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Folded Unipole for 160

—Top-banders, take notice! Here's a top-loaded radiator with the government's seal of approval.

The more you consider and study antenna phenomena, the more you become fascinated with the flow of ideas about radiation devices and their possibilities. Here is just one such interesting antenna type along with its development, which occurred step by step using a lot of published antenna information and much on-the-air discussion and revelation.

This is an uncommon but very effective antenna type that could interest most low-frequency hams. Zoning height restrictions are admittedly something else, though this antenna idea works well at even a 35' height restriction. It works somewhat better at 70' to 130'—and even to 200' if you can arrange it. And, conveniently, it fits most real estate situations. So, it isn't necessary to miss out on the fun of 160-meter operation because you don't have room for a full-sized horizontal antenna.

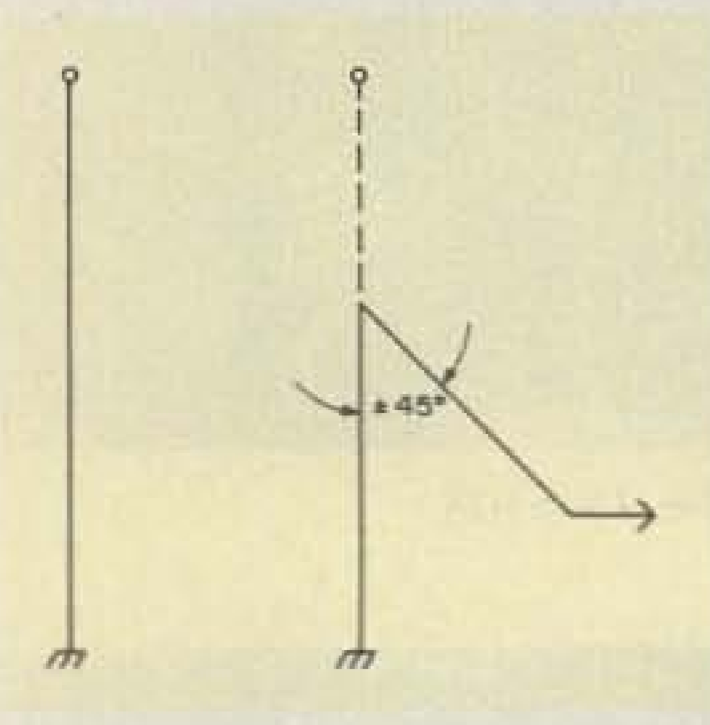

Fig. 1. Basic folded vertical.

Now, short antennas have been proven less efficient than full-size resonant antennas even though the former often provide fair to good communications on occasion. The top-loaded folded unipole (TLU) is a form of shortened antenna that is constructed by folding down the vertical portion to achieve low resonance (because of some height limitation), while increasing resistance and bandwidth and retaining most of the properties and benefits of a high radiator (see Fig. 1).

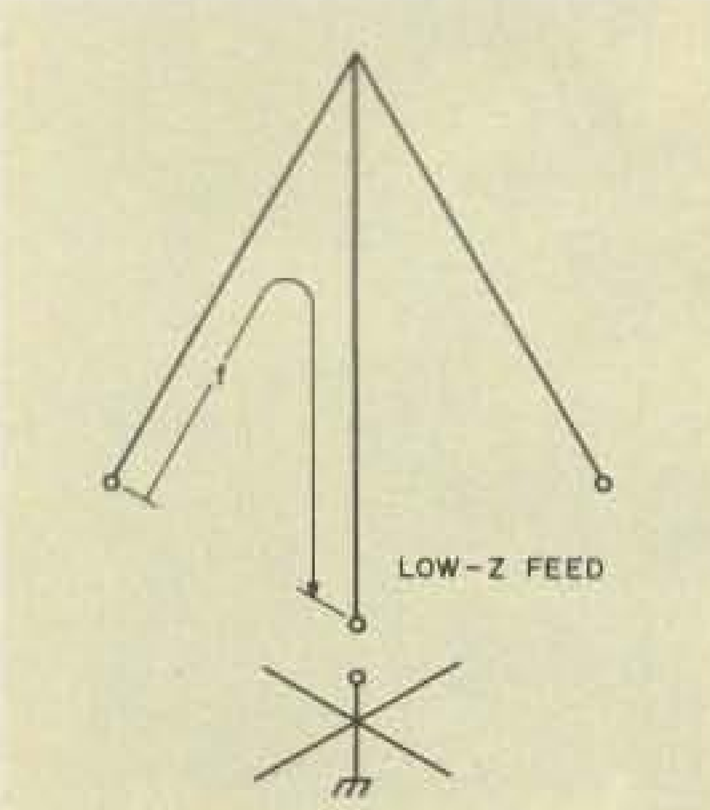

Fig. 2. Series umbrella.

