BY KENT BRITAIN,* WA5VJB

Mobile Antenna Basics

I have to apologize a bit. I like my articles to be more hands-on in nature, but I had to resort to a lot of NEC computer simulations for this month's column.

Many hams like to call their cars "The Ground Plane," but below 10 meters most cars are just too small to be true ground planes. A proper ground plane needs to be a half wavelength wide, and most cars just don't cut it. I guess if you're a dedicated 75-meter phone operator, you should be looking into one of those 20-passenger stretch limos. Meanwhile, let's take a look at the realities of antennas for HF mobile operation (some examples are shown in photo A).

As you can see in fig. 1, most cars have about 200 pF of capacitance between the car body and the ground. Perhaps there is a lot to be said for low riders on the HF bands.

Redrawn in fig. 2, you can see that the mobile antenna system is even more complex. The sine-wave source is your rig, and the capacitor represents the capacitance between the car body and the ground. Sorry, guys, but at the lower HF bands your vehicle chassis is not an RF ground.

The capacitive reactance between the car body and the ground varies with frequency, the size of the car, its height above ground, and a few fudge factors for the tires. However, these values average out pretty well.

Typical values for car/ground reactance are: 3.8 MHz, 200 ohms; 14.2 MHz, 50 ohms; and 28.5 MHz, 25 ohms, but the car body *is* a ground plane. Therefore, if your buddy is running most of a gallon on 75 meters, be really careful stepping out of the car while he has the mic keyed. There can be quite a voltage potential between that car body and the ground. As noted, car bodies are just not an RF ground at HF frequencies.

Photo A– Some antennas for HF mobile operation.

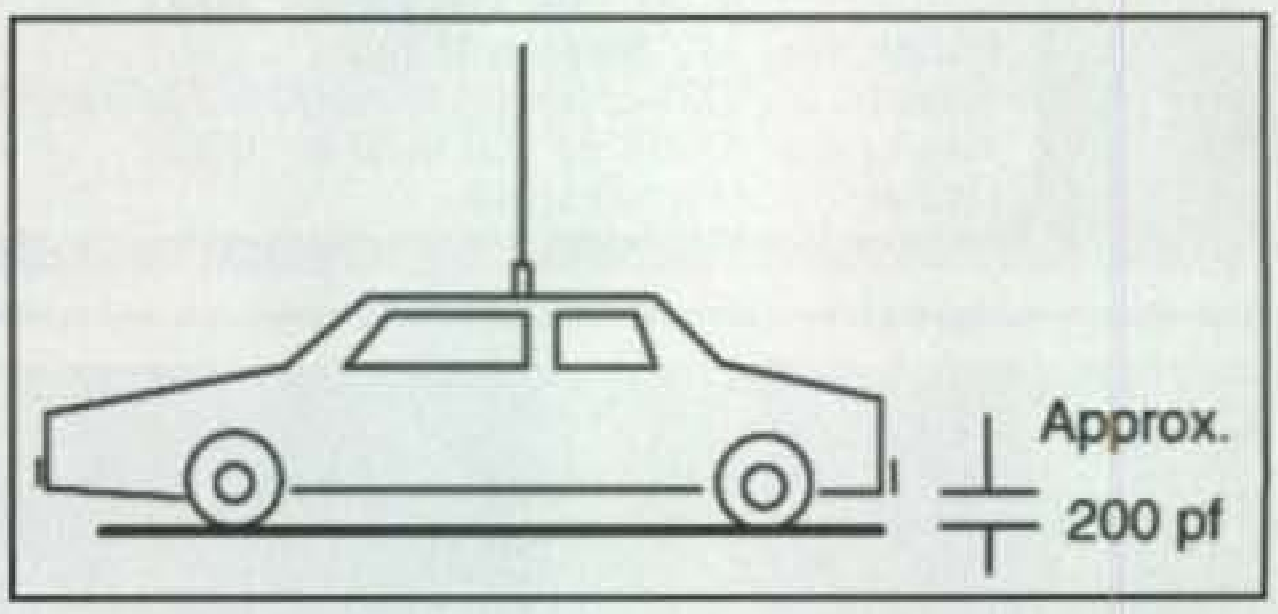

Fig. 1– Capacitance between the car and ground.

