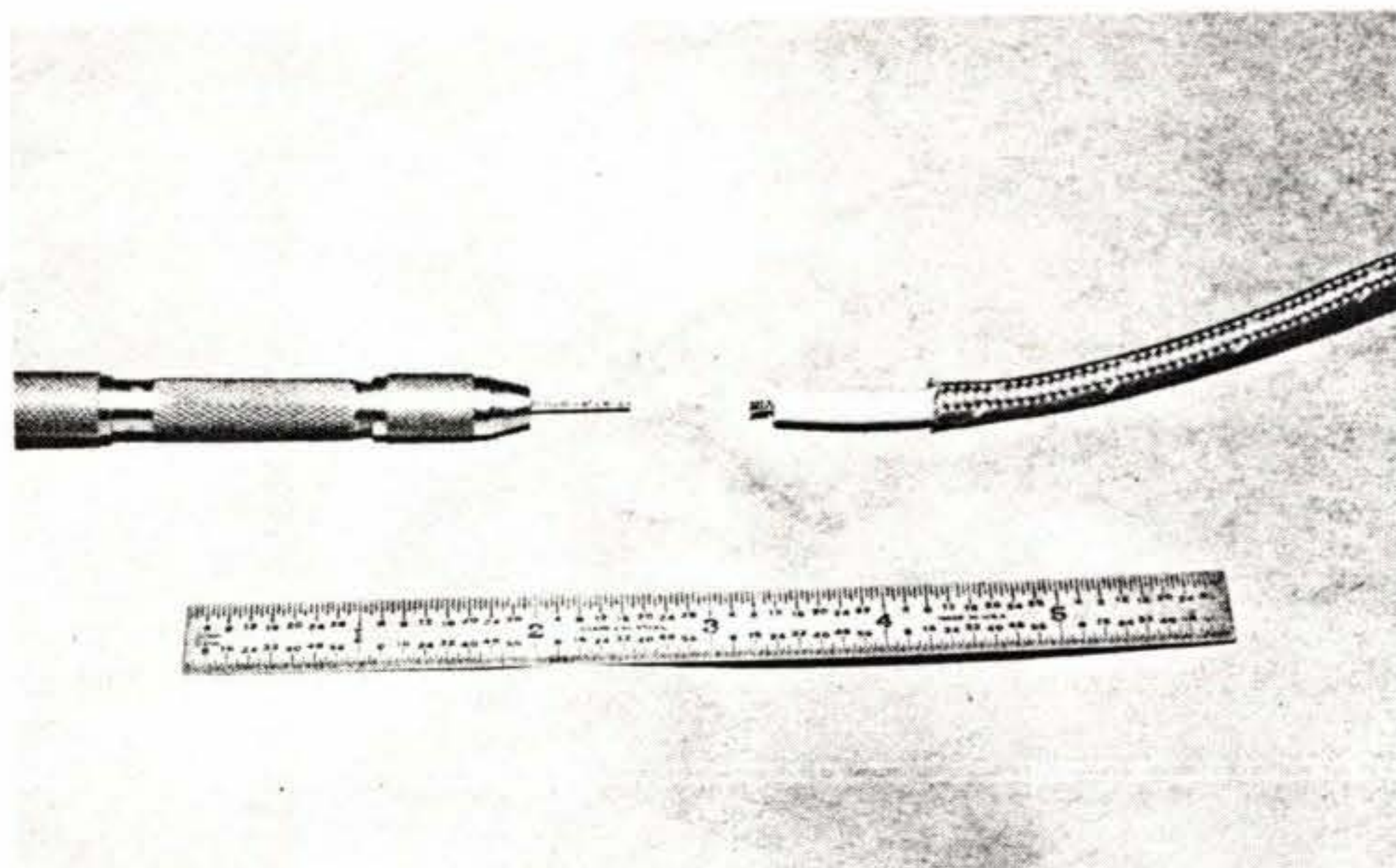
at \$261 Linda Lou Inc., Box 30340, Memphis, TN 38130; phone 1-800-824-9912 or 901/365-6611); you will not need everything that's in it. The tools and hardware that you'll need are all available separately (ask your local Slick Aircraft Products dealer to quote your needs), and if you've been nice to your A&P, he may let you borrow the special-purpose tools at no charge. Or nominal charge, anyway.

For this story, we repaired both ends of a cable from an O-320 with Slick magnetos. Keep in mind that the exact engine and magneto model numbers will determine the particular type of hardware you'll need. Bendix, Slick, and Eisemann all differ.

## The Spark Plug End

This portion of the job, you should be able to do without much problem on the aircraft (no need to remove the  
*(continued on next page)*





Here, the properly stripped wire is ready to accept an electrode screw (M-1498). Pin vise and No. 72 bit are shown on left.

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harness or cable). The main requirement is a little slack in the cable—you want enough excess so that after trimming a couple inches of cable and fabricating a new end, there's still enough lead to reach the plug (without radical bending). Oftentimes, extra cable will be bundled with wireties near the magneto end, or the cable run will be long enough at the cylinder that you can shorten it slightly without creating a problem. Obviously you'll want to check this out carefully. (You'll also want to keep in mind how useful this slack is the next time you replace a cable and cut new material to length.)

Remember that sharp bends and strained routing are no good. If shortening the cable will cause this, invest in a new run of cable.

