We might have called this "Climbing the Ladder of Success." W5QJM shows us how to get more power to the antenna and improve our efficiency.

Working With Balanced Line

BY FRED BONAVITA*, W5QJM

At a recent Saturday morning swapfest in South Texas a prospective buyer spotted an antenna coupler for sale, picked it up, turned it over several times, and looked at the owner inquiringly.

"That's for balanced lines," volunteered the owner in anticipation of the question.

"Oh, you mean it'll tune a balun?" asked the man.

"No, it's to tune balanced feeders. You know, open-wire line," the owner patiently replied.

"Oh, I hate that stuff! You can't work with it," snorted the first man, abandoning his role as a prospective buyer as he put the coupler down and turned away.

Not to be put off, the owner countered, "Oh, but you can, and it's very easy. And you don't waste a lot of power heating up a chunk of coax. Your signal is all going into the air where it belongs."

Unpersuaded, the man walked away, but I caught up with him (let's call him Jim) a few minutes later at the coffee and doughnuts counter. We began talking about balanced feed line. Over coffee I told him the ease with which balanced feeders—known variously as twinlead, ladder line, or open-wire line—can be managed.

Jim countered that while balanced feeders do indeed get the signal to the antenna, coax is easier to handle, cheaper, and more versatile. It took some talking, but I showed him that for the most part he was wrong.

When the coffee break ended, Jim went back to the table, and after a little face-saving haggling over the price, he bought the coupler. He also found a 100 foot roll of 450 ohm twinlead. When last heard from, Jim was happy as a pig in mud. For some reason, he said, he was getting and giving better signal reports.

There are instances when use of coax is inescapable. I use it in my antenna system, but at last count I have fewer than 10 feet of it, mostly linking my rigs to my antenna coupler. An additional 15 feet connect my 2 meter rig and antenna in my car. But that's it. I am an unreconstructed QRPer, and I want my power in the antenna, not absorbed by the feedline.

Rather than reopen the balanced-versus-unbalanced feeder battle here, this article is to help dispel the notion that twinlead or open-wire line is difficult to manage. The second part of this series will show how easy, inexpensive, and satisfying it is to roll your own open-wire line for great performance.

Numerous articles on how easy it is to work with balanced feeders have appeared in the literature[1] over the years, and I will not rerun them here. The footnotes list some of these articles and sources of commercially available feedline.[2]

Lew McCoy, W1ICP, set the tone for a resurgence of interest in and use of balanced line in these pages in an August 1982 article that asked, "A time for revival?" Lew once again proved himself a prophet. One major dealer later reported that over five years "the volume of the stuff through our doors has risen about 2000 percent." Balanced feeders were back.

Before dealing with ways of working with twin feeders, it is necessary to list

Electric fence insulators are an inexpensive and easy tool for managing balanced feeders. Runs of 450 ohm "windowed" ladder line fit over the top. Three-hundred ohm "windowed" line can be held by the hooks on the side, and a pair of these at the required spacing will keep open-wire line in place. (Photos in this article by Don Randall, WB5ROU)

