Some of you may recognize this antenna as being one manufactured by Barker & Williamson. No, it's not a rip-off of their design. W3JIP is the Chief Engineer for B&W, and it's their way of showing you how to roll your own, plus teach you a bit about how it works.

Parallel Verticals

A Broadband Antenna Covering Six Bands Without Traps

BY ROBERT H. JOHNS*, W3JIP

In fig. 1, a 25 foot vertical made up of three separate elements is shown. The antenna is resonant on 80, 40, 30, 20, 15, and 10 meters with low s.w.r., and does not have any traps in it, only one loading coil. The bandwidth is unusually broad on all bands from 7 MHz on up.

Parallel dipoles have been successfully used in the past to get multiband operation without traps, but parallel verticals have not been widely used by amateurs. They make a very effective antenna. By clustering three vertical elements into a triangle, a sturdy, tower-like structure is produced. The antenna in fig. 1 is built from ½ inch steel electrical tubing, EMT, held in place by insulator rings cut from PVC pipe. Both of these are readily available and not expensive. The absence of any traps in the antenna makes it easy to build and tune.

Operation

Each of the three elements is resonant on two bands. The 40 meter quarter wave is top-loaded by three capacity loops which shorten its length down to 25 feet. It is also a ¾-wavelength radiator on 15 meters. The 30 meter element also works on its third harmonic, 10 meters. The 80 meter element has a large loading coil located at the top of a quarter wave for 20 meters. This coil acts as a high-impedance choke on 14 MHz, cutting it off from the rest of the antenna on 20 meters. This gives the same result that a trap would do, but no capacitor is used with the coil, and the inductive reactance of the coil, 3000 ohms, is high enough to effectively separate the quarter-wave base section from the rest of the antenna. This coil is also enough to inductively load the 25 foot element so that it resonates in the 75–80 meter band. Top capacity is used on this element also, giving it a fairly wide bandwidth—about 75 kHz at the 2:1 s.w.r. points—considering its restricted height.

The harmonic operation of an antenna is not a routine matter if a low s.w.r. is desired. If a half-wave dipole is cut for 7.1 MHz, the third harmonic resonance will *not* occur at 21.3 MHz; it rather will be well above the 15 meter band. This is because the end of the antenna has capacity-to-free space, which makes the antenna electrically longer than its physical length. The antenna is really shorter than a half wavelength. On its third harmonic, the end quarter waves are shortened by the end capacity, but the inner wavelength is not. You have to raise the frequency to get three shorter half waves to resonate on this antenna.

In order to get 15 meters to resonate on this vertical, where the end capacity effect is greater, some extra side capacity is added one third of the way up the antenna. This lengthens the part of the antenna where the inner two quarter waves have a voltage loop, and lowers the resonant frequency down into the 15 meter band. Two side capacity loops are used on the 40 and 15 meter elements and only one on the 30 and 10 meter elements.

Capacity loading to shorten an antenna has a big advantage over inductive loading: it doesn't reduce the bandwidth. In this antenna, the three parallel elements together with the loops at the sides and top make a very thick effective radiator, and the resulting bandwidths are very broad.

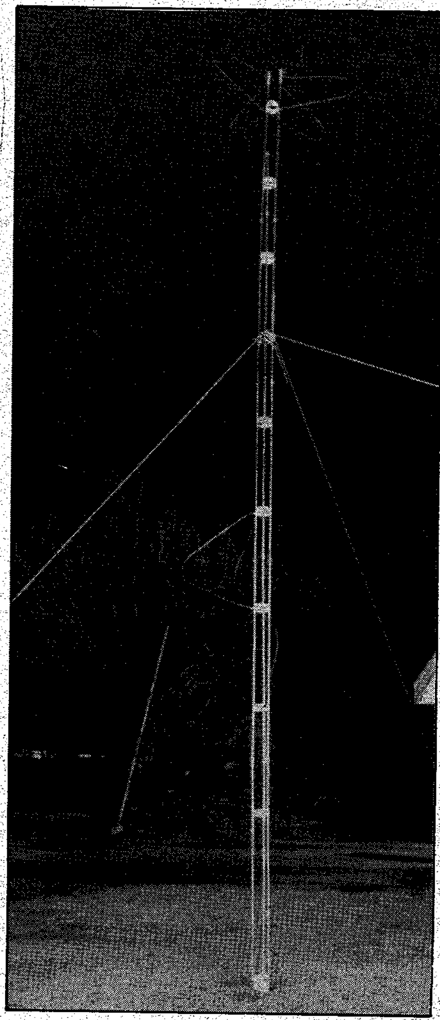

Fig. 1– The six-band vertical uses no traps. Instead there are three separate elements, each resonant on two bands. The capacity "hats" keep the height to 25 feet.