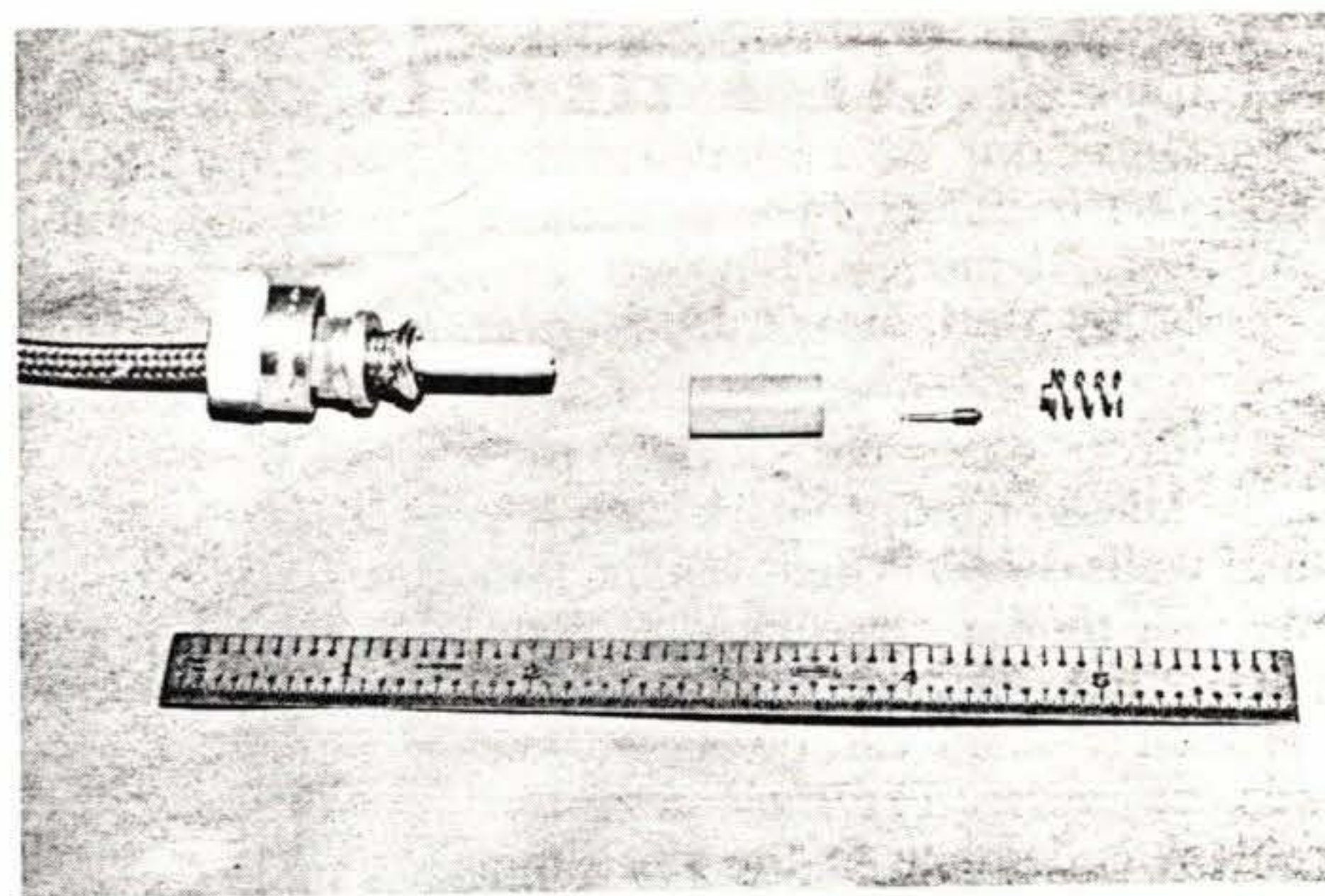
Step One: Cut the damaged portion of cable off at a point where the shielding is in good shape. Don't just clip it with a pair of dikes, however, because the shielding will get smashed and deformed. Instead, first cut the shielding with a Slick T-126

*Below: Ignition harness hardware (for the spark plug end).*

shield stripper (or with a sharp knife) using a rolling motion. Then use dikes to cut through the silicone insulation and inner conductor. We marked the shielding back 15/16-in. for the 5/8-24 standard cable end. This length of shielding will now be cut off, but this time using great care not to damage the silicone insulation. The T-112 stripping tool is designed to prevent insulation damage; you just slip it between the shielding and insulation up to a point about 1/4-in. past where you marked the shielding. (This is easier if you pull the shielding back a little along the length of the cable. Be careful, though, not to allow the shielding to fold under, and don't insert the stripping tool any further than is necessary to protect the insulation.) Cut the shielding with a sharp knife, again using a rolling motion. Pull the piece of shielding off.

Next, use your sharp knife to cut 1/8-in. of silicone insulation off the end of the wire. *Don't cut the inner conductor*, and be careful not to pull on the insulation as you're trying to cut it. Remove the insulation by gently pulling it and turning it clockwise. There should now be three conductor coils showing. Clean away any insulation that may remain in the center of the coil using a knife and #72 drill in a Slick T-111 pin vise.

The next step is to put an M-1498 electrode (actually called an *electrode screw* in Slick parlance) in the end of

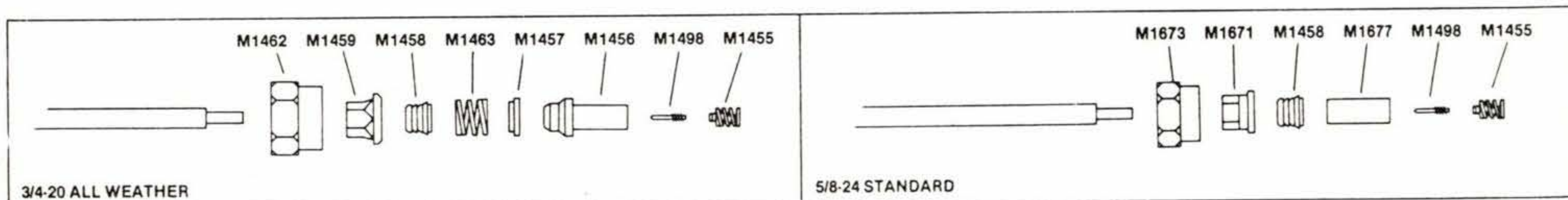


The spark-plug end ready for pressing. From left: an M-1673 5/8-in. hex nut, an M-1671 hex ferrule, the M-1458 drive ferrule (inserted under shielding, but with lip exposed), M-1677 insulator, M-1498 electrode screw, and M-1455 contact spring.

the conductor. The easiest way to do this is to clamp the threaded end of the electrode screw into a T-111 pin vise and turn the electrode CCW (counter-clockwise) on the conductor end until the threaded portion is flush with the insulation. Pull the pin vise tool off clockwise so the electrode screw doesn't back out.

Murphy will get you now if you don't remember to slip the spark plug nut (M-1673 for 5/8-24 ends) and a hex ferrule (M-1671) onto the cable so that the smallest diameter of the nut and the largest diameter of the ferrule are closest to the end of the cable. (If you're making up a 3/4-20 all-weather lead, you'll use an M-1462 nut and an M-1459 ferrule.)

Now bend and rotate the silicone insulation so as to flare the edge of the shielding. (If you have the stripping tool, a nice trick here is to use it to help flare the shielding.) Don't let the sharp shielding cut into the insulation, however. Slip an M-1458 drive ferrule between the shielding and insulation so that the shielding rides up to within 1/16-in. of the ferrule's lip (the M-1458's flange or lip). Then





slip the hex ferrule (M-1671) down over the shielding so as to sandwich the shielding between the two ferrules. Push the two ferrules together tightly, being sure that the shielding doesn't ride up under the flange or double over. Press the two ferrules together using a Slick T-109 pressing tool or equivalent. (This is a plier-like device that is specially designed to mash the two ferrules together when you grip the handles.)

Next, clean the exposed insulator with solvent and avoid touching it any more at this point. (One longtime A&P that I know uses choke and carb cleaner for this.) Slide the insulation sleeve (M-1677, otherwise known as a cigaret) over the silicone insulation, and—using the T-115 spring assembly tool—screw the M-1455 spring (otherwise known as a contact spring) clockwise onto the electrode screw until the end of the screw is flush with the first big coil on the spring. If you back the spring off at this point, you may inadvertently unscrew the electrode screw (in which case, just reassemble it as before). I mention this because this may happen if you ever have to replace a burned or corroded spring (*LPM*, November '87). Use some solvent to clean off the fresh cigaret assembly.