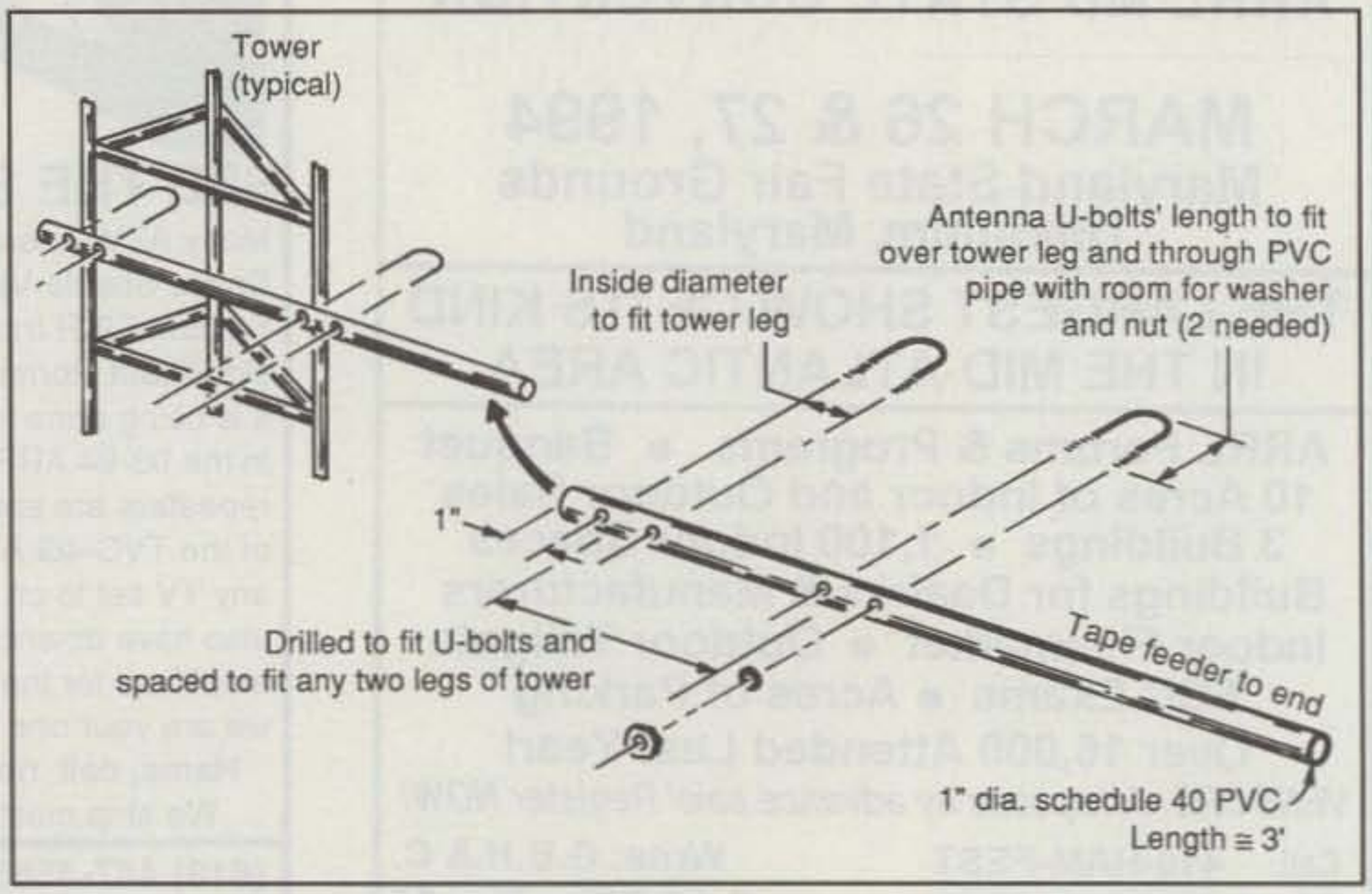

Fig. 1– A simple tower stand-off for balanced-line feeders.

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Electric fence stand-off insulators hold these two runs of 450 ohm ladder line in place under the eaves of the house. Note one at right is twisted about twice each 3 feet. The run at left has been replaced with homemade open-wire line.

some important don'ts (which thereby recite some problems with ladder line) when handling them so mistakes won't be made.

•Keep them clear of metal. The rule-of-thumb holds that balanced line should be kept away from metal a distance equal at least to twice the width of the line. For 300 ohm TV-type ribbon, for instance, that would be about an inch. For 600 ohm line with a spacing between conductors of as much as 6 inches, the separation from metal should be at least a foot. Standing off from a metal tower will be discussed in a moment.

•Don't bury the line.

•Changes in direction of ladder line should be gradual, not abrupt. An arc is preferred to a sharp angle.

•Avoid long, unsupported runs of twin-lead, especially in areas of high winds or where icing could occur. This applies to coax, too.

Okay, with those no-no's out of the way, let's get to handling balanced feeders: routing them from the output of the coupler to the feedpoint of the antenna overhead.

