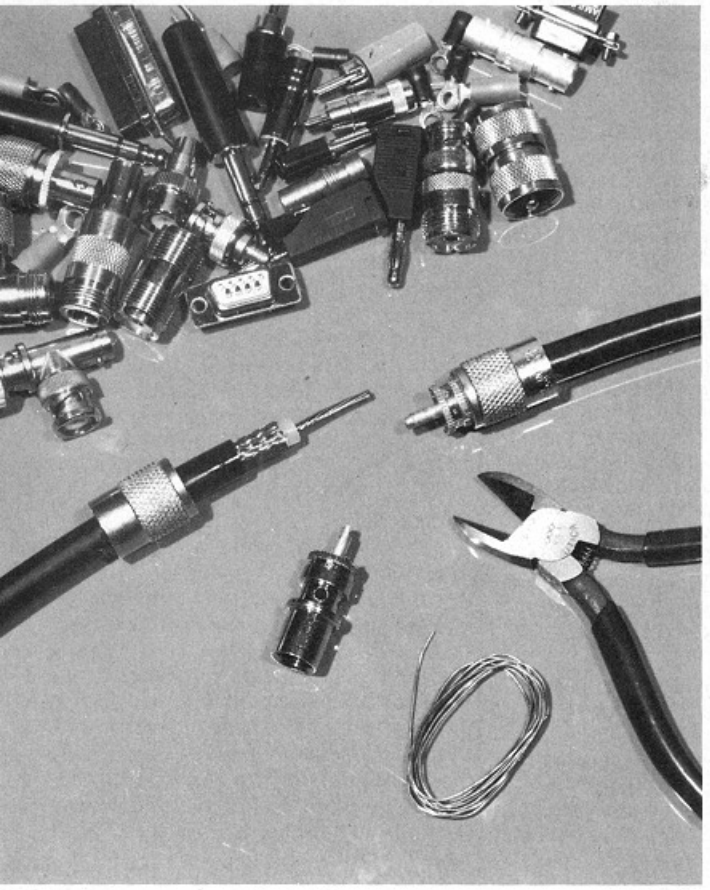


(Photo by NU1N. All other photos in this part, except Fig 1, are by NT0Z.)

Connectors for (Almost) All Occasions—*Part 1*

At some time in your ham career, you'll probably need to make interconnecting cables. Here's help with applying common ham-station connectors so you can minimize busywork and concentrate on communicating.

By David Newkirk, WJ1Z
Senior Assistant Technical Editor

You're a rare ham indeed if you can put a new radio on the air right out of its box. Even if you're gutsy (or foolhardy) enough to end-run The Operating Manual Guilt Trip (usually couched in terms somewhere between "read all instructions" to "only an *ungrateful slob* would power up this equipment without first consulting this painstakingly prepared manual"), you're almost sure to be stopped in your tracks by Lack of Proper Interconnecting Cables. *Now* they've got you! *Now* you'll have to trade Instant Radio Gratification for reading the manual *and* doing a bit of grunt work. *Grrr!*

Well, relax. It's worthwhile integrating your gear with well-made interconnecting cables instead of a sleazy web of clip leads and bargain audio patch cords. Your station will look *and work* better if you do the job right. You may already possess some of the necessary cables; you may be able to buy some of them ready-made. Those you don't own or can't buy, you'll have to make yourself. This two-part article provides help on the do-it-yourself front by *showing* you how to install most of the connectors you're likely to need in your Amateur Radio station.

This month, I cover phone and phono connectors available at Radio Shack (and many other outlets). Next month, I'll cover DIN, microphone and antenna plugs: UHF-series (PL-259), BNC and N connectors. I *won't* cover F, "mini UHF," SMA, TNC and a host of other RF connectors not currently used in the majority of Amateur Radio stations. I also won't cover fiber-optics, rotator, Molex, banana, power and ground connectors. And I won't cover connectors commonly used for computer data (DB9, DB25 and so on), because Bruce Hale covered that family in January 1991 *QST* (see Further Reading for details). (Hint, though: If you need a shielded, standard-length serial-data cable that completes all 9 or 25 signal lines, *buy a ready-made cable* and save yourself the hassle of making *and maybe having to troubleshoot* a bunch of closely spaced connections yourself.)