You now have a complete, new spark plug end—at a cost of \$7.96 in ferrules, insulators, and springs. (Every item mentioned above is available separately from Slick, including the special tools, the most expensive of which is the T-109 presser at \$31.) You've saved yourself the cost of a whole new lead, and maybe a whole new harness. (Remember, if an A&P sees a frayed lead, he may order a new half-harness for that mag, rather than take the time to make up a new end.)

### The Magneto End

Rather than repeating each step again, let's just look at the differences. Most of the steps in fabricating a magneto-contact end are identical to



*Above: The T-115 spring assembly tool can be used to punch the old drive ferrule out of the harness cap.*

those for the spark plug end, except part numbers. All you're doing is installing an electrode screw (M-1498, same as before) and some ferrules on the end of the properly stripped cable.

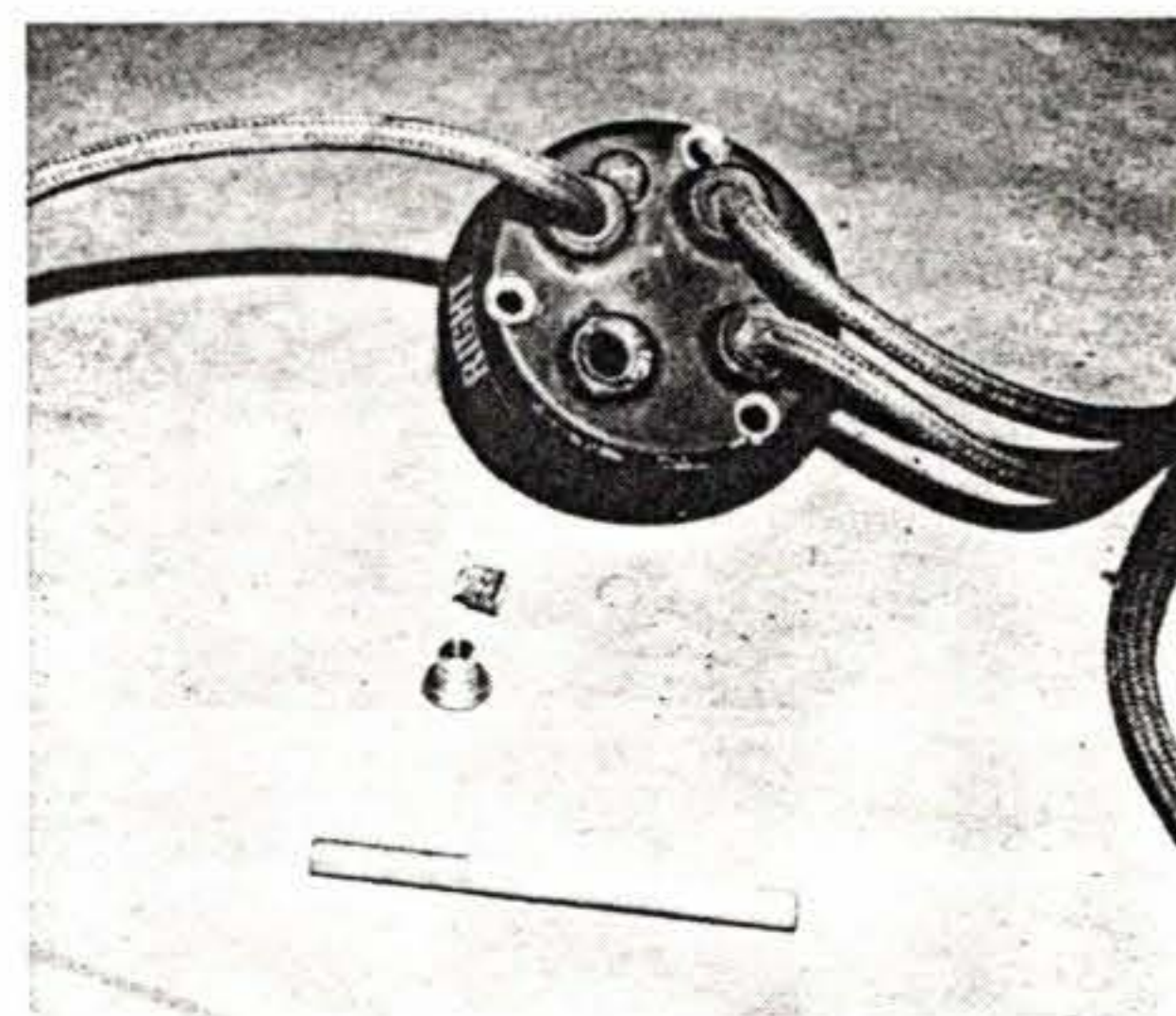
In order to gain access to the magneto end and get enough free cable to work with, you may need to clip a few wire-ties (and you'll need to pull the distributor cap off the mag). Once again we'll talk about how to make up a new end on an old wire. Obviously, the same techniques apply if you're making up an entirely new lead from fresh wire.

Start by cutting the bad cable as close to the distributor cap as possible, using the two-step cutting procedure described earlier to prevent damage to the shielding. [If you're going to fix more than one lead, work with one lead at a time, or else carefully label the wires as to location so you don't end up accidentally changing the firing order of your plugs.—Ed.] On the cap, fold the shielding in towards the center of the cable and use the spring assembly tool or a punch and hammer to knock the slug of cable out from the cap. (See photo.)

Mark the shielding for stripping as follows: For Slick 400 and 600 series mags, mark the wire one inch from

*Below: Ignition harness hardware (for the magneto end).*

*Below: The ferrule, punched free and ready to be reused. (The small bit of shielding can be discarded.)*

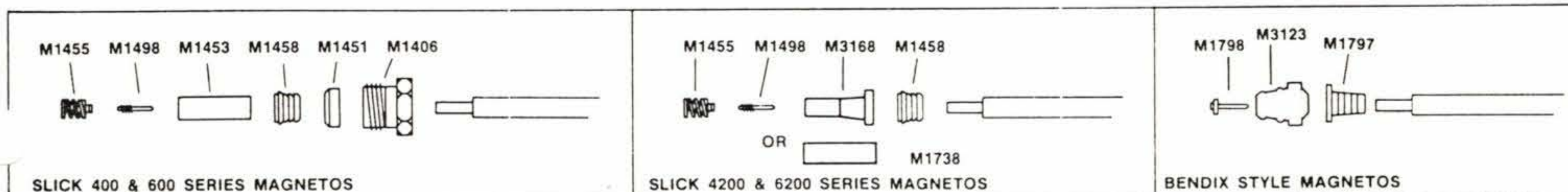


the end; for 4200 and 6200 series mags, make the mark 3/4-in. from the end; and for Bendix mags, mark it 9/16-in. from the end. Once more, removal of the short section of shielding will be easier if you insert a T-112 stripping tool under the shielding before cutting with a sharp knife (being careful to avoid pricking the silicone insulation). The 3/4-in. or 1-in. piece of shielding will then pull off cleanly with the T-112 tool.