Lew McCoy revisited the problem in the January and February 1993 issues of *CQ*, and those pieces are recommended for some methods of getting the line out of the shack.

I have successfully used another approach for years: I had built an insert for the horizontally sliding window next to the operating position. It is a variation of the wood insert long used for windows that raise or lower vertically.

My insert is made of a piece of Plexiglas® framed with metal and drilled for feed-through connectors. On the inside are the leads from the antenna tuner, and the outside connects to the line to the feedpoint of my antenna.

The inside connectors are quick-disconnect types so the antenna can be unplugged easily and promptly in case of a lightning-packing storm. But they also make a solid electrical connection to transfer the energy.

The Plexiglas originally was a carpet protector for a desk chair in an office building, but it cracked and was tossed in the trash, where I found and salvaged it. Not only did I get the main ingredient of my insert, but I cut up other pieces for antenna end insulators. Over the years I have harvested large pieces of Plexiglas from office trash.

Cutting Plexiglas is tricky, however, and it will fracture at the slightest wrong pressure from a saw. I took mine to a friend who owns an advertising sign shop, and he cut it to order in a matter of minutes on a saw equipped with a special and expensive blade.

My next trip was to the shop of a man who specializes in replacement window screens. He caught on immediately as to what I wanted, and since he knew the measurements of the standard-size windows in my house, he was able to frame my insert in a matter of hours. The cost was $10, but that was in the mid-1980s. The insert went with me when I moved and fit exactly in the window of my new house.

The outside edges of the insert were lined with adhesive-backed weather stripping, and the whole thing fits snugly into the window frame. For security, the sliding portion of the window is kept from being opened farther. Could a burglar pry it loose and gain entry? Only by pulling the window out too, and that would be a noisy job.

Having found a way to get my leads outside without having to drill any holes in the house, I began tackling the job of running the ladder line into position to approach the antenna feedpoint from a right

A close-up shot of the insert in the window shows the snug fit and the 450 ohm "windowed" ladder line leading off to various antennas.

angle. That meant snaking the feeders a short distance along the roof overhang.

Several options were available. The easiest and least expensive were plastic stand-off insulators for electric fences, and I found a package of them for a few dollars at a farm-supply store. They are sold by Radioware and other sources of wire, spreaders, insulators, and the like.

These insulators are ideal for 300 or 450 ohm ladder line—the kind with the "windows" cut in it to reduce weight and pressure on the line in strong winds. These insulators also work with roll-your-own open-wire line. An insulator every few feet not only keeps the ladderline in place, it also lets you tuck the line out of sight. Two are needed to handle open-wire line with, say, more than 2 inches between feeders—one for each side.

My shopping also turned up insulated staples from All Electronics and a simple standoff made from PVC pipe from the Wireman. The staples work well with 300 or 450 ohm twinlead with windows, while the PVC unit handles anything from 72 or 300 ohm ribbon twinlead (with or without windows) to 600 ohm open-wire line.

Despite the fact ladderline and open-wire line cannot be taped to the leg of a metal tower, balanced feeders still can be used easily for antennas hung from a tower. Just stand them off.

Faced with this problem several years ago, I came up with some 3 foot sections of 1 inch diameter, schedule 40 PVC pipe. I drilled the pipe to accept surplus antenna U-bolts, spaced so they would hold the pipe to any two legs on the triangular tower. I then routed the open-wire line to the outside ends of the pipe and taped it in place for ease of removal later. The result was a line that was not affected by the presence of all that metal.

One other hint: When running balanced feed line, whether under the eaves of the house, up the side of a tower, or to the feedpoint, twist the line at least twice in every 3 feet of length. An old hand told me that further reduces unwanted reaction and coupling with nearby objects.

In any event, working with balanced feeders is not the chore some folks would have you believe.

(To Be Continued)

Footnotes

1. L.A. Moxon, "HF Antennas for All Locations," Radio Society of Great Britain publication, 1988, pp. 47–51.

J.D. Heys, "Practical Wire Antennas," RSGB publication, 1991, pp. 34–35.