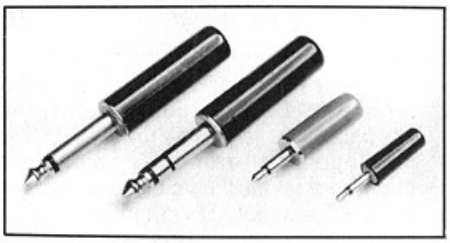


Fig 1—Phone plugs handle headphone and key/paddle signals in many MF/HF transceivers, and mike and PTT inputs in many hand-held transceivers. This photo shows, from left to right, ¼-inch, two-conductor; ¼-inch, three-conductor; 1/8-inch, two-conductor; and 3/32-inch, two conductor plugs. Radio Shack carries them in a variety of sizes, configurations and colors.

The Cables Ham Connectors Connect

Electronic equipment receives its power from, and communicates with, the outside world via a vast and burgeoning array of cables and connectors. Luckily for radio amateurs, though, interconnection standards, some official and most unofficial, have evolved to meet ham-equipment interconnection needs with a relatively narrow range of cables and connectors.

Ham stations use three basic cable types: coaxial cable or *coax* (two syllables: *co-ax*)—insulated wire surrounded by a concentric metal (commonly wire-braid) shield), multiconductor shielded cable and "zip" cord (so named because you can

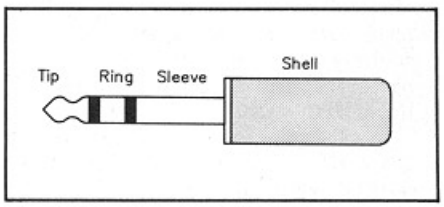


Fig 2—The standard names for phone-plug contacts are *tip*, *ring* and *sleeve*. The *shell* is the plastic or metal cover that screws over the sleeve base to protect the plug terminals. Shells sometimes include a spring, rubber or plastic strain relief.

Suggested Tools for Connector Installation—Part 1

Which of these tools you'll need depends on the type and number of connectors you need to install. Before starting work, anticipate your requirements by working the job through in your mind.

Diagonal cutters—large (for cutting thick cable) and small.

Continuity/short-circuit checker—A digital voltmeter (DVM), digital multimeter (DMM) or volt-ohm-milliammeter (VOM) or even just a flashlight bulb in series with a dry cell, will suffice.

Emery board or small file—for removing hard-to-solder plating.

Eye protection—whenever you solder, saw, drill, pound, cut or snip.

Flux remover—usually not required, but if excessive flux remains on a completed connection, denatured alcohol—dabbed with a cotton swab—works fairly well if applied *soon after soldering*. Otherwise, use a commercial flux remover (Radio Shack 64-2324 or equivalent).

Lighting—good lighting sufficient for the job.

Magnifier—mounted on gooseneck or adjustable arm—for reducing eyestrain if close work taxes your vision.

Marking pen, permanent, fine-tip—for marking cut or strip lines on wire or cable insulation.

Needle-nose pliers, small, with side cutter.

Operating manual(s) for the equipment to be interconnected—Operating manuals can show you connector pinouts and types required; some manuals may make your connector-installation job even easier by suggesting what type of cable to use.

Paper and pencil—for taking notes and making pinout sketches as you go.

Razor knife, utility or disposable—for stripping wire, braid and scraping terminals to base metal.

Soap and water—to wash your hands after you're done, or in the middle of the job, *before* you handle food or smoking materials.

Solder—60/40 "electronics" type with rosin core. Silver solder (Radio Shack 64-013) is best for soldering silver-plated terminals/connectors, but standard solder is acceptable.

Soldering flux—nonacidic paste (Radio Shack 64-021) or liquid.

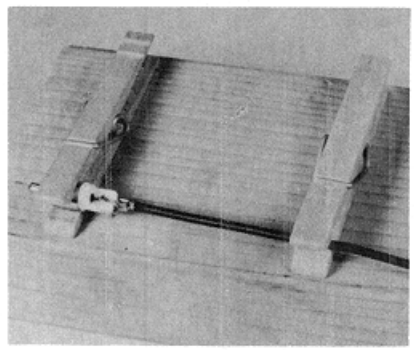
Soldering iron—A pencil iron is sufficient for phone and phono connectors. An adjustable-heat iron is a plus.