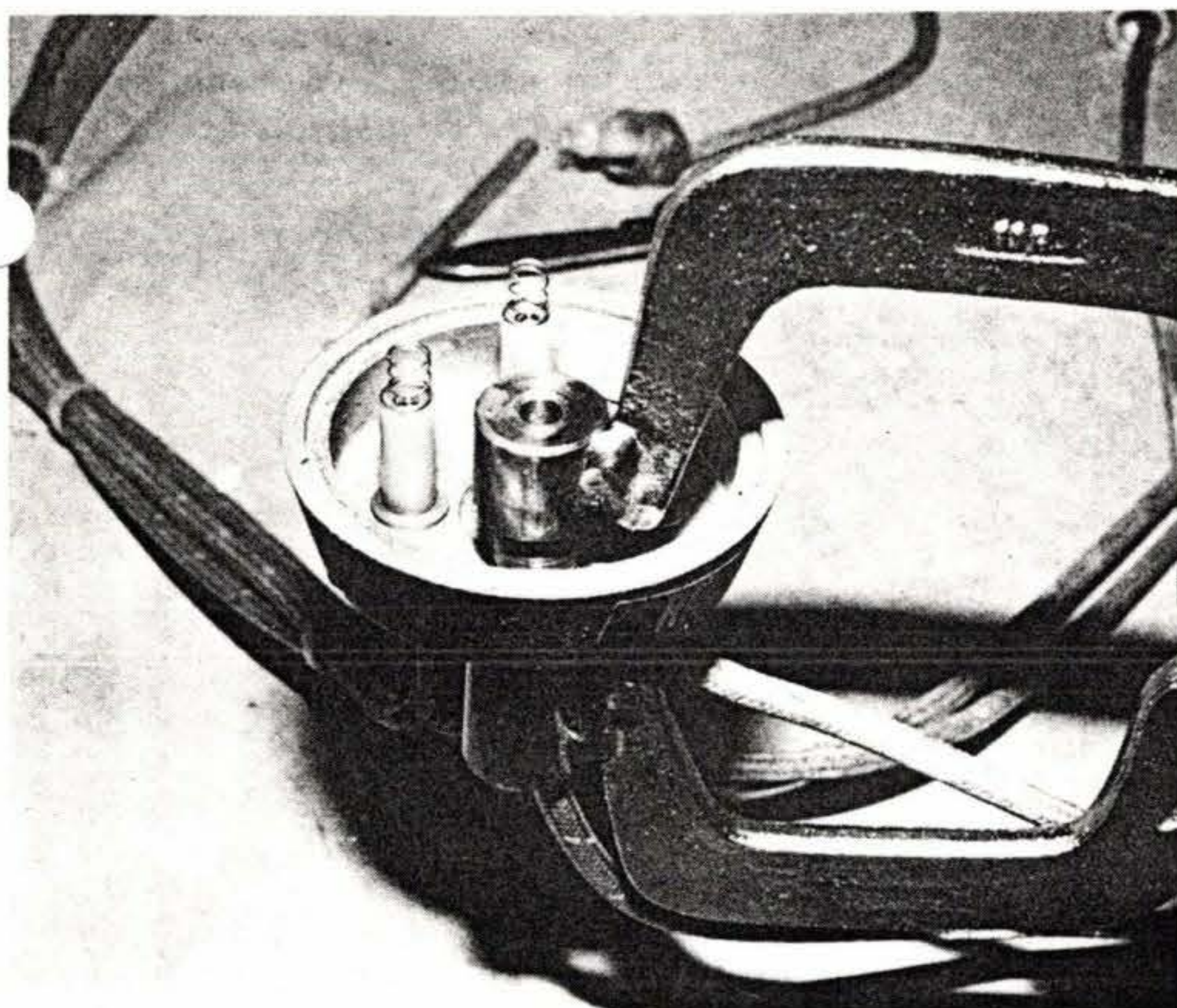
Next, cut 1/8-in. of insulation off the tip of the cable as before, being careful not to pull on (or deform) the coiled conductor when removing the silicone. The coiled conductor should protrude approximately three coils, and the interior of the coils should be clear of debris.

The terminal for a 400 or 600 series Slick harness cap is different from that of a more modern 4200 or 6200 lead in that the older 400 and 600 series Slicks have threaded output towers, which means it's necessary to slip an M-1406 nut onto the wire (with the threaded portion facing the end of the wire, obviously) along with an M-1451 washer. (The beveled side of the washer faces the end of the wire.) If you have a 4200 or 6200 mag, you'll skip the nut and washer.

Pull the cable's free end through  
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*The T-109 pressing pliers are used not only at the spark plug end but also (as here) at the magneto cap end. Its purpose is to ensure good contact of the shielding to the M-1458 drive ferrule and an electrical ground (such as the mag end cap).*

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...ne harness cap a few inches. Flare the shielding (by flexing and rotating the end of the wire), being careful not to let the metal braid cut into the soft silicone insulation. Then slide an M-1458 drive ferrule onto the end of the wire, with the lipped end of the ferrule facing the magneto end of the wire. Push the ferrule into the flared portion of shielding, stopping 1/16-in. short of the shielding touching the ferrule lip. (This was described further above, in the section on making a new cigaret end.) Don't let the shielding actually overlap the lip. Press the ferrule into the magneto harness cap using the T-109 pressing tool. (Bendix mags only: You want an M-1797 ferrule instead of the M-1458, and you want a T-109C pressing tool.)

For Slick applications, screw an M-1498 electrode (or "electrode screw") into the three coils at the end of the conductor wire as described in the previous section. For Bendix mags, push an M-1798 electrode pin into the wire instead. (In either case, use a T-11 pin vise and turn CCW while inserting.)

