The 40 Meter Full-Wave Horizontal Loop

Take your signal to the treetops.

by Dean Frazier NH6XK

If you have the space to put up 142 feet of wire in a closed loop configuration, and you desire 10-80 meter operation, including the WARC bands, the 40 meter full-wave horizontal magnetic loop may be just what you're looking for. It doesn't have to be square, out in the open, or very high off the ground to perform well.

My 40 meter loop averages 35 feet in height (about 1/4 wave high on 40 meters), and yields 5-9 signal reports to middle America and 5-6 reports to the East Coast from my QTH on Oahu, Hawaii, with 100 watts. The loop gets 5-9 to 10 dB over into VK and ZL, across open water, and this despite the fact that (1) the loop is buried in and amongst trees of a forest, (2) the loop is not at all square, and (3) my feedline (50 ohm coax terminated with 22' 6-5/8" of 75 ohm coax, velocity factor 0.66, giving 1/4 wave on 7.2 MHz) is almost 300 feet long.

I use #12 AWG copper wire, PVC covered, and I do not use a balun. A 1:1 current balun (inductive coupling) can help to reduce RF signal pickup and re-radiation by the coax braid, but I suggest not using a balun for multiband operation unless the balun is very broadbanded (low Q) lest you burn it up at high reactance levels on frequencies other than the design band. I do cancel RF at the feed point with eight turns of the coax wound to a diameter of 6", taped together as a "coil" or RF air choke.

All antenna attachment points are via 1/8" nylon line terminating in a 3" loop of spaghetti tubing. I avoid direct contact with trees because this seems to increase the antenna's noise level on receive and also seems to cause some degradation of transmitted signal due to energy absorption into the trees (see Figure 1 and Table 2).

On bands other than 40 meters I use a matchbox (L/C circuit) to tune out reactance and help keep the SWR down to allow full power transfer. Some form of magnetic coupling in the transmission train from rig to antenna helps to suppress harmonics which can cause TVI/RFI, so a tuner, no matter how simple, is suggested, regardless of whether it is needed for impedance matching or reactance tune-out.

The feed point mechanical construction consists of a strip of plastic (a 2" PVC strip cut down the middle to make a "plate" or strip, about 9" long) to which is mounted, via plastic ties, an SO 239 connector. One end of the antenna wire is soldered directly into the SO's center conductor; the other, after making its way around the forest through the trees, is attached to the braid side of the PL connector of the coax (now screwed onto the SO connector) by a small hose clamp. (See Figure 2). The plastic strip is hoisted up into the trees by nylon line thrown up previously. I use the "weight and string" method of getting lines up into trees. Some fast