Position of the Loading Coil

For these examples, I am comparing the relative signal strength of a quarter-wave monopole on the roof of a car to a 5-foot long whip with the loading coil at different positions on the antenna. These values were all done at 7.2 MHz, so while some of you just might drive along with a 30-foot vertical sticking out of your car *(I think I saw one at Dayton a few years ago)*, most of us would not consider that a practical antenna.

Quarter wave: 0 dB reference
Base load: –10 dB
Center load: –9 dB
Top load: –9 dB

Thus, the center load and top load do have less loss, but maybe not enough to make up for a pretty top-heavy antenna.

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Next we'll compare the relative signal strength of a quarter-wave monopole on the roof of a car to different lengths of a base-loaded antenna at the same spot (see Table I).

For short antennas, you are picking up about 3 dB more signal for every foot longer you make your 75-meter mobile antenna and about 2 dB on 40 meters. At the longer lengths you are picking up about a dB per foot. Therefore, a longer antenna really helps. In the base/center/top-loading example, this means that about a $5^1/2$-foot base-loaded 40-meter whip has the same signal as the 5-foot long top-load, and that base-load will go in and out of the garage much easier than the top-heavy top-load.

Loading Coils

Quite a bit of paper has been used covering loading coils, so for those of you who are still trying to tweak the Q for your 160-meter vertical over 1000, this section is not for you.

In photo B we have a commercial HF antenna loading coil. The diameter of the wire, the spacing

