BY ARNIE CORO,* CO2KK

More Low-Cost Antennas for 2 Meters

Two meters is the most popular amateur band worldwide, and everything indicates it will continue to be a favorite for newcomers to the hobby. In some parts of the world the band spans a full 4 megahertz, while in others it is just 2 megahertz wide. Building your own 2 meter antennas is a lot of fun, will cost almost nothing, and will give you a lot of hands-on experience in antenna work. It will also be a challenge for you.

Each of the projects that follows will give you an antenna better than a "rubber duckie," but will require some skill and patience. On the other hand, building your own rubber duckie is no simple task, either.

Photo A– Full-size, 2 meter ,omnidirectional, vertically polarized antenna at CO2KK's QTH using three 5/8-wavelengths elements. With its estimated 6 dB gain over a dipole, it's my standard of comparison for 2 meter FM work.

Nearly every amateur in the world today owns at least one 2 meter FM radio. Many of us own two or more. Some hams give their 2 meter handheld a lot of use, while others enjoy working FM from the mobile. Still others own multi-mode rigs, so they need to install a horizontally polarized antenna for the weak-signal modes as well as a vertical antenna for FM.

It is well known that the helically wound short vertical antenna, or "rubber duckie," provided with the typical 2 meter handheld is a pretty poor radiator. Losses may range from –6 to as much as –10 dB when compared with a reference-standard half-wave vertical dipole. Why do we keep using it? The obvious answer is that the popular rubber-duckie fits nicely and provides communications when you are either talking to a nearby station or using a hilltop repeater. At home you may be tempted to hook up your HT to a big outdoor antenna (photo A), but that may have drawbacks as well as benefits. The typical HT cannot handle the high field intensity of nearby out-of-band stations, something that leads to very bad cross-modulation problems. A rubber duckie isn't sensitive enough to pick up these stations, but a big outdoor antenna is. HTs require either smaller antennas or tight bandpass filters between the external antenna and the radio.

Better HT Antennas

Of course, you can carry a better antenna for your handie-talkie, such as my favorite 0.32-wavelength vertical which provides a substantial increase in signal strength while at the same time matching the 50 ohm output impedance of the transceiver. Antenna experts will tell you that the 0.32-wavelength vertical has a resistive component that is near 50 ohms, while also having a reactance that is easily compensated by introducing a series matching capacitor between the antenna and the rig's antenna connector.

The 0.32-wavelength antenna measures about 56 cm (22 in.) in length when cut for the 145 to 146 MHz segment and a little less when you resonate it for operation between 146 and 148 MHz.

Homebrewing your 0.32-wavelength vertical for a handie-talkie is a nice weekend project, but remember that you must tune out the antenna's reactance by using a small trimmer capacitor, located at the base of the antenna and connected in series with the radiator.

Because handheld FM transceivers happen to use the case of the radio as part of the antenna system (yes, believe me, the metal case of your radio is the actual "ground system" to complete the vertical antenna's image), you must adjust the 0.32-wavelength vertical with the help of a field-strength meter and a lot of patience.

A weak station will provide the first approximation, because you can tune the series trimmer capacitor with a non-inductive tool, looking for maximum signal strength. The second step will be to use the field-strength meter out in the open and