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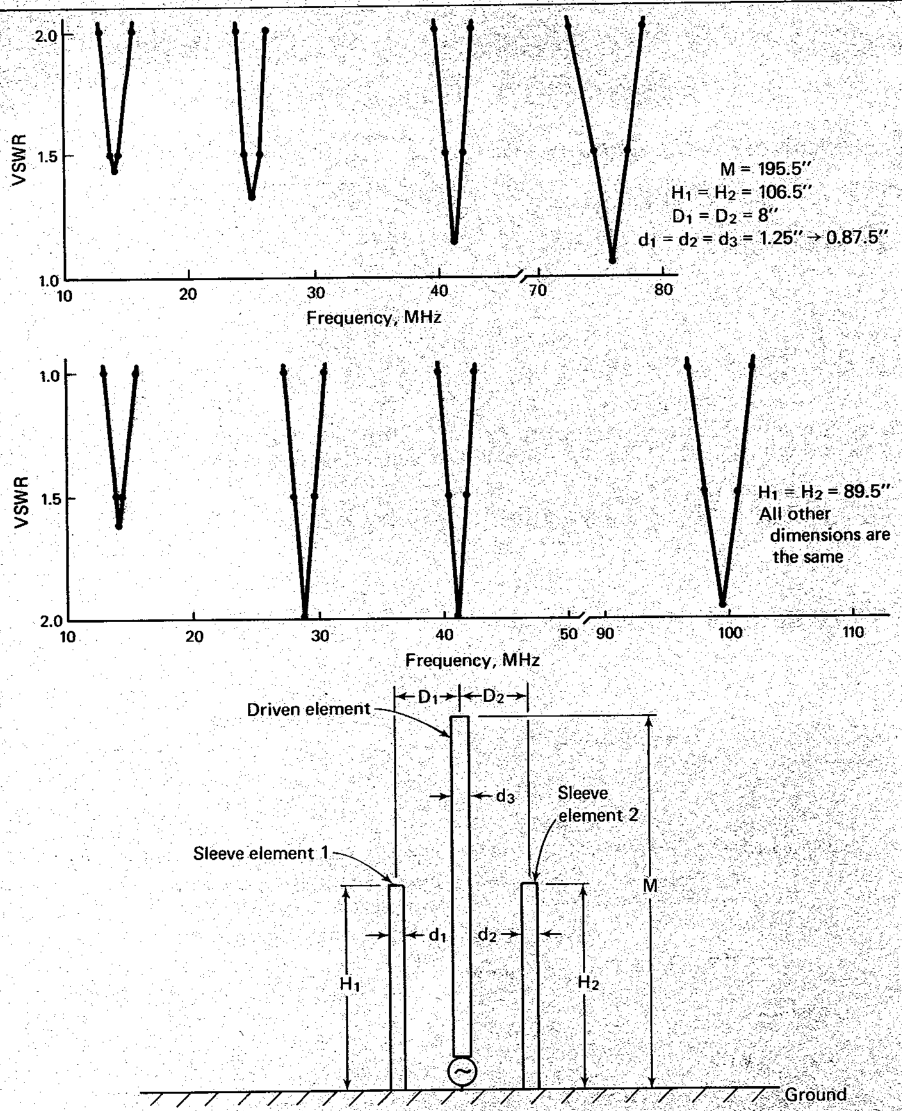

Fig. 13– Diagram of an open-sleeve monopole. The plot shows the v.s.w.r. of two configurations using a central monopole resonant near 14 MHz.

the sleeve elements while maintaining a constant spacing and relatively constant sleeve-element diameter. As one can easily see, the v.s.w.r. curves merge together as the sleeve lengths approach that of the central element. This could allow multibanding of frequencies too closely spaced for conventional traps. This could also be used to broadband h.f. antennas where low v.s.w.r. is required over a frequency range too broad for conventional dipole elements.

