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Chapter 19

Portable Antennas

Portable operation is usually taken to mean a temporary operating site away from a fixed station location. Field Day is probably the best-known such example and so a casual search through the literature will find literally dozens of "Field Day Special" antennas intended to provide coast-to-coast coverage on the HF bands and some directivity on the VHF/UHF bands. Rover-style operation is also very popular on the VHF/UHF bands during contests and "hilltopping" has always been fun whenever the bands are open. You will also find stations operating portable while camping or RVing or hiking and special event stations are often using temporary antennas as well. Emergency communications or "emcomm" operation during local and regional communications emergencies also requires portable antennas.

With portable operation becoming increasingly popular, antennas for temporary operation are receiving a lot of interest. As of early 2015, a count on the **www.eham.net** review forum — Antennas: HF Portable (not mobile) — shows 154 different portable antennas! They must be designed to be easily packed and stored, transported, unpacked and erected — usually by a single person. They should be able to radiate and receive effectively in a variety of installation environments and they should be robust enough to be used again and again. With such a wide range of operating needs, it should not be a surprise that antennas designated as "portable" come in a wide variety of sizes and shapes for use on any amateur frequency. Similarly, "transport" can mean anything from a backpack to a truck.

Bearing this range of uses in mind, this chapter describes antennas that are designed for portability. However, many of these antennas can also be used in more permanent installations, particularly where a "low profile" antenna is needed as discussed in the **Stealth and Limited Space Antennas** chapter. The antennas in the **Mobile and Maritime HF Antennas** chapter can often be employed as portable antennas, too, so there is overlap between the three applications. Often, the only meaningful difference is the mounting of the antenna or how it is supported! As you read these chapters, envision how each antenna might be adapted to other uses. The goal of this chapter is not necessarily for you to reproduce a design exactly but to give you examples of how other amateurs have satisfied their operating needs in ways you might find useful as well.

The complete construction articles for all antenna designs in this chapter are provided on the CD-ROM included with this book. Additional articles are listed in the Bibliography.

19.1 HORIZONTAL ANTENNAS

The most common horizontal wire antenna used for portable operation is the $\lambda/2$ dipole or inverted-V, followed by an end-fed dipole or Zepp. These typically require some kind of support several meters high — such as a tree or one of the portable masts described later in this chapter. If trees are used, some means of getting the support lines over a branch is also required.

Some types of operation such as backpacking place a premium on minimizing weight of the entire antenna system — antenna, feed line, antenna tuner and supporting lines. For this type of antenna system, some extra loss or operation on a single band is an acceptable tradeoff.

Another solution often used when the operation will be of short duration or if frequent stops along a route will be made is to use a pair of loaded mobile whips in a dipole configuration. These antennas can be mounted on a short mast and tripod. Setting up and taking down these antennas is quick and is completely independent of any other support.

19.1.1 ZIP-CORD ANTENNAS AND FEED LINES

Previous editions of this book included a section on the use of common zip cord (used for ac power cords) for antennas and feed lines. That information was based on a March 1979 *QST* article by Jerry Hall, K1TD and it has been updated according to the March 2009 *QST* article by William Parmley, KR8L. (see Bibliography)

A lighter weight style of zip cord (#22 AWG speaker wire, Radioshack part number 278-1385) was used compared to the heavier ac power zip cord in the original article. **Tables 19.1** and **19.2** give the measured values for velocity factor and loss in dB/100 feet. The characteristic impedance was estimated to be 150 Ω, somewhat higher than the 105 Ω for ac power cord. Performance of the lighter zip cord appears to be intermediate between the miniature RG-174 coaxial cable (light, but lossy) and RG-58 (less lossy, but heavy). This may be a good trade-off for your application. The author notes that some samples of light speaker cord were measured to be more lossy and suggests that loss be measured before committing to a particular type of line.

Antennas are made using the electrician's knot shown in **Figure 19.1** — a handy knot to use whenever zip cord is used. The dipole length is calculated as described in the **Dipoles and Ground-Planes** chapter. At the end of the dipole, extra wire folded back on itself to make a loop for attachment to a support line.

If a low SWR at the transmitter is important, the feed line length can be cut to some multiple of $\lambda/2$ using the measured velocity factor. This causes the dipole's feed point impedance to be replicated at the opposite end of the feed line, regardless of the line's characteristic impedance. (See the **Transmission Lines** chapter for an explanation.)

At the transmitter end of the feed line, unzip the wire a couple of inches and attach a banana plug to one side and an alligator clip to the other. The banana plug fits perfectly in the center conductor of a transceiver's SO-239 coax connector, while the alligator clip makes a convenient way to attach to the transceiver's ground connection (as shown in **Figure 19.2**). At low power or QRP levels, the unbalanced connection did not present any problems.

After building antennas and feed lines for 30, 20 and

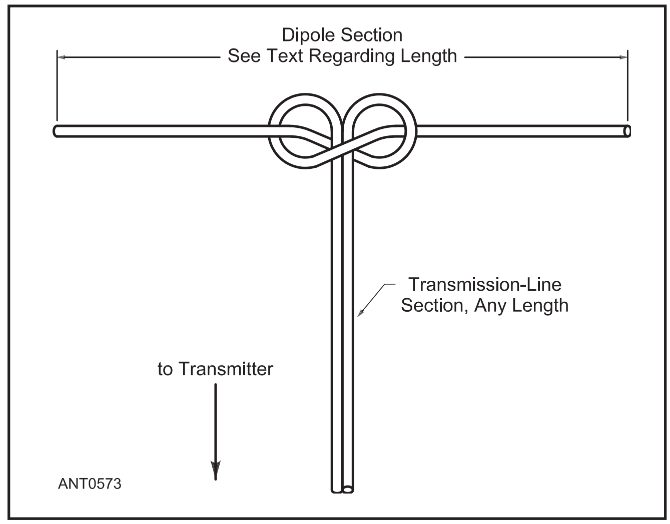


Figure 19.1 — The electrician's knot, often used inside lamp bases and appliances in lieu of a plastic grip, can also serve to prevent the feed line section of a zip-cord antenna from unzipping itself under the tension of dipole suspension. To tie the knot, first use the right-hand conductor to form a loop, passing the wire behind the un-separated zip cord and off to the left. Then pass the left-hand wire of the pair behind the wire extending off to the left, in front of the un-separated pair, and thread it through the loop already formed. Adjust the knot for symmetry while pulling on the two dipole wires.

Table 19.1
Measured Velocity Factor

Frequency (MHz)	*Velocity Factor (VF)*
3.31	0.68
6.75	0.69
13.67	0.70
27.77	0.71

Table 19.2
Calculated Attenuation of Zip Cord Compared to Small Coax, dB/100 feet

Frequency (MHz)	*RS 278-1385*	*RG-174*	*RG-58*
3.31	0.97	2.7	0.8
6.75	1.48	3.3	1.2
13.67	2.39	4.0	1.6
27.77	3.41	5.3	2.4

Figure 19.2 — Rear of radio showing banana plug and clip lead connections.

17 meters, the antennas were installed in an inverted-V configuration with the apex at about 20 feet. This was done using either a telescoping fishing pole, or by tossing a line over a tree branch and pulling the dipole up with that. The ends of the dipole were brought down to 6 to 8 feet off the ground and tied off with nylon line that was then tied to tent stakes.

The dipole was pruned to resonance by changing the fold point at the end. The extra wire was left in place and was not trimmed off. The 20 meter and 17 meter antennas were also tested as indoor dipoles by attaching the apex to a ceiling lamp and taping the ends to the walls with masking tape. In this configuration they were easily tuned to resonance.

Once the antenna was tuned to resonance it was possible to adjust and optimize the feed point impedance by changing both the horizontal and vertical angles between the two legs. For the author's outdoor installation the best match was obtained with the dipole legs arranged at a horizontal (azimuthal) angle of between 90 and 120°. For indoor applications the feed point impedance was found to be adjustable by changing the amount of droop in the legs, proximity to walls or floors, and the angle between the legs.

As should always be done with parallel-wire feeders, keep the feed line clear of other objects and equidistant from both legs of the dipole to the maximum extent practical.

19.1.2 TWINLEAD FOLDED DIPOLE

A lightweight folded dipole developed by Jay Rusgrove, W1VD, and Jerry Hall, K1TD, is made from TV twinlead. The characteristic impedance of this type of dipole is near 300 Ω, but this can easily be transformed to a 50-Ω impedance by placing a lumped capacitive reactance at a strategic distance from the input end of the line. **Figure 19.3** illustrates the construction method and gives important dimensions for the twinlead dipole.

A silver-mica capacitor is shown for the reactive element, but an open-end stub of twinlead can serve as well, provided it is dressed at right angles to the transmission line for some distance. The stub method has the advantage of easy adjustment of the system resonant frequency.