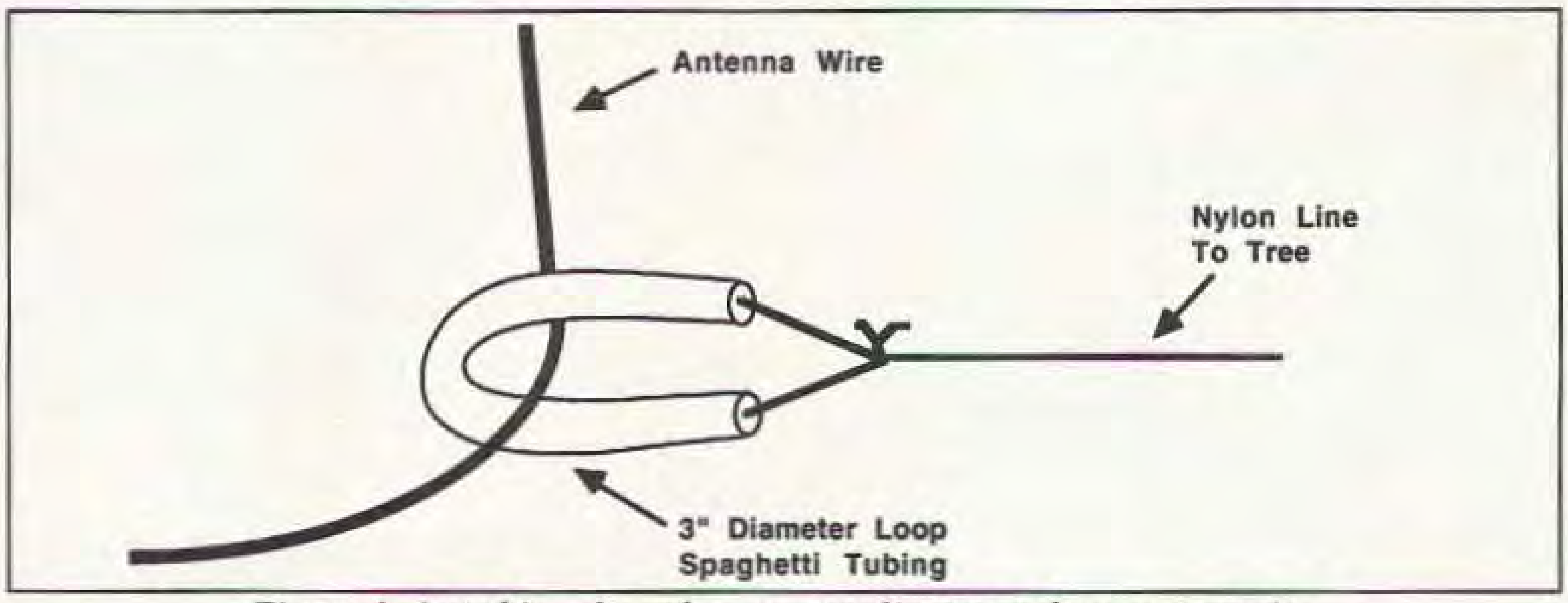

Figure 1. Attaching the nylon support line(s) to the antenna wire.

Band (meters)	Frequency (MHz)	# Waves (on wire)	Gain (dBd)	Feed Point (resistance, ohms)	Wave Angle (degrees)
10	28.500	4	+5+	140	10
12	24.940	3-1/2	+5	130	
15	21.225	3	+4+	125	13
17	18.118	2-1/2	+4	120	
20	14.200	2	+3+	110	15
30	10.120	1-1/2	+3	100	
40	7.150	1	+2+	90	30
80	3.750	1/2	+1+	60	

Table 1. 40 Meter Full-Wave Horiontal Loop (142 feet of #12 PVC covered copper wire) at 35 feet.