Next comes the insulator (analo-

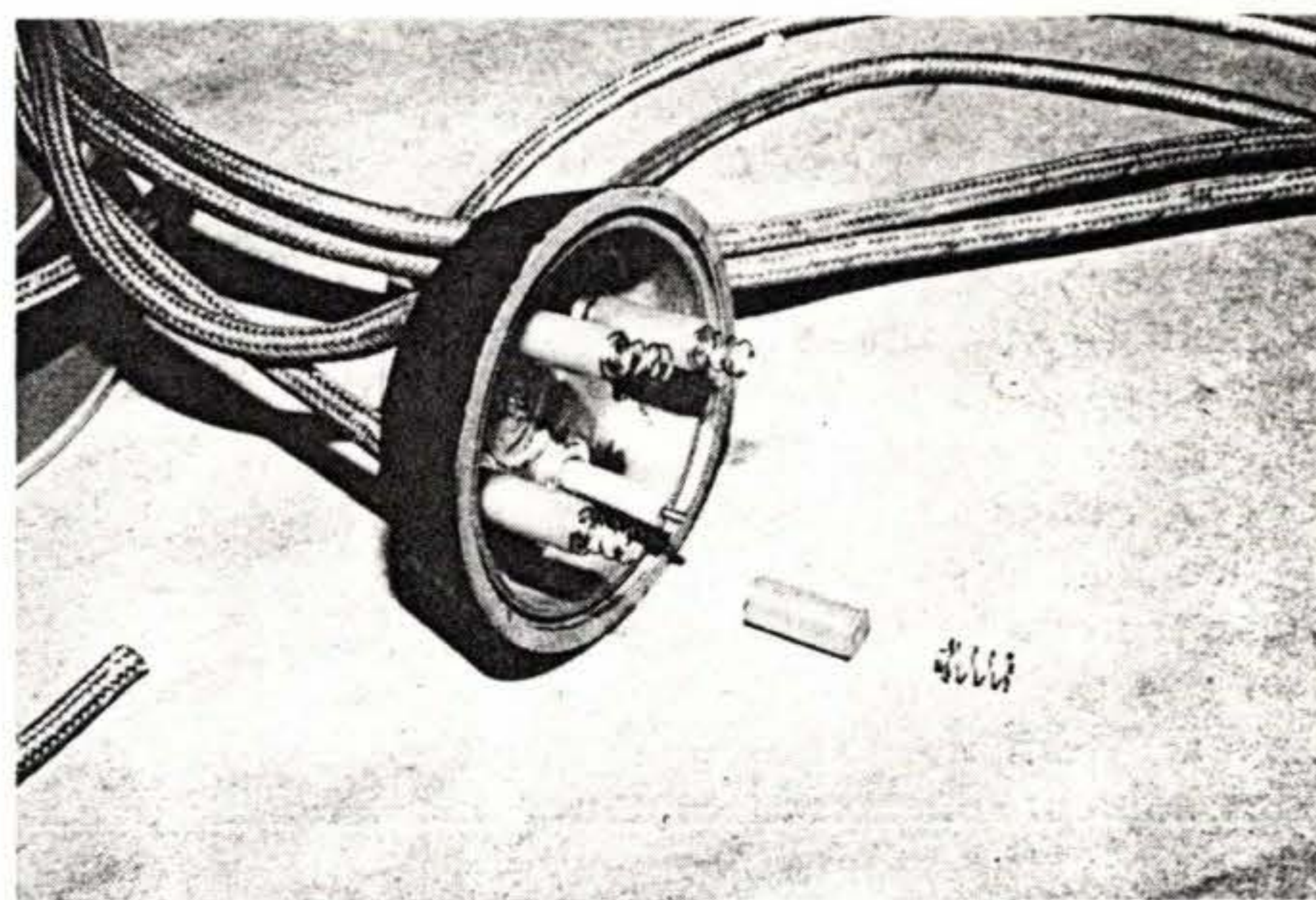
gous to the cigaret at the other end of the wire). For 400 and 600 series Slicks, use a white M-1453 insulator sleeve (one inch long); for 4200 series mags, use an M-1738 (white, 3/4-in.); for 6200 Slicks, use a brown M-3168 (3/4-in.); and for Bendix mags, use a brown M-3123 insulator. Regardless of P/N, clean the insulator with solvent and avoid touching it afterwards.

Bendix mag wires need no further work at this point, since Bendix spring contacts are integral to the magneto. With Slicks, however, the spring contacts are integral to the wires in the harness cap. So to finish the job, get an M-1455 cigaret spring and (using the T-115 spring assembly tool) turn the spring clockwise onto the electrode screw threads in the end of the wire assembly. (Turn three full turns or until the end of the screw is flush with the first large coil of the spring.)

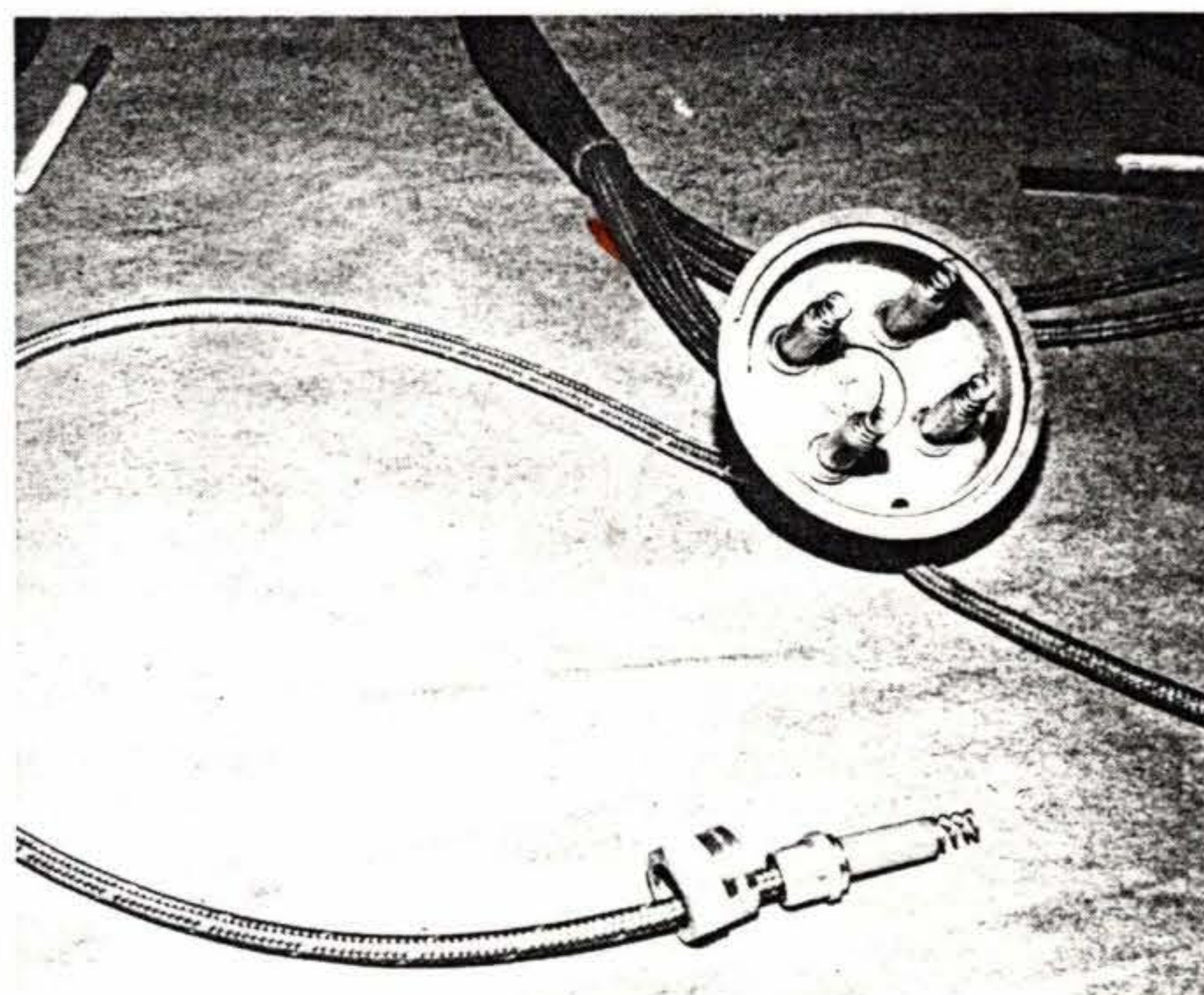
At this point, you're done.