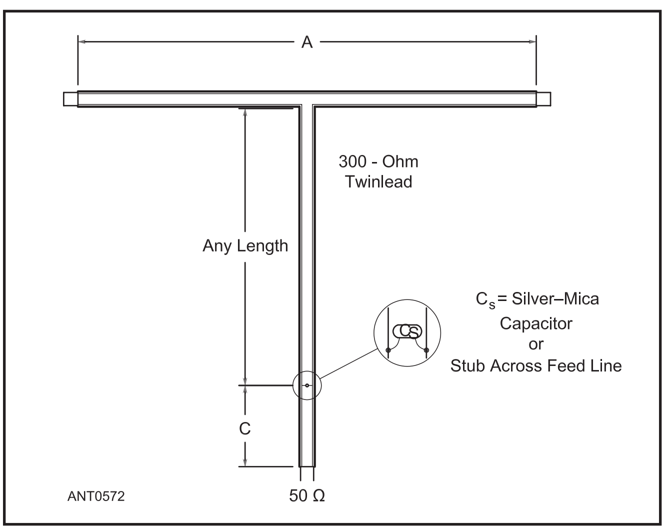


Figure 19.3 — A twinlead folded dipole makes an excellent portable antenna that is easily matched to 50-Ω equipment. See text and Table 19.3 for details.

Table 19.3
Twinlead Dipole Dimensions and Capacitor Values

Frequency	*Length A*	*Length C*	*C_s*	*Stub Length*
3.75 MHz	124' 9½"	13' 0"	289 pF	37' 4"
7.15	65' 5½"	6' 10"	151 pF	19' 7"
10.125	46' 2½"	4' 10"	107 pF	13' 10"
14.175	33' 0"	3' 5½"	76 pF	9' 10½"
18.118	25' 10"	2' 8½"	60 pF	7' 9"
21.225	22' ½"	2' 3½"	51 pF	6' 7"
24.94	18' 9"	1' 11½"	43 pF	5' 7½"
28.5	16' 5"	1' 8½"	38 pF	4' 11"

The dimensions and capacitor values for twinlead dipoles for the HF bands are given in **Table 19.3**. To preserve the balance of the feeder, a 1:1 balun must be used at the end of the feed line. (See the **Transmission Line System Techniques** chapter.) In most backpack QRP applications the balance is not critical, and the twinlead can be connected directly to a coaxial output jack as shown in Figure 19.2.

Because of the transmission-line effect of the shorted-radiator sections, a folded dipole exhibits a wider bandwidth than a single-conductor type. The antennas described here are not as broad as a standard folded dipole because the impedance-transformation mechanism is frequency selective. However, the bandwidth should be adequate. An antenna cut for 14.175 MHz, for example, will present an SWR of less than 2:1 over the entire 14-MHz band.

19.1.3 PORTABLE INVERTED V ANTENNA

The antenna shown in **Figure 19.4** is a strong, lightweight, rotatable portable system that is constructed of inexpensive and readily available materials. (See the Bibliography entry for Joseph Littlepage, WE5Y.) The apex of the antenna can be raised or lowered to any convenient height. The antenna is light enough for limited backpacking and can be used for emergency communications and Field Day. Since it is easy to raise and lower, it might also be a good choice for a stealth antenna where permanent antennas may not be used.

A telescoping pushup pole is used as a support mast. A portable antenna tripod is used to support the pushup pole.

Table 19.4
Wire Half-Element Lengths

Band (Meters)	*Design Frequency (MHz)*	*Length*
20	14.175	16' 6½"
17	18.1	12' 11½"
15	21.175	11' ⅝"
12	24.94	9' 4⅝"
10	28.4	8' 2⅞"

Figure 19.4 — The portable inverted-V antenna is built using a lightweight fiberglass support mast and two fishing poles. No additional supports are required and the antenna can be moved and rotated by hand.

The basic construction of the antenna is described in **Figure 19.5**. The feed line and wire elements are brought together at an angle of at least 90°. Two 10-foot telescoping fishing poles are used as spreaders. A ¾-inch PVC cross sliding on the central support mast is used to mount the fishing poles (see the full article on CD-ROM for construction details).

Lengths for the elements on the 20 through 10 meter bands are given in **Table 19.4**. Final measurement and adjustment can be made with an antenna analyzer or SWR bridge.

To set up the antenna, attach the antenna feed point to the top of the mast. The author found the top section of his mast too weak to support the antenna and leaves it telescoped into the next section for additional strength. The mast is then raised section by section and the feed line secured to the mast as it rises.

19.1.4 PORTABLE WHIP DIPOLES

This project describes an antenna that is typical of the style that uses a pair of mobile whip antennas to create a loaded dipole. The design was originally published in the May 2003 issue of *QST* by Ron Herring, W7HD. This style of antenna can be adapted to any band for which mobile whips are available. The low height of the dipole makes this antenna useful for NVIS operation in support of emergency communications, as described in the January 2005 *QST* article by Robert Hollister, N7INK. (Both articles are included on the CD-ROM provided with this book.)

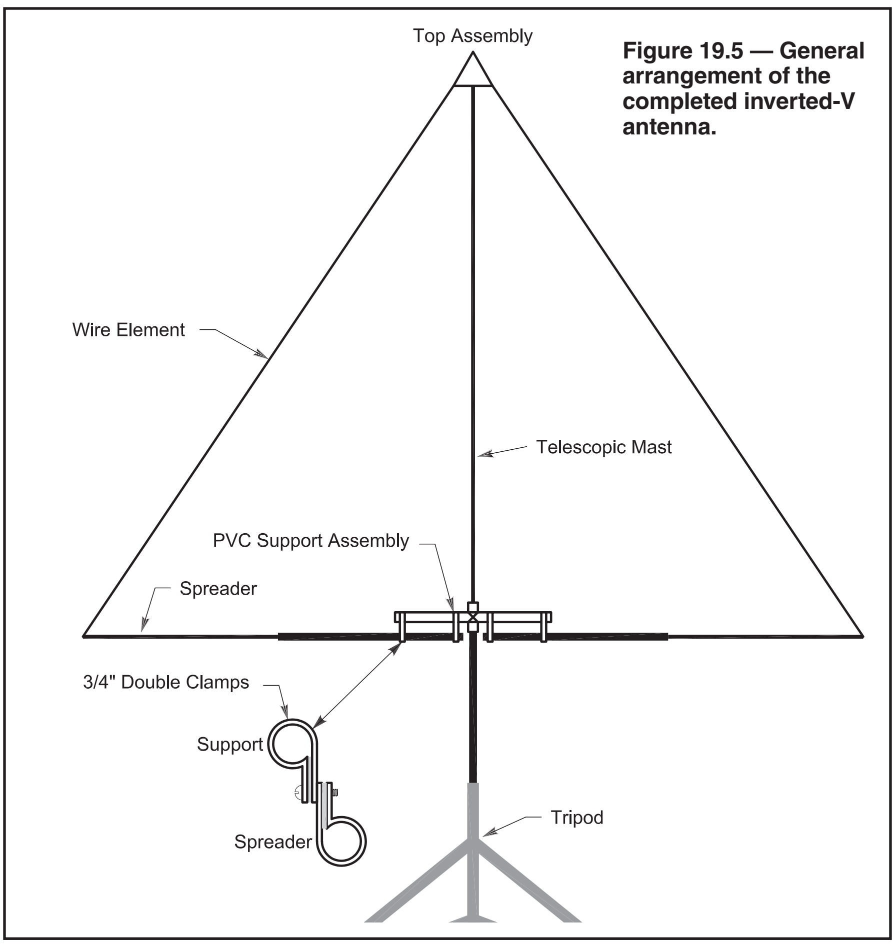


Figure 19.5 — General arrangement of the completed inverted-V antenna.

A bracket for mounting the mobile whips can be homemade as described in the article and shown in **Figure 19.6**. Any whip antenna that uses ⅜-24 threads can be used. Similar brackets are available from commercial vendors of mobile antenna supplies and materials.

The mast for the antenna needs only be strong enough to hold the antenna securely above head height, 8 to 10 feet. The author used a wooden pole. Push-up paint poles or TV mast sections would also work well.

With a collection of whips, the antenna can be used on any band for which mobile whips are available. Wires can also be attached to the ⅜-24 threaded hole by using a suitable bolt and a large solder lug.

The antenna shown in **Figure 19.7** is similar to the dipole made from mobile whips but uses telescoping whip sections attached to a fixed-length center section.

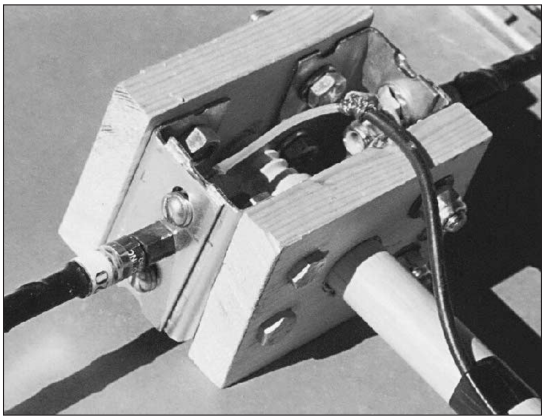


Figure 19.6 — The homemade dipole center support showing the wooden mast, the antenna mounts and the connected transmission line.

Figure 19.7 — This portable dipole uses a fixed center section and extendable telescoping whips to adjust the resonant frequency.

The center section is made from copper and PVC plumbing parts. A small loading coil connects the center section to the whip on the lower bands. The design was originally published by Clarke Cooper, K8BP in the May 2007 issue of *QST* (see Bibliography).