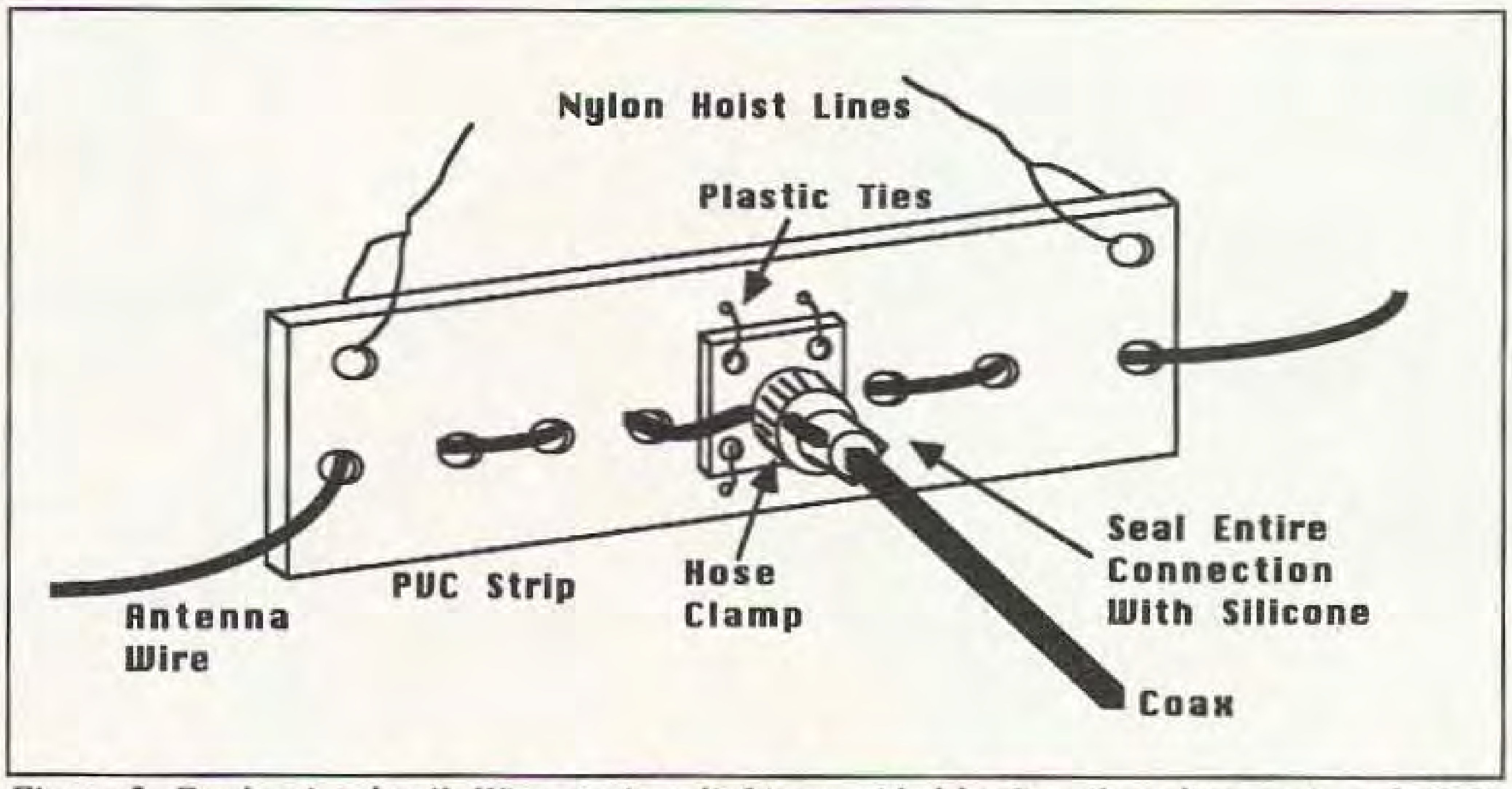

Figure 2. Feed point detail. Wire strain relief is provided by first threading each end of the loop's wires through three holes each about an inch apart, on each side of the S.O. connector, before electrical connections are made.