D. DeMaw, "Feeding Your Station," *QST*, December 1983, pp. 20–23.

2. Among suppliers of commercially-made balanced feedline, stand-off insulators, and wire staples are: Radioware Corp., P.O. Box 1478, Westford, MA 01886 (1-800-950-9273). Free catalog.

All Electronics, P.O. Box 567, Van Nuys, CA 91408 (1-800-826-5432). Free catalog.

The Wireman Inc., 261 Pittman Road, Landrum, SC 29356 (1-800-727-9473). Catalog $2.

The Radio Works, P.O. Box 6159, Portsmouth, VA 23703 (1-804-483-1873). General reference catalog $4.

In this concluding installment, W5QJM reassures us how easy it is to not only use, but make our own open-wire line.

Working With Balanced Line—Part II

BY FRED BONAVITA*, W5QJM

High in the litany of problems allegedly faced by those who use balanced feedline to get their signal to the antenna is the question of which line is best.

Being among those who see no problem there at all, I use whatever is convenient and works under the circumstances. Those circumstances, however, can vary by application. For instance, I use TV-type 300 ohm ribbon from Radio Shack to feed a simple, compact antenna for vacations, camping, and other portable operations away from home. In addition to costing only pennies a foot, it is easy to work with, light, and flexible. It is much easier to pack 50 feet of 300 ohm ribbon than 50 feet of RG-58 coax.

I would not willingly use the same line for a permanent installation at home, however. There I use much sturdier stuff. Ribbon feeders with a plastic dielectric (i.e., 72, 300, and 450 ohm) can change impedance when wet. If 300 ohm line must be used in a permanent installation, make it the heavier-duty "windowed" variety available from several sources which advertise in these pages.[1]

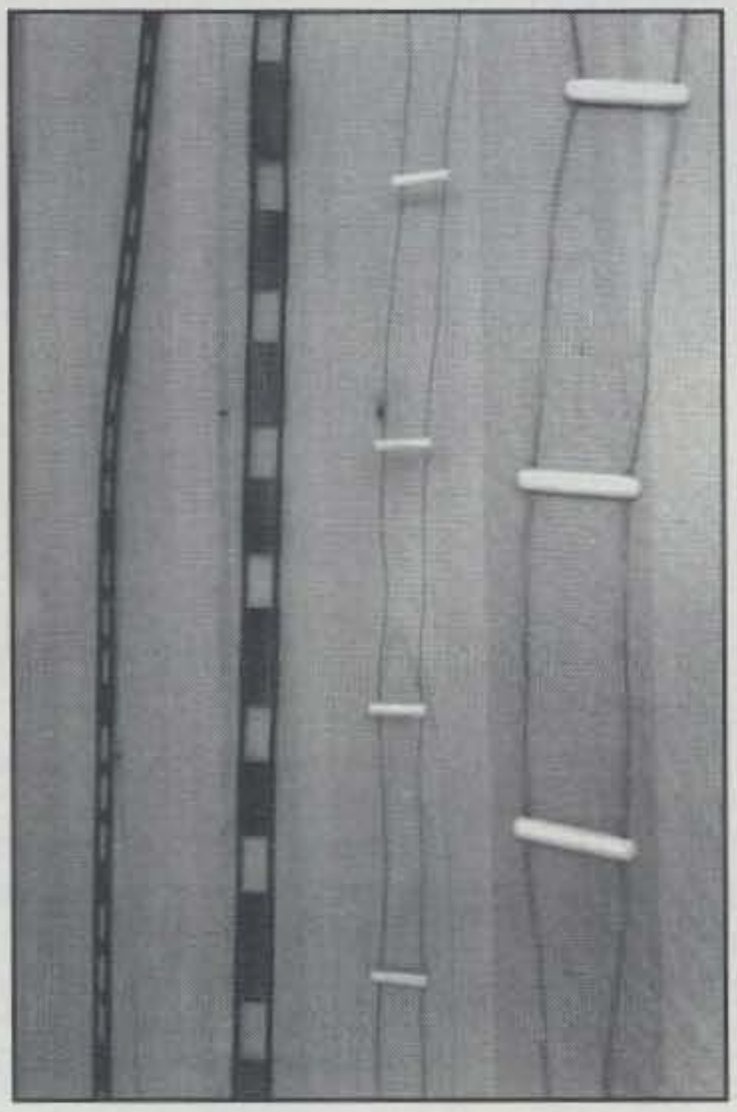
It also is easier to pass off 300 ohm line as TV lead-in where an outdoor antenna may be a no-no, for instance. The same holds for 72 ohm twinlead. Although 72 ohm ribbon line is available, it is slightly more expensive than the others, and it rarely is called for these days.