The telescoping whips (MFJ Enterprises MFJ-1954) are 10 feet long when fully extended. (see **Figure 19.8**) A table of lengths for each band allows the operator to quickly adjust the antenna for the desired frequency. The antenna has been tested on 20 through 10 meters and should be useable on 6 meters with a shorter whip. By using loading coils with more turns, operation on 30 and 40 meters may be possible, as well.

As with the previous antenna, the support mast is not a critical part of the assembly, only needing to be high enough to hold the antenna above head level. The author uses a folding portable flood light base to hold the mast.

Figure 19.8 — One side of the antenna with the telescoped whip attached.

19.1.5 OFF CENTER END FED (OCEF) DIPOLE FOR 40 TO 6 METERS

In this project's design, Kai Siwiak, KE4PT, describes a dipole antenna that is physically connected to the feed line at one end of the main antenna wire. Electrically, though, it is off-center fed including the desired section of the feed line's shield and an additional "droop" wire, becoming the "OCEF" dipole. The antenna is designed to roll up into a compact and convenient package for travel. (The full article is available on this book's CD-ROM.)

As shown in **Figure 19.9**, the OCEF consists of two dipole legs and an optional droop wire. For the far-end portion, use 30 feet of Teflon insulated #20 AWG stranded copper wire, beginning at the egg insulator at A. The wire is then soldered to the center conductor of miniature RG-174 coax, forming the physical feed point at B. The second radiating section is the outer shield of the 11.5 feet long section of RG-174 coax extending from the electrical feed point to the ferrite chokes at C.

A 2-foot droop wire can be attached at C to extend the lower frequency range of the antenna and lower the impedance of the antenna near the chokes. This combination of lengths results in impedances that are relatively easy for the antenna tuning unit to match on the ham bands, even though the antenna is not self-resonant in any of the ham bands.

The OCEF can be held away from a vertical structure with a nonconductive fishing pole or other support in either a horizontal or vertical orientation. Alternately, the antenna can be tied to a support structure such as a tree and stretched out back toward the operating position. In either arrangement, the antenna tuning unit should be able to create a 50-Ω match on any band from 40 to 6 meters. If 80 meter operation is

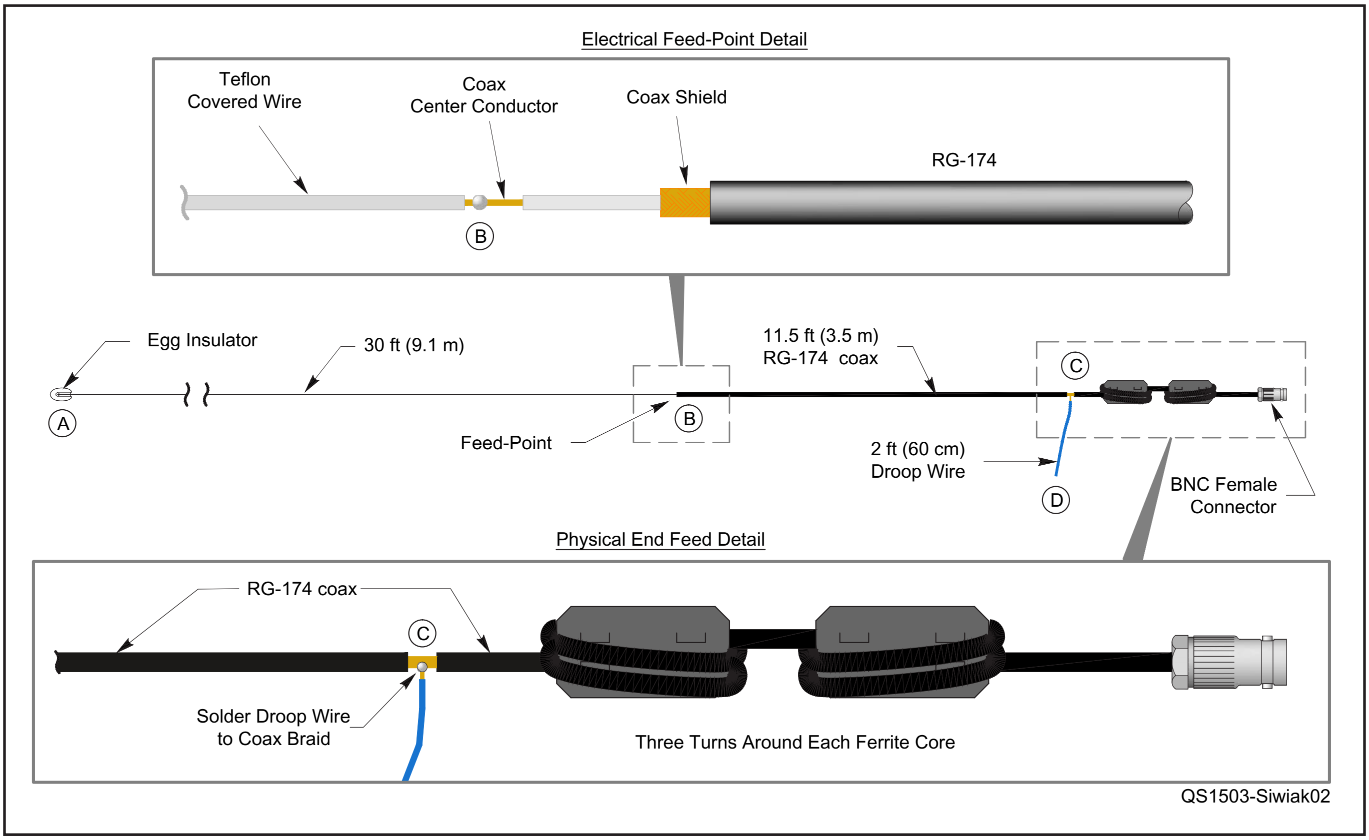


Figure 19.9 — The OCEF dipole detail shows the radiating portions A-D, details of the electrical feed point, and the common mode chokes at the physical feed end. See the full article on the CD-ROM for dimensions and a parts list.

desired and the ATU will not create the required match, additional lengths of wire can be clipped onto the droop wire until a match can be obtained. This extra piece of wire must be removed to operate on the higher bands, however.

The OCEF dipole allows all sorts of portable operation, but pay attention to RF exposure — with 50 W of RF input power, the minimum safe distance rises from about 1 foot on 80 meters to 10 feet on 10 and 6 meters.

19.2 VERTICAL ANTENNAS

Somewhat simpler than the horizontal dipole, the many variations of the vertical ground-plane antenna are very common in portable operating. Vertical antennas have even been built into walking sticks for "pedestrian mobile," an increasingly popular activity with the many excellent QRP radios available. A growing number of amateurs are using PRC-type backpack military surplus radios with built-in vertical whips with excellent results. (See **hfpack.com** for more information.)

Vertical antennas can be ground-mounted if they are self-supporting or only need a single line to be hung from a tree or other suitable support. The tradeoff for that simplicity is a greater dependence on the quality of ground system making up the "missing half" of a ground-plane antenna. (See the **Effects of Ground** chapter for more information.) Providing a reasonable ground system will reduce losses and improve the performance of the portable antenna system.

19.2.1 TREE-MOUNTED HF GROUND-PLANE ANTENNA

A tree-mounted, vertically polarized antenna does not cost much, is inconspicuous, and it works. This antenna was described by Chuck Hutchinson, K8CH in *QST* for September 1984 (see Bibliography). In addition, losses in the ground are reduced by the antenna's counterpoise radials and raising it off the ground.

The antenna itself is simple, as shown in **Figures 19.10** and **19.11**. A piece of RG-58 cable runs to the feed point of

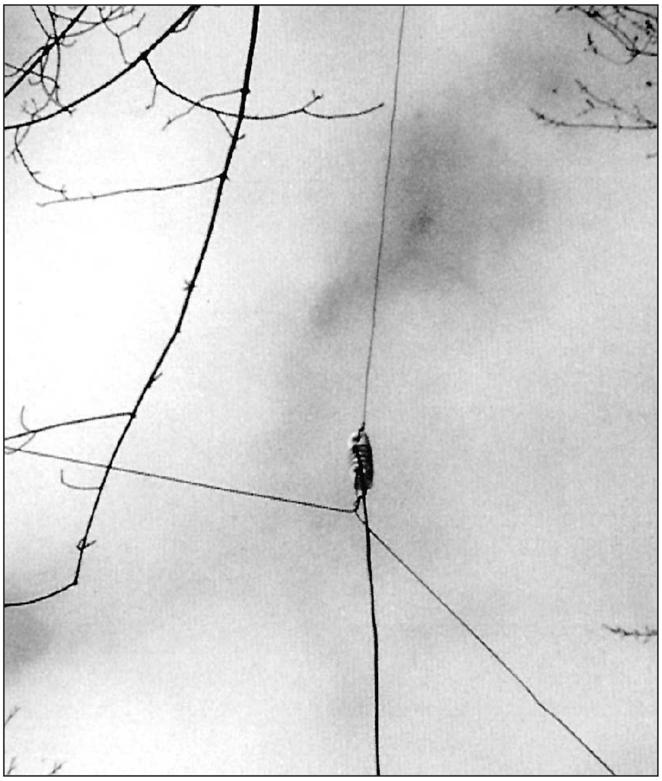


Figure 19.10 — The feed point of the tree-mounted ground-plane antenna. The outside ends of the two radial wires may be tied off to stakes or other convenient points.