Fig. 12 shows the results of a model using a central dipole resonant near 14.3 MHz. The sleeve lengths were chosen at random using the 2:1 criteria established earlier. A slightly shorter sleeve length should make a perfect 20 and 10 meter antenna, whereas longer sleeve elements could make 20/12, 20/15, or 20/17 meter multiband antennas.

Although I have not tried lower frequencies, it should be possible to make open-sleeve antennas for the 40/20, 40/30, 30/20, 30/15, 30/17, 80/40, and 160/80 meter bands. Unique triband configurations should work on 40/30/15, 40/20/15, or 40/17/15 using the central dipole as 3 half waves on 15 meters.

The open-sleeve monopole was also modeled on h.f. Fig. 13 shows the v.s.w.r. of 2 configurations using a central monopole resonant near 14 MHz. One configuration used sleeve elements resonant at 25 MHz (12 meters). It also had ¼-wave resonances near 41 and 76 MHz. The other model used sleeve elements resonant at 29 MHz, with corresponding ¼-wave resonances near 41 and 100 MHz. The h.f. open-sleeve monopoles were ground mounted with 8 radials, each 12 feet long, buried slightly below ground level.

Summary

Even though the open-sleeve antenna has been in existence since the early 50s, I feel as though I have discovered an entirely new and exciting antenna. In a way it is new to the amateur community. Why, in over 30 years of existence, no amateur has put its simplicity and broadband capabilities to work, I do not know. But I do know that with the current popularity of broadband no-tune transceivers, a new broadband antenna will not be overlooked for long.

References

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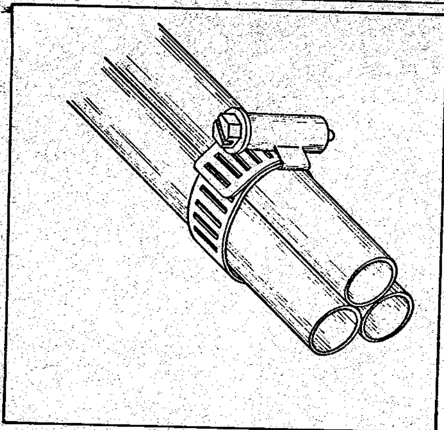


Fig. 2– Hose clamps are used to hold three lengths of steel EMT tubing together so that holes for attaching them to the insulating rings can be drilled in the proper places. The holes need to be in the same plane in a single tube and at the same height on all three tubes.

Tuning

The 75 meter antenna can be tuned by spreading the two capacity loops at the top. With the two together, resonance is near 4 MHz, and when they are spread apart, the antenna tunes just below 3.8 MHz. For 80 meter operation, add some wire straight up. With two more feet to the height of the element it tunes to about 3.6 MHz.

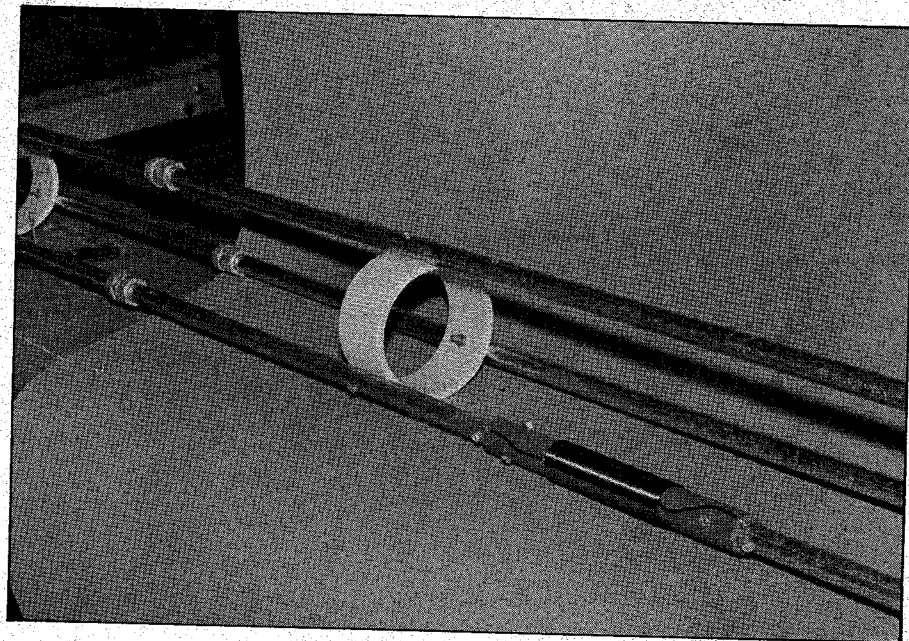
With the dimensions given in fig. 8, the 20 meter element is tuned to the top of the band. It can be lowered in frequency by adding a few inches to the wire between the coax connector and the element, or with a small capacity rod about a foot long attached to the top of the 20 meter section at the insulating ring just below the coil. This is visible in fig 1. Bending this rod outward lowers the frequency on 20. Thirty meters can be tuned similarly.