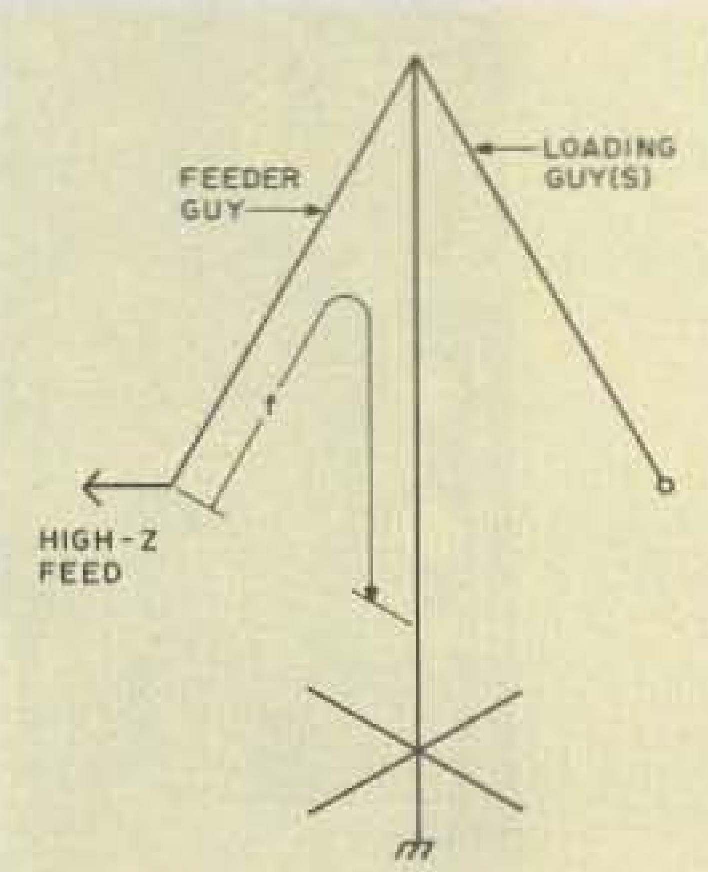

Fig. 3. Grounded umbrella.

Lots of hams have existing towers, poles, trees, or buildings from which to hang this efficient, effective, broadband, and easy-to-use-and-adjust antenna. And, happily, this is a low-cost way of getting up a really good low-band radiator—a real problem for most hams on city-size lots; a 30' to 50' TV push-up mast works well in this configuration.

The TLU is just one of many types of vertical antennas. It uses top feed and loading, which gets the antenna current up in the air where it belongs for maximum radiation efficiency. It differs from the series-fed vertical (Fig. 2) that is fed at the bottom, and is coil-loaded at the bottom, center, or top. The TLU is similar to the "umbrella" vertical that is grounded (Fig 3), then fed at the top via the sloping guy wires which come down near to the ground adding length to the system and thus lowering the resonant frequency while simultaneously feeding the antenna. This TLU gives considerably higher impedance to the antenna structure than does the series- or gamma-fed vertical (Fig. 4), a most important consideration. The TLU is a grounded vertical structure (Fig. 5) that is simple, follows the basic engineering principle that simplest is best, and easiest. This antenna is remarkably free of bugs.

This article covers my application of the radiator designed by the U.S. Navy at the Corona, California, antenna range for ship and shore use. Navy Captain Paul Lee (ex-K6TS) describes the principle of the antenna type in his book, *Vertical Antenna Handbook*, pp. 28-31, published by CQ.

It is a very low-angle and broadband vertical. Mine has a 400-kHz bandwidth and I have worked the world with it on 160. It also performs very well on 40 and 80 at a 70' height. On 160, this vertical (at 70') tunes with either just a series variable capacitor (when the resonant frequency of the entire structure is 3/8-wave, 160' to 200' total) or by adding a coil to ground the feedwire with a ceramic rotary switch, forming an L network. This may be necessary with various antenna heights, volumes, grounding systems, etc., and is required on 40 and 80 to resonate the structure.

The structural basis for this TLU vertical is a grounded metal tower, tree, pole, building, or wood tower of from 30' to 200' in height for the 160-meter band, but should be as high as possible to reduce losses and to lower radiated wave angles. We can't always have a tower of optimum height for one reason or another, but a most effective radiator can be achieved with this TLU principle.