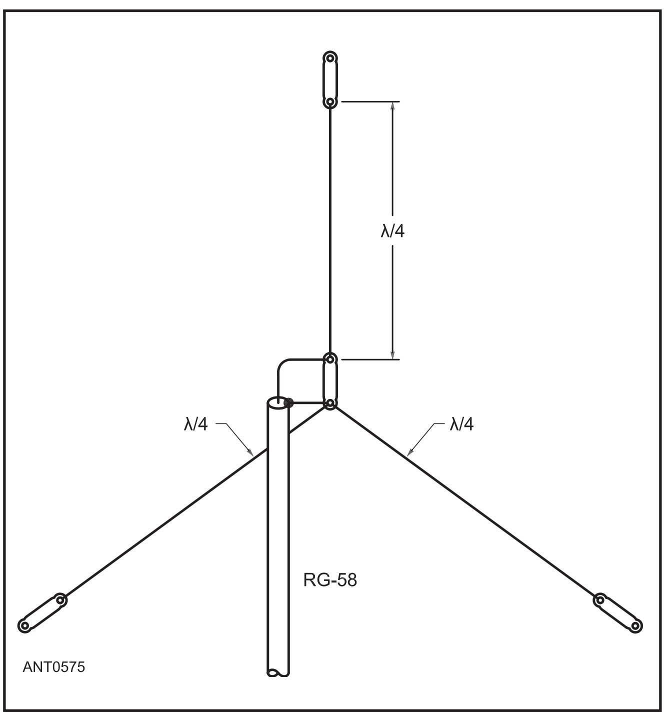


Figure 19.11 — Dimensions and construction of the tree-mounted ground-plane antenna.

the antenna, and is attached to a porcelain insulator. Two counterpoise radials are soldered to the coax-line braid at this point. Another piece of wire forms the radiator. The top of the radiator section is suspended from a tree limb or other convenient support, and in turn supports the rest of the antenna.

All three wires of the antenna are $\lambda/4$ long as discussed in the **Dipoles and Monopoles** chapter. This generally limits the usefulness of the antenna for portable operation to 7 MHz and higher bands, as temporary supports higher than 35 or 40 feet are difficult to come by. Satisfactory operation might be obtained on 3.5 MHz with an inverted-L configuration of the radiator, if you can overcome the accompanying difficulty of erecting the antenna at the operating site.

The outside surface of the coaxial cable shield will couple to the antenna and may carry substantial common-mode current. This re-radiates a signal just as the antenna does and is generally not a problem unless the current disrupts operation of the transmitter. To reduce common-mode currents on the feed line, use a choke balun as described in the chapter **Transmission Line System Techniques**.

The tree-suspended vertical can also be used for fixed station installations to make an invisible antenna. Shallow trenches can be slit for burying the coax feeder and the radial wires. The radiator itself is difficult to see unless you are standing right next to the tree.

19.2.2 HF VERTICAL TRAVEL ANTENNA

This vertical antenna designed by Phil Salas, AD5X, from July 2005 *QST,* is intended for easy packing and transport, breaking down into several mast sections, a center-loading coil, a short telescoping whip, and a small base support. The total antenna is about 16 feet high when assembled and can be used on 60 through 10 meters. (See the Bibliography for both of the author's articles on this antenna design.)

Figure 19.12 shows the assembled antenna and **Figure 19.13** shows author holding the complete set of disassembled antenna parts, none of which is over 20 inches long. The antenna uses a ground system of at least six #22 AWG insulated radials. As the author notes, almost any gauge wire can be used, insulated or not, and more radials will improve operation. If the antenna can be mounted on metal structures such as a chain-link fence, even lower ground losses can be obtained.

The antenna is designed for easy assembly and disassembly but do not neglect to make solid, soldered connections for the spade lugs that connect the various radials and jumpers. In small antennas, resistive losses can consume an appreciable amount of signal power.

Guying is required in a strong breeze and the author uses three lengths of light nylon cord to stabilize the antenna. Fishing line would also work well. An adapter is described that will allow the antenna to be mounted on a standard ⅜-24 mobile mount for use while at rest. The antenna is not strong enough for use while moving.

Figure 19.12 — The complete antenna set up in the author's front yard. Total height is about 16 feet.

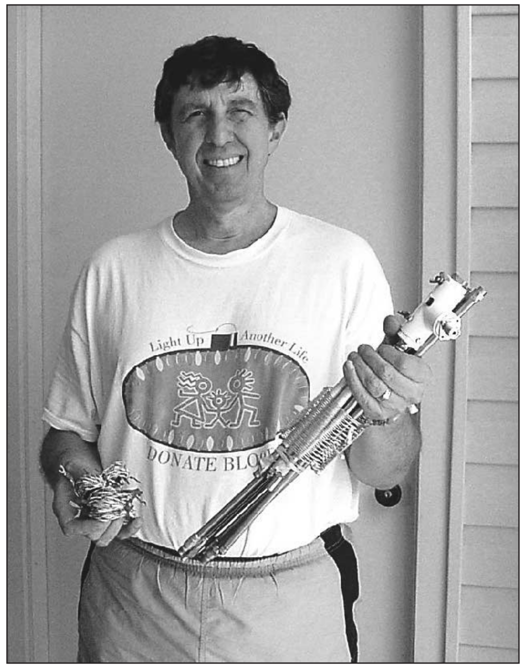


Figure 19.13 — The author holding the complete unassembled antenna.

19.2.3 COMPACT 40 METER LOOP FOR RECREATIONAL VEHICLES

Once a mobile station is at rest, it becomes a portable station and antenna choices become more flexible. An antenna can be optimized for efficiency and not so much for ruggedness to survive highway speeds. Height restrictions are generally relaxed as well. John Portune, W6NBC, developed this electrically-small loop to have a higher efficiency than mobile antennas. Described in March 2007 *QST*, the antenna can also be used at a fixed station where low-profile antennas are required. (see Bibliography)

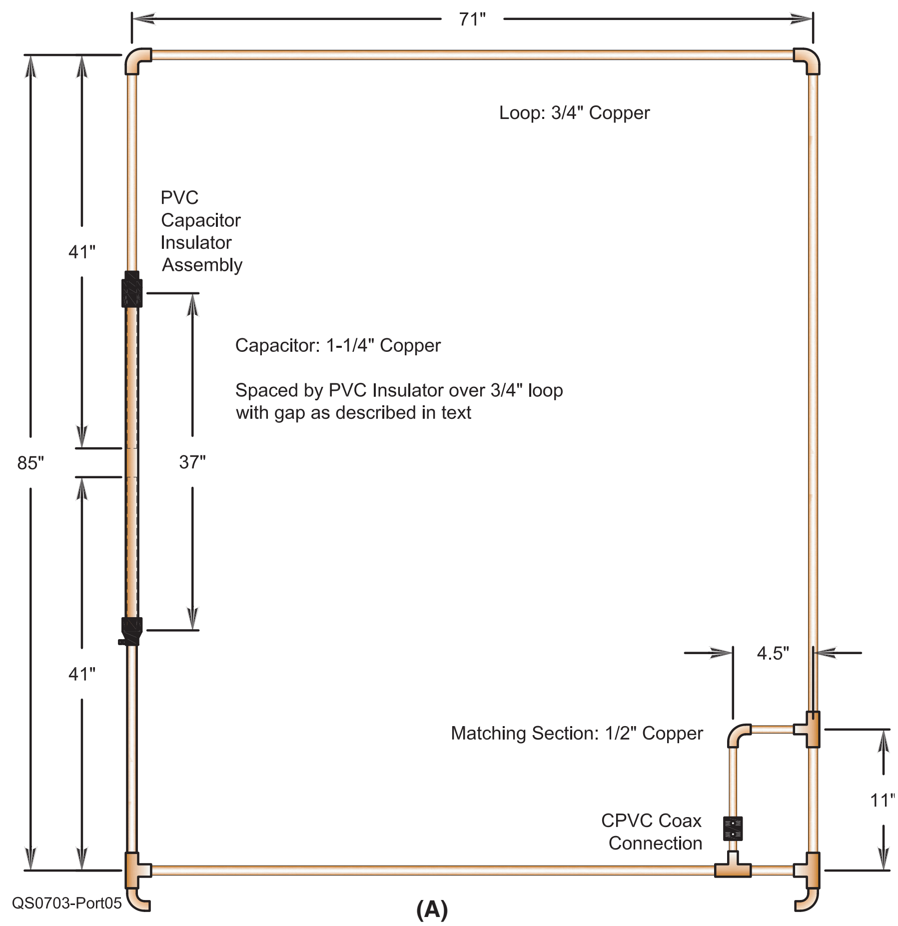
The antenna is not a loop in the sense of being a complete "turn" of tubing or wire. It is a short dipole of copper tubing folded into a rectangular loop shape with a capacitor across the open ends for tuning. **Figure 19.14** shows how the loop is constructed. It is 71 inches across and 85 inches tall. The loop can be constructed for other bands and the article provides a link to a spreadsheet for calculating the required dimensions.

The tuning capacitor is made of two concentric pieces of copper tubing with air between them. A matching assembly similar to a gamma match is shown at the feed point. **Figure 19.15** shows the loop mounted on the author's pickup truck bed. While in motion, the antenna is lowered to the horizontal position and secured.

The antenna avoids some of the ground losses associated with ground-plane vertical antennas and as a result, modeling estimates its efficiency at about 70% of a full-size dipole. Like all electrically-small loops, the bandwidth of this antenna is quite low — about 10 kHz. The antenna is tuned by sliding the outer tube of the capacitor up and down. Do not try to adjust the loop tuning while transmitting as the voltage at the open end of the capacitor will be thousands of volts even at 100 W. The author uses an automatic tuner at the operating position with the loop tuned to the center of the band and a short (25 foot) run of RG-8X coax.

19.2.4 FIVE BAND PORTABLE VERTICAL ANTENNA

This multi-band vertical antenna project uses five quarter-wave vertical monopoles in parallel, using a common ground screen of 16 radials. This allows multi-band operation without requiring an antenna tuner. (The entire article is included on this book's CD-ROM.)



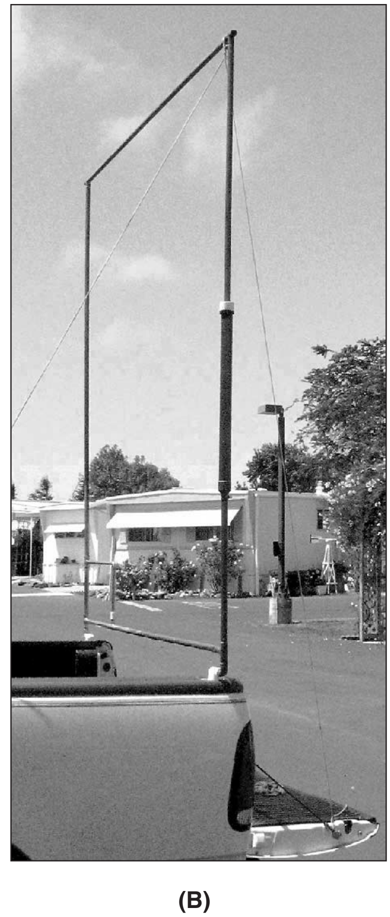


Figure 19.14 — Tuning capacitor and loop assembly details at A. Part B is a photo of the loop mounted on the walls of the author's pickup truck bed.

The antenna, shown schematically in **Figure 19.15A**, consists of four quarter-wave elements attached to spreader rods and the longest, 20 meter element wrapped around the central support. Each antenna is terminated in a banana plug that is attached to a feed point ring on the mast. Each of the 16 radials is 17 feet (5.6 m) long and attached to a similar ring at the bottom of the antenna. Remember that the length of the connection from the radial attachment ring to the feed point RF connector also counts as part of the antenna and should not be changed after tuning.

Tuning consists of beginning with the 10 meter element. Trim about ½ of the total length needed to bring the element to resonance. This is in recognition of the interactive tuning process. Move to the 12 meter element and repeat, then the 15 meter element and so forth. Continue to tune each element in sequence until the SWR is acceptable on all bands.

Mechanically, the antenna is assembled on a portable fiberglass fishing rod, 16 feet (5.25 m) long. A ground stake and PVC pipe provide the base support. A triangular guy attachment point slides down over the top of the pole until it rests on the top of a middle section. (Guying may not be required if the base support stake and pipe are sufficiently sturdy.

As with all portable antennas, RF exposure can be an issue as RF power begins to exceed QRP levels. Keep people away from the base of the antenna both to minimize exposure and to keep them from tripping over the radials! The edge of the radial field is a good point at which to establish a "safety perimeter" both for electrical and mechanical security!

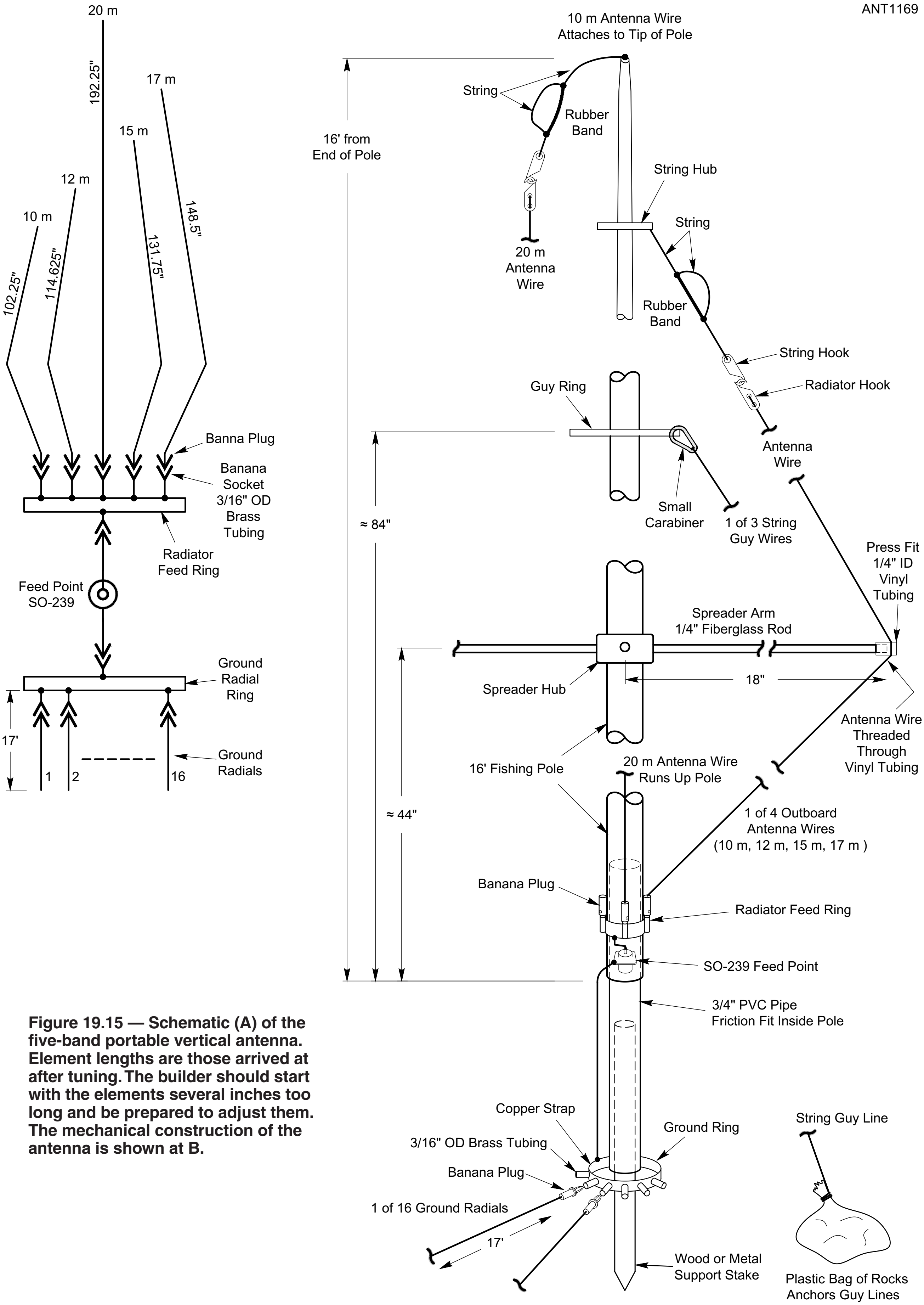


Figure 19.15 — Schematic (A) of the five-band portable vertical antenna. Element lengths are those arrived at after tuning. The builder should start with the elements several inches too long and be prepared to adjust them. The mechanical construction of the antenna is shown at B.

19.3 BEAM ANTENNAS

Simple horizontal and vertical antennas are light and easy to use for portable operating but having some gain and directivity in the field is very nice. While a full-size triband Yagi or quad is probably out of the question for most portable operations, smaller antennas can still provide good performance at low cost and with relative simplicity of installation. This is particularly true on the higher frequency HF bands and the VHF bands.

19.3.1 PORTABLE 6 METER BEAMS

Two-element Quad

The quad antenna was originally described by Markus Hansen, VE7CA, in *The ARRL Antenna Compendium, Vol 5*. After years of HF operation, he became enthusiastic about VHF/UHF operation when he got on 6 meters and discovered the joys of driving to high mountain peaks to operate. Not only does an antenna have to be portable for this kind of operation, it must be easily assembled and disassembled, just in case you have to move quickly to a better location. An article describing a three-element 6 meter Yagi by VE7CA is also provided on the book's CD-ROM.

The distance between the driven and the reflector elements was selected so that the intrinsic feed point impedance was 50 Ω without using a gamma match. (A gamma match does not hold up well to travel and repeated assembly and disassembly.) **Figure 19.16** shows the dimensions for the boom and the boom-to-mast bracket. The boom is made from a 27-¼-inch length of 2 × 2. Use whatever material is available in your area, but lightweight wood is preferred, so clear cedar or pine is ideal. The boom-to-mast bracket is made from 1/4-inch fir plywood.

The spreaders are ½-inch dowels. Fiberglass would be ideal but it is not always available locally. Sleeves of plastic pipe over the ends of the spreaders insulate the wire from the spreaders. Elements are made from #14 AWG hard-drawn stranded bare copper wire. Do not use insulated wire unless you are willing to experimentally determine the element lengths, because the insulation detunes each element slightly. The final circumference of the reflector element is 249 inches and of the driven element is 236⅝ inches from the points where the feed line is attached.

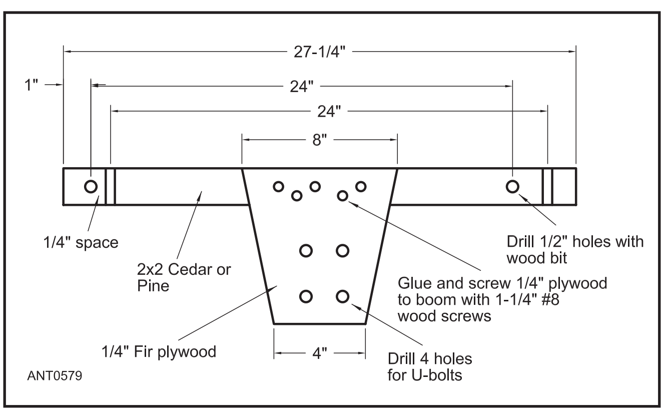


Figure 19.16 — Dimensions for the boom-to-mast bracket of the 2-element 6 meter quad.

The author used RG-58 feed line as it is lightweight. The length required for a portable installation is typically not very long, maybe 20 feet, so the loss in the small cable is not excessive. Near the feed point, coil the coax into six turns with an inside diameter of two inches to choke off RF currents flowing on the outside of the coax shield.

Two U-bolts are used to attach the boom-to-mast bracket to the mast. When the quad is raised, the shape of the loop is commonly known as a diamond configuration and the feed point at the bottom produces horizontally polarization. The mast consists of two six-foot lengths of doweling joined together with a two-foot length of PVC plastic pipe, held together with wood screws.

Four-element Yagi

Six meters is a great band for home built Yagis. The elements are reasonably small, but not so small that building tolerances are critical. With careful construction and detailed instructions, it is certainly feasible to build no-tune Yagis up to 432 MHz as the author, Zack Lau, W1VT, shows here. (The full article, including detailed construction information, is included on this book's CD-ROM.)

Element construction is shown in **Figure 19.17**. Only a few elements are needed for portable work — more elements mean more assembly/disassembly. An extra element allows the beam to work well over a wider bandwidth with more elements, while keeping the boom length constant. Extra bandwidth helps the antenna to work well despite the effects of rain.

The design is taken from Lawson's *Yagi Antenna Design* because it has good gain and pattern for just four elements. (See the Bibliography of the **HF Yagi and Quad Antennas** chapter) The antenna has 10.6 dBi of free-space gain with the unwanted lobes suppressed by 20 dB — a reasonably clean pattern. At typical portable operating heights of 11 to 16 feet, the antenna shows less than 2:1 SWR over the bottom 400 kHz of 6 meters with the minimum SWR close to the edge of the band.

To simplify the electrical design, insulated, telescoping elements of aluminum tubing are used, spaced 1/4 inch above the boom. This makes the boom interaction minimal, so it isn't necessary to factor in a boom correction. Lexan mounting plates for the boom and elements were used for strength and UV resistance. Oak blocks were used to attach the elements to the mounting plates. The author fabricated custom element clamps, but regular worm-screw hose clamps would also work.

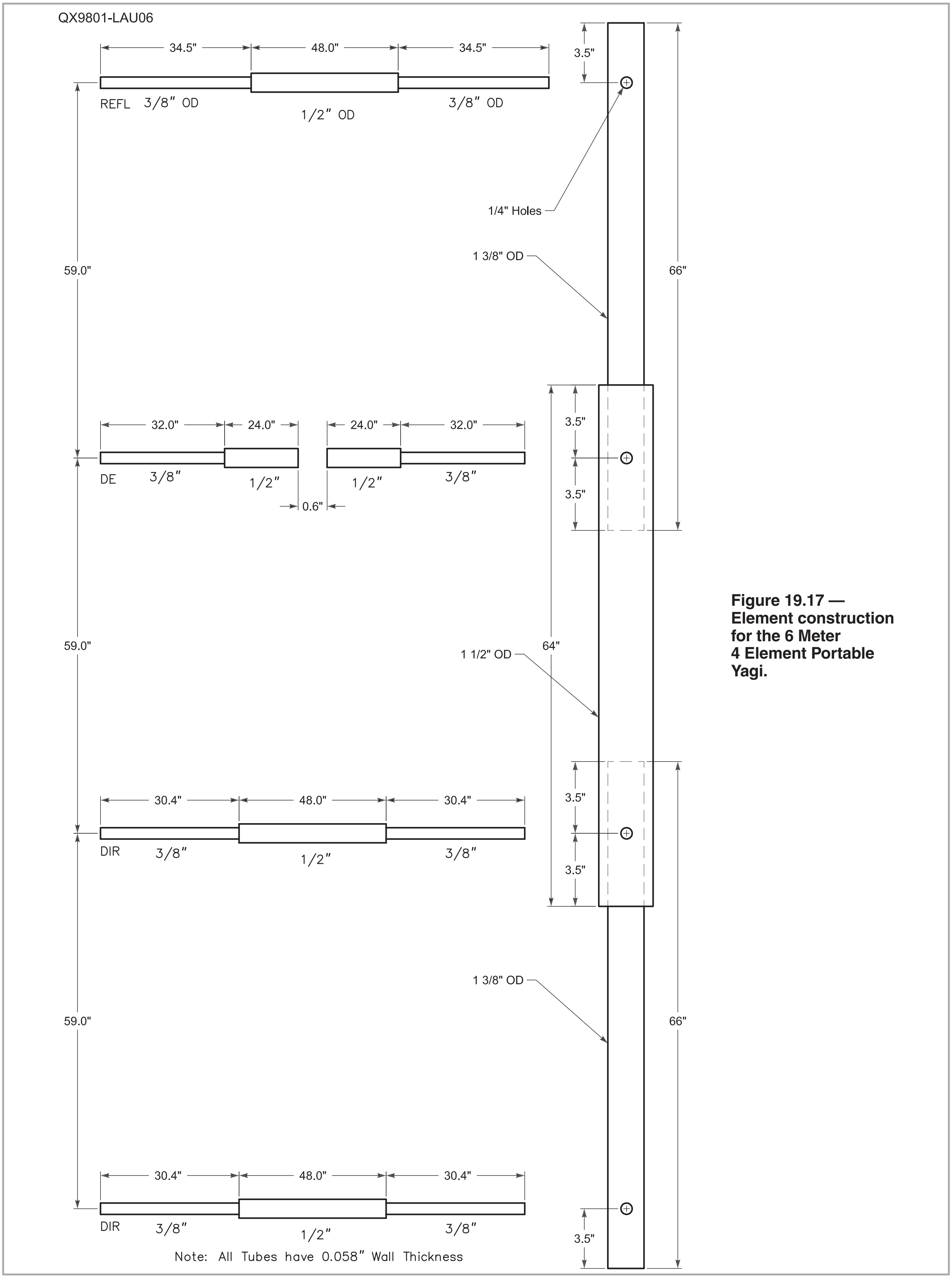


Figure 19.17 — Element construction for the 6 Meter 4 Element Portable Yagi.

19.3.2 2-ELEMENT 20/15/10 METER TRIBAND YAGI

This portable HF wire Yagi was described by Markus Hansen, VE7CA, in November 2001 *QST* and in *The ARRL Antenna Compendium, Vol 7*. The need was for a 2-element wire Yagi for 20/15/10 meters that could be easily transported by car. The basic concept comprises three individual dipole driven elements, one each for 20, 15 and for 10 meters tied to a common feed point, plus three separate reflector elements. (See **Figure 19.18.**) The elements are strung between two 2.13-meter (7-foot) long, 2 × 2-inch wood spreaders.

A feed point impedance was achieved on each band that allowed the use of a single setting for the shorting bar on a hairpin match. The result was a very acceptable match over the lower portions of each band. The hairpin match is one of the easiest matching systems to make. It is easy to adjust and since wire is the only ingredient, it can be coiled up with the rest of the antenna when the antenna is disassembled. The feed point impedance of the Yagi with a reflector element spaced 0.1 λ behind the driven element typically produces a resistance around 20 Ω. By shortening the driven element from its resonant length, capacitive reactance is added to the feed point resistance. This can be cancelled by shunting the feed point with an inductor in the shape of a wire loop resembling a hairpin. This causes a step up of the 20-Ω feed point resistance to 50 Ω.

Figure 19.19 shows the hairpin match and the common-mode choke balun for the 10/15/20-meter triband wire Yagi. The coax drops straight down from the center insulator and is attached to the center of the hairpin shorting bar. Make a choke balun by coiling the coax in 8 turns with a diameter of

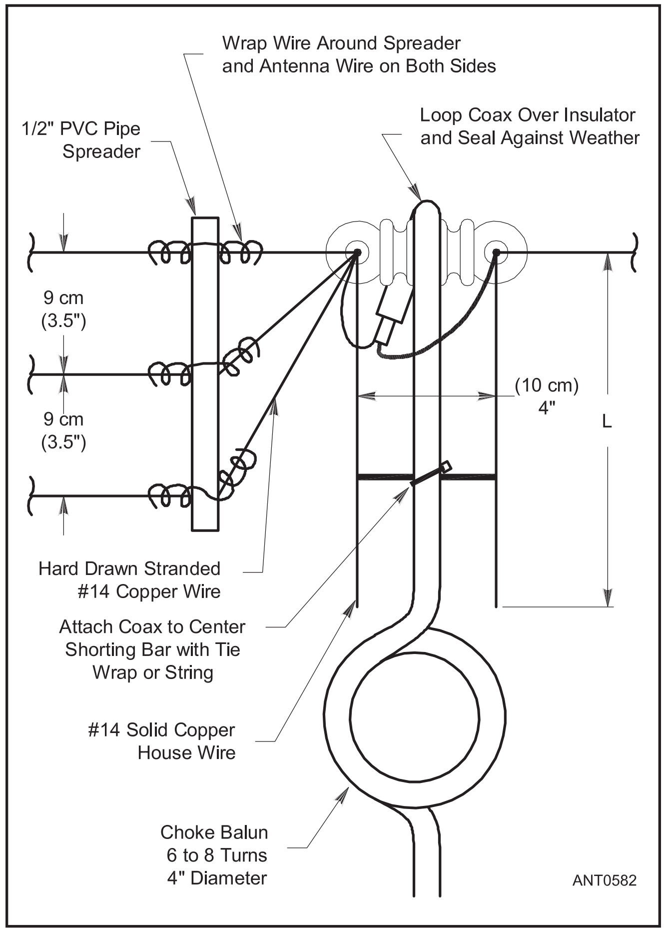


Figure 19.19 — Details of the feed point for the 20/15/10 meter triband Yagi.

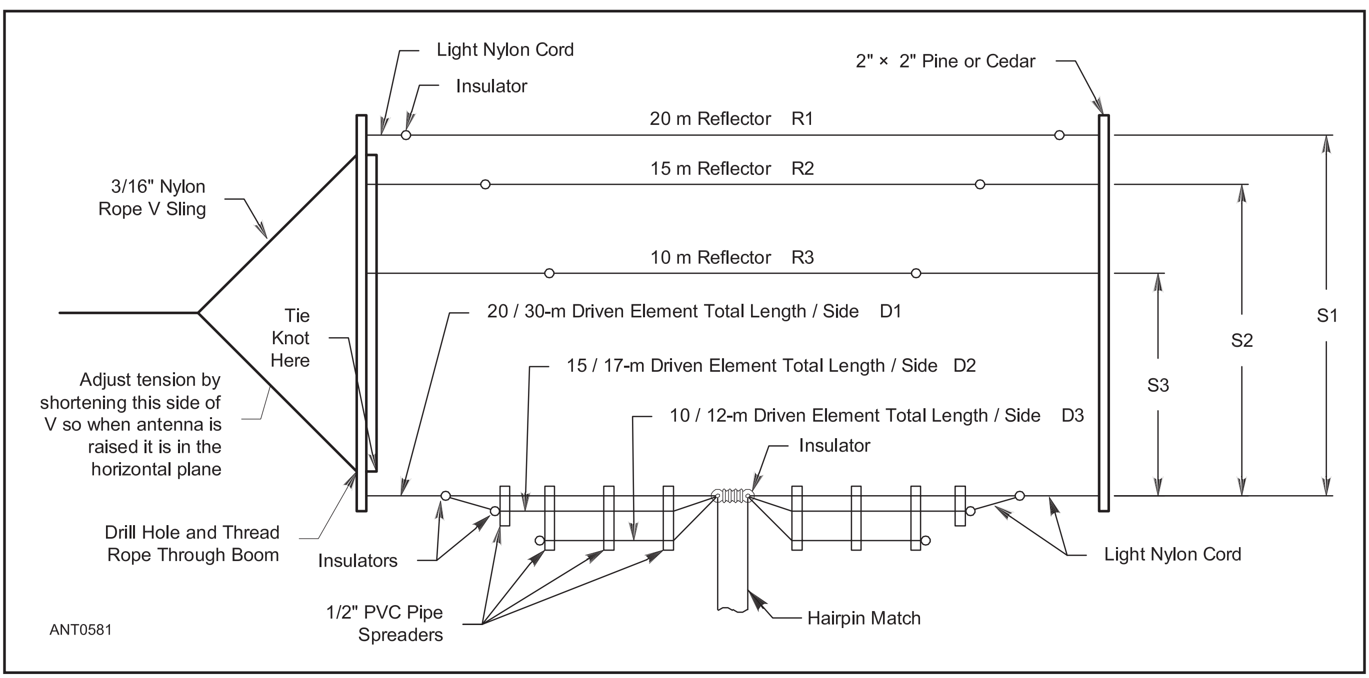


Figure 19.18 — Dimensions for VE7CA's 2-element 10/15/10 meter triband Yagi.

about 4 inches. This balun will choke off RF flowing along the outside of the coax shield that would otherwise distort the radiation pattern of the antenna. The center of the shorting bar is at a neutral potential, so there is no harm in mechanically attaching the coax feed line at that point.

Using #14 AWG wire allows all the Yagi antennas referenced in this article to be used at the maximum power levels allowed in North America. The only limiting factor is the power handling capability of the feed line. However, even RG-58 should work for the relatively short length from the feed point down to ground level where you can change to RG-8 or some other higher-power, lower-loss coaxial cable.

19.3.3 BLACK WIDOW 15 METER BEAM

The 2-element Moxon Rectangle (see the chapter **HF Yagi and Quad Antennas** for a description of the Moxon Rectangle) is often used for single-band Yagis because it reduces the overall element length. In this design by Allen Baker, KG4JJH, a wire Moxon Rectangle is suspended between fiberglass fishing poles (see Bibliography).

The completed antenna is shown in **Figure 19.20**. The fishing poles are mounted on a central hub and the wires

Figure 19.20 — The completed 15 meter beam mounted on a painter's pole mast.

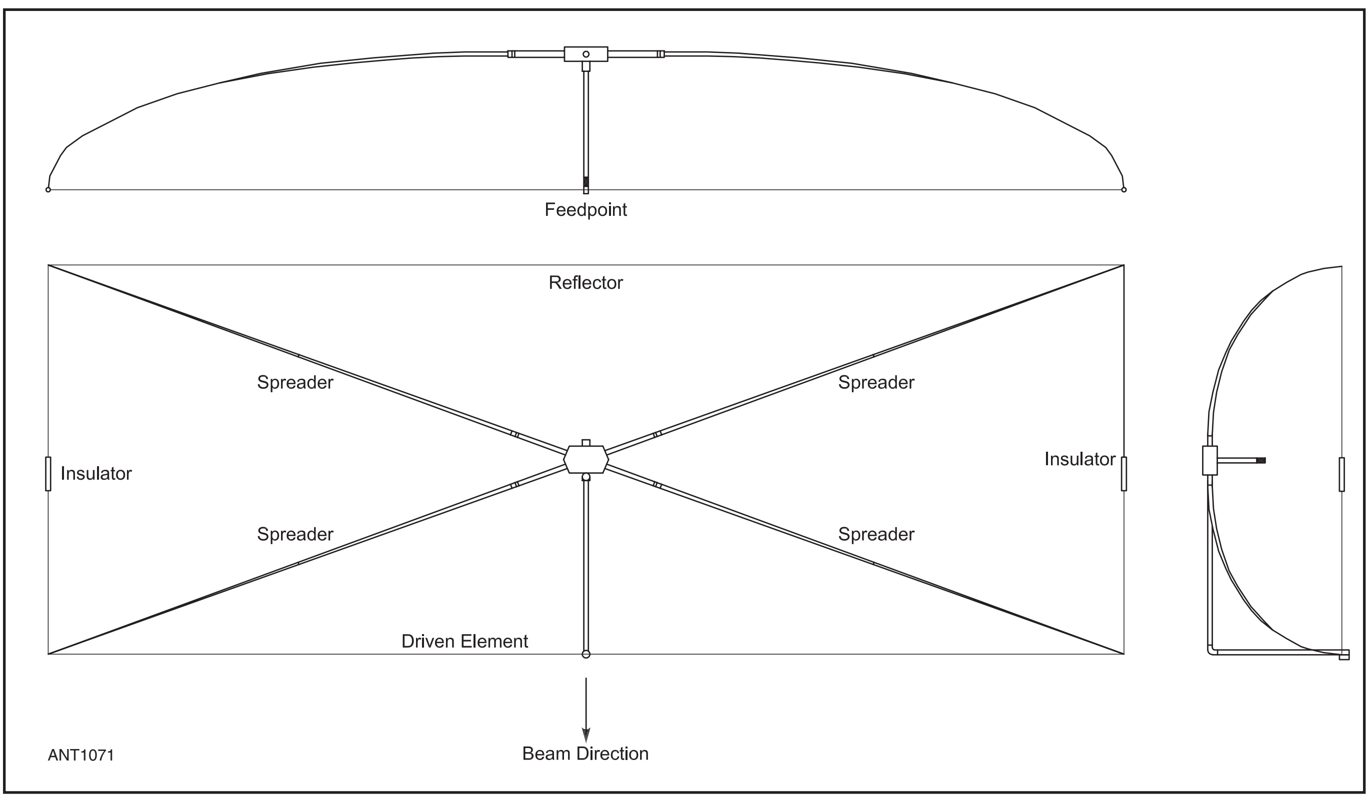


Figure 19.21 — An overview of the antenna and its components. Side drawings show the approximate final bend of the fishing poles with the wire elements attached.

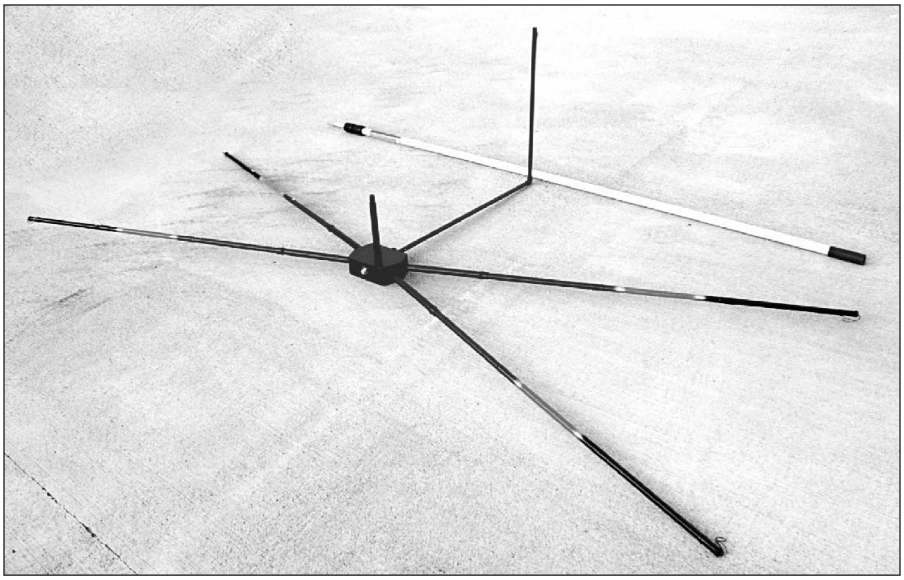


Figure 19.22 — Broken down into its major components — spreaders, hub, feed line support, and wire elements — the beam is ready for transport.

stretched between their tips under tension. **Figure 19.21** presents a mechanical drawing of the antenna showing the antenna's basic construction. The disassembled antenna is seen in **Figure 19.22**.

The modeled performance of the antenna gives a gain of 9 dBi when mounted at 15 feet above ground and 10.5 dBi at 23 feet. The assembled antenna produced an SWR of 1.2:1 to 1.3:1 across the entire 15 meter band.

19.4 PORTABLE MASTS AND SUPPORTS

Any of several schemes can be employed to support an antenna during portable operation. For HF antennas made of wire, probably the most common support is a conveniently located tree at the operating site. (See the **Building Antennas and Towers** chapter.) Temporary, lightweight masts are also used such as the increasingly popular extendable fiberglass and aluminum models that reach up to 80 feet in height. An aluminum extension ladder, properly guyed, can serve as a mast for Field Day operation as described in the article on the CD-ROM included with this book. A trip to the hardware store will also turn up several other candidates, such as painter's pole and other extendable handles.

Supporting tubular masts is usually done with guys of nylon cord or fishing line. This is fairly straightforward but requires at least three guy points and can be difficult for the usual one-person operation. (See the **Building Antenna Systems and Towers** chapter for more information on guying.) Other possibilities include using concrete- or sand-filled buckets as shown in **Figure 19.23**.

Masts constructed of separate aluminum sections are also widely available new or as military surplus. The June 2011 *QST* article by Bob Dixon, W8ERD, shows how to use a mast tripod to construct a sturdy mast rising to 40 feet. **Figure 19.24** is a drawing of how the various pieces go together, including guying lines. Since the mast is assembled from the bottom, piece by piece, it is much easier to erect than a mast which must be pulled up from horizontal or lifted and placed in a base.

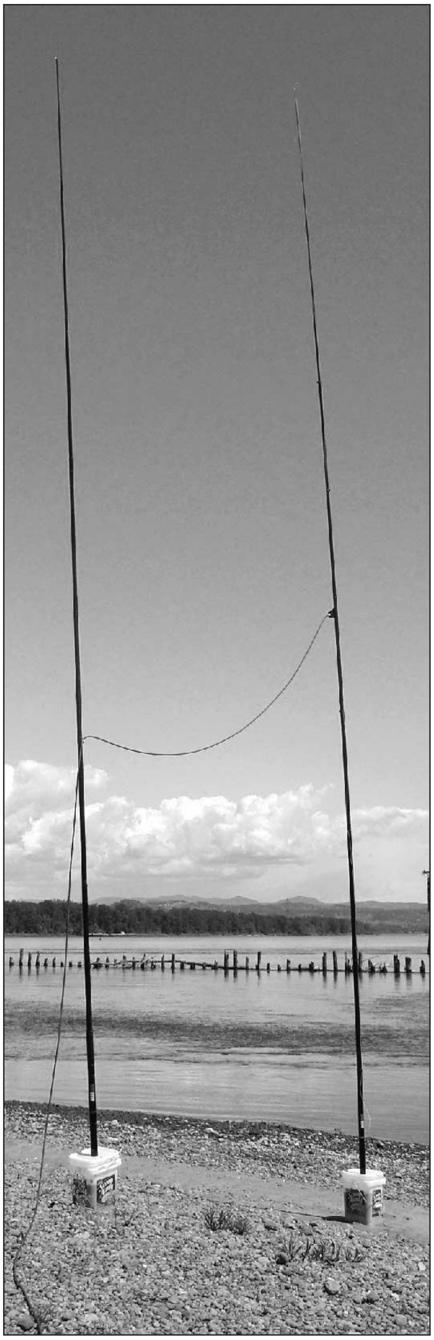


Figure 19.23 — A five-gallon plastic bucket filled with sand and rocks weighs from 40 to 60 pounds and makes a solid base for a fiberglass mast.

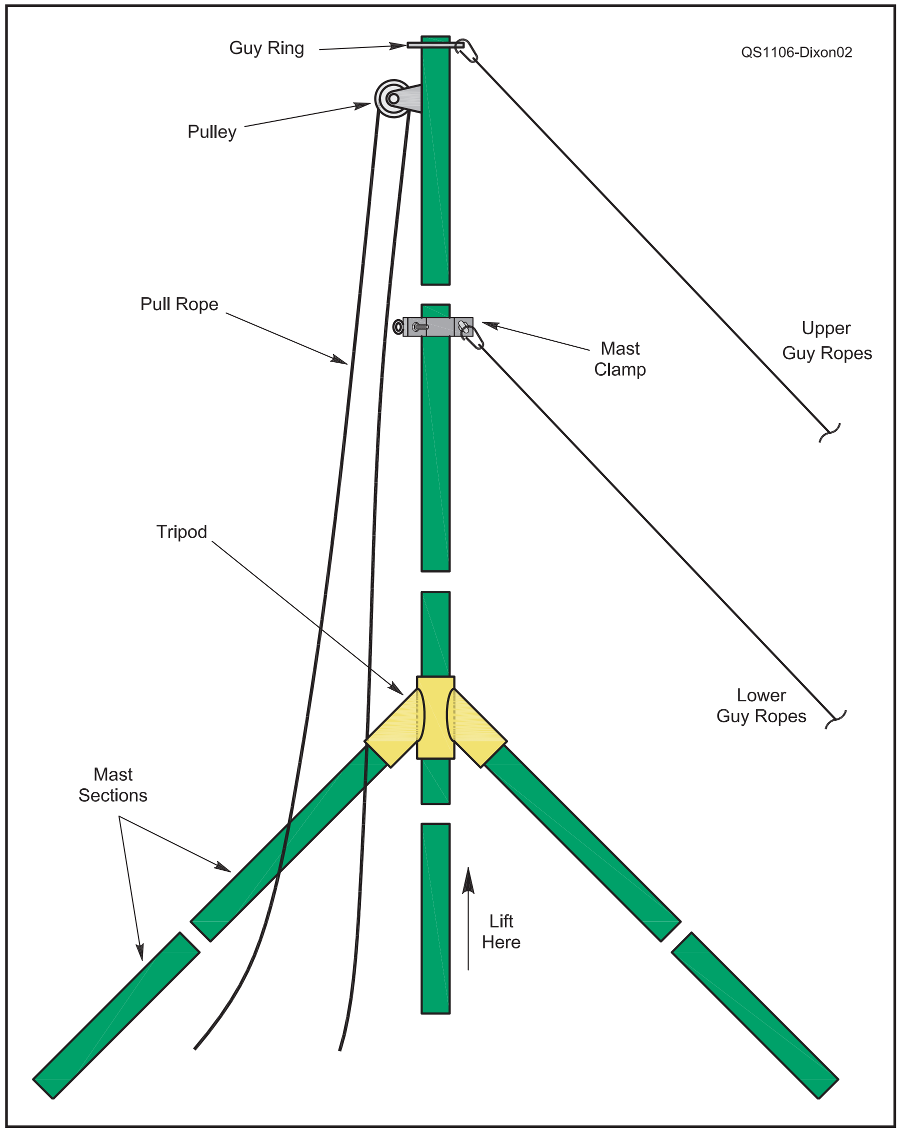


Figure 19.24 — Aluminum mast sections can be combined with a tripod center section to create a mast up to 40 feet high.

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