#### **Parting Comments**

Virtually everything described in this article requires a signoff by an A&P mechanic, so don't just dig in and expect that somebody will sign it all off after you're done. Contact your



*After pressing the cap and ferrule together, the proper insulator and contact spring can then be installed.*

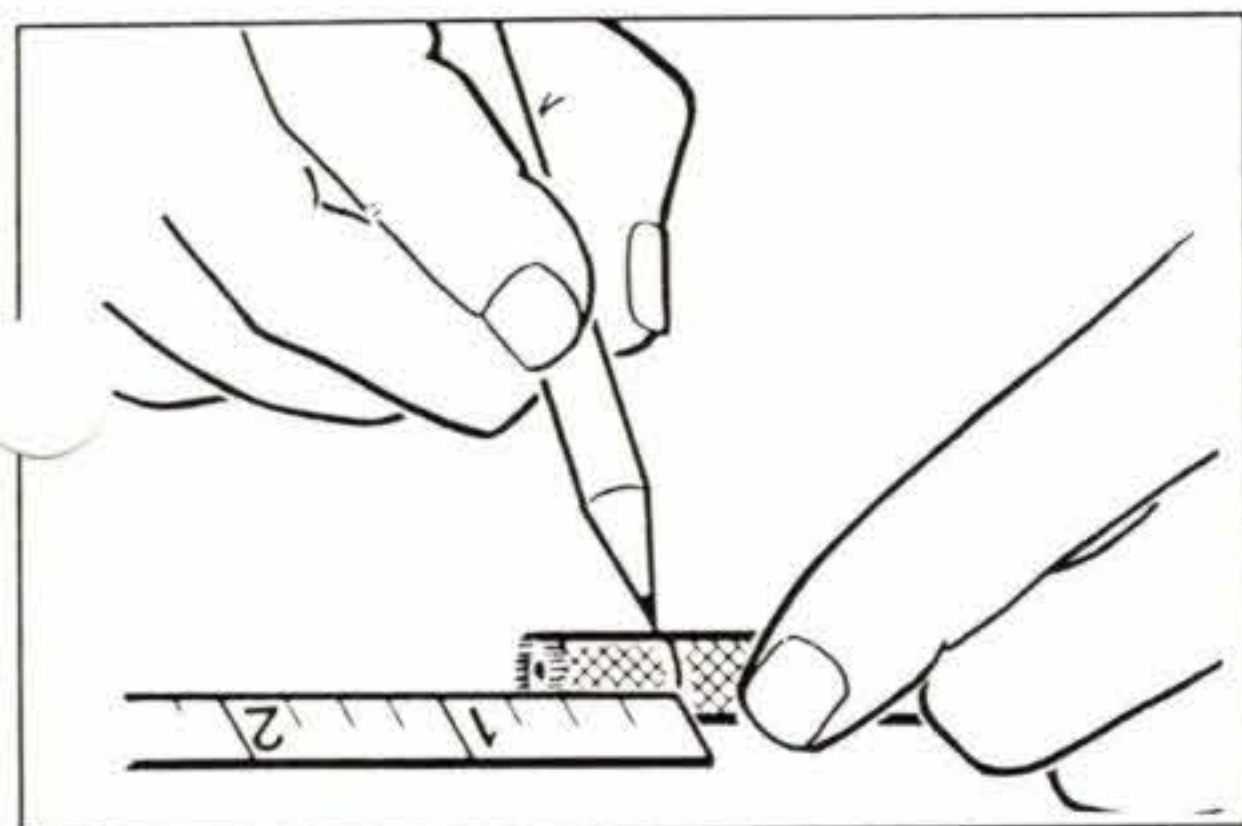


*The finished lead, with new spark plug termination and magneto cap end.*

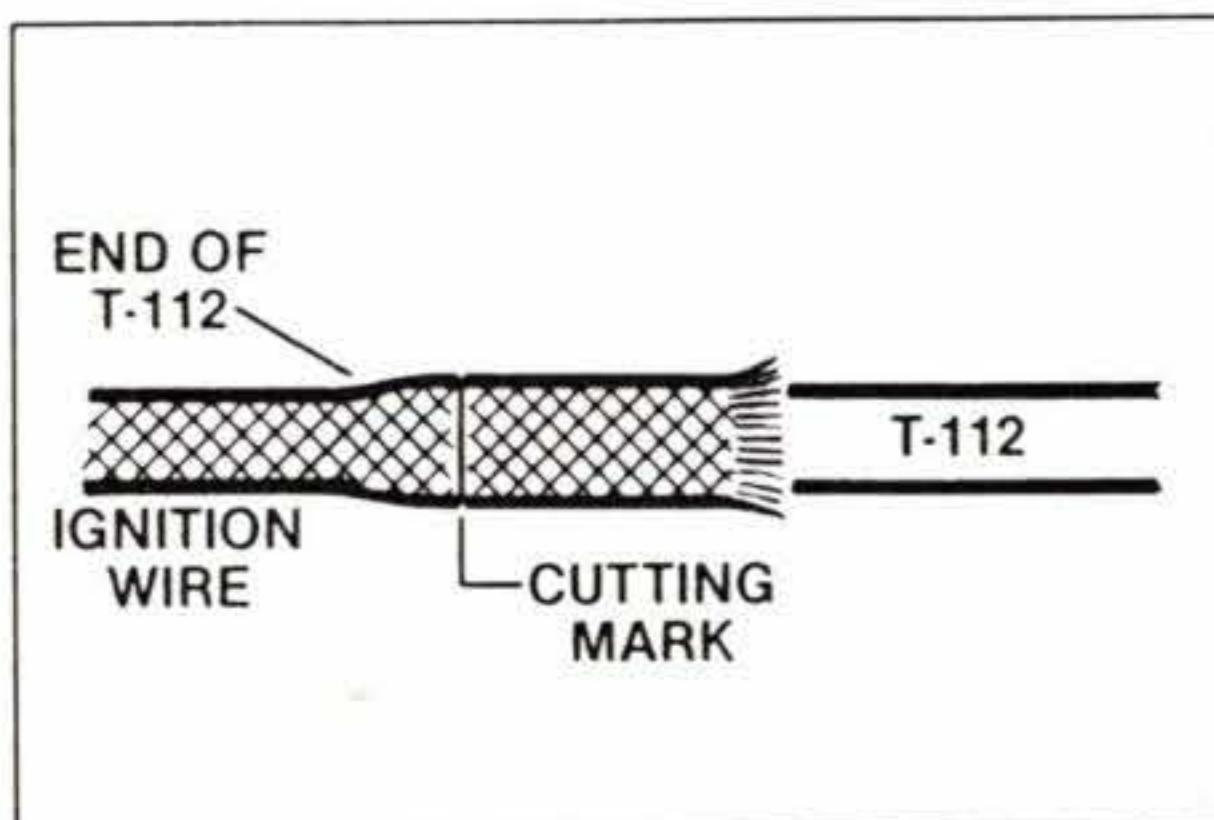
A&P before you start. And don't hesitate to call on him at any point if you're unsure about something. An A&P is going to want to be absolutely sure that you know what you're doing, because he really can't (for example) inspect a drive-ferrule/harness-cap connection after it's been press-fit together to see that you've joined the parts together with the shielding properly positioned.

