Apartment Antennas: A Challenge

How to cope with a less-than-ideal QTH.

by Stan Gibilisco W1GV

I recently moved into an apartment complex where outdoor antennas are not allowed. This predicament is not unfamiliar to radio hams and shortwave listeners. It does not have to mean a low-performance station, but it inevitably means that there must be some compromises. A full-size, 4-element, 40 meter yagi, and other such antennas, are out of the question.

Here are some of the schemes I have tried so far, and some ideas for future experimentation. I can always go back to my parents' house on the hill to work contests and DX, and this is the attitude I carried into the new apartment.

Survey the Layout

Whatever your particular situation, you will immediately see some obvious possibilities for antennas if you take the time to look things over.

My apartment is on the third floor of a three-story complex. My main motivation for choosing this location was noise: No one will be clomping around above me all day and all night. It turned out to be good from a ham radio standpoint, too. The ceiling is 30 feet above the ground. The building is old, and is therefore probably not of the solid concrete-and-steel Faraday-shield construction typical of newer high-rise complexes. There is a fire escape right outside the living room window, a formidable mass of metal that ought to make an excellent ground for a high-impedance antenna system.

The point is that any apartment will have some redeeming properties for radio communications. Well, almost any. Perhaps my friend who used to live in Arlington, Virginia, had just about the worst deal I have ever seen, a low floor in a jungle of tall buildings. Evidently hamming was not high on his list of priorities.

Any apartment living arrangement presents the danger of RFI and it is far better to put extra effort into the antenna system than to attempt to overcome a deficiency by running high power. I prefer not to get into wars with my neighbors. I'd just as soon have them never suspect I am a radio ham and never have any interference from me. With this in mind, I kept in mind the corollary to the antenna restriction: If you never get caught with an outdoor antenna, then, in effect, you don't have one as far as the management is concerned.