Soldering jig or "third hand"—to hold connectors and wires in place for soldering. One or two pairs of pliers rendered spring-closable by doubling rubber bands around their handles may suffice; in a pinch, and if your work surface allows, you can tape the connector and cable down with masking or packing tape.

Vacuum cleaner, shop or hand-held—to clean your work area after the job is done.

Ventilation (or a respirator)—to keep you and others from breathing soldering fumes.

Waste basket—where to put snipped-off wire, insulation and—perish the thought—ruined-beyond-recovery connectors and cable.—*WJ1Z*



A soldering jig like this takes less than 10 minutes to build and makes connector installation much easier. Brads, driven through predrilled pass holes to avoid splitting, hold clothespins to a piece of 2 × 4.

separate its two conductors by grabbing one in each hand and pulling—*zip!*). Those cables will need connectors of seven possible types: phone, phono, microphone, DIN, UHF, BNC and N.

Coaxial cable is more than just feed line. It's standard for signal inputs (mike, key, modem, voice recorder, transverter) and most signal outputs (modem, antenna, voice recorder, transverter, amplifier control). Of these, antenna and transverter-RF connections in particular must be well-shielded to avoid signal loss and leakage. Unlike audio hookups, antenna and transverter-RF connections are also generally *impedance sensitive*—the coax involved must operate at or near its *characteristic impedance* (in most ham installations, ≈50 or, less commonly, ≈75 ohms) to ensure maximum power transfer and efficiency. RF cables commonly used in 50-ohm systems include RG-8 and RG-58 variants (foam or solid dielectrics, solid or stranded center conductors) and RG-174 (about 1/10 of an inch in diameter, for short receiving and low-power-transmitting runs). In 75-ohm systems, hams use RG-11 and RG-59 variants (foam or solid dielectrics, solid or stranded center conductors). But 50-ohm coax is pretty much standard.

Although cable impedance is generally unimportant in mike, key, modem, voice-recorder and amplifier-control hookups, using well-shielded cable in these applications minimizes audio hum and RF pick-up. *Braid*-shielded audio cables are generally okay for this purpose; *spiral-wrap*-shielded audio cable *isn't* because spiral-wrap shielding isn't very effective at radio frequencies. Hint: You generally can't go wrong by using RF coax for audio and control lines. Of the cables just mentioned, RG-174 serves best for this application because of its small diameter and flexibility. Radio Shack carries RG-8, RG-58, RG-59 and braid-shielded audio/data cables.

Your station probably already contains zip cord in the form of two-wire power cords, speaker wire and headphone cables. It's a good idea to limit your use of zip cord to such low-impedance, high-signal-level situations because zip cord's lack of shielding can cause exasperating control glitches, hum and feedback in low-level (mike/modem-audio, keying and control-signal) hookups. (In case you're wondering, zip cord makes *really* crummy RF transmission line, as "Further Reading" can reveal.)

The Connectors Ham Cables Connect

Before I discuss connector installation, and which connectors our radios require for particular interconnection tasks, I must plug the obvious: *Look to your radio's operating manual as your best source of information on your radio's connector needs.* Why? Well, try this instant quiz: You need to wire a three-conductor phone plug to connect a paddle to your radio's internal keyer. Which plug terminals equate with common, dot and dash? Hint: There is no industry-wide paddle-wiring standard. Solution: Don't guess; *read the manual!*

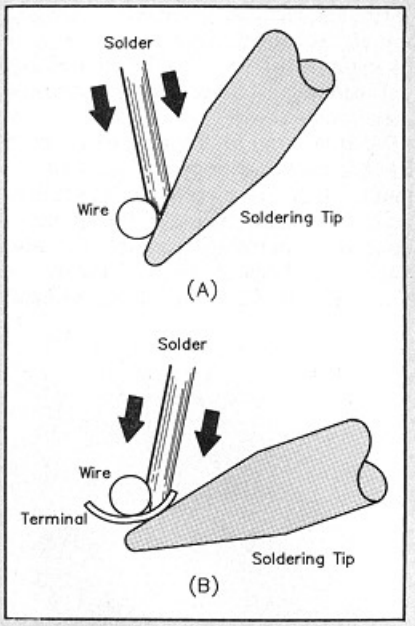
One more suggestion before I get to the connectors: Have a look at the sidebars "Suggested Tools for Connector Installation—Part 1" and "Connector-Installation Hints and Kinks—Part 1." They'll give you more information about what you need to do—*before* you start to do it!