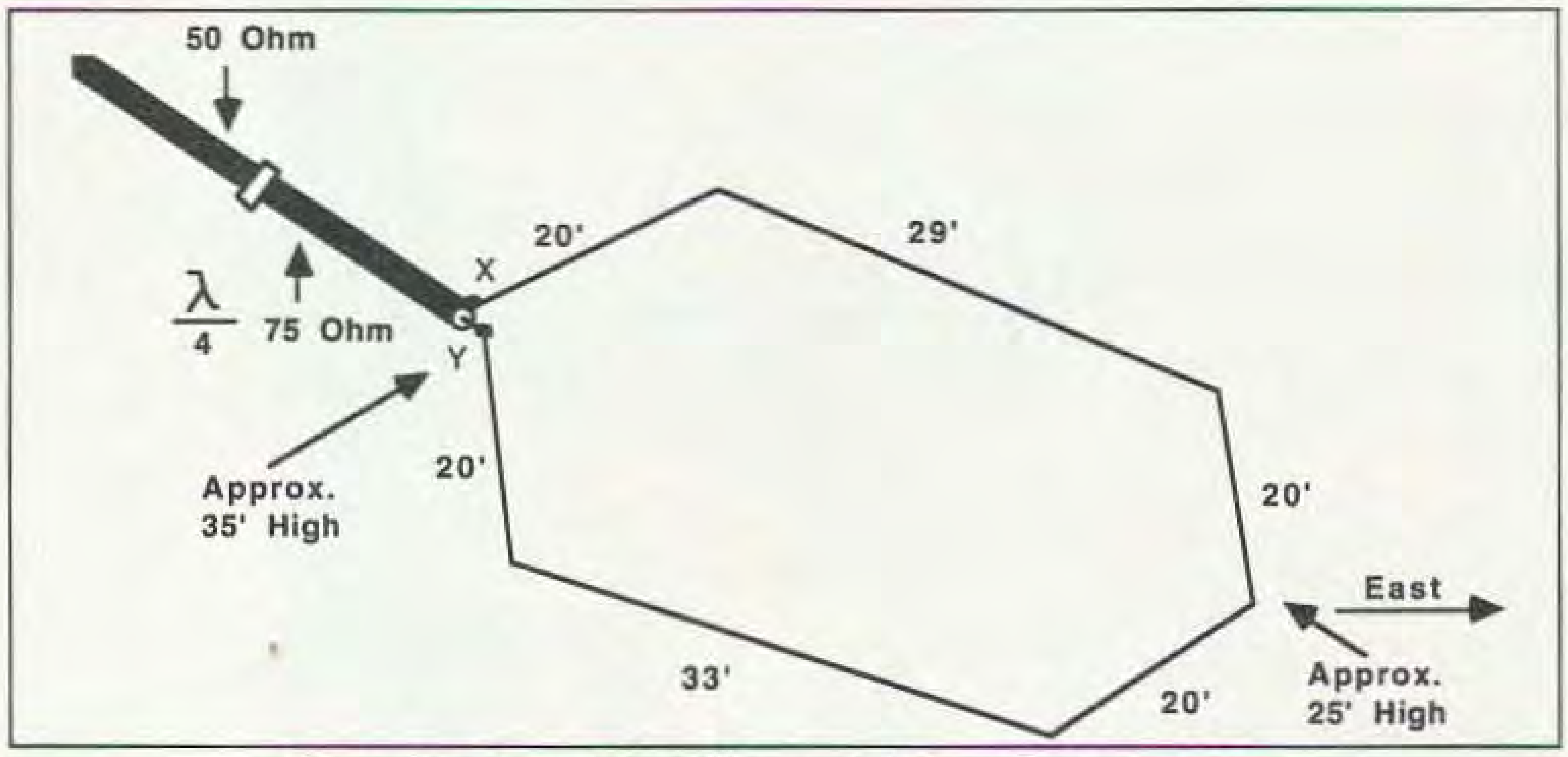

Figure 3. A view of the 40 Meter Full Wave Horizontal Loop.

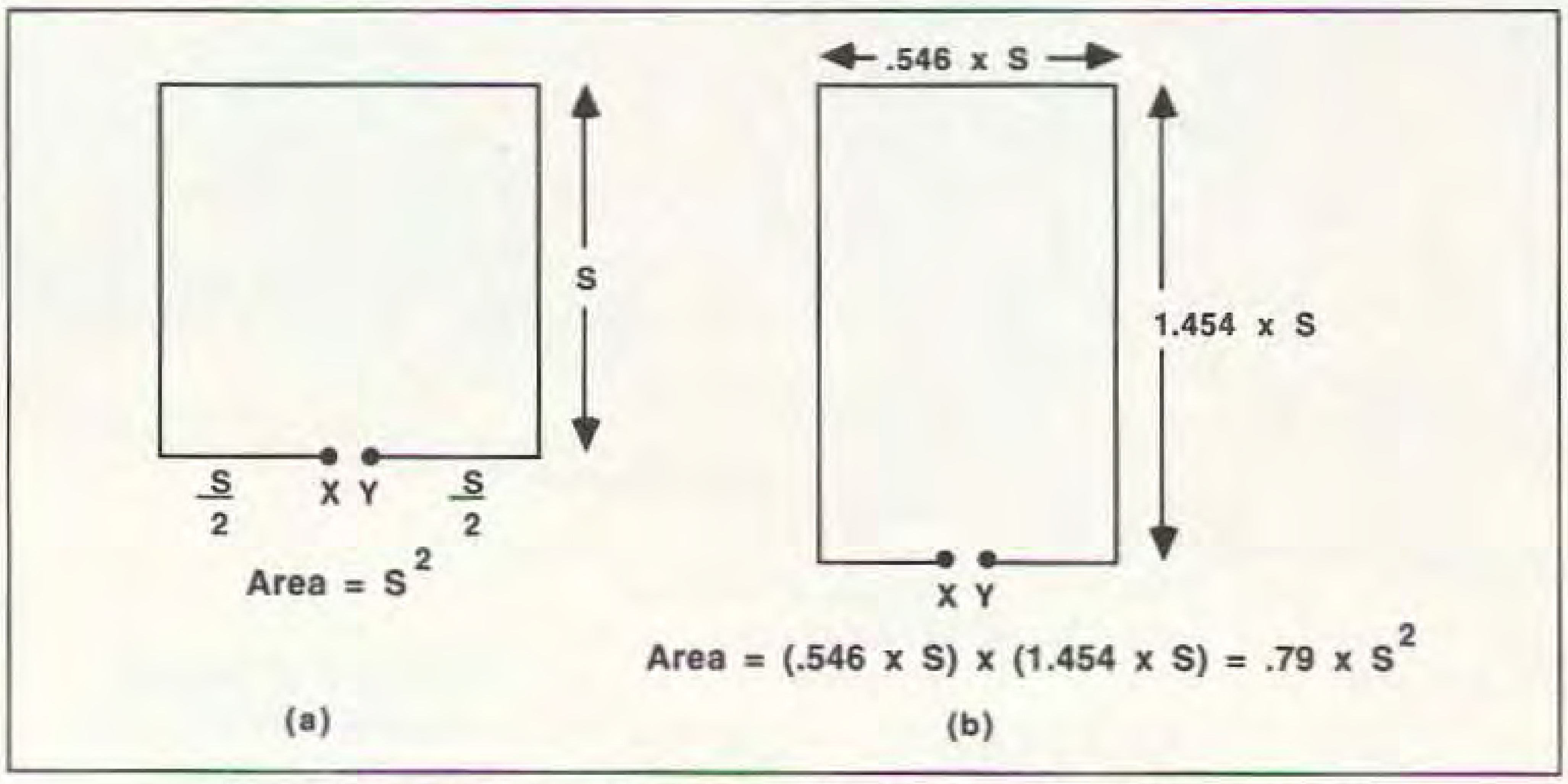

Figure 4. You don't have to make the loop square to make it work well.

