Do you have a couple of big trees hanging around doing nothing? N4PY shows us how to make good use of them with his multiband antenna project.

A DX Antenna For 160, 80, 40, And 30 Meters

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Most wire antenna designs center around a scheme to yield a natural 50 ohm feed point. The matching system is usually the primary goal and the radiation pattern the secondary goal. In this antenna I set out with the radiation pattern being the primary goal.

The antenna is a top-loaded electrical 3/8-wave vertical for 160 meters, a top-loaded quarter-wave vertical for 80 meters, an electrical half-wave vertical for 40 meters, and a half-wave vertical for 30 meters. The antenna is a vertical with a 45 foot vertical radiator, a special trap at the top, and a 70 foot straight-wire top hat across the top. I also have a modest ground system comprised of sixteen 80 foot radials buried about 1 to 2 inches in the ground (see fig. 1).

The trap is made up of an inductor and capacitor in series with another inductor across the series capacitor and inductor (see fig. 2).

Feeding is accomplished with a specially constructed match box or a commercially purchased automatic outdoor antenna tuner. The match box is placed outdoors at the base of the antenna.

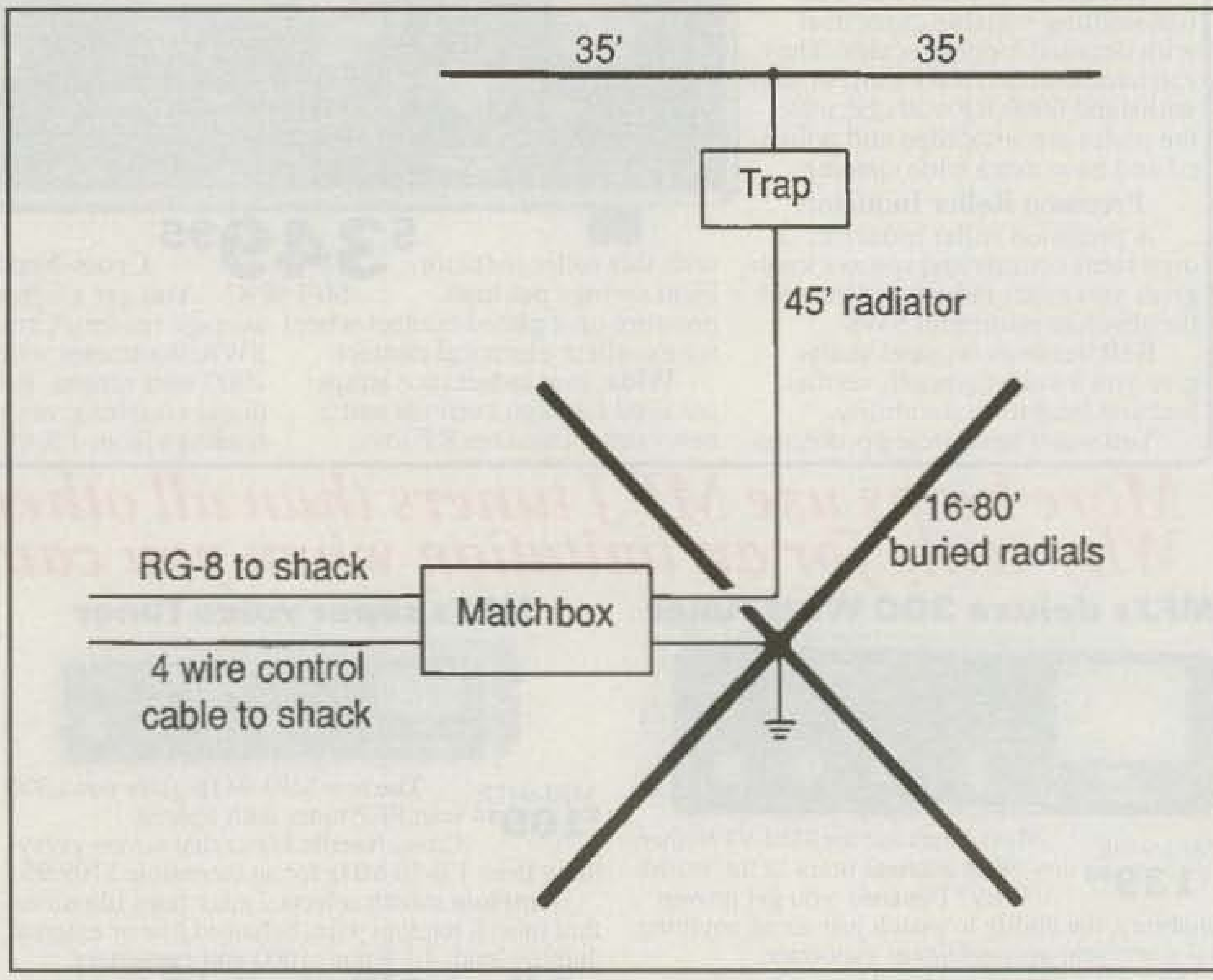

Fig. 1– The overall antenna configuration.