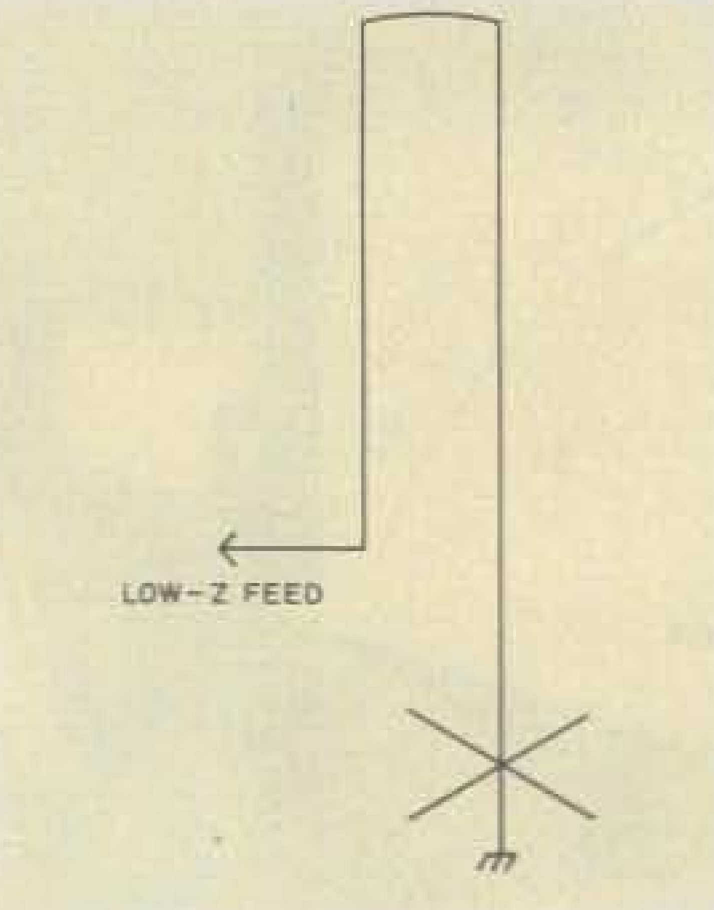

Fig. 4. Gamma feed.