Phone Plugs

These connectors (Figs 1 and 2) come in three common diameters (1/4, 1/8 and 3/32 inch, the smaller two of which are sometimes specified metrically [3.5 and 2.5 mm]). Each size is generally available in two electrical configurations (two-conductor ["monaural"] and three-conductor ["stereo"]). (Radio Shack currently does not stock three-conductor 3/32-inch plugs.) Many MF/HF transceivers handle key and headphone hookups via 1/4-inch phone jacks, and external-speaker connections via 1/8-inch phone jacks. (Computer-controllable ICOM transceivers generally accept serial-data I/O

Connector-Installation Hints and Kinks—Part 1

- Obtain (or construct) and *use* a soldering jig.
- If the connector includes a shell, ferrule or coupling ring through which the cable must pass, slide it on the cable—*facing the right way—before* you solder the cable to the connector.
- Use the strain-relief portion of a connector whenever possible so your soldered connections won't have to withstand physical stress.
- When installing zip cord, pay attention to and use its conductor indexing scheme. (Some manufacturers index speaker wire by tinning one conductor and leaving the other bare [and therefore copper-colored]; on many zip cords, one wire's insulation is ridged or striped. In my station, I use the darker, ridged or striped wire for negative, common or ground.)
- Check for continuity and short circuits as you go, especially when working on multipin connectors or installing connectors on both ends of a cable. If you don't check connector integrity when installing plugs at both ends of a cable, *and* if the cable tests shorted after you've installed both connectors, which connector—if not both—must be reinstalled? (Hint: Murphy's Law all but guarantees that if one only connector is bad, you'll snip off the *good* connector *first!*)
- Minimize soldering time at the connector terminals by staging the job: (1) flux and tin the connector terminals or solder cups; (2) strip, flux and tin the cable wire(s); (3) solder the tinned wires to the connector terminals.
- If you encounter difficulty soldering to nickel-plated connector terminals with rosin-core solder, scrape or file them down to their base metal—commonly brass—and try again. A dab of soldering flux (Radio Shack 64-021 or equivalent) may also help. Don't remove *silver* plating, though, and don't unnecessarily remove even silver *tarnish*: The tarnish layer protects the underlying silver from further tarnishing and conducts almost as well as silver itself.)
- *Solder rapidly* as opposed to following the misleading "use minimum soldering heat" instruction so commonly preached. Soldering well, cleanly and quickly with a hot—700- to 750-°F—iron gives much better results than torturing cable and connector for half a minute with an insufficiently hot iron. Use as heavy a soldering-iron tip as feasible, too; heavier tips' higher heat-storage capacity allows them to heat connections faster. Staging the job (see the previous item) goes a long way toward minimizing heat damage to wire and connector insulation.
- You'll need a hotter soldering iron if you solder in moving air—especially cool or cold air. A soldering iron just sufficient for an indoor job may be useless outdoors.
- See "Further Reading" for more on soldering safety.
- Keep cable wires, especially those with PVC or foam insulation, as straight as possible when soldering, and solder as quickly as you can if you must attach bent or sharply curved wires to a connector. Overheating bent wires may cause heat-softened insulation to lift away from the wire. If this happens, snip off the ruined wire, desolder and clean the plug, and start over.
- You can improve the longevity of a well-installed plug by filling its shell with hot-melt glue; "Further Reading" reveals how.—*WJ1Z*



A well-tinned soldering tip is a must, of course, but you can further speed connector installation by feeding the solder into the line or point where the soldering tip and wire (A) or wire and connector terminal (B) meet.

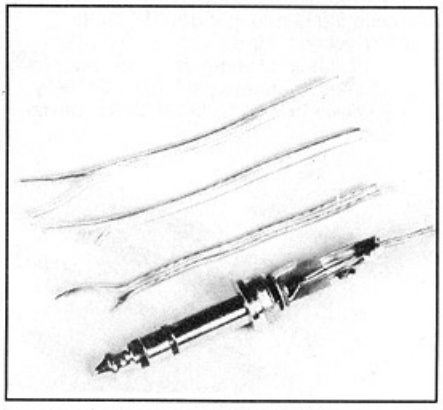


Fig 3—Installing a phone plug to zip cord is easy: Split the cord conductors; cut the sleeve conductor to match the plug terminal spacing; strip and tin; solder; crimp the strain relief; and screw on the shell. (To avoid that sinking "I've been had" feeling, be sure to slide the shell on the cord the right way *before* soldering the cord conductors to the plug!)