Another drawback to ribbon line, especially the type using copper-coated steel wire, is that a break in a feeder cannot be seen because of the plastic dielectric. Super-cold temperatures and strong winds can play havoc with long runs of even "windowed" feedline; coax is similarly vulnerable. The effects of wind can be lessened by twisting ribbon line about two turns in every three feet.

The best solution is to roll your own open-wire (air-dielectric) feedline. It won't change impedance when wet.

Relax. It's an easy job and rewarding in that you know *you* are producing the best possible feeder. It's also cheaper than commercially made line and far cheaper than coax. Like I said: Roll your own for fun and profit.

It was not long ago that TV-type, open-wire line—a 450 ohm, bare-wire line with plastic spreaders spaced every 6 or 12 inches and costing about $12 per 100 foot roll—was available commercially. It was troubled, however, by poor physical properties, including plastic spreaders that easily pulled free from the feed line.



A family portrait. From left are 300 ohm TV-type twinlead (72 ohm is similar), "windowed" 300 ohm, "windowed "450 ohm ladder line, all-but-extinct 450 ohm TV-type "ladder line," and home-made open-wire with 2 inch spreaders. (Photos by Don Randall, WB5ROU)

Wire for balanced feeders is readily available from many sources, some of which are cited in the footnote at the end of this article. No. 14 stranded wire is commonly used because of its availability and price. For a concealed application something as thin as No. 20 will work, but is more vulnerable to breakage.

I have used No. 12 or 14 solid copper wire, the type electricians use to wire houses. It comes in 500 foot rolls for literally pennies a foot at building supply stores. The insulation must be stripped from it, however, but that's an easy task. (This wire with black insulation is less visible than No. 14 stranded wire for those instances where an outdoor antenna must be concealed.)

Before going further, I need to say a word about the impedance of balanced line. For the most part and for our purposes here, it matters little whether the antenna is fed with 72, 300, 450, or 600 ohm line, or something in between. A good coupler will make the match for the transmitter, and couplers will be discussed later. For those rare instances, however, where a specific impedance is required, it can be calculated easily.[2]

Once the size of wire and the length of the run are known, it is time to consider spreaders. They can be had from many suppliers listed in footnote 1 and range from 2 to 6 inches in length. Prices vary from a quarter (Fair Radio Sales) to several dollars (Radioware and Ocean State Electronics), depending on length.

Some suppliers also offer ceramic feedpoint insulators as companions to spreaders. But be careful handling anything made of ceramic, as it will shatter if dropped on a concrete floor or driveway or other hard surface.

Less vulnerable and usually cheaper, but equally as effective are do-it-yourself spreaders made from almost anything that is light enough, is an insulator, and can withstand exposure to the sun's ultraviolet rays.

Early spreaders were made by cutting lengths of half-inch wood dowels, drilling them for the feed wires, and boiling them in wax to permeate and protect them. While this method is practical, it's not without its problems. C.F. Rockey, W9SCH, a self-styled "feeder-spreader boiler," cautions: "In the past I boiled lots and lots of dowel-rod spreaders. It's a pain in the posterior and can be dangerous, too. Burning wax is worse than napalm!"