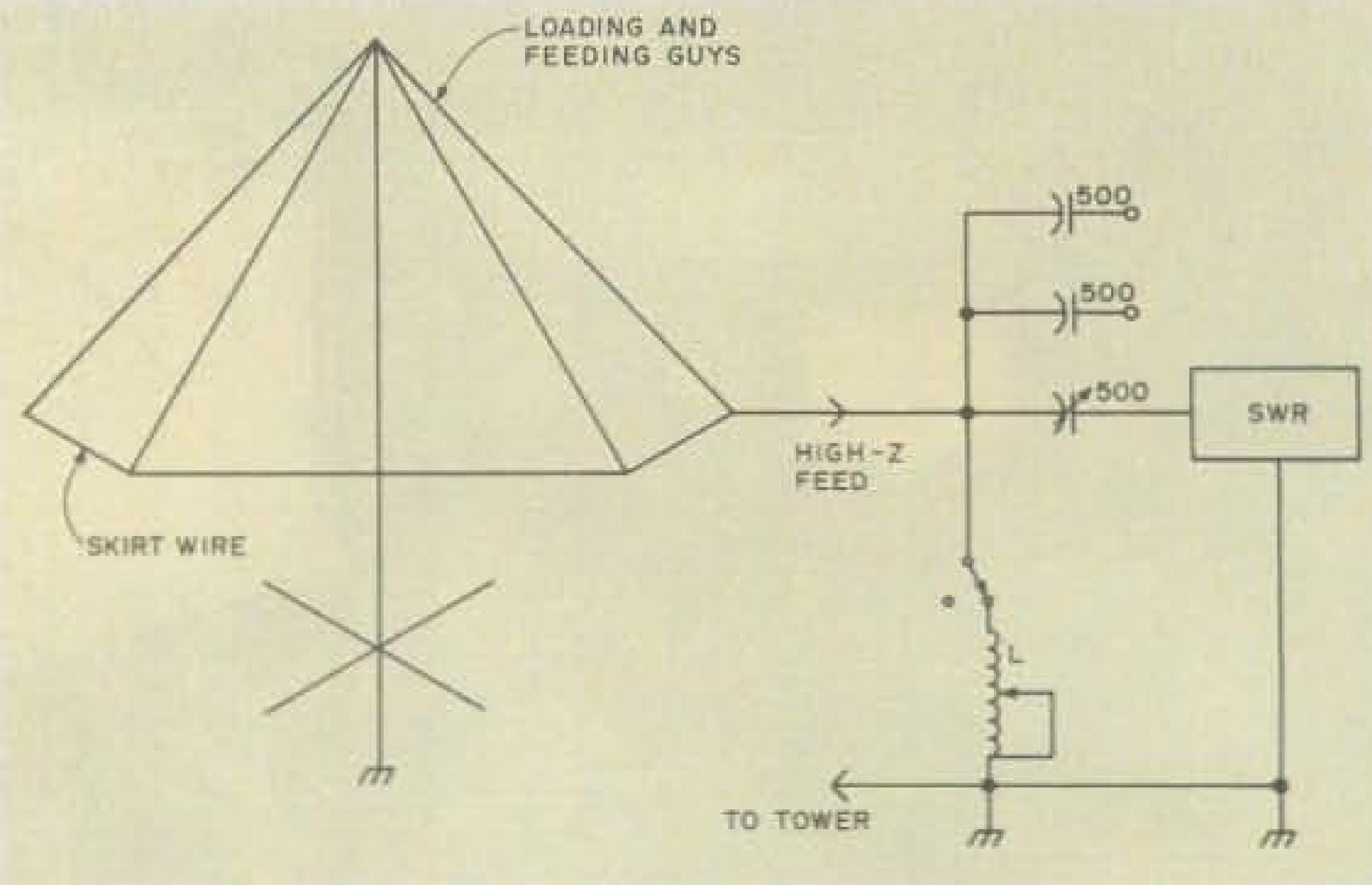

Fig. 5. High-Z umbrella (top-loaded folded unipole, or TLU).

Height, tuning, and loading can vary considerably with a TLU for efficient, effective performance and ease of adjustment. This radiator is simply a big, grounded, closed-loop, similar to any folded antenna, of up to a full wavelength in circumference, much like a grounded quad or triangle. The sloping (and loading) feeder and top guys descend at just under a 45° angle. The sloping line thus becomes part of the radiating portion of the antenna itself, much like the (higher-impedance) "umbrella" vertical that is fed at the bottom (series feed). In both cases, the top guy(s) bonded to the tower top increase the radiator's length and lower the antenna's resonant frequency.

The feedline (and any top-loading guys) descend to guy posts (trees or other guy anchors) at about ten feet above ground. Any guy angle higher than 45° introduces horizontal components into the radiated signal. The higher angle may better suit the purposes of those hams seeking higher-angle coverage for close-in contacts of under about 1000 miles. For serious DX work (low-angle radiation) a less-than-45° angle is a must. Further, the TLU has a considerably higher impedance than the series-fed vertical. Top-loading guys, long used by commercial and military stations, raise the impedance to over 50 Ohms, a highly important and desirable factor. Resonating the antenna of course increases radiation efficiency. Q of the TLU is low—the bandwidth is about 200 kHz with only one feeder-guy. With 4 or 5 such loading guys, bandwidth is near to 400 kHz on 160.

The vertical portion of the antenna (a tower) can be simulated by hanging a grounded wire from any of a variety of structures (trees, buildings, etc.) and the feeder wire brought down at the 45° angle. A tower with beam atop simply becomes a more top-loaded vertical, the beam(s) increasing "top-hat" capacitance loading and further lowering resonant frequency. All this, in combination with some sort of ground system, has proven to be a top performer on all three of the low bands.

Vertical polarization has consistently proved to be optimum over the years under all sorts of propagation conditions on frequencies below about 8 MHz for more than, say, about 3000 miles. Any horizontal antenna on 160 meters would have to be about 130' up (1/4-wave) for consistent, effective DX work beyond about 3000 miles. This is obviously not an easy height to attain in urban areas, consequently, the desirability and need to go vertically. This TLU is not only a top performer on the lower frequencies but is a very uncomplicated structure.

Inasmuch as the high-current portion of an antenna does most of the radiating, get current up at the vertical's top. In the TLU, the drooping and radiating guys do this current raising well even when the vertical tower is not very high, but, of course, the higher the better (up to 5/8-wave high). A top-loading coil in a coil-loaded vertical is a lossy device and acts like an rf choke, though the coil-loaded and series-fed vertical can be very effective within its narrow bandwidth of 15 to 18 kHz on 160 meters.