Theory of Operation

For 160 meters, the trap forms an equivalent loading inductor that causes the 70 foot top hat to make the overall antenna appear as a 3/8-wave vertical. The impedance of the antenna at the feed point becomes 50 ohms plus some inductive reactance. By making the antenna 3/8 wave, the typical short vertical problem of the radiation resistance being only a few ohms is solved. This means efficiency is much higher and matching is accomplished simply with a series capacitor to cancel the inductive reactance.

For 80 meters, inductor L1 and capacitor C1 in the trap are resonant, causing the top hat to be connected directly to the vertical radiator. This causes the overall antenna to be an electrical quarter-wave antenna and present approximately a 50 ohm direct match at the feed point.

For 40 meters, the trap values are such that the top hat is almost completely disconnected from the vertical radiator, leaving just enough connection to yield the equivalent of a half-wave radiator. The antenna presents a very high impedance at the feed point and is matched with a simple LC "L" network.

For 30 meters, the trap values completely disconnect the top hat from the vertical radiator. This leaves the vertical section as a half-wave vertical. Similar to 40 meters, the antenna presents a very high impedance at the feed point and is matched with a simple LC "L" network.

Construction Details

The trap is constructed on a 4.5 inch PVC pipe core cut approximately 10 inches long. On this core I wound inductors L1 and L2. Inductor L1 is 76 microhenries and is made up of 21 turns of 17-gauge enamel wire wound as closely and tightly as reasonably possible. Inductor L2 is

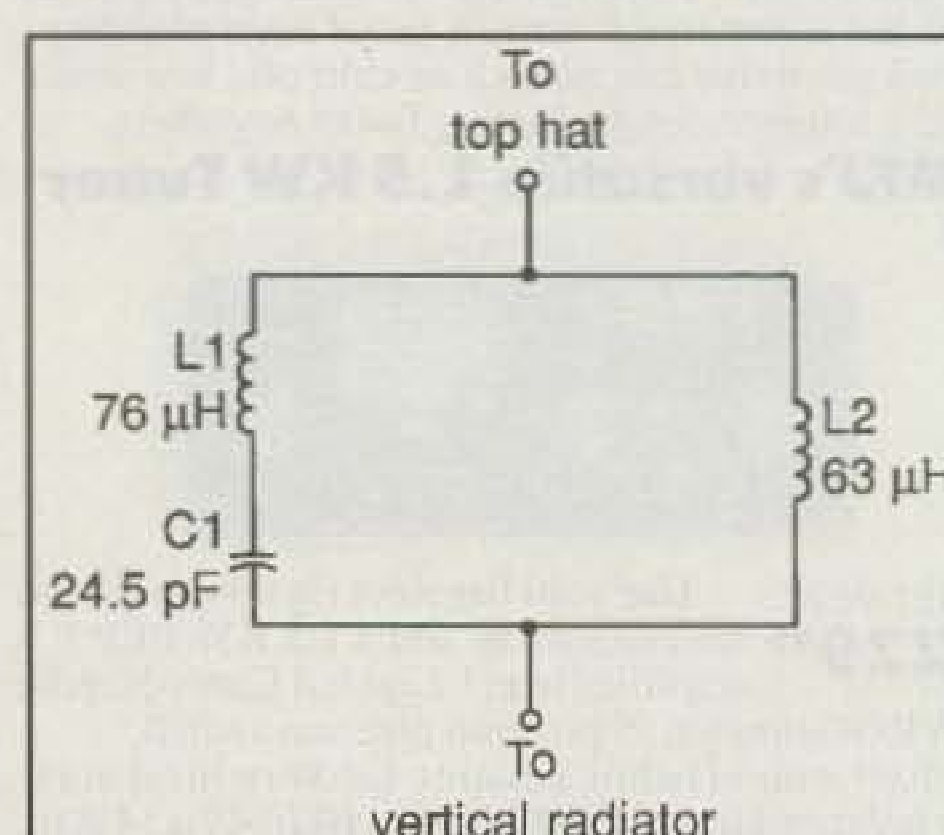

Fig. 2– Schematic diagram for the trap.