The astute reader has probably noticed that most of the special-purpose tools listed above are of the "nice, but not essential" variety and can be dispensed with, with the possible exception of the T-109 pressing tool (which is actually nothing more than a set of Vise-Grips with special ends that fit the ferrules). I have been told by knowledgeable sources that if you

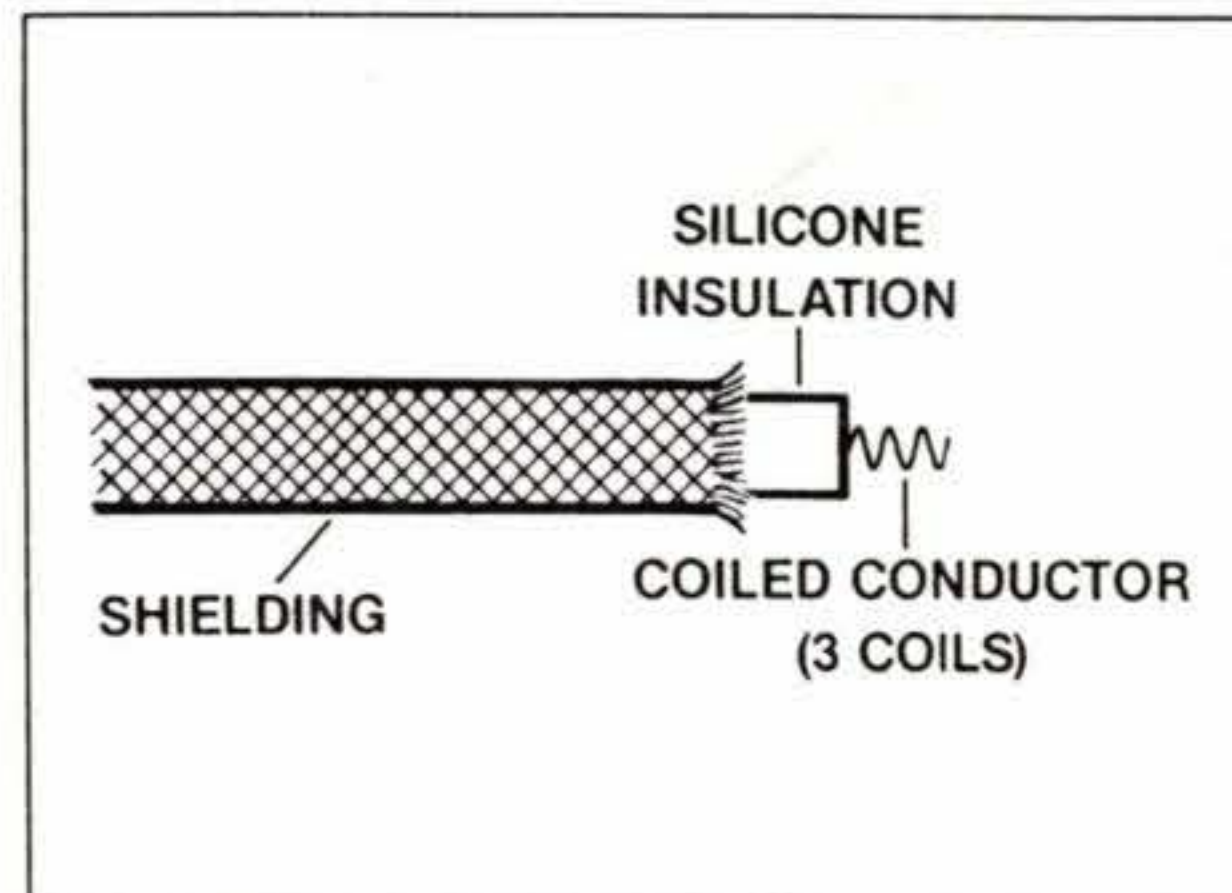




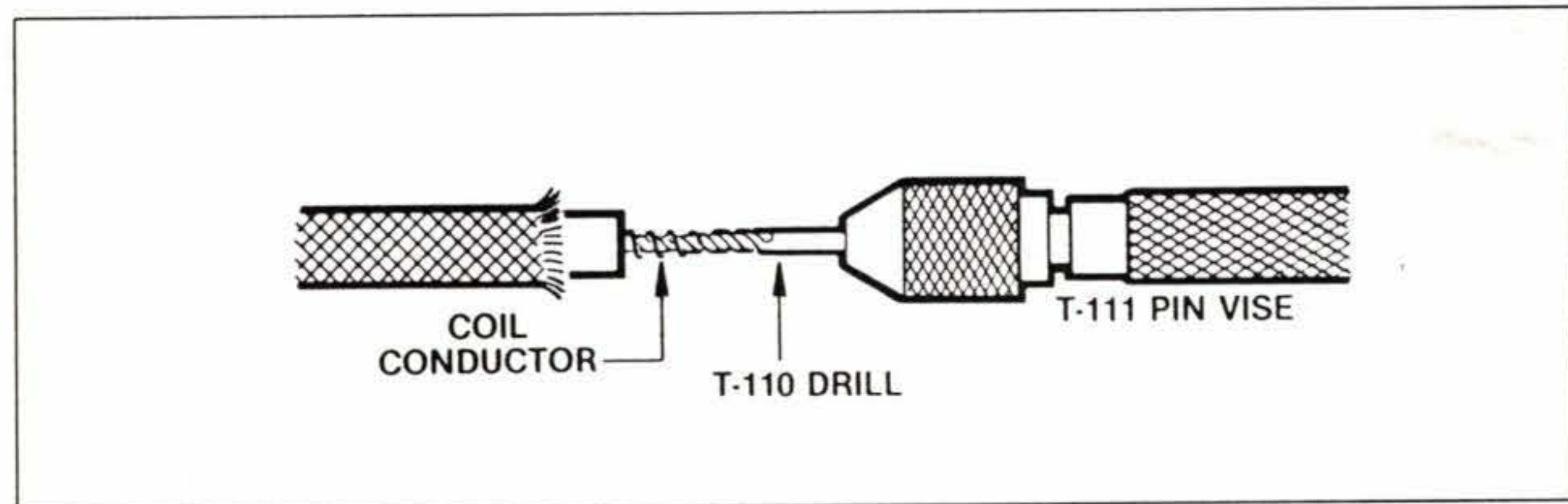
Mark the shielding 15/16-in. from the end (to make a 5/8-24 standard spark plug termination).