It is, of course, a bit of a chore to have to run out in the back yard to adjust the base-matcher in the cold, wind, rain, sleet, snow, and maybe trip over lawn furniture, etc., or fall into the swimming pool in the dark (160 being a nighttime band), not to mention mosquitoes, stray dogs, etc. This, to me, seems to be the hard way to QSY beyond that 15 to 18 kHz and still keep your solid-state finals happy (low swr). Besides, by the time all this has happened, any DX pileup has gotten bigger and deeper. Imagine operating in a contest this way, all over the band—all night.

This TLU is a real convenience and can be adjusted right beside you in the shack. While any artificially loaded antenna is a compromise, this wire-loading using folded-down sloping and radiating guys is a least-lossy compromise. This configuration becomes a sort of multiple-sloper, and acts as a 2-element driven array with maximum radiation (and some gain) along the tower-to-guy axis.

These guys descend to a point about ten feet above ground to where they are secured to guy posts, trees, etc. These guys are bonded to the tower top, and continued down the tower, bonded to the tower every few feet, down to ground level to be bonded into the grounding system—fencing, metal well-casing, etc. Connect these to the shack ground, radials, screen, etc., to complete the circuit and minimize losses which will make the system more broadbanded. These guy wires and/or feeder are tied together at the guy posts' level by a skirt wire which further adds capacity to the structure and feeds directly into a matching network. See Fig. 5.

I feed this antenna not from a gamma match device at the tower top as recommended by the developers, but from the skirt wire as it passes near the shack window about ten feet above ground. It is fed directly using an swr bridge through a series-variable capacitor (about 500 pF) with three 500-pF fixed capacitors added as required by a ceramic rotary switch.

All this has raised my signal by three S units on local and long DX contacts. The swr bridge is grounded to the station ground system and is connected by heavy cable to the grounded tower, all of which forms that big grounded loop. Spacing of the tuning capacitor plates of the matcher can be of the receiving type for power up to 200 Watts dc input. The higher impedance of the antenna makes it more flexible and easier to adjust.

The grounding system of a vertical radiator performs like the other half of a balanced antenna. As with most vertical radiators, the ground system is indispensable in balancing the system properly, fully grounding the vertical, and increasing conductivity of the soil or ground plane as much as possible to reduce losses

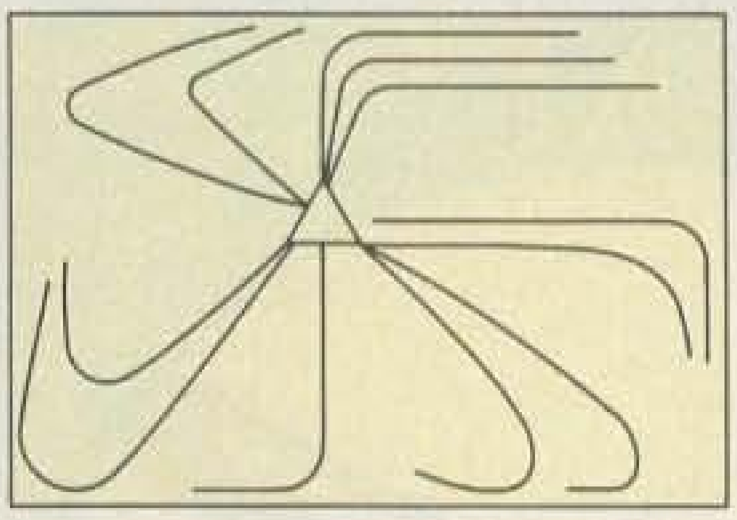

Fig. 6. Radial installation.

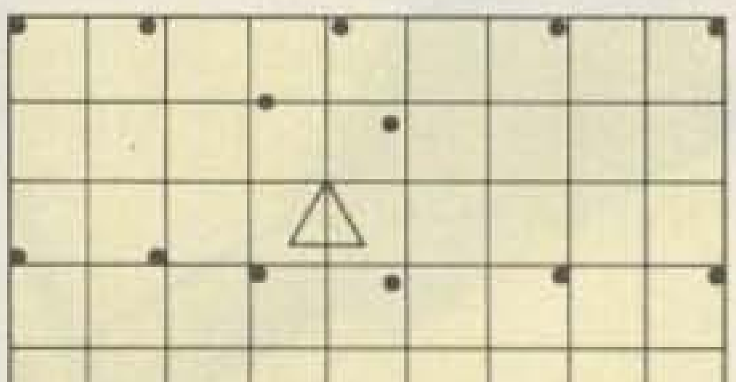

Fig. 7. Ground screen and ground rod installation.

and to bring down the angle of radiation. The grounding system may consist of only one ground rod, particularly in circumstances where there is not access to even a tiny patch of soil ground, but the grounding system should be as extensive as possible.