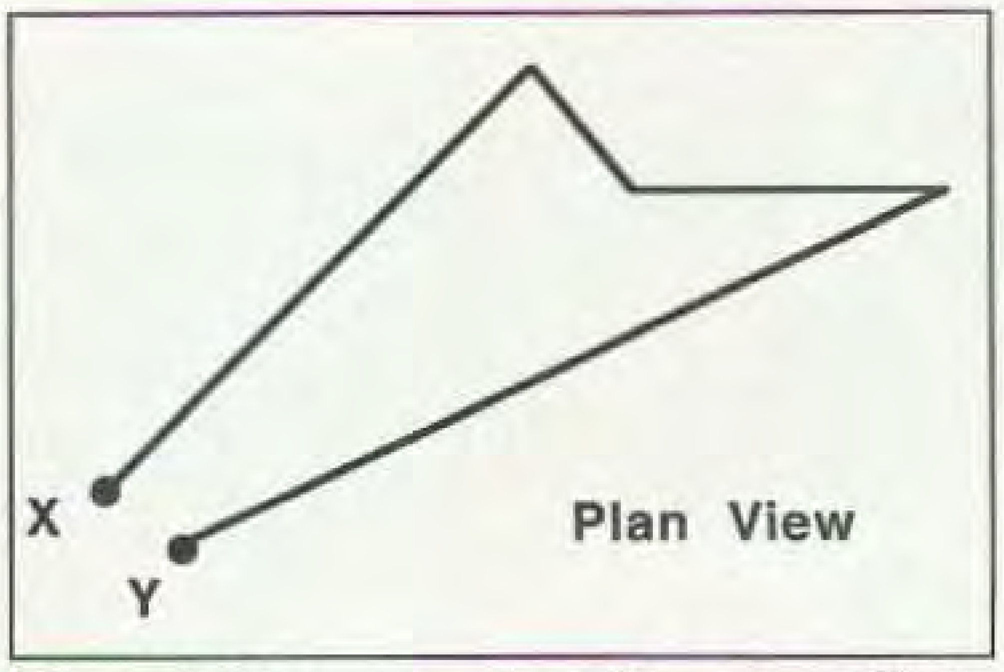

Figure 5. Internal angles of less than 90 degrees can cause signal cancellation problems.

twirling and a hard launch at the right angle can put a 4 oz. lead weight with light line some height up. A fishing rod/spinner works well also.

Lots of line throwing, tree branch trimming, climbing, sweat and hard work may be necessary in a thick forest to get the loop up and clear of small branches, but then again, in a clear area some supports for the antenna would be required, and it takes work to put them up, too. So, as long as you can avoid near ($\lambda/2\pi$) field proximity to large (over 6") limbs, the loop will work almost as if the forest weren't there . . . e.g. on 40 meters, try to stay 22 feet away from large tree trunks, 12 feet on 20 meters, etc., otherwise a significant percentage of energy will be absorbed by the trees, resulting in reduced primary signal strength (see Table 1).

Concerning gain and enclosed areas, realize that a square loop (each side 1/4 electrical wave long, all corner angles 90 degrees) has a bit more than 2 dB gain over a dipole at the same height over the same ground. For a not-square loop to lose 1 dB in signal strength compared to a square loop (a just barely detectable audio difference), its enclosed area has to be reduced about 79% of that of a square:

10log (0.79) = -1 dB

The signal from the loop in Figure 4B will be about 1 dB less than that from the loop in Figure 4A.

The point of this geometrical digression has been to show that you don't have to make the loop square to make it work well; just avoid making (if rectangular) the short side less than 0.546 x the length of a square loop's side.

Example:

Total wire in loop = 1005/f(MHz) feet.

40 meter loop wire = 1005/7.077 MHz = 142 feet.

If square, then each side length = 142/4 = 35-1/2 feet, but not less than 0.546 x 35-1/2 = 19-1/3 feet.

Avoid internal angles less than 90 degrees. Don't use a design like that in Figure 5, for obvious reasons of signal cancellation.

If you desire stronger propagation in a preferred direction, angle the plane of the loop toward the desired direction in a sloping loop (or diamond) configuration (see Figure 6).

But if you do make the loop into a diamond shape and slope it, don't let the short width (across) become less than 0.885 x the length of a side when square (see Figure 7).