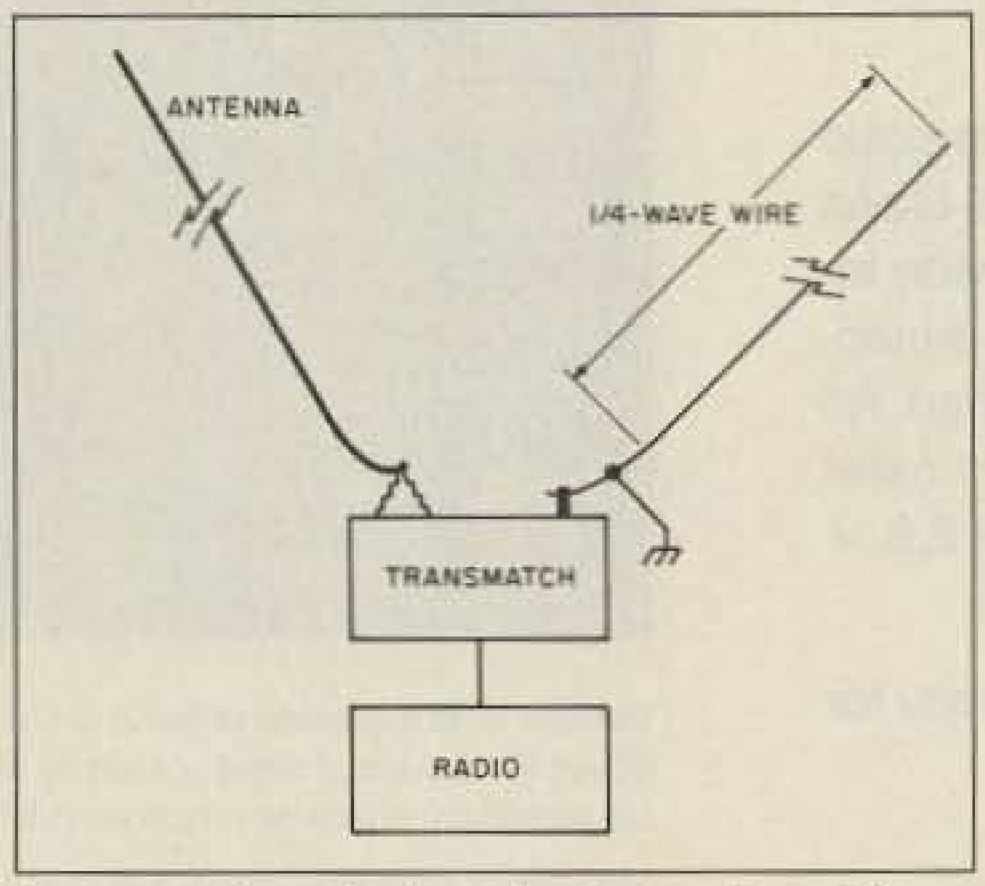

Figure 1. Installation of a ¼ wavelength "radial" wire as an RF ground. The wire should be as straight as possible, and the far end left free.

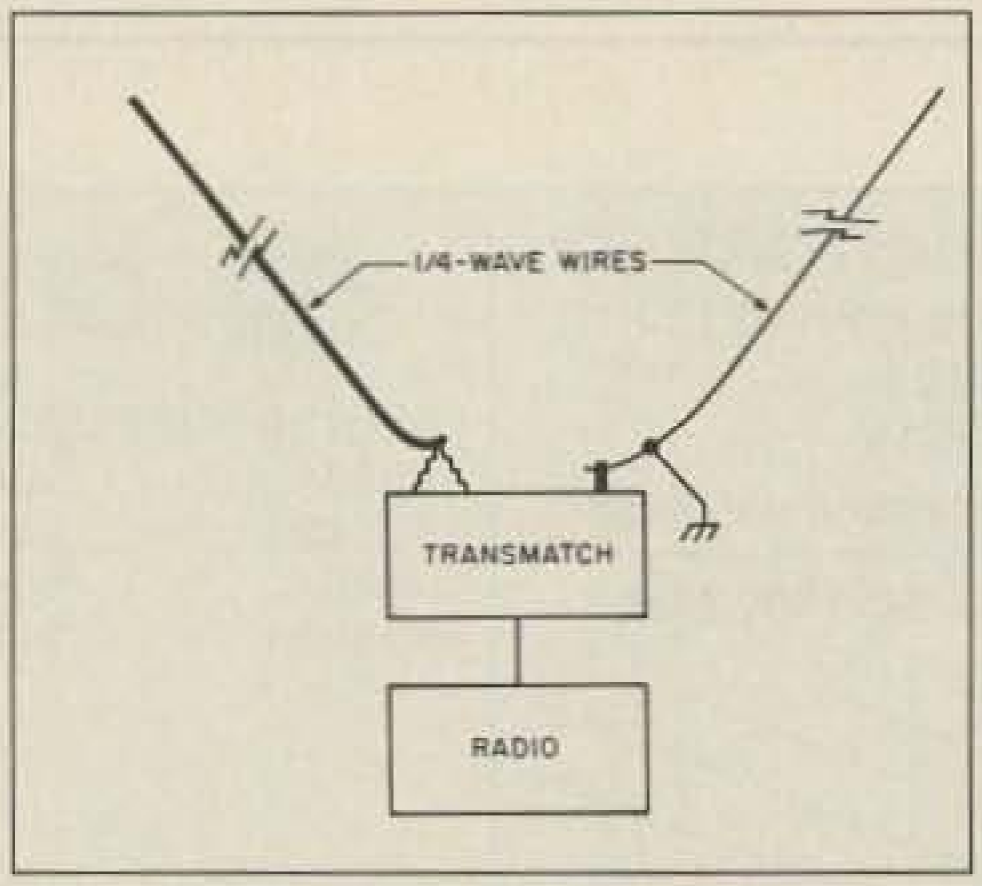

Figure 2. When a ¼-wave, end-fed wire antenna is used with a ¼-wave ground lead, the result is a center-fed dipole antenna. In this case the "radial" contributes to the radiation of the antenna system.

