stub bandswitched antennas

Two multiband verticals are described: a fixed-station antenna and a twinlead portable— no loading coils; no traps

John J. Schultz, W2EEY, 40 Rossie Street, Mystic, Connecticut 06355

One of the problems in designing vertical antennas is finding a simple bandswitching method. To decouple portions of the antenna for different bands, you can use (a) basemounted switched loading inductors, or (b) traps. Each method has disadvantages. A remotely controlled switching system adds extra wiring and cost, and traps are difficult to build, adjust and mount.

This article describes a simple and inexpensive method of bandswitching using the *principle of stub decoupling.* I used it with two antennas: a portable multiband wire antenna and a fixed-installation vertical. The idea can be extended to many other antennas as well.

stub switching

A 33-foot vertical is shown in **fig. 1A.** This antenna would function as a quarter-wave vertical on 40 meters. If a stub approximately 15½ feet long were added, as shown in **fig. 1B**, tri-band operation would be possible.

Operation on the various bands is as follows. On 40 meters, the stub is too short to have any effect, and the antenna performs as a simple ¼-wavelength vertical. On 20 meters, the 15½-foot stub is a quarter wavelength long; the short circuit at the base of the stub is reflected as an open circuit at the high end of the stub. Thus the upper portion of the 33-foot vertical is decoupled, and the antenna performs as a ¼-wavelength vertical on 20 meters.

On 15 meters, the 15½-foot stub has no switching effect since it is neither ¼-wavelength or ½-wavelength long. The 33-foot section is active, and the antenna functions as a ¾-wavelength vertical. Such a length will present a low impedance at the antenna base to match a coaxial transmission line.

There is some disadvantage to this antenna length, however. It is slightly longer than the optimum length for maximum low-angle radiation. Therefore, some high-angle radition will also occur on 15 meters.

Still another stub can be used to extend operation to 10 meters. This stub can be placed in a number of ways, but the most advantageous arrangement seems to be that shown in **fig. 1C**. An approximate 8-foot stub is placed about 8 feet from the base of the antenna. The stub acts as a phase reversal device to couple the lower 8-foot section (¼ wavelength on 10 meters) to the upper 16-foot section (½ wavelength on 10 meters) on the main antenna. A collinear vertical array results as a consequence of the phase reversal. This keeps the antenna radiation at a low vertical angle and produces a slight gain (1 to 2 dB) over a simple ¼-wavelength vertical. The 15½-foot stub has no effect on 10 meters since it is ½-wavelength long and simply reflects a short circuit at its upper end. The 10-meter stub has no effect on operation on other bands.

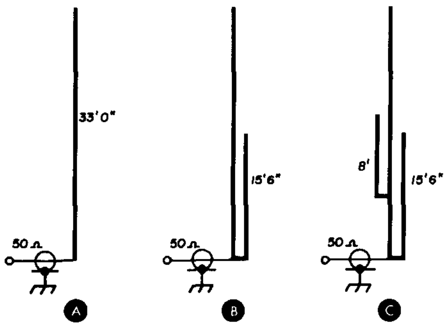


fig. 1. Various arrangements with a 33-foot vertical antenna. Simple vertical in A performs on 40 and 15 meters. The 15½-foot stub in B adds 20-meter capability. Another stub, approximately 8 feet long, makes the vertical operational on all bands from 40 through 10 meters.

The over-all result is a 4-band antenna that performs as a ¼-wavelength vertical on 2 bands, a ¾-wavelength vertical on 1 band, and a collinear array on the highest-frequency band. The dimensions of the antenna differ slightly from those of a basic ¼-wavelength antenna, because the stubs affect the diameter-to-length ratio of the antenna on the various bands. Provision must be made during construction for adjusting the antenna element lengths and for initial stub placement in some cases.

fixed vertical antenna construction

I experimented first with a tri-band antenna of the type shown in **fig. 1B**. A multisection telescoping aluminum element was used for the antenna section, which had a maximum diameter of 1¼ inches. The stub was made of similar material but with fewer sections. Spacing between stub and antenna was determined by the type of insulating spacer used as shown in the photograph; about 4½ inches between stub and main-element centers.

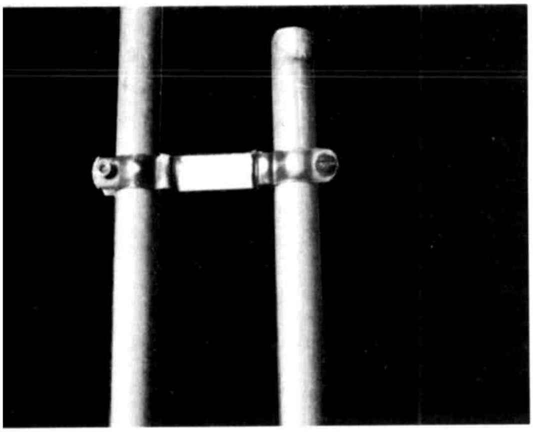
Birnbach Company produces a series of pillar insulators that can be used for stub holders of almost any desired size. Their type 445H, for instance, is 3 inches long and ¾-inch in diameter. Both ends are threaded for 10-32 hardware. The holders on each end of the pillar insulator can be purchased or you can make your own.

At the base of the antenna, the stub and main element ends are joined by a piece of Belden braid. The center conductor of the 50-ohm coax is connected to this braid and the shield of the coaxial cable to another braid, which connects two 6-foot ground rods spaced 3 feet apart, centered on the antenna base. I used only ground rods because the soil is fairly moist in the vicinity of the antenna. Dry locations will require a radial system. The antenna is physically supported by a wooden post. There is nothing special about the construction, and almost any method for vertical antenna construction can be used.