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63 microhenries and is made up of 17 turns of 17-gauge enamel wire also wound as closely and tightly as reasonably possible. I left about an inch gap between the two inductors on the core. The capacitor is 24.5 picofarads and is simply an 11 inch piece of RG8 coax. See fig. 3 for trap construction details.

Once the trap is constructed, capacitor C1's length should be adjusted with a dip meter to provide resonance approximately 150 kHz higher than the desired 80 meter operating point. For my operation I adjusted C1 for a dip-meter resonance at 3670 kHz. This provided a 1.1 SWR at 3520 kHz. The 2 to 1 SWR bandwidth on 80 meters is about 50 kHz. It is important to note that the two inductors should **not** be adjusted, but simply left at the stated values. The entire trap should then be placed inside a water-tight container (at least water tight from the top). I used a large 2 liter, plastic soft-drink bottle. I cut the bottom off and placed the trap assembly inside the bottle. The wires enter and exit the trap through the bottom of the bottle. I bolted an 18 inch 1×2 piece of wood to the side of the bottle. This provides strain relief and a tie point for the trap.

The top hat is simply a 70 foot wire. The top-hat wire and vertical radiator are 14-gauge insulated wire. I used three trees that were each about 50 feet tall and separated by about 50 feet each to set up my antenna. I made halyards that go over the tops of the two end trees to support the ends of the top hat. I put another halyard over the center tree that attaches to the top of the trap for the center support of the antenna. At the bottom of the radiator I built a special relay-switched match box to select the desired band of operation.

Match Box Construction Details

Feeding this antenna on the four bands requires the use of a selective match box of some type. The match box must be at the base of the antenna and therefore must be weatherproof. One very simple method (although quite costly) is simply to purchase an automatic antenna tuner and place it at the base of the antenna. I chose to build my own match box. It is built inside a metal ammunition box that provides excellent weatherproofing and RF shielding. I used four Radio Shack DPDT 12 volt relays with 10 amp contacts (Radio Shack catalog number 275-218) to select the desired band. I have a four-wire cable that runs from the match box to a rotary switch in my shack. I used a Radio Shack six-position rotary switch, catalog number 275-1386. The control cable can be any four-wire or more light-duty TV rotor control cable.