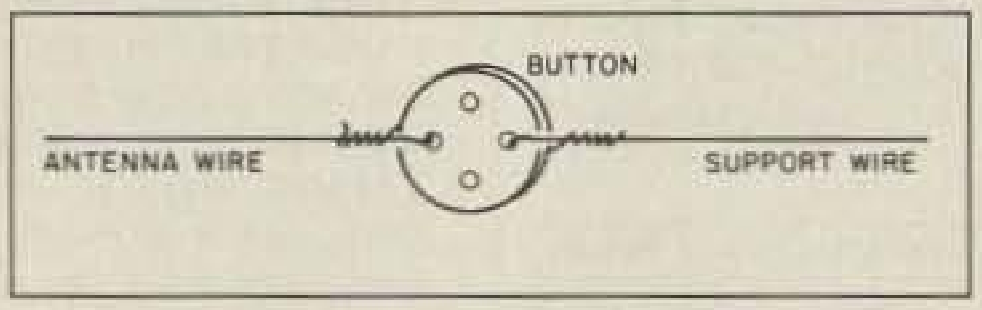

Figure 3. A button may be used as an insulator for "invisible," low-power antennas.

This last statement is not intended as an encouragement to break the rules of your lease. You do that at your own risk. If you try it and get into trouble, I shun all responsibility.

Establishing Ground

I cannot overemphasize the importance of obtaining a good ground for radio-frequency communication. A good direct-current (DC) ground is not necessarily a good radio-frequency (RF) ground.

The term "RF ground" is somewhat nebulous. A good ground at one frequency may be terrible at another frequency. The type of antenna being used makes a great difference.

If the ground loss resistance is given by R_L and the antenna input radiation resistance is given by R_R, then the efficiency of the ground system is given by:

$$\mathrm{Eff}(\%) = 100 \bullet R_R/(R_R + R_L)$$

The higher R_R is, compared to R_L, the higher the efficiency of the ground system. End-fed antennas measuring an integral multiple of 1:2 wavelength tend to have very high values of R_R and are therefore best for use when the RF ground is marginal—and in an apartment situation, it almost always is marginal, at best.

You can get a good RF ground by installing a quarter-wavelength wire at the station transmatch or transmitter chassis, as shown in Figure 1. This will produce high current, and therefore low resistance, at the operating frequency, and also at odd integral multiples of this frequency. Such a "radial" ground wire will radiate to some extent, but this is minimal when the antenna feedpoint resistance is very high. If the antenna is a quarter-wave wire with a rather low feedpoint resistance, the arrangement will combine with the antenna to form a dipole having a feeder length of zero (Figure 2). This arrangement will still function quite well. For multiband operation, multiple "radials" can be installed, each cut to ¼ wavelength at the center of the desired band according to the equation:

$$L(\mathrm{feet}) = 240/f(\mathrm{MHz})$$

where L is the length of the ground lead and f is the frequency. The far ends of these "radials" are left free, not connected to any object.

MFJ Enterprises, Inc., makes a tuner designed especially for resonating an RF ground. According to a *QST* review, this device works quite well.

The Transmatch

I have mentioned the use of a transmatch almost as if it were given that you have one. It ought to be; transmatches are indispensable for apartment dwellers and any radio ham who operates portable very often. The added versatility is well worth the cost of the device.

The best transmatches allow for tuning random wires and balanced feeders. Most modern transmatches employ ferrite balun transformers to obtain tuning for balanced antenna systems. This is fine as long as the core does not saturate during transmission. Depending on the impedance at the feedpoint, the core may saturate at power levels much lower than that specified by the manufacturer for operation of the transmatch. I have actually cracked a ferrite balun core using 500 watts output when the transmatch specifications stated that it was usable up to 3 kW. This same transmatch became quite hot during operation using 500 watts output and an unbalanced ⅝-wave wire at 1.8 MHz. The choice of a transmatch is obviously important. In general, those with very large components will be better suited for high power (more than 200 watts output) than those with smaller components, even if the latter carry impressive specifications. Certain laws of nature will not yield to miniaturization technology—not until we have superconductor coils and cryogenic vacuum-variable capacitors!