Specifically, for 40 meters, a sloping diamond would look like Figure 8 (The sketch shows the minimum width and maximum length allowable before the loss resulting, compared to that of a square loop, exceeds 1 dB).

Comment: My 80 meter SkyLoop (282 feet of wire, another antenna) enjoys the advantage of both horizontal and vertical polarization, as half of the loop (the west half) is more or less horizontal, while the remaining east half slopes down into a gulch. The result is that the SkyLoop is effectively a sloping loop. It's plan layout is not at all square, but the short width is greater than 0.885 x the length of a square loop's side.

Always feed horizontal loops at their highest point. And note that a 40 meter full-wave loop is a half-wave vertical on 80 meters, the loop functioning as a capacitance

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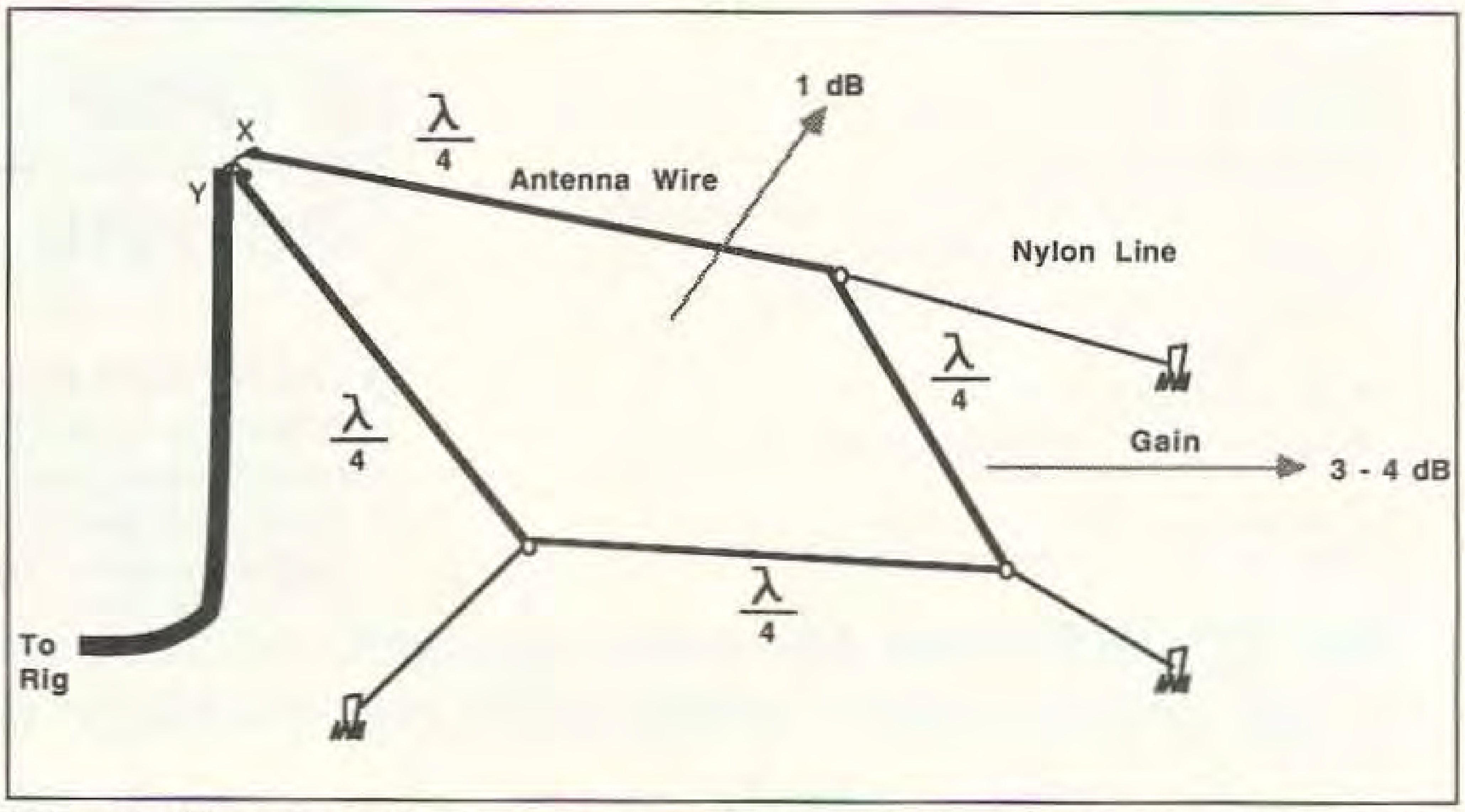

Figure 6. Directional enhancements are made by positioning the plane toward the desired angle.