Forty, fifteen, and ten meters are so broad that you won't need to adjust for different ground conditions or your favorite part of a band. The side loops can be pushed together on 15 meters or the single one folded in on 10, if you do want a tuning adjustment.

Construction

The ½ inch EMT is available from hardware and discount stores, but an electrical distributor will have it at a better price. Nine 10 foot lengths are needed. With some care match up three lengths that will be side-by-side in the antenna so that the antenna will be straight when assembled. If the differences in length are more than an eighth of an inch, equalize them with a hacksaw. The lengths needed are shown in fig. 8, as well as the location of the holes to be drilled in the tubing. All the holes are $^3/_{16}$ inch in diameter. The insulating rings are 30 inches apart and

Fig. 3– The lengths of EMT are bolted to the insulating rings with $^3/_{16}$ inch (#10-24) bolts. The loading coil for 80 meters is wound on a thick-walled PVC pipe which is a good fit over the ½ inch EMT. Notice that the coil connections are not made to the antenna by the through bolts that bolt the form to the tubing, but rather are made by separate self-tapping screws into the steel for a positive electrical contact.



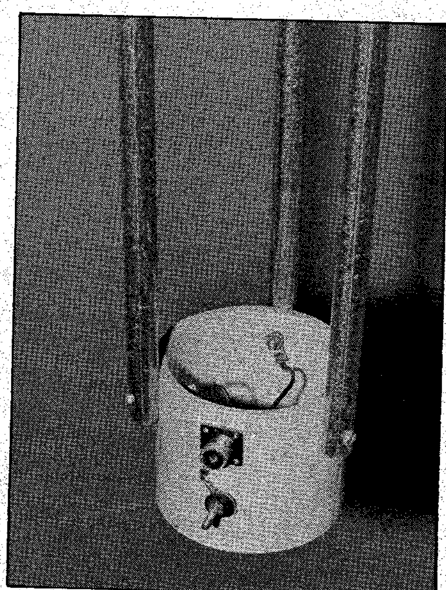


Fig. 4– The base insulator with the SO-239 coax connector mounted on it and wires connecting to the elements. The bolt below is for a ground connection and the radials. A shallow hole can be dug for the base to sit in, or the base can sit on level ground.

15 inches from the ends of the EMT tubes, except at the base.

The holes in the EMT must be parallel to one another in each length of tubing. To help in laying them out correctly, strap three lengths together with two 1½ inch hose clamps, as shown in fig. 2. This will hold them in place and prevent them from rotating while you measure, mark, and center punch for the holes to be drilled. A rubber band wrapped around the tubes

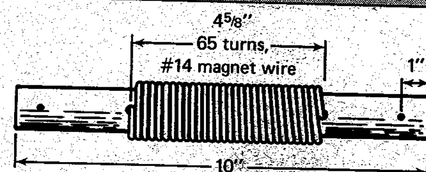


Fig. 5– Dimensions and hole locations for the 80 meter coil and form. The coil is ¾ inch PVC pipe, schedule 80.

will help locate holes in the same place on all three tubes.