The main advantage of a transmatch is that it allows practically any antenna to be resonated. You should choose the antenna with efficiency in mind, regardless of the availability of a tuner, but high-impedance antennas, the kind that work best with marginal grounds, generally require a tuner to produce an acceptable standing-wave ratio (SWR).

A Simple End-Fed Wire

Perhaps the simplest antenna is an end-fed wire, running directly to the output of the transmatch and cut so that it is an integral multiple of ½ wavelength on all of the desired transmitting bands. In amateur radio at high frequencies the bands are harmonically related, so if an antenna is cut to be ½ wavelength at 80 meters it will be close to an integral multiple thereof at 40, 30, 20, 15 and 10 meters.

Outdoor antennas are often not allowed, but a thin wire, three stories above the ground, is difficult to see. I recommend enameled copper wire of American wire gauge (AWG) No. 24 or smaller, down to AWG No. 30. The larger wires are physically stronger but more likely to be seen; the finer wires are more likely to break. Don't string such an antenna where it might cause problems for people if it breaks. Keep in mind, also, that if there is a frost, an "invisible" antenna may greet you some morning with an announcement to the world almost comparable to reveille.

The far end of a thin wire antenna may be tied to a button as an insulator, as shown in Figure 3. Allow plenty of slack for the wire to swing with the wind. A strong tree branch is all right for the far end of the antenna, but a solid, stable object is superior since it will not move in a wind. Avoid stringing the wire over or under utility wires. Table 1 gives good lengths for wires for various lowest amateur bands.