Yes, I wired this three-conductor plug to connect only two conductors; its sleeve terminal is unused. You can take either of two approaches when preparing *coaxial* cable for connection to a phone plug: solder the braid into the strain relief; or separate and twist the braid to treat it as a single wire.

[input/output] via 1/8-inch jacks, too.) Hand-held transceivers commonly use 1/8-inch phone jacks for external speaker and 3/32-inch phone jacks for multiplexed mike and push-to-talk (PTT) connections. (For the record, some older MF/HF gear [notably, a number of transmitters and transceivers made by R. L. Drake and Collins] used three-conductor, *0.21-inch-diameter* plugs for mike and PTT connections.)

In buying phone plugs, you may be confronted with the choice of solder versus screw terminals. If you *do* have a choice, get plugs with *solder* terminals. Screw-terminal connections pose two problems: Tightening the screws over stranded wire may squeeze out stray strands and short-circuit the plug; and screwed-down wires tend to work loose over time because screw terminals are usually intended to double as strain reliefs. If you must buy screw-terminal plugs—or you buy screw-terminal jobs by mistake, as I did in preparing this article!—remove the screws and treat the screw holes as solder terminals.

Fig 3 shows how to apply a phone plug to zip cord. Split the cord for a half inch or so. Using the plug as a cutting guide, cut the sleeve conductor to match the plug-terminal spacing. Strip and tin the cable wires. *Slip the shell—facing the right way—onto and down the cable.* Tin the plug terminal(s), keeping their hole(s) clear. Solder the cable wires to the plug terminals. After the plug and cable cool, use needle-nose pliers to gently crimp the strain relief around the cable. Screw on the shell, and you're done.

Phono Plugs

Many radio amateurs call these *RCA phono plugs* because of their early association with Radio Corporation of America phonograph equipment, but I'll call them just *phono plugs* because many manufacturers make them. Base-station-transceiver manufacturers make extensive use of phono

connectors for low-level audio, RF and control connections; some older ham gear (notably, some transceivers and transmitters manufactured by Collins and Heath) used ceramic-insulated phono jacks as antenna connectors.

The archetypal phono plug offers complete shielding when properly installed; next month, I'll discuss where you can get these and how to install them. Of the solder-on phono plugs currently available at Radio Shack (Fig 4 shows two of them), the metal-shell "shielded" variety offers better *partial* shielding than plastic-shell models. (See the sidebar "Shielded Connectors that Really Aren't.")

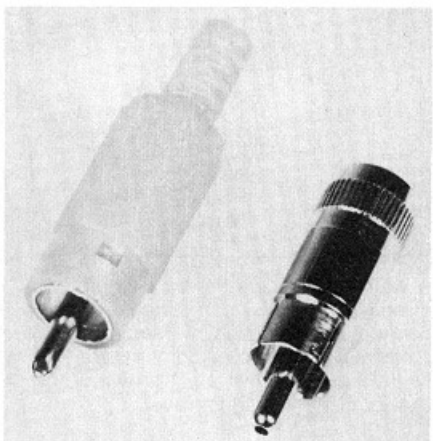


Fig 4—Two Radio Shack incarnations of the ubiquitous phono plug. The metal-shelled version (Radio Shack 274-339, right) affords a bit more shielding than its plastic-shelled counterpart (274-451, left). Fig 5 shows how to install both to coaxial cable.

Fig 5—Installing a phono plug to coaxial cable is easy: Bare enough cable braid to clear the connector strain relief; remove about half the braid; strip about 1/16 inch of insulation from the center conductor; tin the center conductor, braid, center-conductor contact and the inside of the strain relief; *slip the connector shell, facing the right way, onto the cable*; solder the center conductor to the plug's center-conductor contact; crimp the strain relief around the braid and solder it; and install the shell. This photo shows unshielded and shielded (lowermost) phono plugs installed on RG-174 coaxial cable. Although the shielded plug allows you to continue the cable center conductor through to its center-conductor-pin tip, doing so offers no advantage and merely uses more cable.