The first step in establishing a ground system is usually to install one or more ground rods, then add as many quarter-wave radials as possible to the tower, up to about 120. Some antenna experts claim that radials do not have to be any longer than the physical height of the tower, and do not necessarily (and ideally) need to be laid out symmetrically similarly to a fan or uniformly-spoked wheel. Also, that it is better in the case of a less than 1/4-wave vertical to have, say, 20 1/8-wave radials than to have 10 1/4-wave radials.

I am on a city lot, 50′ × 100′, with the tower in the exact center of the lot. I've "copper-plated" the entire lot with 51 82′ radials (0.15λ on 160) spread out as symmetrically as possible and curved around clockwise to fit onto my lot (Fig. 6) Then, covering the entire lot, is a 3′ mesh ground screen laid down over the buried radials—under the house, garden, and unpaved driveway! Oh, what a job! But the results make it all worthwhile to the striving, resourceful, dedicated ham.

The wires become invisible when they sink down in the earth from the original burial depth of 1″ to 2″ to more than 6″ after the first rains of the season. All of this was secured to the ground by 14 ground rods strategically placed (Fig. 7). Four more rods were put down around the tower ten feet from each other and from the tower. Old iron pipe (4′ lengths) will be quite adequate.

To extend this ground plane as much as possible within my circumstances, I even stapled four 135′ radials to the side of my wood-frame house. I put them just a few inches above where the cement foundation joins the wooden house siding, a few inches above ground, and spaced them about 2″ apart. These also could be put up under the house eaves. The idea is to make that ground plane as extensive and dense as possible. All this means longer DX paths and contacts for your signal. The rig will load and perform better, too.

There are those experts who claim that an extensive ground system will add nothing to the receiving capabilities. But it has been my experience that after the ninth radial was put down I suddenly began hearing DX that I had not been able to hear before and that DX which had been regularly heard before became clearer (less "watery"), more distinct, and stronger.

Some have even buried large masses of metal like old car bodies, copper tubs, tubing, pipe, metal mats, fencing, etc., obtained from a junkyard. And, of course, connect to your lawn sprinkler system (and maybe that of an obliging neighbor), metal water pipes, and fences. I have worked hams with radials laid in their swimming pools or put down a well casing who get top results even though the antenna theorists belittle such ground systems.

Try studying your situation at length, be adventuresome and imaginative, and you may well surprise and delight yourself with the results, as many of us old-timers have. So in spite of what the experts say about grounding systems, just get down whatever metal you can. There is a great deal of testimony and evidence about the validity of these grounding ideas. Every little bit of buried metal will pay off.

My "loop" is approximately 3/8λ wave in circumference, tuning fully with only a series capacitor of 1500 pF total. For larger or smaller "loops," an L network may have to be formed by switching in a coil from feeder wire to ground as shown in Fig. 5.

This also will have to be done on 40 and 80 meters to resonate the TLU to those bands. The coil should be tappable, mine is 50 turns of #16, 2″ diameter × 5″ long. Or, try using your commercial tuner of whatever type. I have successfully used pi and parallel networks as well. This will give a 1:1 swr across the entire band. With my feeder plus four top-loading guys and skirt wire, the bandwidth is excellent, as shown in Fig. 8.

I have tried various gamma-feed systems with this TLU with only fair results. The on-the-air reports were materially increased (3 S-units) both locally and on far DX by feeding the skirt wire rather than using a gamma-feed. The bandwidth becomes more than doubled with the same structure, which gives still better overall performance.

Even though an antenna can be properly matched and loaded, that antenna may or may not radiate the rf at desired angles. By folding down and, in a sense, diminishing by about half the vertical structure, this TLU method does not seem to materially degrade low-angle performance of a vertical antenna. Further data