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hat for radiation from the vertical feedline.

Horizontal loops are easy to build, erect, and require no tuning if you cut the wire according to L = 1005/f (MHz) feet, where the frequency f is for the lowest band of desired operation. Feed the loop either directly with 50 ohm coax or with a quarter wave (electrical, considering velocity factor) of 75 ohm coax; again, the quarter-wave matching section's length is based on the lowest frequency of planned operation. Of course, tuned feeders may also be used.

For those who are unable to erect antennas very high, the 142-foot length of wire as a 40 meter full-wave horizontal loop about 35 feet above ground is a winner. And it doesn't have to be textbook square, or horizontal, to be effective.

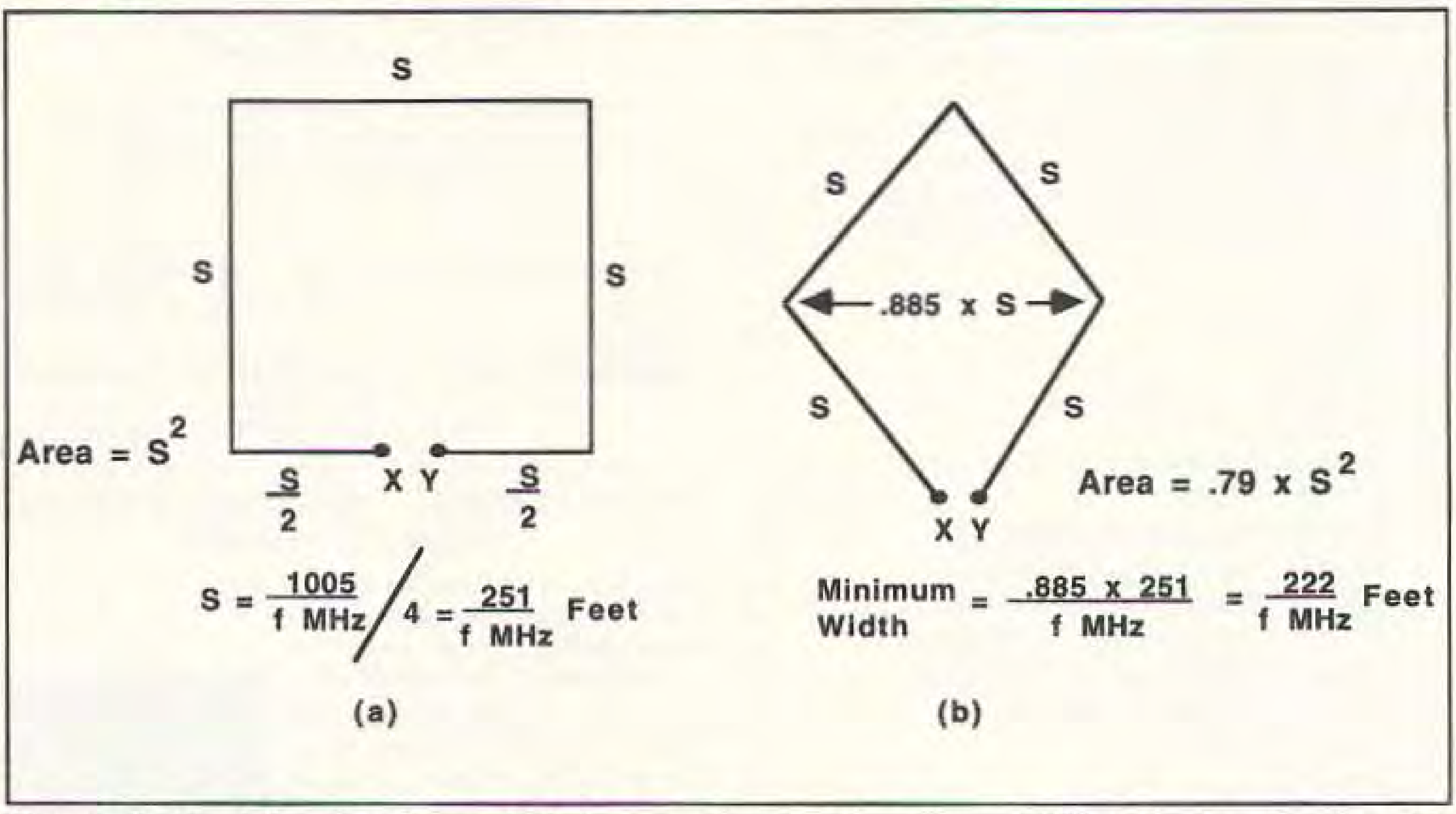

Figure 7. Don't let the short width (across) become less than 0.885 x the length of a side when square.