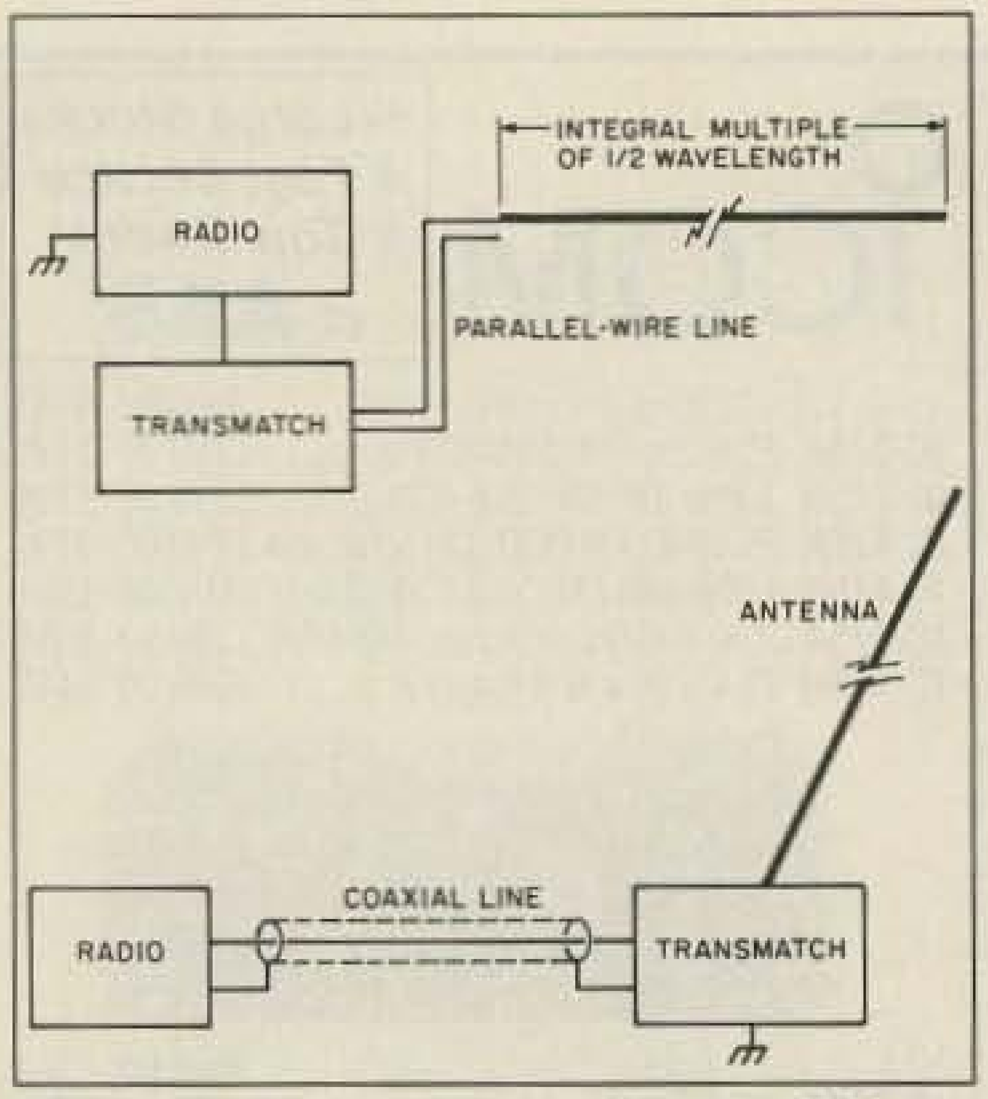

Figure 4. In drawing "a," a parallel-wire feedline is used with an end-fed wire that is very close to an integral multiple of ½ wavelength. In "b," the transmatch is located some distance from the transmitter, and the antenna is end-fed through the transmatch.

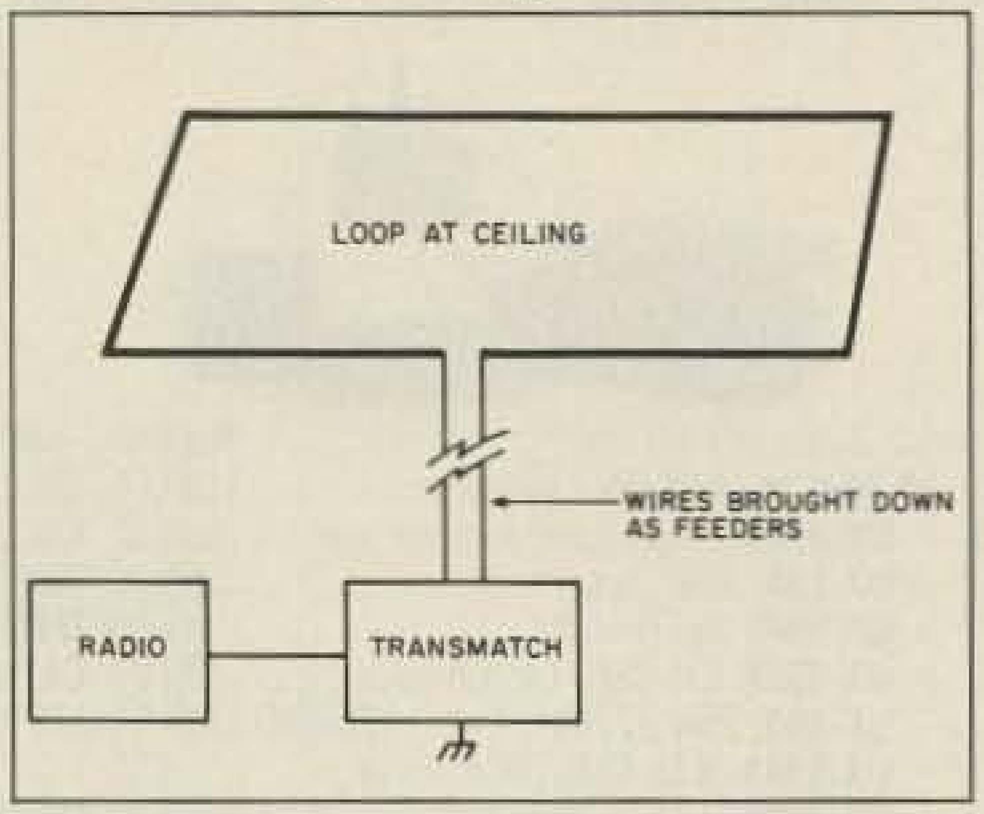

Figure 5. An indoor loop may be fed by bringing the wires down from the ceiling, parallel to each other, to the balanced output of the transmatch.