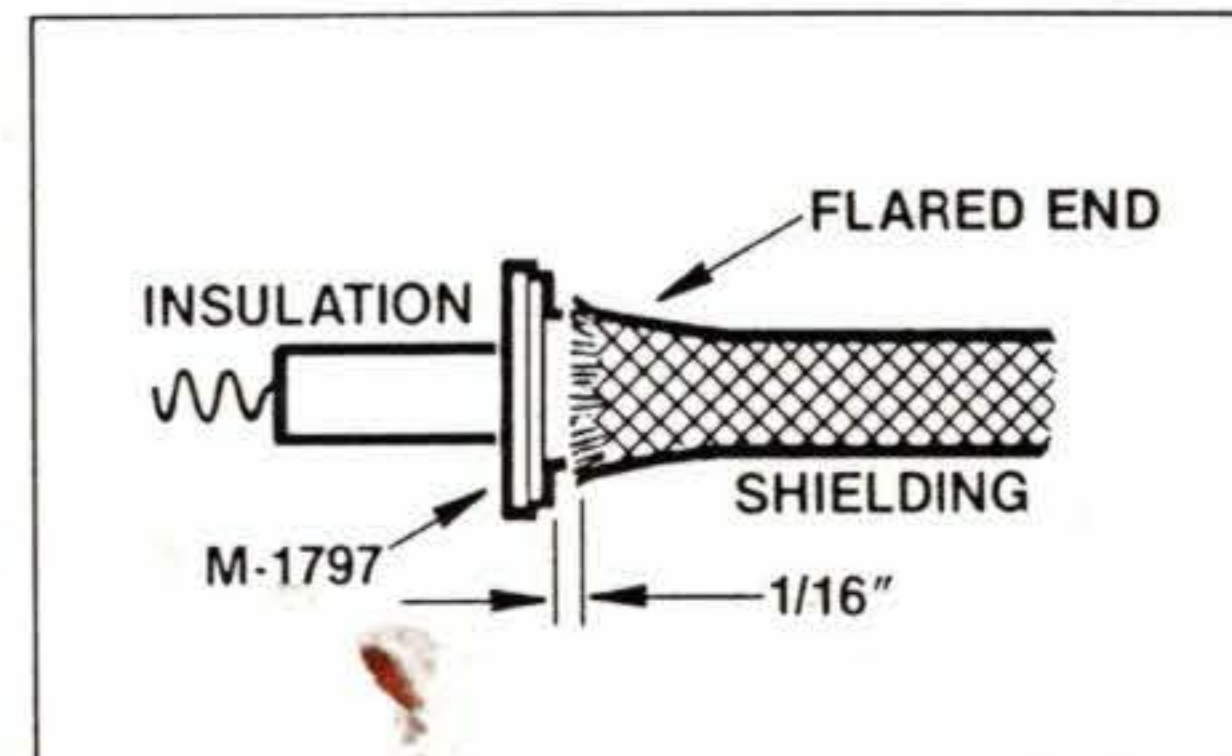
Insert the T-112 stripping tool under the shielding to beyond the mark. Then cut along the mark with a sharp knife.



Carefully remove insulation to expose three coils of wire. Do not stretch the coils.



Using a No. 72 drill and the T-111 pin vise, remove silicone insulation from the center of the coiled conductor to a depth of 1/2-inch. (Turn the drill CCW when withdrawing.)



When inserting the flared end of the M-1458 or M-1797 drive ferrule into the shielding, stop 1/16-in. short of the ferrule's lip as shown here.

find yourself stuck in the Mongolian outback, two sets of channel-lock pliers will work just as well. You'd be well-advised to have a steady hand, however, when trying this; and it'd be a good idea to protect the ferrules and cap from the bite of the channel locks (by applying duct or masking tape to the jaws of the pliers, for example).

Slick has some excellent publications that deal with the operations described here. In particular, I recommend the *Ignition Lead Assembly &*

*Installation Manual* (L-1178-A) and the *Harness Maintenance Manual* (L-1177-A). Both are available together for \$5.00 from Slick Aircraft Products, Unison Industries, Inc., 530 Blackhawk Park Ave., Rockford, IL 61108 (phone 815/965-7704). While you're at it, request Forms L-1039-A (mag end) and L-1040 (plug end); these brochures describe all of the foregoing steps in somewhat abbreviated fashion. If you have a Bendix dual mag (D-2000 or D-3000 series), Slick offers

Form L-1042-A telling how to do all the above for a dual harness cap.

For information on Electrosystems harness kits, write P.O. Box 273, Ft. Deposit, AL 36032 (or phone 205/227-8306).

Mark Howards is a CAD/CAM specialist and Warrior owner based in the Boston area. We told him to do this story.

## Crusty Contact Commentary

A couple years ago, I was preparing to depart Columbia County Airport (Hudson, New York) in the 310 when, on pre-takeoff runup, I fell victim to a bad rpm drop that just wouldn't go away. No amount of mixture leaning or static running would clear the problem up, so I taxied back in, leaving the right engine running on the bad mag. It was rough as a cob. After shutting down, finding the cold jug was a simple matter of touching plastic pen to each exhaust riser. The offender, it turned out, was cylinder number six.

Richmor Aviation's Sal Alessi and I spent the next 20 minutes removing, cleaning, and bomb-testing (i.e., pressure-testing) both spark plugs from the No. 6 jug and safety-wiring the cowl doors for a brief open-cowl ground run. But alas, even with clean plugs, the 200 to 300-rpm mag drop was still there.

We were all set to remove the No. 6 injector nozzle when Sal got the idea to pull the harness cap off the right mag (a Bendix 200-series) to see what evil might lurk therein. When the cap came off, the problem became evident: One wire's contact pin was burned and black. "Look here," Sal said, holding the cap in my face. "See the way the pin is cocked over?" It had been driven into the wire at a 30-

degree angle. "Somebody didn't put the pin in straight."

I never did find out who installed the pin wrong (it wasn't me, I swear). No matter. In seconds, Sal was back out on the ramp with a fresh M-1798 contact pin in one hand and T-111 pin vise in the other. After ensuring that we had enough good wire to work with, Sal cored the old pin out and had a new one pressed in faster than you can say "shower of sparks."

Minutes later, I started the right engine again and happily gave Sal the thumbs-up on selecting single-mag operation. We had indeed found the problem.

For 90 cents in parts, I was on my way.—Kas Thomas