The 16 buried radials are soldered to

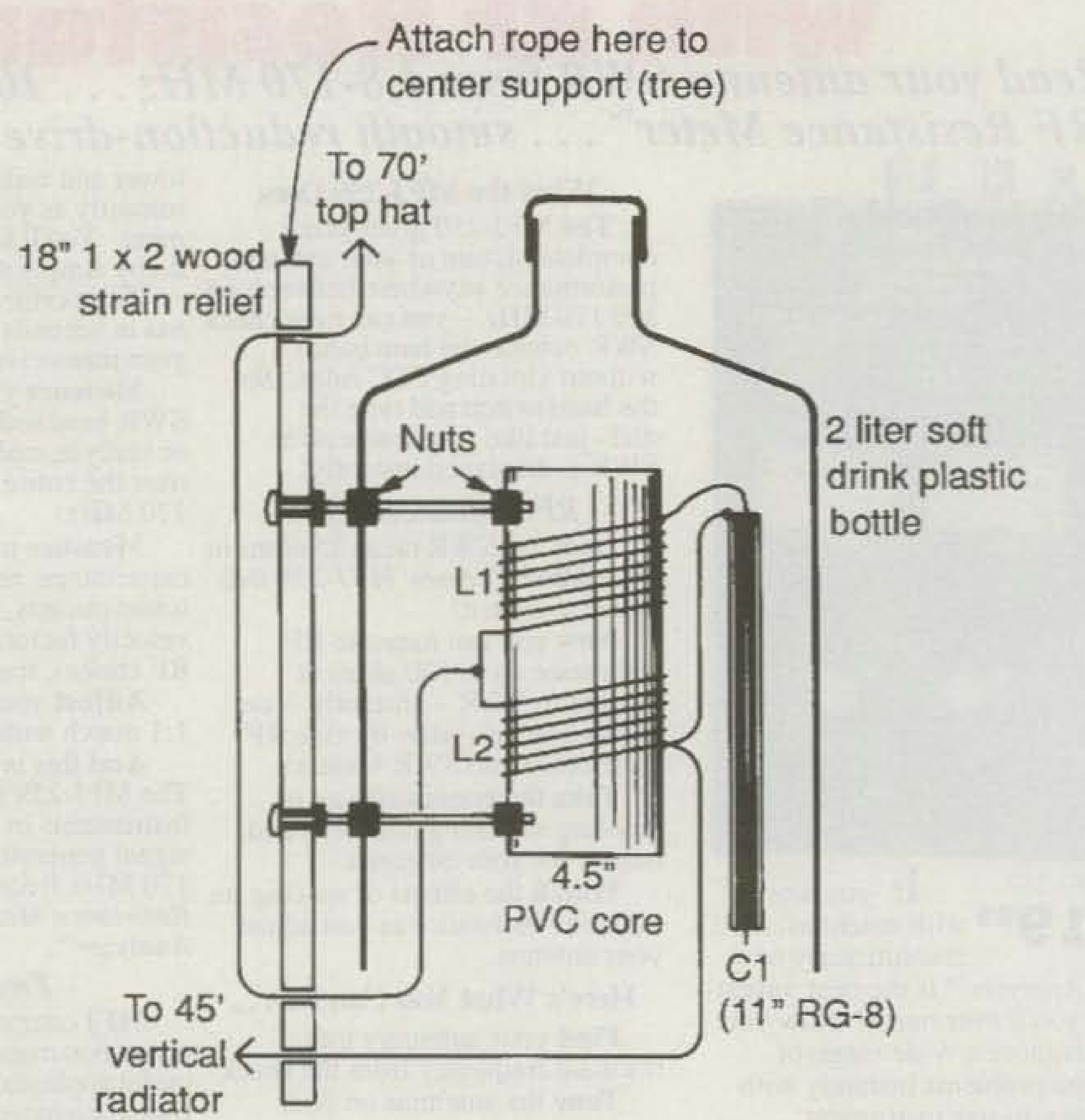

Fig. 3– Mechanical details for constructing the trap.

the outside of the match box. Idrilled a small 1/2 inch hole in the box and glued a piece of wood on the inside to cover the hole. I then drilled a hole in the center of the piece of wood just large enough to bring the vertical radiator wire inside the box. I coated the wood with RTV silicone to waterproof the radiator-wire entry point. On the other end of the match box I drilled two holes, one for the RG8 feedline to enter the box and the other for the four-wire control cable to enter. I used the RTV silicone liberally on the control cable and coax to waterproof their entry into the match box. At the RG8 entry point I soldered the shield of the coax to the inside of the match box.

The matching network for 160 meters is simply a series tuning capacitor with a range of about 30 to 100 picofarads. The capacitor should be reasonably wide spaced so as not to arc over at high power.

The matching network for 80 meters is a direct connection. The antenna is naturally resonant on this band.

The matching network for 40 meters is an "L" network with a variable tuning capacitor of 30 to 100 picofarads and an inductor consisting of 10 turns of 17-gauge enamel wire on a 2.5 inch cardboard tube core.

Similarly, the matching network for 30 meters is an "L" network with a variable tuning capacitor of 30 to 100 picofarads and an inductor consisting of 6 turns of 17-gauge enamel wire on a 2.5 inch cardboard tube core.

See fig. 4 for the wiring details of the match box.

Tuning

Tuning the antenna is straightforward, and each band is quite independent of the other. The hardest band to tune is 80 meters, so I suggest tuning this band first. Once the matchbox is constructed and everything is in place, select the 80 meter position of the match box and find the resonant point on 80 meters. If the resonant point is too high in frequency, lower the antenna and lengthen capacitor C1 in the trap. Likewise, if the resonant point is too low, make capacitor C1 shorter. You will