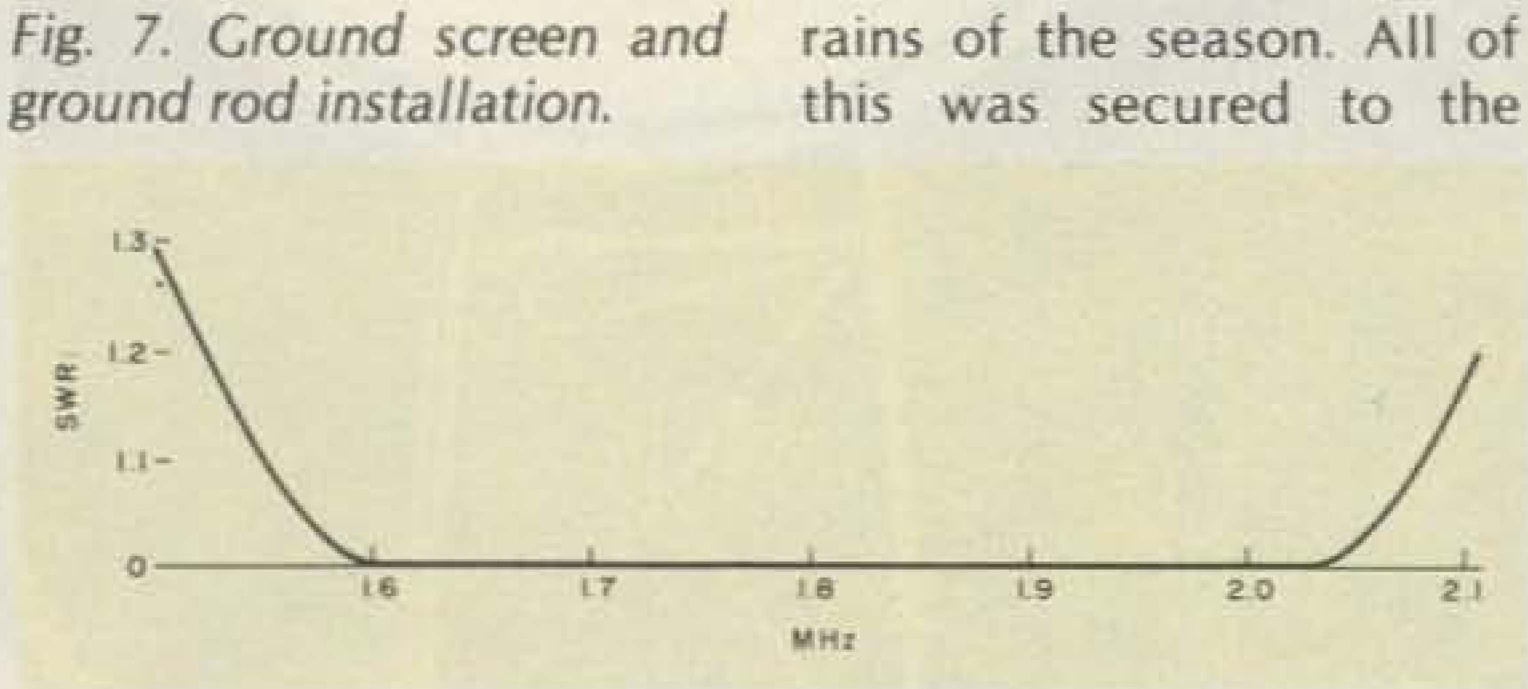

Fig. 8. System bandwidth.

may confirm this.

I keep large maps of the northern hemisphere and of the great circle on the shack wall beside me, and place colored-headed dressmaker's pins on the maps when contacts are made on 160 to record and check performance of my radiated signals. Interestingly, it became very evident that in the directions along the tower-to-radiating guy axes the transmitted signal is maximum, with various diminished reports from between those axes. Consequently, it would no doubt be a more uniform signal pattern if up to 12 nearly equally-spaced top-radiating guys were installed in order to better cover the entire 360°. I have yet to try this.

Utilizing wood towers, poles, buildings, trees, etc. (Fig. 9), from which to hang a TLU, makes for an unobtrusive antenna, especially when a tree is used, which largly hides a TLU. This antenna also can be hung from a building of suitable height or between buildings if necessary. This TLU has proved over the years by many to be a flexible and most worthwhile antenna, and its only limitations have occurred whenever the band is not open (long skip) to my area.

It is an effective DX-getter when the top band is open. Further, this is not a noisy receiving antenna as are most solely-vertical antenna structures. This is probably because of the 40° slanting guys, which pick up less noise (which generally is vertically polarized, thus readily flooding into a vertical.)

Whatever remnants of noise do get picked up are cut out with audio filters plugged into the output jack of the transceiver. So, I am hardly even aware of QRN. (See my article in *73 Magazine* for February, 1980.) Besides, I like to use this TLU structure for receiving because there is 900′ of wire and metal surface up there in the air which seems to capture more wave-front energy than do the low receiving antennas of several types in use here. QSB does not seem to be as critical, either, as when using those low receiving antennas, perhaps also for the same reason (sloping feeder and guys).