The insulating rings, 2 inches long, are cut from 4 inch PVC pipe, schedule 40. This is available from plumbing and swimming-pool suppliers. The base insulator is 4 inches long. Three $^3/_{16}$ inch holes are spaced equally around each ring. Measure and lay out these with some care so that the elements will be straight after they are bolted to the rings. See figs. 3 and 4.

Details of the coil for the 20 and 80 meter element are given in fig. 5. The thick-walled schedule 80 PVC pipe for the coil form is harder to find than schedule 40 pipe, but it is worth phoning around for since it is a good fit around ½ inch EMT. The ¾ inch schedule 40 pipe can be used if necessary.

The base insulator in fig. 4 has a ⅝ inch hole drilled in it for the SO-239 coax connector. File a flat on the outside of the insulator so that the connector will lie flat against it. Solder three wires to the inside of the connector to run to the base of the elements. The connector will also need weatherproofing.

The 10 foot lengths of antenna can be built anywhere, but the final joining of the sections will need a smooth, level surface. I suggest assembling everything

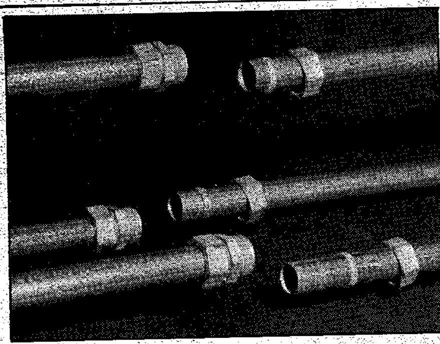


Fig. 6– The EMT compression couplings in place ready to join two sections of the antenna together. A split ring will be trapped between the sleeve and the large nut and forced into the EMT, actually cutting grooves into it. A very strong joint results.

loosely at first, both the couplings and the nuts and bolts. This will permit some twisting and adjusting of the elements to get them straight.

The compression couplings are easy to use if they are disassembled and the nuts and split inner rings put onto the two EMT pipes to be joined, as in fig. 6. The pipe ends then slide easily into the coupling sleeve. Remove any cutting burr first. For final tightening of the joints, use large wrenches or arc joint pliers and tighten with a lot of force. The compression couplings are very strong. They are subject to compression and tension in the antenna and do not have to resist much bending. Such short sleeves could not provide much stiffness.

With the top of the assembled antenna on a chair or stepladder, the top loops can be installed (see fig. 7). The top insulators are made from a ½ inch PVC slipcap and a 4 inch length of ½ inch PVC SDR pipe. This type (SDR) has thinner walls than the schedule 40 pipe and is used because it makes a good fit over ½ inch EMT. Place the cap over the pipe and drill a $\frac{3}{16}$ inch hole near the edge of the cap. When the bolt that holds the top loops in place is tightened, the cap and pipe flatten to make a tight grip on the element. Make sure the bolt isn't touching the element; it should be an inch or so above it.

The capacity loops are all the same size, each made from a 6 foot length of #9 galvanized steel wire. This is a hardware item that is sold in 50 foot rolls for clothesline and dog runs. It is difficult to cut. If your pliers won't cut through, make as deep a notch as you can and then bend the wire sharply at the notch and it will break there. The loops are held to the antenna elements by the $\frac{3}{16}$ inch bolts that hold the EMT to the insulator rings. Bend eyes (small rings) into the ends of the loops that will fit around the $\frac{3}{16}$ inch bolts. The longer 2 inch bolts and washers are used where the loops attach.

The EMT and the #9 wire have a good galvanized coating and should last for many years. Places where that coating

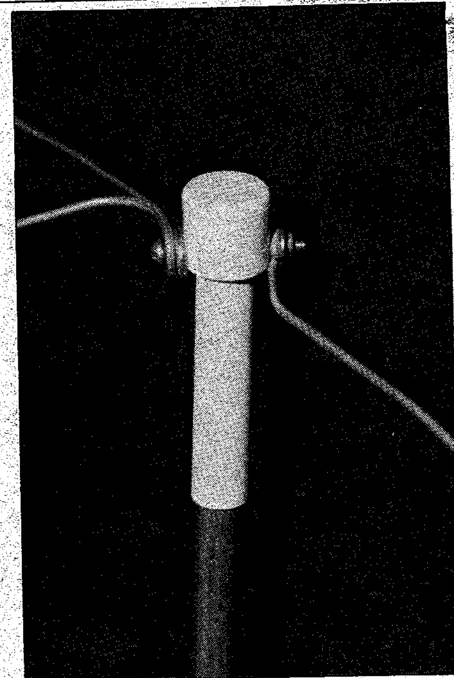


Fig. 7– An insulator cap that supports the capacity loops at the top of the antenna. This one, with three loops bolted to it, is on the 40 meter element. The ½ inch PVC pipe is a good fit over the EMT, provided it is the thin-walled type, SDR. The ends of the #9 wire loops have been bent into small circles to fit over the $\frac{3}{16}$ inch bolts, and washers have been used under the bolt head and the nut.

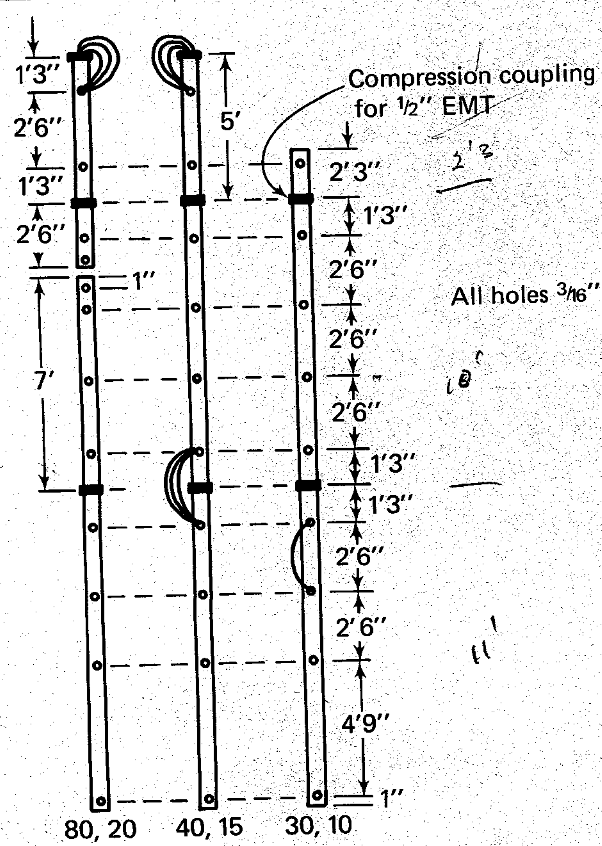


Fig. 8– Location of the holes to be drilled in the EMT. All of the holes are $\frac{3}{16}$ inch and pass through both walls of the tubing. The drilling will go better if you have a new, sharp, good-quality, high-speed drill bit.

Quantity	Material
90 ft.	½" EMT, electrical tubing in 10 ft. lengths
6	Compression couplings for ½ EMT
26	1½" long, #10-24 bolts, with nuts and lockwashers
8	2" long, #10-24 bolts, with nuts and lockwashers
2 ft.	4" PVC pipe, Schedule 40
10 in.	¾" PVC pipe, Schedule 80
10 in.	½" PVC pipe, SDR
2	½" PVC slip caps
1	SO-239 coaxial cable connector
40 ft.	#14 copper magnet wire
560 ft.	wire for radials, any
16	washers, $\frac{3}{16}$"
2	1½" hose clamps
5	solder lugs, for #14 wire, $\frac{3}{16}$" hole
50 ft.	#9 galvanized steel wire
1 qt.	plastic roof coating

Table I– Parts for the six-band vertical.