"Shielded" Connectors That Really Aren't

Phone and phono connectors come in plastic- and metal-shelled versions. Those with metal shells are usually termed *shielded* and cost more than their plastic-shelled equivalents. Does the extra shielding they provide justify their higher cost?

Probably not, if you seek a significant improvement in the connector's *radio* shielding. A water pipe leaks water unless its entire circumference, *over its entire length*, is solid; coaxial cable leaks considerable radio energy unless its entire circumference, *over its entire length*, remains unbroken except for the tiny braid interstices that account for the few percentage points short of 100% shielding that good coax provides. Fig 5 reveals that neither plastic ("unshielded") nor metal-shell ("shielded") phono plugs continue unbroken to the connectors' ground-contact sleeves the entire circumference of the cable braid. The shielded connector's metal shell provides additional *electrostatic* (capacitive) shielding for the connector terminals by interposing a bit of grounded metal between the terminals and the outside world; it does not prevent RF currents flowing on the inside of the braid from escaping to the outside of the braid, and vice versa. Only connectors that require the cable braid to be soldered or efficiently clamped around the entire circumference of the braid and connector body provide RF shielding worthy of the name. I'll discuss such connectors next month.—*WJ1Z*

Fig 5 shows how to install the phono plugs pictured in Fig 4. Using the plug as a strip-length guide, remove enough of the cable jacket to clear the plug's common terminal (which doubles as a strain relief). Remove enough braid to expose about half the length of the insulated center conductor. Strip the center conductor to match the length plug's center-conductor terminal—about 1/16 inch of insulation. Working rapidly to avoid melting the center-conductor insulation, tin the center conductor and braid. Slip the connector shell, *facing the right direction*, onto the cable and out of the way. Mount the connector and cable in your soldering jig. Tin the plug's center-conductor contact and the inside of its strain relief. Solder the cable center conductor into the plug center-conductor terminal. Lightly crimp the strain relief around the braid. *Rapidly* solder the braid into the strain relief, being careful not to melt the center-conductor insulation and short-circuit the cable. Screw on the connector shell (shielded plug) or slip the shell (plastic-shelled plug) over the connector body until the body's shell-retaining tab pops into its matching hole in the shell wall.

Conclusion, Part 1

Now that you've gotten basic connector-installation techniques down with phone and phono plugs, you're ready to move on DIN and mike plugs—multipin connectors that handle an ever-widening variety of interconnection tasks in modern ham shacks. Those mastered, you'll be ready to take on the job of connecting your station to its antenna(s) via UHF, BNC and N plugs. I'll cover these topics next month. See you then. QST

Further Reading—Part 1

On installing mike, phone, DIN and DB-series serial-data connectors: Bruce S. Hale, "Packet Hardware for Beginners," *QST*, January 1991, pages 20-23; "Interconnecting Your Equipment," Larry D. Wolfgang and Charles L. Hutchinson, editors, *The ARRL Handbook for Radio Amateurs*, 1991 edition (Newington: ARRL, 1990), pages 36-10 to 36-12.

On zip cord as a feed line and radiator: Jerry Hall, "Zip-Cord Antennas—Do They Work?," *QST*, March 1979, pages 31-32.

On healthier soldering: Bryan P. Bergeron, MD, "Making Soldering Safer," *QST*, March 1991, pages 28-30.

On improving connector longevity with hot-melt glue: Bob Locher, "A Fix for Cable Breakage at Connectors," Hints and Kinks, *QST*, July 1990, pages 37-38.—*WJ1Z*

New Products

HIGH-VOLTAGE RECTIFIERS

☐ Spi-Ro Manufacturing has introduced 8-kV encapsulated rectifiers intended for high-current power-supply and amplifier applications. Measuring 1.4 × 0.75 × 3 inches (HWD) and rated at 1 A continuous and 50 A peak, these rectifiers, designated HVR-8, have silver-plated copper terminals that are insulated from the case. They can be mounted in any position and operated over a −20 to 135 °C temperature range.

Prices: HVR-8, $7 each in single quantities. Add $2 shipping and handling per order when ordering fewer than four HVR-8s; shipping is free with orders for four or more. Canadian residents: Add $2.50 per order for air-mail delivery. Manufacturer: Spi-Ro Manufacturing, Inc, PO Box 5500, Lakeland, FL 33807, tel 813-646-7925.