For shortwave listening the length is less critical, since antenna efficiency is not as important. Generally, a length of at least 50 feet will suffice, although longer wires are recommended for listening below the 160 meter (1.8 MHz) amateur band, and at longwave frequencies, length should be as great as can be managed.

The disadvantage of an end-fed wire is that the radiating portion of the antenna comes right down to the station. However, in an apartment situation where the landlord will not allow rooftop antennas, long feedlines are impractical anyway. If the station must be located away from the window where the antenna comes in, then a parallel-wire line may be used and the antenna connected to one end of this line. However, the antenna must be very close to an integral multiple of ½ wavelength to avoid line radiation (Figure 4a). Alternatively, you can run coaxial cable from the transmitter to the feedpoint, then connect the tuner to the antenna and RF ground at this remote point (Figure 4b). This is inconvenient when it comes to changing bands, but it is the best alternative in some cases. The RF ground must be connected and effective at the transmatch when this scheme is used.

An Indoor Loop

Simple end-fed wires may be connected for use indoors, although the lengths may vary somewhat when the wires are not straight. For indoor antennas, a balanced loop is probably better than an end-fed antenna.

Basically, the loop antenna always presents a balanced load at the input. This eliminates the need for a good RF ground and also gets rid of frequency sensitivity. The loop should be at least ½ wavelength, and preferably at least one wavelength, in circumference.

My apartment is quite large, and the ceiling is about 30 feet above ground level. An indoor loop, run around the entire apartment at the ceiling level, was an obvious choice. I installed this antenna almost before I got all the furniture in and the bed made up. I found stranded, insulated AWG No. 20 wire at a surplus shop for a few dollars. Hamfests are great places to get wire like this. I connected the loop to the balanced terminals of the antenna tuner, without regard to the overall length of the loop: I knew only that it was at least 100 feet in circumference, and close to a full wavelength at 7 MHz. I did the tuning on all bands, 80 through 10 meters, and logged the transmatch settings for future reference.

The loop was fed by bringing the end wires down parallel to each other, as shown in Figure 5.

Separate Receiving Antennas

Indoor antennas, and any antenna in a population-dense place like an apartment building, will pick up considerable man-made noise. The noise blanker on my FT-101EE is effective against much of this noise, but some broad-spiked noise is difficult to suppress with any noise blanker. In some cases a special receiving antenna may be needed.

A small loop with a tunable preamplifier is an asset in noisy places. The loop should be rotatable in both the vertical and horizontal planes, allowing you to find the noise null. It can be exasperating when there is more than one noise source and they keep alternating; the loop may need

Table 1. Lengths of wire antennas (end-fed) for half-wave operation at various amateur bands. The bands are indicated in meters, with the lowest frequency band first. Half-wave resonant frequencies are given in MHz, and represent the centers of the lowest bands.

Bands of Operation	Resonant Frequency	Wire Length Feet	Wire Length Meters
160, 80, 40, 30, 20, 15, 10	1.900	246	75.1
80, 40, 30, 20, 15, 10	3.750	125	38.0
40, 20, 15, 10	7.150	65	19.9
30, 15, 10	10.125	46	14.1
20, 10	14.175	33	10.1

frequent adjustment. The subject of receiving loops is complex and is beyond the scope of this article. However, Doug DeMaw W1FB has written numerous articles in *QST* about receiving loops.

Commercially-manufactured receiving loop antennas are available. Palomar Engineers manufactures one that has a preamplifier and a ferrite loopstick that can be rotated in both the vertical and horizontal planes.

A separate receiving antenna is, of course, necessary only for ham stations in which there is also a transmitter. When a separate antenna is used for receiving, precautions must be taken to ensure that the signal from the transmitter does not damage the receiver front end or the preamplifier. Some preamplifiers have protection built in. Some don't. Protection may not be necessary at low levels of transmitter power, but it is always a good idea.