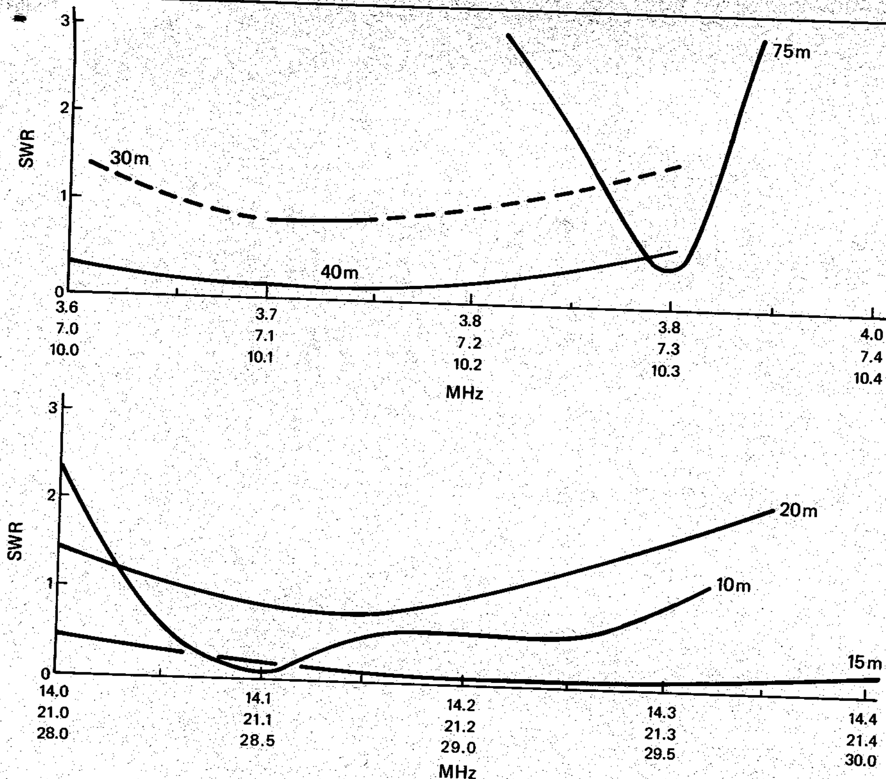


Fig. 9– S.w.r. curves for the six-band vertical.

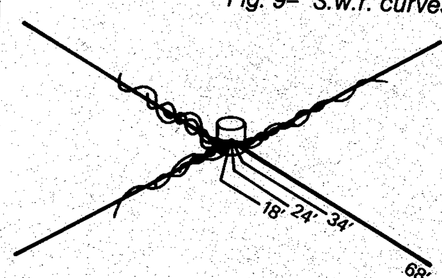


Fig. 10– A set of radials for the six-band vertical. The radials for 30 and 40 meters are also resonant on 10 and 15, so only four wires are needed in each "leg" of the radials. If you don't have the room to run them out straight, bend them and wind them around your property. Any type of wire may be used for the radials, and they can be buried or laid on top of the ground. If insulated wire is used, the four-in-one leg can be twisted together as shown above. The ones shown straight are just to indicate the lengths to use.

has been lost, such as holes or cuts, will need protection. I recommend coating each nut and bolt and coupling with an undercoating or a roof-patching compound. These adhere to metal and stay somewhat flexible and waterproof. Coax-Seal® is also a good choice for a sealant.

Radials

A vertical antenna fed at a current loop must have a good ground system to work against. Four radials, each with four wires, as shown in fig. 10, will do an adequate job, but a larger radial system will do even better. Aim for a good system, with 50 to 100 wires, and put out a good low-angle signal that will work DX. Consult an antenna handbook for a discussion of radials. Fig. 9 shows the s.w.r. curves for the six-band vertical when used with a proper radial system.

Guys

The antenna may be supported by a tree or the side of a house with good results. The best installation, however, will be in the clear away from interfering objects. It will need guying, just below the coil, as shown in fig. 1. Quarter inch or larger nylon or polypropylene rope is good and will not require insulators. Watch out for nylon stretching, especially in wet weather. Phillystran guy cable, of course, would be ideal. If you must use wire guys, install insulators every few feet, especially near the antenna.

The complete antenna weighs about 40 pounds and can readily be put up by a large person. By butting the base against a tree or building, you can simply walk it up to a vertical position and carry it upright to the installation point. If a helper isn't available to tie the guys, you can secure two guys and raise it against them by lifting and pulling the base in under the rest of the antenna. Once all the guys are tied, the vertical can be raised and lowered for adjustments quite easily this way without loosening the guy ropes.

Several of the features shown in this antenna are the subject of a patent application. Amateurs are welcome to build the vertical for their own use, but manufacturers are cautioned that all rights under the Patent Code will be strictly enforced. A complete antenna is available from Barker & Williamson, 10 Canal St., Bristol, PA 19007. See their ad in this issue.