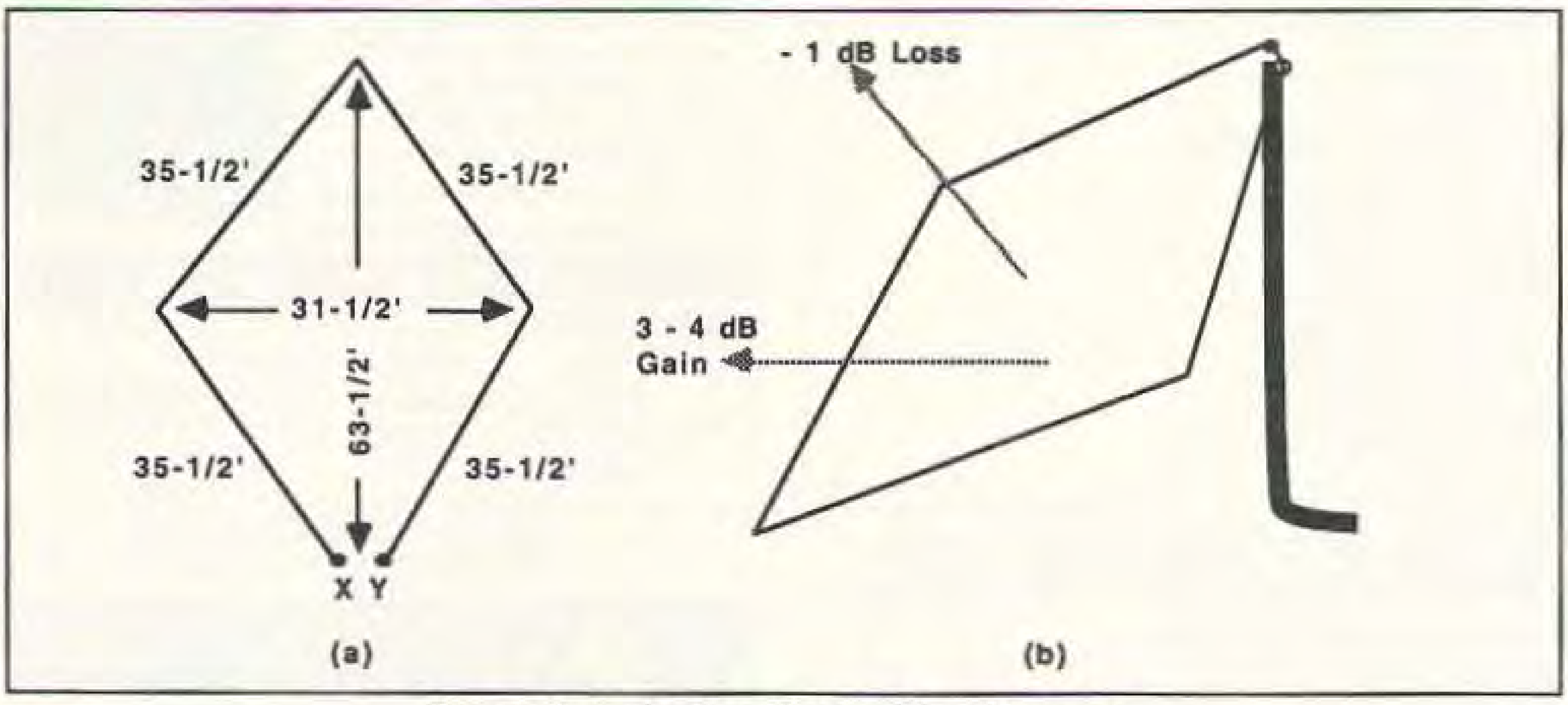

Figure 8. A sloping diamond for 40 meters.

Band (meters)	Near-Field ($\lambda/2\pi$) Clearance Distance (feet)
10	6
12	7
15	8
17	9
20	12
30	16
40	22
80	42
160	83

Table 2. When an antenna is within $\lambda/2\pi$ feet of a nearby object, such as a tree (a capacitor) or some metal (an inductor), being the free space wavelength at the frequency of operation (feet), primary signal attenuation occurs due to the energy of the near (storage) field being absorbed by the tree or metal. As a result, this energy is no longer available to reinforce, by ground reflection, the signal of the primary radiation. The loss can amount to as much as 6 dB. To avoid this phenomenon, keep all antenna wire at least these distances away from 6" diameter or larger energy-absorbing objects: