folded umbrella antenna

An effective, easy-to-build, all-band amateur antenna based on the principles of the folded unipole used in the broadcast service

A survey of amateur antennas would probably show that 95 per cent of them fall into one of four general categories:

1. Horizontal dipole (including inverted vee)
2. Vertical (ground mounted and ground plane)
3. Yagi (multiband and monoband)
4. Quad (multiband and monoband)

The folded umbrella falls into none of these groups — yet, when you see what it can do you'll wonder, "Why not?" This article describes a versatile antenna that is:

1. Broadband on all frequencies, 1.8 through 30 MHz
2. Easily tuned
3. Fully effective without ground radials
4. Without critical dimensions
5. Simple, inexpensive, and easily erected by one man
6. Space saving
7. DC grounded
8. Adaptable to your tower

It seems that most homes lack the space required for a 3.5-4 MHz dipole, or for the ground radials needed to operate a conventional series-fed vertical antenna efficiently. The folded umbrella has evolved from the effort to overcome these space problems.

The first step was to consider an antenna used in the commercial-broadcast field and known as a folded unipole. Shown in **fig. 1**, it is a *grounded* broadcast antenna tower, with steel arms across the top which are connected electrically to the tower. Wires are connected to the ends of these arms and dropped to the bottom, forming a cage around the tower that is insulated from the tower at all points except the top. The cage wires are tied together at the bottom and fed directly at that point with 50-ohm coaxial cable. The advantages claimed for this antenna are as follows:

1. Broadband performance
2. Low radiation-angle
3. Elimination of expensive base insulator
4. Elimination of approximately 6100 meters (20,000 feet) of copper wire
5. Elimination of expensive matching network and weatherproof housing

These features are important to the operator who's trying to put a broadcast station on the air with limited funds.

the result

The folded umbrella is simply the result of several approaches to the development of an antenna which is, roughly, the *electrical equivalent* of the folded unipole. The outcome of the evolution process is shown in **fig. 2**.

design considerations

In the interest of simplicity and economy, this antenna was built around a 12-meter (40-foot), four

By John M. Haerle, WB5IIR, Route 2, Box 348, Frisco, Texas 75034

section, telescopic or pushup TV receiving-antenna mast. In the development process, it soon became evident that the cage wires could best be supported by the nylon guys. Thus, the wires were pulled much farther away from the center mast — a fortunate accident as will be seen later.

Also, a 4.6-meter (15-foot) aluminum top-loading whip was added at the 12-meter (40-foot) level, making the antenna 16.8 meters (55 feet) high. The antenna will work well enough without the top loading, but the whip lowers the radiation angle and improves efficiency, especially at frequencies below 7 MHz.

Note that this antenna is *not* to be confused with the conical monopole or the discone. It is not within the scope of this article to discuss the differences, but they are well covered in reference 1.

tuning and matching

The commercial broadcast version of the folded unipole requires no variable tuning or matching arrangement, since it's designed for a single frequency. However, to match the folded umbrella on any frequency across all six high frequency amateur bands, a tuned open-wire line and transmatch unit are used. **Fig. 3** shows four different transmatch and feedline combinations. **Fig. 3A** is the basic combination, using an unbalanced transmatch. In this configuration, be sure that the side of the feedline grounded at the antenna is the *same side* that's connected to the ground terminal on the transmatch.

Fig. 3B illustrates the use of a balanced transmatch. In this case, a 4:1 balun is used at the antenna to maintain a balanced condition on the feedline.

Fig. 3C shows an arrangement which, theoretically, should unbalance things and bring unwanted rf fields into the shack. However, it has been tried and found successful in some cases. As a matter of fact the experimental antenna, which has drawn so much favorable mail, is operated in this manner. Note the *balanced* transmatch, and *no balun* at the antenna.

Fig. 3D shows the use of a short length of coax when it's inconvenient to bring open-wire line into the station. Keep this coax *as short as possible*. The open-wire part of the feedline should be, ideally, about 20 meters (65 feet) long (or a multiple thereof). When using other lengths it may be difficult to obtain a 1:1 swr on some frequencies, especially the higher frequencies. If this happens, experiment with slightly different line lengths of plus or minus 0.9-3 meters (3-10 feet) until it becomes easy to obtain 1:1 swr on virtually any frequency.

performance

Performance of the folded umbrella is quite gratifying. When operated properly, the swr should be 1:1, and your rig should see a 50-ohm resistive load on all hf amateur frequencies. On 1.8 MHz, the folded umbrella substantially outperforms a half-wave inverted vee, whose apex is 15 meters (50 feet) above ground. For all other bands, the comparison antenna is a multiband inverted vee, 40 meters (130 feet) long, 15 meters (50 feet) above the ground, with tuned feeders and transmatch.

From 3.5-4 MHz, the inverted vee is generally better up to 805 km (500 miles) because of the high radiation angle of the inverted vee or the low radiation angle of the folded umbrella. Between 805-1610 km (500-1000 miles) the superiority of the two antennas alternates depending on propagation conditions. Beyond 1610 km (1000 miles) the folded umbrella takes over, its superiority improving with increasing distance.

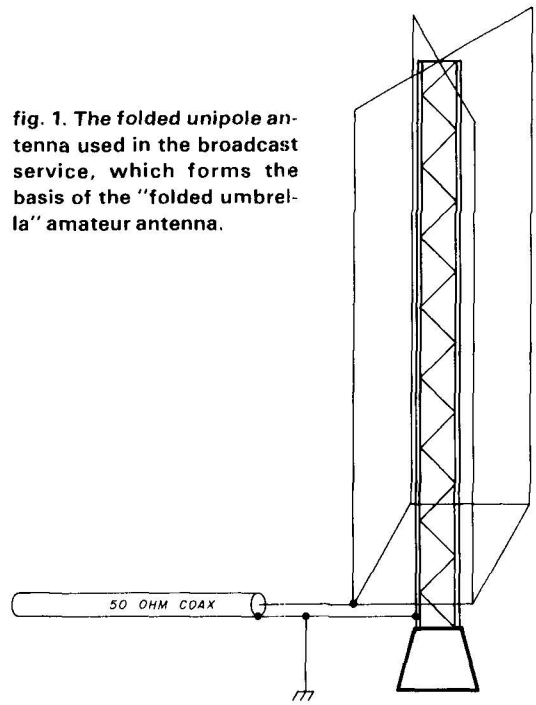


fig. 1. The folded unipole antenna used in the broadcast service, which forms the basis of the "folded umbrella" amateur antenna.

From 7-7.3 MHz, the folded umbrella definitely outperforms the inverted vee at any distance. It appears that the diamond shape of the wire cage begins to provide a measure of cross-polarization from 7 MHz up resulting in the following:

1. A diversity effect, which minimizes fading on the transmitted signal
2. A much better snr on receive because of the closed-loop design and because the antenna is dc grounded
3. Broadband performance. For example, if the folded umbrella is tuned for a 1:1 swr at 7.150 MHz and the transmatch is left untouched thereafter, the maximum swr observed at either 7.000 or 7.300 MHz is 1.2:1

The experimental model was not used much between 14 and 30 MHz since a quad is generally used on these bands, but performance is comparable to that of a dipole on these frequencies. Other builders have reported excellent DX results on the upper bands.

operation without transmatch

The folded umbrella is basically a 3.5-4 MHz antenna. If it is fed directly with coax and no transmatch, the swr is less than 2:1 at both 3.5 and 4 MHz. From 1.8 to 2 MHz the coax-fed antenna shows an swr of approximately 2:1. On the 7-MHz band, swr is in the 2.5:1 range. At 14.2 MHz, swr is 5:1, at 21.3 MHz, swr drops back to 1.5:1, and on 30 MHz, swr is about 3:1.

Since none of these swr numbers is really high, a transmatch and tuned feedline can easily subdue them, resulting in *1:1 swr* across all six bands.

using your tower

By applying unipole principles, you can use your tower. Just start by connecting one wire at some arbitrary point on the tower, say 12 meters (40 feet)

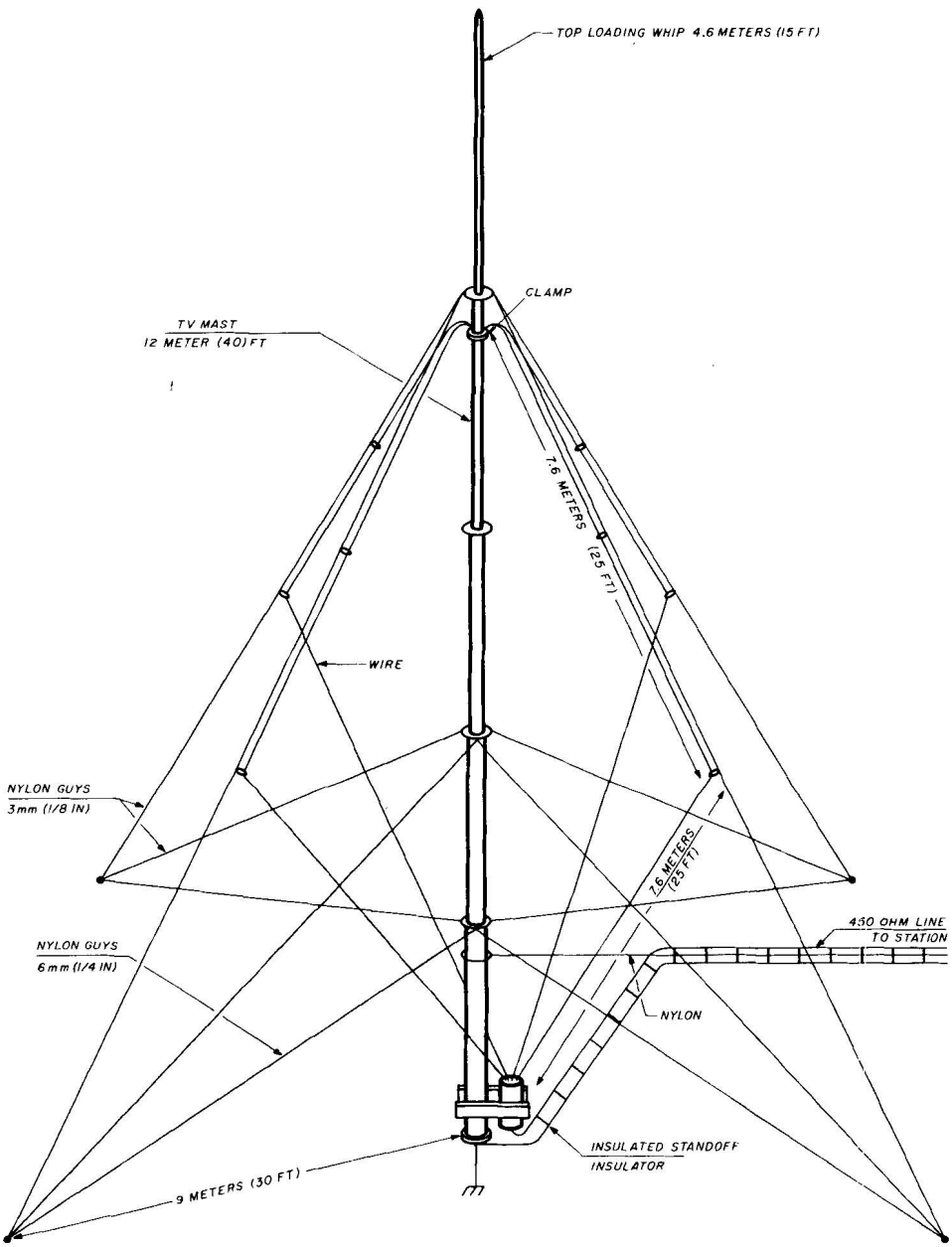


fig. 2. Construction details of the folded umbrella antenna, which is, roughly, the electrical equivalent of the folded unipole. Dimensions are approximate and are not critical.

above the ground. Use nylon line to pull the wire away from the tower. Then, bring the wire back to the bottom of the tower, as shown in **fig. 4**.

Use an exciter/vswr meter and a bridge or a grid dipper to check the resonant frequency. If it falls within the 3.5-4 MHz range, add the other three wires and proceed as with the folded umbrella. Your beam should provide adequate top loading. Be sure to ground the tower well.

construction

1. Set up the collapsed pushup mast, using 6-mm (1/4-inch) nylon guys on all four sides. Use the closely woven nylon, not the loosely braided type. The former is much stronger and will not unravel. Do not

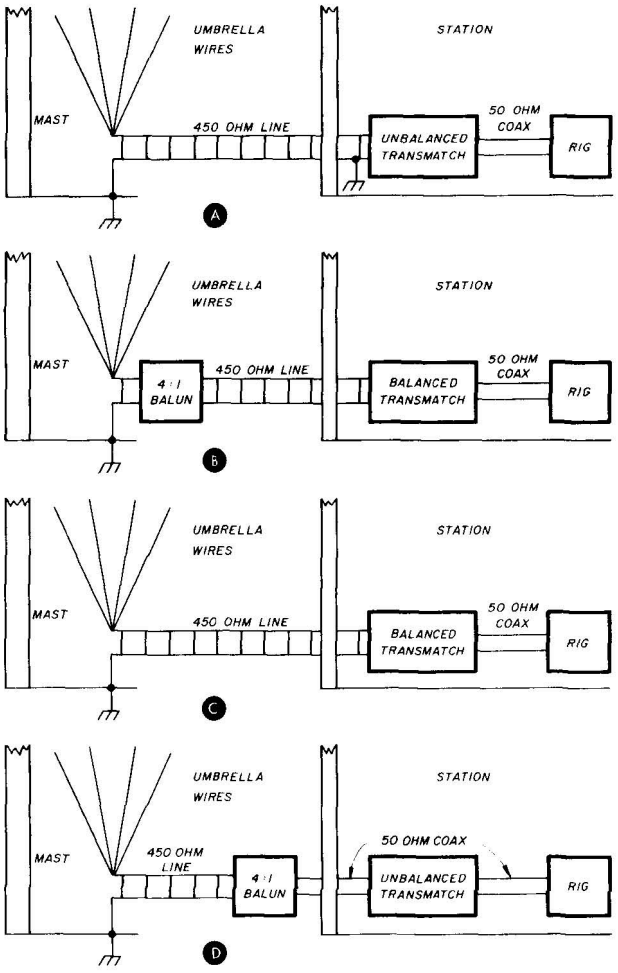
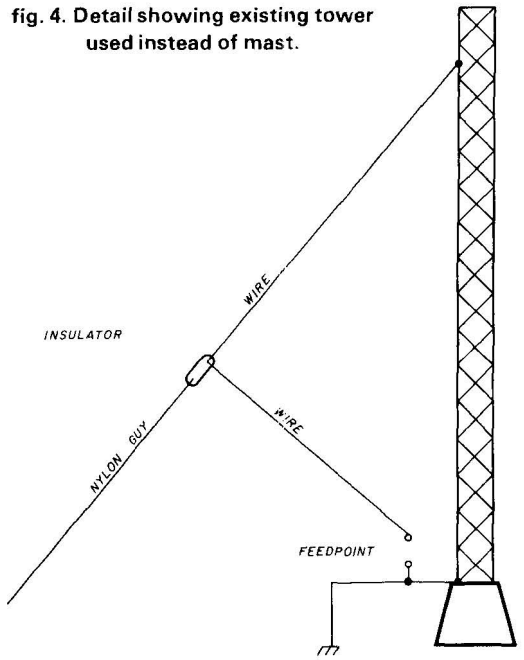


fig. 3. Transmatch and feedline configurations for the antenna. Sketch (A) shows the basic arrangement using an *unbalanced transmatch*. Note grounding. In (B) a balanced transmatch is used. A 4:1 balun is required. Sketch (C) shows an arrangement as in (B), but without the 4:1 balun. Transmatch is balanced (no ground). Sketch (D) shows how to use a short length of coax cable between the open-wire line and the station. The coax cable length should be as short as possible.

fig. 4. Detail showing existing tower used instead of mast.



use other synthetic line. Some of the other kinds of line become brittle with exposure to sunlight and will eventually break, while nylon retains its strength indefinitely. Nylon will stretch, but the close-woven type requires tightening only a few times initially.

2. Place the guy anchors at least 9 meters (30 feet) from the base of the mast (or use the house or trees where possible). Tighten the bottom guys firmly and place your ladder against the mast for further work.

3. Metal rings are supplied on the TV mast for attachment of guys. Be sure these rings are now in place before proceeding.

4. Insert 4.6 meters (15 feet) of aluminum tubing into the top of the pushup mast. This tubing can be made up of two or three telescoping pieces, if desired, just so long as the bottom (largest) piece fits snugly inside the top section of the pushup mast. The tubing can be secured by drilling through and bolting or by slotting the pushup mast and using a clamp (see **fig. 5**).

5. Attach four nylon (close-woven) guys to the top guy connection ring (**fig. 5**).

6. Pull the top section up out of the collapsed mast assembly about 0.6 meter (2 feet) to facilitate connection of the umbrella wires.

7. Tie two small loops in each of the four top nylon guys as shown in **fig. 2**. These loops should be about 4 and 8 meters (12.5 and 25 feet) from their attachment points on the mast.

8. Install umbrella wires.* Use approximately 16.8 meters (55 feet) of wire for each of the four elements. Clean and tin about 5 cm (2 inches) at one end of each wire. Clean and sand the mast just under the guy attachment ring. Using a stainless-steel hose clamp, attach the umbrella wires, spacing them equally around all four sides of the mast (**fig. 5**). Smear silicone rubber cement (GE or Dow-Corning)

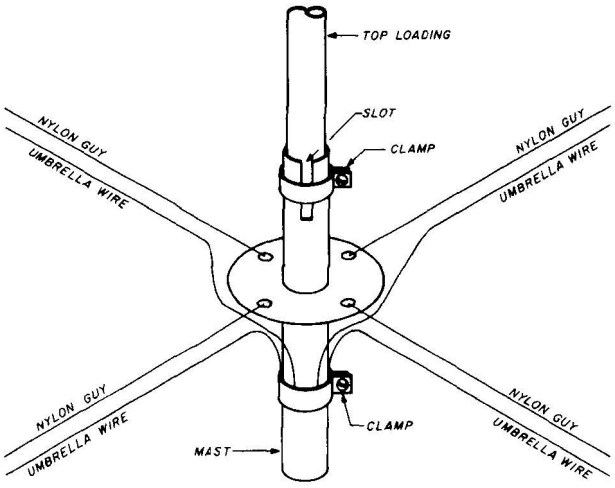


fig. 5. Detail showing attachment of top guys, "umbrella" wires and top loading whip.

liberally over the hose clamp and bare wire ends to prevent corrosion of the electrical connection.

9. Thread one of the antenna wires through the two loops on each of the guys. You are now ready to begin raising the mast.

10. Use heavy leather gloves and be very careful when pushing the mast up. Whenever you stop the mast part way up, be sure to tighten the locking bolt very firmly, using pliers or a sufficiently large crescent wrench. If the mast should slip unexpectedly, it can pinch and cut your hand most painfully. This is the reason for the heavy leather gloves.

11. As you raise the mast, temporarily secure the bottom ends of the umbrella wires to their respective guys with tape. Then, keep these four wire/guy assemblies tied away from the mast as you raise it. This prevents the wires and guys from becoming tangled during the erection of the mast.

12. Now, push the top section up to its full length. There will be a hole at the top of the next section below. When the bottom of the top section is pushed high enough to clear this hole, push a large cotter pin (provided in the mast hardware) through this hole. Spread the ends of the cotter pin only enough to secure it, which will make it easy to remove at some later time. Now, tighten the locking bolt firmly. Repeat this process on the other sections.

13. Push the next section up and secure as above.

14. Attach four more 3-mm (1/8-inch) nylon guys to the ring at the top of the section just above the bottom section. This set of guys will end up, on full erection, 6 meters (20 feet) above the ground (**fig. 2**).

15. Push this last section up and secure, as above, and temporarily secure all guys.

16. Now, provide a bracket at the base of the mast for the purpose of connecting the four umbrella wires together while insulating them from the mast. This is the feedpoint for the antenna. One suggested method of anchoring and insulating the feedpoint is shown in **figs. 2** and **6**. However, as with other parts of this project, there are many different mechanical arrangements which will produce the same electrical results. Use your ingenuity. Remember, none of the dimensions are really critical, since the tuned feeders compensate for physical variations. If you're following **fig. 6**, however, pull the umbrella wires through the PVC tubing, tighten the clamp below the tubing, and trim off excess wire, leaving several cm of wire below the clamp. Now, bare the wires below the clamp and solder them together.

17. Drive three or four 2.4-meter (8-foot) ground rods around the base of the mast and connect them

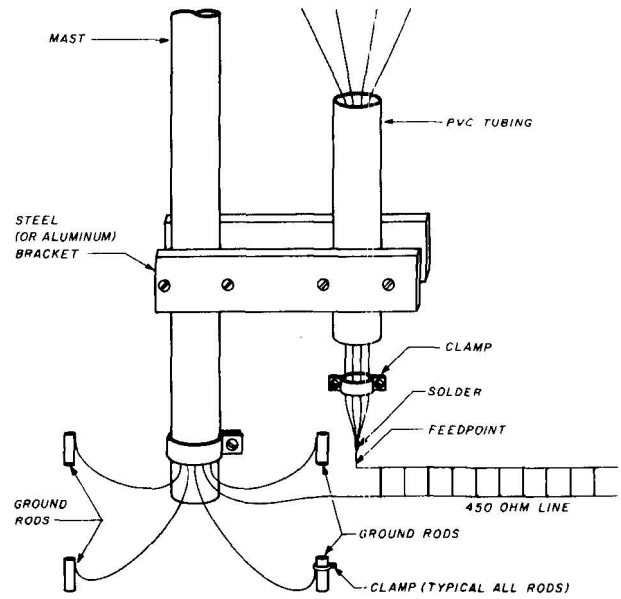


fig. 6. Mechanical details at the bottom end of the TV mast. The ground rods are essential for good performance.

*Any available type of copper wire up to 2 mm (no. 12 AWG), solid or stranded. The experimental model uses surplus 1.3 mm (no. 16 AWG) stranded, insulated wire.

securely to the mast with heavy copper wire, tubing or strap (**fig. 6**).

18. Attach feedline, soldering one side to the feedpoint and connecting the other side to ground. The most practical line to use is the 450-ohm plastic ladder line made by Saxton. It is strong, flexible, and much easier to use than bare open wire while just as effective. Furthermore, it's affected very little by ice,

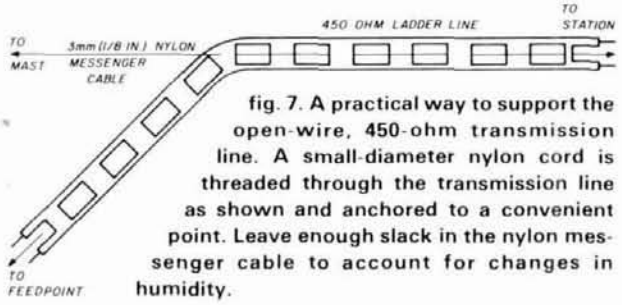


fig. 7. A practical way to support the open-wire, 450-ohm transmission line. A small-diameter nylon cord is threaded through the transmission line as shown and anchored to a convenient point. Leave enough slack in the nylon messenger cable to account for changes in humidity.

snow, or rain, as far as tuning is concerned. **Figs. 2** and **7** show a simple, practical way of supporting the line. For the experimental model, it was necessary to run the line 18 meters (60 feet) to the house, keeping it at least 3 meters (10 feet) above ground. To relieve tension on the line, 3-mm (1/8-inch) nylon was threaded through the holes in the line and stretched from the mast to the house, serving as a "messenger" cable. Here again, use your own ingenuity to fit your situation.

19. After tuning and testing, tighten and secure the guys, using a plumb level to be sure the mast is vertical.

closing remarks

Here is an antenna that can do many things for you. Don't expect it to perform like a beam — but it will more than hold its own against conventional dipoles and trapped verticals at all frequencies and on all high frequency amateur bands.

I have received literally hundreds of inquiries from people who were impressed with what they heard when I was using the umbrella antenna. All inquiries have been answered, and those who have built the antenna report equally gratifying results.

The writing of this article was deliberately delayed pending receipt of data from others to provide the reader with authentic, reliable information.

reference

1. Paul H. Lee, K6TS, "The Amateur Radio Vertical Antenna Handbook," Cowan Publishing Company, 1974, pages 49-52 (discones and monopoles); pages 75-80 (folded unipoles).

ham radio