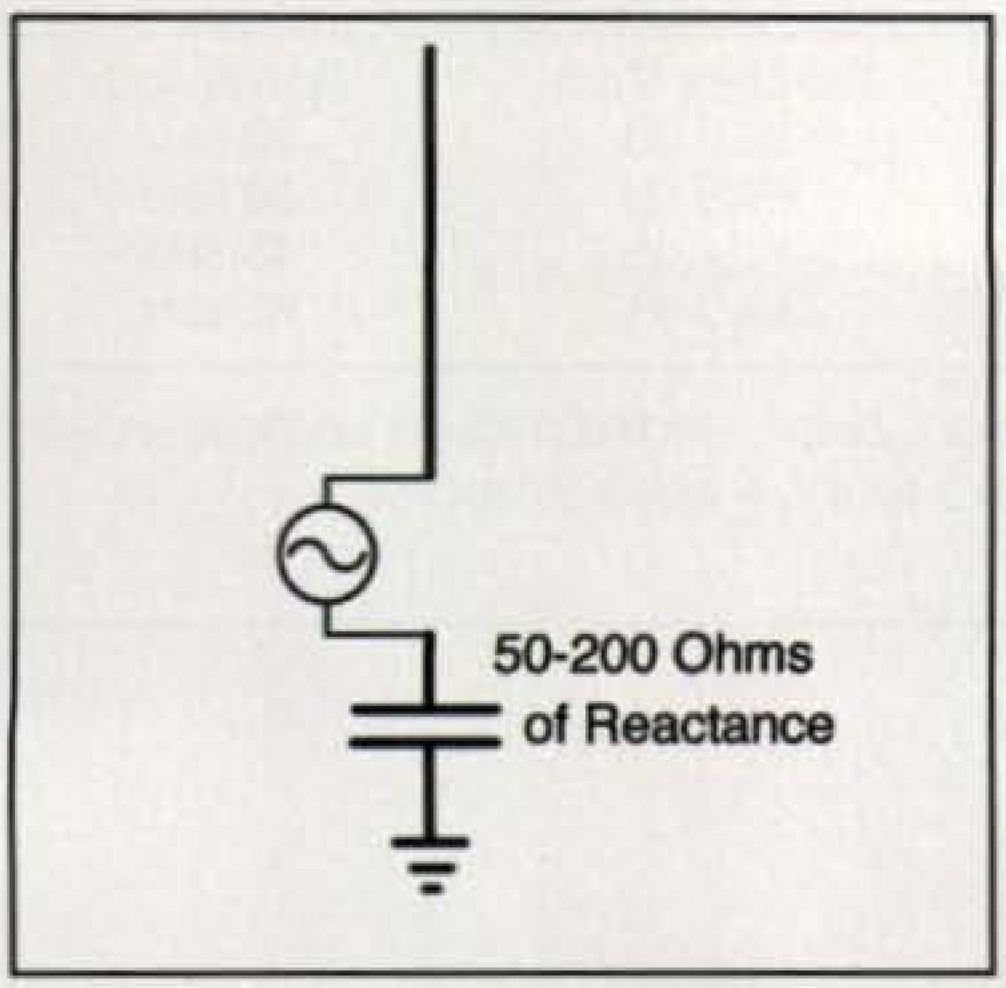

Fig. 2– Equivalent circuit of a mobile antenna.

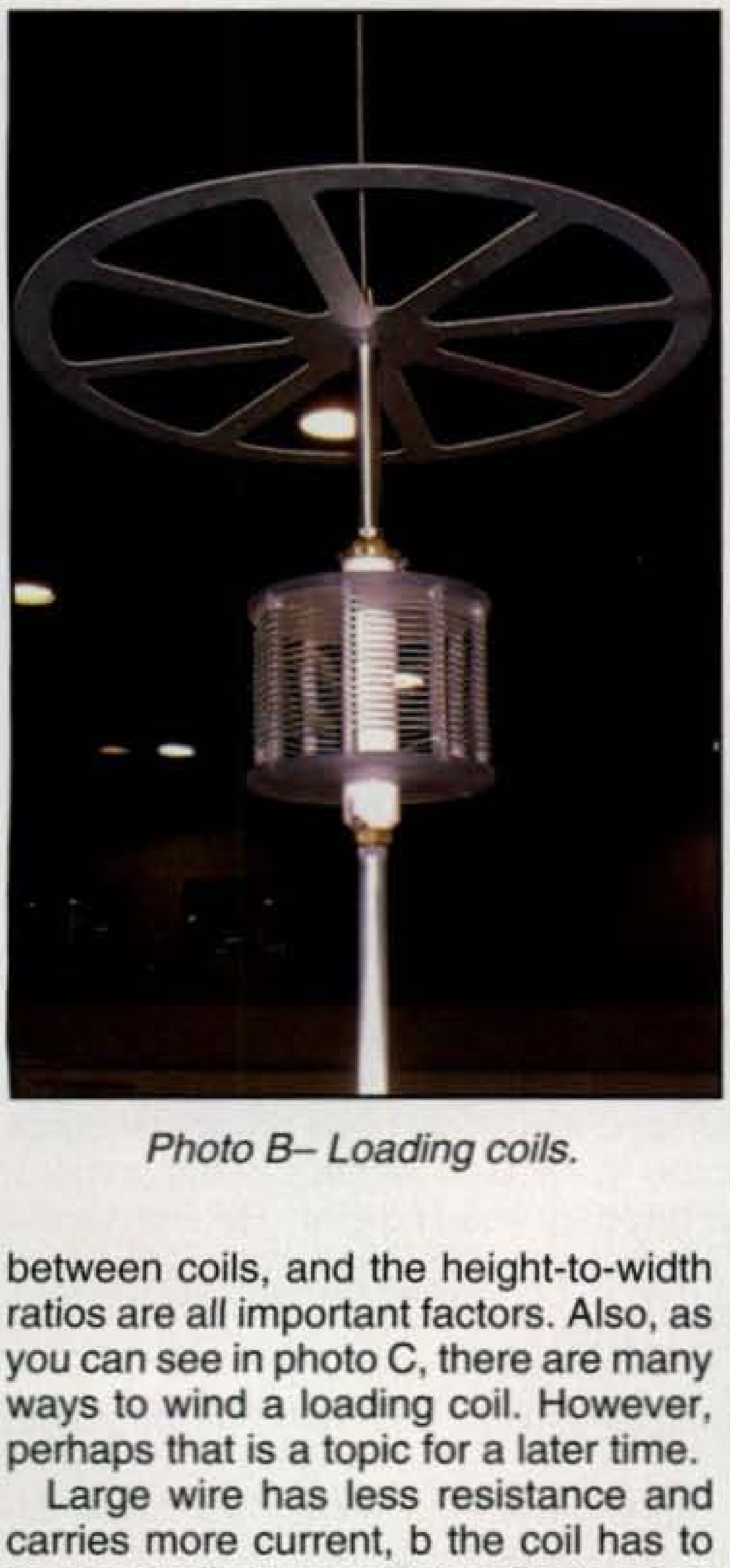

Photo B– Loading coils.

between coils, and the height-to-width ratios are all important factors. Also, as you can see in photo C, there are many ways to wind a loading coil. However, perhaps that is a topic for a later time.

Large wire has less resistance and carries more current, b the coil has to be physically bigger. This reflects a fact of life for mobile antennas: *physical size, gain, bandwidth—pick only two.*

All antenna designs are tradeoffs among how big they are, how much gain they have, and how wide a frequency range they can work over. This is particularly true for mobile HF antennas.

If we go back to our 5-foot high 40-meter antenna and look at different wire diameters for the loading coil with a bit more precision, we get the data in Table II. This table assumes round copper wire, and there are some fancy tricks with silver plating and flat conductors that we will pass over this month, but you can see how it is possible to trade gain for bandwidth. If you just happen to have a favorite 40-meter net frequency, and a favorite ragchew frequency more than 30 kHz away, then there can be a real advantage to using smaller wire in the loading coil. Now you don't have to retune the antenna every time you QSY. Just understand that you are trading about 2 dB for that privilege.

Ferrites

A ferrite core such as the ones in photo D can boost the efficiency of a loading coil way up there. However, ferrites have a condition known as *saturation.* That means the inductance of the coil changes with the current, or power through the ferrite. Saturation is a minor

Quarter Wave		0 dB Reference	
	75 meters	40 meters	20 meters
3 feet	−30 dB	−16 dB	−7 dB
4 feet	−23 dB	−12 dB	−5 dB
5 feet	−20 dB	−10 dB	−4 dB
6 feet	−17 dB	−8 dB	−3 dB
7 feet	−15 dB	−7 dB	−3 dB
8 feet	−13.5 dB	−6 dB	−2.5 dB
9 feet	−12 dB	−5 dB	−2.5 dB
10 feet	−11 dB	−4.5 dB	−2.5 dB

Table I– The relative signal strength of a quarter-wave monopole on the roof of a car compared to different lengths of a base-loaded antenna at the same spot.

Photo C– Low- and high-Q loading coils.

Photo D– Ferrite cores are not something you want in antenna loading coils.

issue with a computer switching power supply, but in an antenna circuit you can see this saturation as a frequency shift.

Just imagine your rig running 1 watt while your antenna is tuned to the CW portion of the 40-meter band near 7.0 MHz. Crank up the power to 50 watts and the antenna is now in the SSB portion of 40 meters near 7.25 MHz. Now up the power to 100 watts and the antenna has its best SWR near

Gauge of Coil Wire	Relative Gain	Bandwidth
# 14	−10.0 dB	32 kHz
# 16	−9.6 dB	30 kHz
# 22	−11.4 dB	45 kHz
# 26	−14.0 dB	82 kHz

Table II– Five-foot high, base-loaded mobile vertical antenna relative to a 1/4-wave antenna.

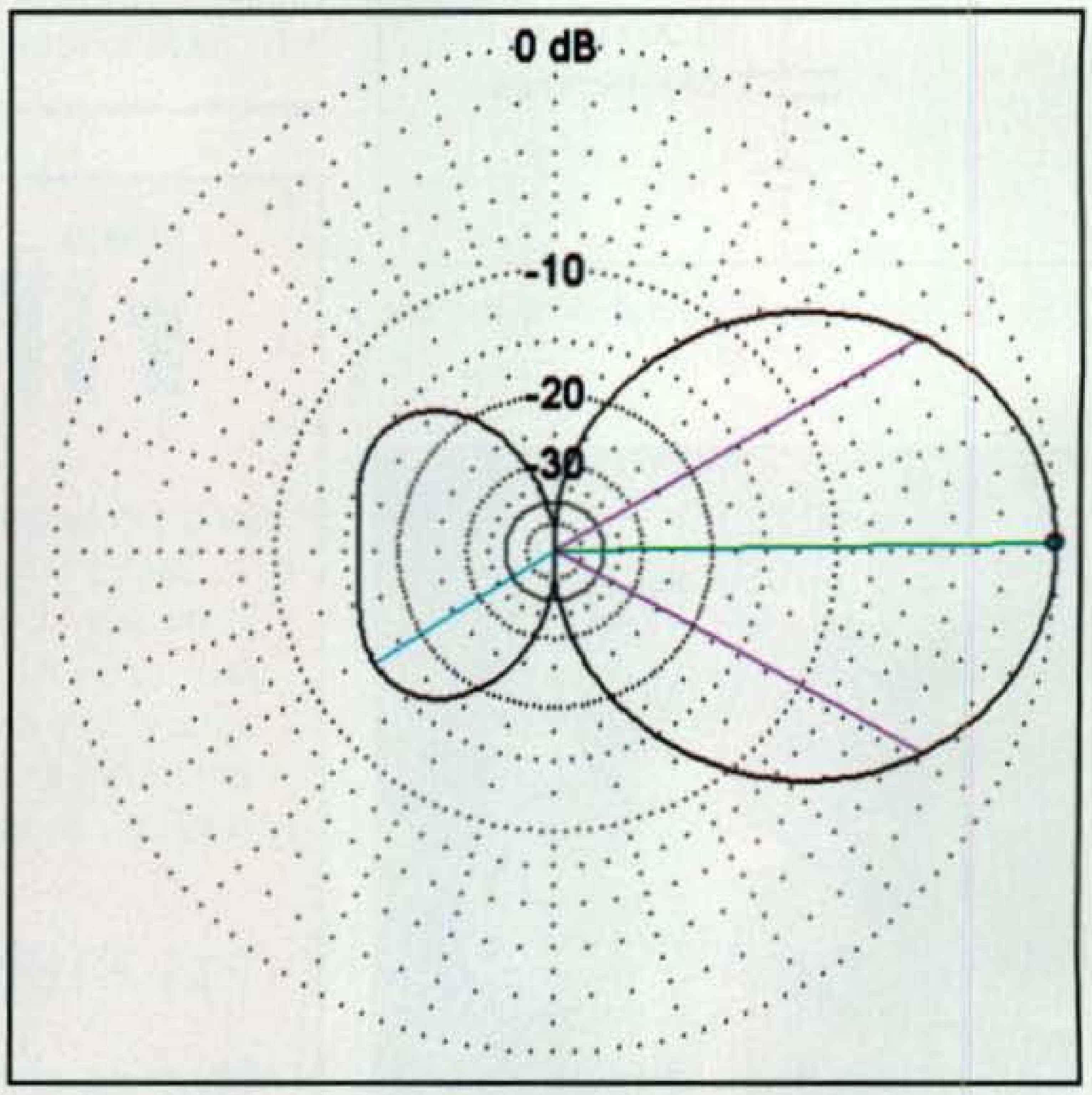

Fig. 3– Antenna polar plots for next time.

8 MHz. This is the effect you see when you have the wrong kind of ferrites in your antenna system. Thus, unless you really know what you're doing, avoid using ferrite inductors in your antenna coils. But hey, ferrites are still great for keep RF from running around your shack. I clamp them around power cords, mic cords, CW keys, and antenna leads ... anything that acts like it has a bunch of RF running around on it. The clamp-on ferrites and the loose ones on power cords were originally put there to keep RF signals in the computers, but they are also good for keeping stray RF signals out of your radios.

Bottom Line

Antenna length: As long as you can deal with (the longer the better).

Loading coil: High up is better, but there's not much difference unless you have a capacitance hat.

Coil windings: Big, fat wire gives you the best efficiency; thinner wire gives you more bandwidth.

Capacitance hats: They're great on 160 and 80 meters; marginally helpful on 40 meters; and of little value on 20 meters and up.

Next time we will be going over what antenna polar charts, such as the one in fig. 3, are really telling you about an antenna.

As always, some of our best ideas for projects and columns come from you, our readers. For antenna questions and topic suggestions, you are welcome to contact me at <wa5vjb@cq-amateur-radio.com>. 73, Kent, WA5VJB