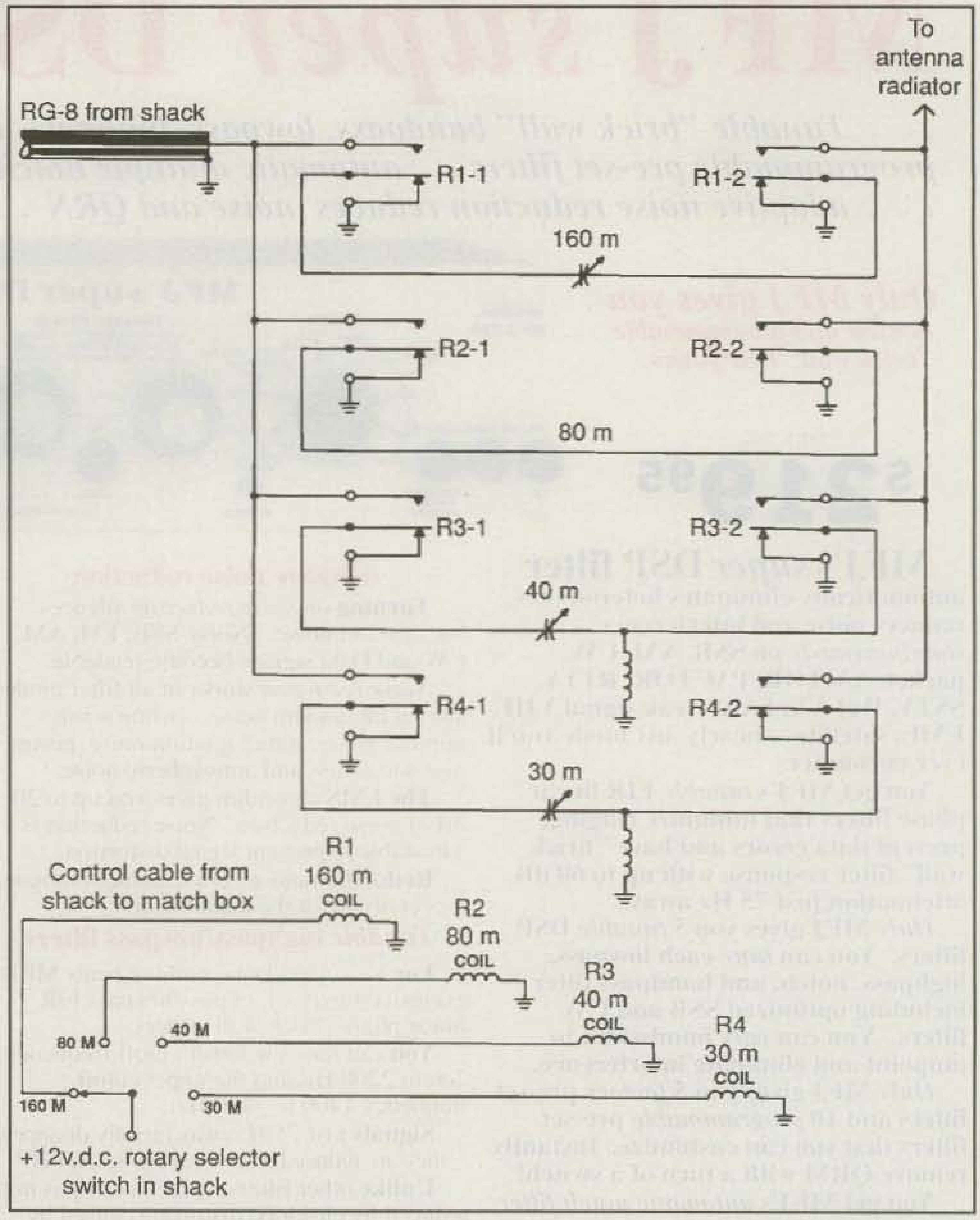

Fig. 4– Schematic diagram for the antenna match box.

find that this capacitor is very critical, and small changes in the length of C1 greatly change the 80 meter resonant point. Fortunately, C1 has very little effect on the other bands.

Once 80 meters is adjusted, select 160 meters on the match box. Simply tune the 160 meter capacitor for resonance at the desired 160 meter operating point. The 2 to 1 SWR bandwidth for this antenna is only about 25 kHz. You should be able to get an SWR of 1.2 or better at the resonant point.

Now select the 40 meter position on the match box. Tune the 40 meter capacitor for best SWR. If the best SWR is too high, the 40 meter inductor will also have to be adjusted. Some experimentation will be necessary here. Once 40 meters is adjusted, it should be possible to get the entire 40 meter band within the 2 to 1 SWR bandwidth range.

Likewise, now select the 30 meter position on the match box. Tune the 30 meter capacitor for best SWR. If the best SWR is too high, the 30 meter inductor will also have to be adjusted. Some experimentation may be necessary. Once adjusted properly, the SWR should essentially be the same everywhere on the 30 meter band and very near 1 to 1.

Operation

Operating this antenna is a dream in simplicity and results. On 160 meters I run 400 watts and have no trouble getting through pile-ups to work DX stations. On 80, 40, and 30 meters I run 100 watts and consistently get through to DX stations when others are calling. The low angle of radiation on all these bands yields a very effective signal to DX stations. If you build one of these antennas, be sure to write to me and let me know how it works out for you. ■