Today's home-brewed spreaders are more often crafted from PVC pipe, plastic paint stirrers (try Sears), plastic rod, and the like. Several articles on making spreaders can be found in various publications.[3]

The most prevalent method of fastening line to spreaders is to thread the line through the holes in the spreaders and leave the outside notches for the holding wires to keep the spreaders in place. Some favor just the opposite: Feed the

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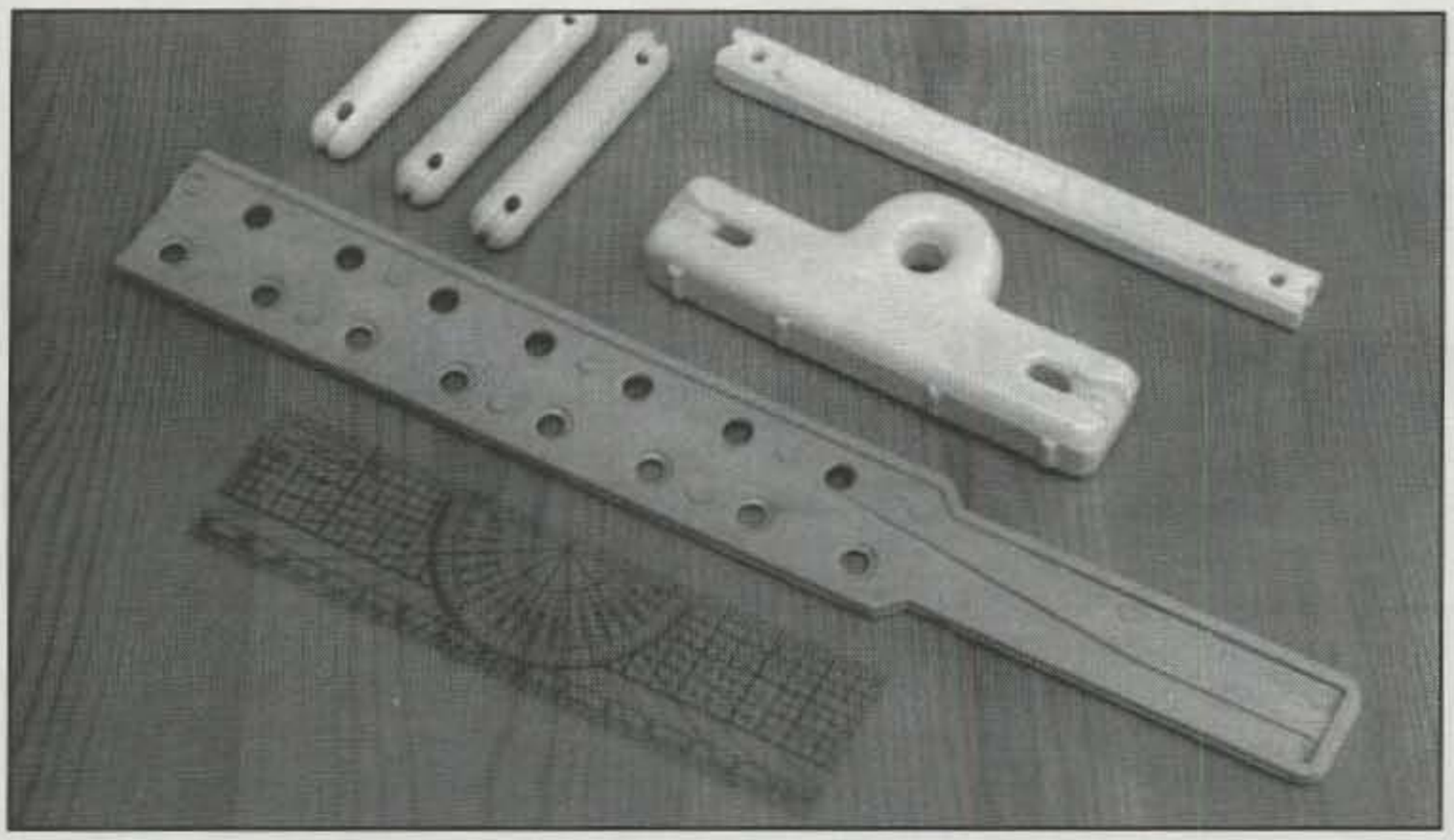

Building blocks for open-wire line. From upper left are three 2 inch ceramic spreaders with a ceramic feedpoint insulator. Above it is a 5 inch spreader, and below is a plastic stirrer for paint. It can be cut as needed to make spreaders.

holding wires through the spreader holes and put the line in the notches on the outside. Most commercially made spreaders allow either, and home-brewed spreaders can be made to suit. The latter is simpler, but the former is sturdier and is recommended. However, once a line has been threaded through the hole and the holding wires soldered on the outside, replacing a broken spreader in the middle of a run can be a chore. A broken spreader is easier to replace with the feed wire on the outside. The holding wire can be removed far easier than having to undo part of a line to replace a broken spreader.

Tying feed wires to spreaders is easy, too. If you use stranded wire for feed line, cut a few 3 inch lengths from one end, peel one strand free, and use it to snug the line to the spreader with pliers. I prefer to solder holding wires in place, but others have found a dollop of so-called "super glue" over the joint works, too.

How many spreaders are needed? The literature and experience say only as many as it takes to keep the lines from shorting and to provide a physically sound run from the tuner to the feedpoint. One well-informed source suggests one every 12 inches, which if nothing else makes it easy to keep track of how many feet of line are in use. Others have said one spreader every 2 feet is sufficient, and I have found this to be true.

All this supposes the use of an antenna system tuning unit, or coupler. I would not be without one. One of the best for tuning balanced feeders is by Charles Lofgren, W6ZZJ, [4] and it can be built as easily as the lines it will tune. Even Louis Varney, G5RV, designer of the popular antenna bearing his call, has come up with a coupler for balanced feeders (see books by Heys and David in the footnotes). Read Lofgren, Varney, Moxon, and others on the merits of couplers, if you have any doubts.

I will be happy to answer questions about balanced feeders from those who send along a stamped, self-addressed envelope for a reply.

Footnotes

1. Among sources for commercially made balanced line, wire, spreaders, center insulators, and the like are:

Radioware, P.O. Box 1478, Westford, Massachusetts 01886 (1-800-950-9273). Free catalog.

The Wireman Inc., 261 Pittman Road, Landrum, South Carolina (1-800-727-9473). Catalog $2.

Ocean State Electronics, P.O. Box 1456, Westerly, Rhode Island 02891 (1-800-866-6626). Free catalog.

Fair Radio Sales Co., P.O. Box 1105, Lima, Ohio 45802 (1-419-223-6763). Free catalog.

Kilo-Tec, P.O. Box 1001, Oakview, California 93022 (1-805-545-9645). Free catalog.

The Radio Works, P.O. Box 6159, Portsmouth, Virginia 23703 (1-804-483-1873). Catalog $2.

2. *The ARRL Antenna Book,* 16th ed., p. 24–26.

H. Turner, "Open Wire Transmission Lines: Tools for Design and Analysis," *Communications Quarterly*, Winter 1991.

E. David, "HF Antenna Collection," Radio Society of Great Britain, 1991, p. 4.

3. L.A. Moxon, "HF Antennas for All Occasions," RSGB, 1988, pp. 248–249.

J.D. Heys, "Practical Wire Antennas," RGSB, 1991, pp. 15–24.

L. McCoy, "Open-Wire Feed Lines, A Time for Revival?" *CQ*, Aug. 1982, p. 40.

R. L. Measures, "Constructing Ladder (Open-Wire) Transmission Line," *QST*, Feb. 1990, pp. 35–36.

4. C. A. Lofgren, "The Z-Match Coupler—Revisited and Revised," *The ARRL Antenna Compendium*, Vol. 3, pp. 191–195.

Heys, *ibid*, pp 85–86.

David, *ibid*, pp 113–119.

Bill Orr, "The Z-Match Antenna Tuning Unit," *CQ*, August 1993, p. 50; "The Z-Match Revisited," *CQ*, Sept. 1993 p. 91; and "The Z-Match ATU for 160 Meters," *CQ*, Oct. 1993, p. 86.

David Jackson, "Compact Z Match A.T.U.," *G-QRP Club Antenna Handbook*, 1992, pp. 20–22.

Note: RSGB publications are available from Townsend Electronics Inc., Box 415, Pierceton, Indiana 46562 (1-800-944-3661) free catalog; from the ARRL; and from other sources. ■