That Gremlin: RFI

Radio-frequency interference (RFI) is so common nowadays that, unless you are running milliwatts or are extremely fortunate, you will encounter it in an apartment situation. There are video tape machines, low-cost hi-fi and television receivers, and all kinds of other devices that are susceptible to interference from amateur radio signals. It seems that the problem has multiplied in recent years because of two factors: the greater number of susceptible devices, and the general neglect of manufacturers when it comes to protection from strong electromagnetic fields.

The RFI problem takes a different, reversed form when consumer devices interfere with the radio amateur's communications. Home computers are notorious for this. Other devices, such as cordless telephones, can cause trouble as well. It seems that a double standard applies in the public mind for RFI: It's all right if the radio ham gets interfered with by a consumer device, but it's a cosmic catastrophe if it happens the other way around. It is not my place to say whether or not soap operas and video games are more important than radio communications of a hobby nature, but radio amateurs have to be prepared to face the facts.

In the event of a confrontation with neighbors, the American Radio Relay League, 225 Main Street, Newington CT 06111, (203) 666-1541, may be of assistance. They are familiar with legal cases that have occurred as a result of RFI.

My own attitude is that I won't operate if it interferes with some other person's activities. I don't consider myself that serious an operator. I'll reduce power or operate when nobody else is awake. But not everyone shares this tempered, retiring view. The most the ham can do is be certain that his transmitted signal is "clean"—free of harmonics or other defects in quality—and that he is running no more power than is necessary to carry out the given communications. This power issue is often overlooked: We hams tend to run more power than we need, most of the time. Apartment dwellers must keep constraints such as this in mind.

Many RFI problems can be cleared up by the installation of such things as line filters, better grounds, or different antenna systems. An indoor antenna is more likely to cause RFI than an outdoor one. There is some evidence to suggest that vertically-polarized antennas are more RFI-prone than horizontally-polarized antennas. A two-wire line must be kept in proper balance; a coaxial line must be free of "antenna currents" on the shield.

Further Ideas

The outdoor "invisible" end-fed wire and the indoor loop are the two antennas I have tried so far. Of course, there are other possibilities. A balanced "invisible" dipole, actually a shortened random V beam, is another scheme that might lend itself to my situation. This would be a set of two end-fed random wires, each of the same length, connected to opposite poles of the balanced transmatch output. Such an antenna would require no RF ground and would be balanced over a wide range of operating frequencies.

Perhaps the most interesting idea must wait until those long, cold winter nights, when the 1.8 MHz band comes to life. I find it hard to resist this band during those times. I figure if I'm not partying in Miami on those winter nights, the next best thing is a good cup of hot chocolate and an efficient antenna for 160 meters. I have used balloons and aluminum welding wire to make full-size "vertical" antennas of ¼ wavelength and longer on this band. Depending on the proximity of the utility lines, a scaled-down version of this idea might be used in an apartment *[Ed Note: Not recommended for apartment dwellers, it's best to try this in the wide-open spaces of the country. If you try this idea, make sure you are more than the length of your antenna wire away from any power lines, and don't try this on a windy night!]*. The balloon would have to be dark, so that it could not be easily seen at night, and it would have to be small enough to fit through the open window. Then there's the problem of getting the gas cylinder up three flights of stairs without provoking questions or getting a hernia. But, as the saying goes, when there's desire, there's no limit to what one can do. For a radio ham fond of the 1.8 MHz band, winters in the Upper Midwest have a way of cultivating desire. Let's see: a pound of that wire alloy 5356 with a 0.030-inch diameter is about 1,250 feet, so ¼ wave at 1.8 MHz, about 125 feet, would be only 0.1 pound, or 1.6 ounces. A 24-inch balloon would easily lift that, and ought to fit through the window with a little effort. Of course, I'd have to have the lights off so no one would see me climbing out onto the fire escape at midnight in below-zero weather with this two-foot balloon, but that's no problem. A little sign on the windowpane could remind me to switch off the lights before going out. . . 73

Contact Stan Gibilisco W1GV at 871 S. Cleveland Avenue, Apt. P-12, St. Paul MN 55116.