In considering antenna performance in the case of 160 meters, there is the tendency to pass judgment quickly after only a short trial, giving a false or incomplete impression of actual performance potential, particularly under "closed" band conditions, and not being mindful of the variations—highs and lows of propagation conditions. Receiving and radiating phenomena should be observed over a sufficient period—a week or month—to allow for the inevitable change in propagation

At times I have wondered if any of my rf was going anywhere, but because I waited to make structural changes for some reason (weather, no time, or being just lazy), propagation conditions would change, the 160 band would suddenly open, long-skip DX would come roaring in as occasionally happens on 160, and my calls were answered with big signal reports. The antenna would thus be vindicated and saved from unwarranted changes.

So, do yourself a big favor and be slow of antenna judgment on 160, a band of continual amazement, confoundment, and strong personal reactions. And another thing: On 160, those "openings" can be greatly selective, occurring only in some areas of any given state or region. There is also the "pipeline" phenomenon to be considered.

After more than 50 years of ham radio and watching variations of band conditions on 160, it becomes apparent that conditions vary very widely even during a single hour of nighttime consideration. This type of grounded antenna (TLU) has been a fine if not outstanding performer, and is well worth trying. ■

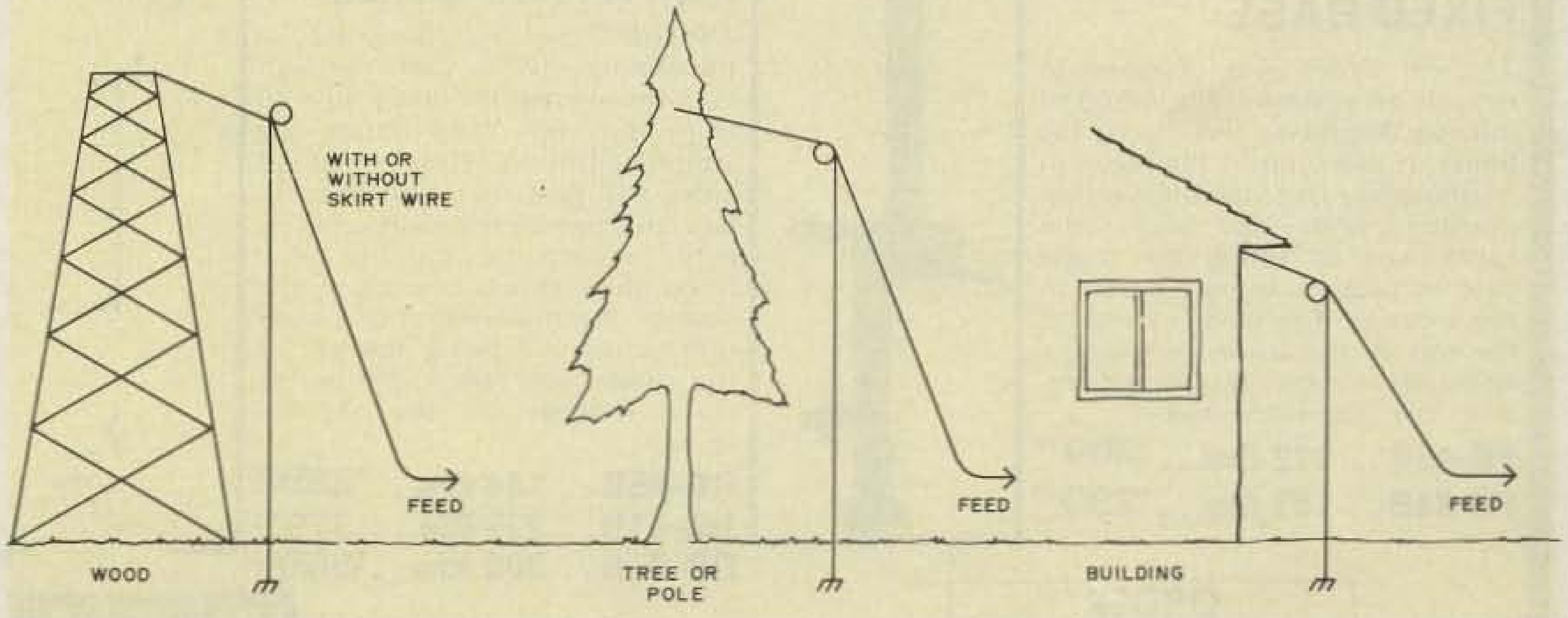

Fig. 9. Simulation of a metal tower.