Little adjustment is required for tri-band operation. With the antenna excited on 40 meters, the **main element** length is adjusted for the lowest swr in the transmission line. A value of 1.5-to-1 or less should result.

Switching to 20 meters, the stub is adjusted for the lowest swr. No significant interaction should occur between these adjustments unless you started with element lengths that were out of resonance. Once adjusted on 40 meters, the antenna should be properly tuned on 15 meters to a compromise setting for coverage between 40- and 15-meter band segments.

Pillar insulators are used between the stubs and the main antenna element.



If an additional stub is added for 10-meter coverage, the preceding adjustments should be made before the stub is mounted. Then the stub should be placed about 8 feet from the base. With the antenna excited on 10 meters, both stub location and length should be varied slightly until the lowest swr is achieved. It would be useful to have another station or a field-strength meter a few wavelengths away to help indicate the stub location for maximum signal.

Finally, the antenna should be rechecked on the other bands to ensure that no significant detuning has occurred. If so, a back-and-forth tuning procedure must be used until proper tuneup is achieved on all bands.

twinlead stub antenna

The basic simplicity of the multi-band vertical stub system produced the idea for a similar antenna made only of 300-ohm twinlead. The twinlead antenna was made for portable use as a multiband antenna that could be strung up and used without an antenna coupler.

Since the twinlead provides only two conductors, a somewhat different stub was used (**fig. 2**). The conductors are connected together at the far end of the antenna, and **one** conductor is cut a little less than 16 feet from the far end to form the 20-meter stub. This stub is $^1/_4$-wavelength long on 20 meters and reflects an open circuit, so the lower portion acts as a $^1/_4$-wavelength antenna on 20 meters.

On 40 meters, the 20-meter stub adds some top loading, but essentially it's not active, and the unbroken conductor forms a $^1/_4$-wavelength antenna. A 20-meter stub can be added in the same manner as for the fixed-station vertical by using the remaining twin-lead conductor after forming the 20-meter stub. On 15 meters the 40-meter section is used as a $^3/_4$-wavelength antenna.

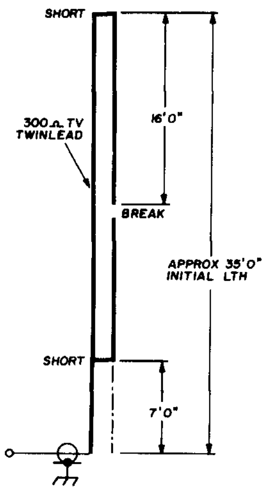
tuning up

Because of the twinlead velocity factor and the nature of the stub arrangement, pruning this antenna is a bit more tedious than the fixed-station vertical. However, twinlead is inexpensive, and even if you foul up the tuning the first time around no great loss will result. In fact, experimenting with the twinlead version is a good way to gain confidence in the basic antenna operation before constructing a more expensive fixed-station version.

As a first step in the tuning process, choose a 35-foot length of twinlead and leave the conductors at the far end disconnected. Connect one conductor to the transmission line and excite the antenna on 40 meters. Then cut the antenna (both conductors) at the far end until the lowest swr is obtained. After this, connect the other conductor at the far end to the 40-meter conductor element and cut about 16 feet from the far end.

Now switch back and forth between 40 and 20 meters, and trim the total antenna length (always leaving the two conductors shorted together at the far end). Trim the 20-meter stub to less than 16 feet from the far end. With care, lengths will be found that give a very low swr on both bands. If triband operation only is desired, the antenna can be operated as is. If 10-meter operation is also desired, cut the 20-meter stub side of the twinlead about 7 feet from the antenna base. Excite the antenna with ten-meter energy and try shorting positions between the upper portion and the 40-meter connector until minimum swr is obtained. Then cut the upper point of the 10-meter stub until a final swr minimum is attained.

fig. 2. Construction of a stub-switched antenna made from 300-ohm twinlead; complete tuneup procedure is outlined in the text.



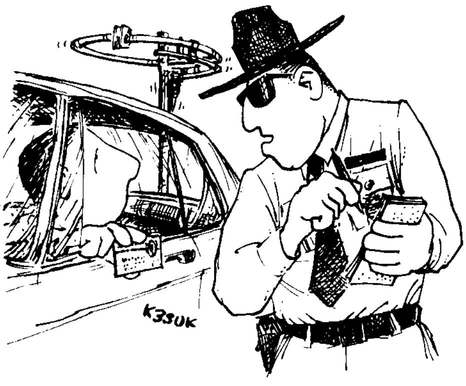
This procedure tends to mess up the twinlead unless done with care. When trimming a conductor, the dielectric should not be cut away entirely. The conductor should be separated from the dielectric and then cut. Also, the proper shorting point between the two conductors can be found by pressing a pin through the dielectric to short the conductors. Only after the proper point is found should a jumper be soldered between the conductors. A proper ground connection is just as necessary for effective use of the twinlead antenna as it is for the fixed-station vertical.

summary

The stub decoupling method for multiband antennas is an effective, no-compromise method of automatic antenna bandswitching. Some designs require careful initial adjustments to establish initial dimensions, but the effort is well rewarded since no later maintenance work need be done. The basic idea of stub multiband operation can be used for any band where a suitable harmonic relationship exists.

The twinlead version of the antenna suggests the possibility of combining two such sections to form a multiband dipole antenna or inverted vee. Although this has not yet been tried, it would seem to be an extremely simple way to build an inexpensive multiband horizontal dipole for 40-10 meter coverage. No traps are required, and the stub arrangement should allow operation over a wider portion of each band with lower swr than is possible with high-Q traps.

ham radio



". . . 50 in a 35-mph zone. Besides that, you were QRMing my receiver."