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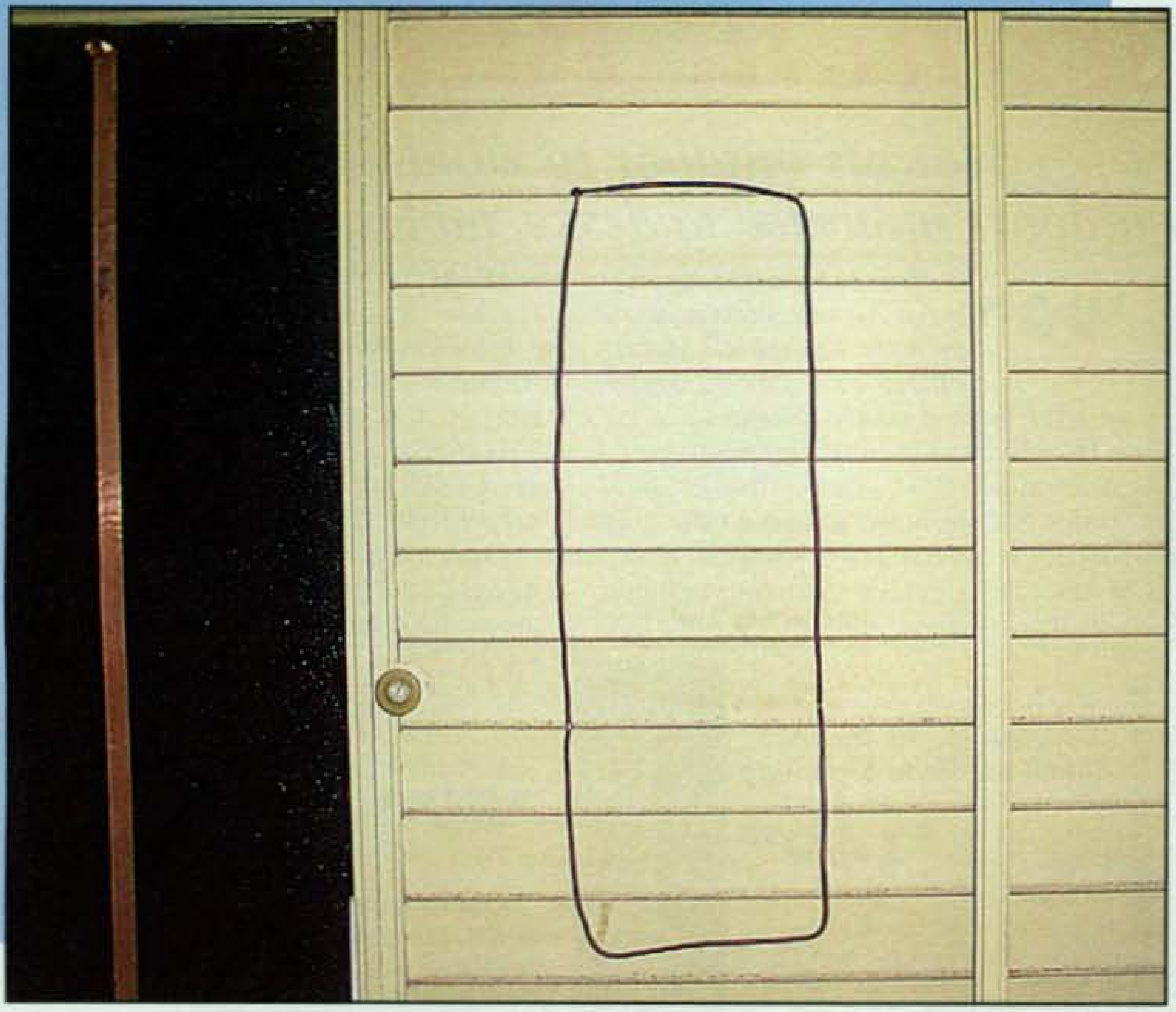

Photo B– Two of my indoor 2 meter band antennas—the copper-foil-tape half-wavelength end fed, and the elongated rectangular loop. There is no feedline connected to the loop.

carefully adjust the series trimmer for maximum radiated signal.

One of the difficulties involved in this otherwise very effective and low-cost replacement for the rubber-duckie helical whip is that you must make it in such a way as to provide good mechanical strength, while at the same time not causing too much stress on the HT's often-fragile antenna connector.

Half-Wave Verticals Are Still Better

By combining a small loading and matching coil, plus a simple impedance transformation network, commercial manufacturers offer telescopic half-wave verticals specially designed for handie-talkie use. The typical half-wave vertical for 2 meter FM use will be about 95 cm ($37^1/2$ in.) long when extended, something that certainly will require a lot of care when handling a radio equipped with such an antenna. In practice, the telescopic whip and matching network can be designed so that when the whip is not extended; it can provide the user with the performance of the standard rubber-duckie antenna. When the whip is extended to its full length, the increase in efficiency of the radiating system is outstanding.

The fact is, a half-wave antenna, when fed at the bottom , presents a very high impedance, so it requires much less of a "ground system" than a quarter-wave vertical or any other similar antenna, such as the rubber duckie. Homebrewing a half-wave 2 meter vertical for use on a handheld radio does require using a telescopic whip and some kind of weatherproof box in which the tuned matching network can be housed.

Again, the use of a telescopic whip is a *must,* and finding the appropriate circuit parameters to make the half-wave vertical work properly when fully extended as a true 0.5-wavelength antenna, and as near as possible to a 0.25-wavelength vertical when the whip is collapsed to its minimum length, can be tricky, to say the least.

My advice for newcomers and oldtimers alike is that the half-wave vertical is an excellent antenna for portable work *if* it is properly built from both an electrical and mechanical standpoint. This leaves little room for homebrewing, except for those *CQ* "Antennas" column readers who have a lot of practical experience in building their own VHF and UHF antennas. Commercial versions are inexpensive, and if you're mainly looking for improved communication, consider buying one. If you're looking for a challenge, build one instead.

Magnetic Loops on 2 Meters

Yes . . . they both are pretty small and work very well *when properly designed and tuned to the operating frequency.* Magnetic loops for VHF work have the same narrow bandwidth feature as those made for the HF bands, so you may find yourself having to *retune* the magnetic loop when changing frequency . Not doing so may harm your radio's output stage, something that many of us have learned the hard way (and include your columnist among those who have blown a nice HT output module while testing a magnetic loop).

What may move the average ham to build and use a magnetic loop with a 2 meter radio? The answer is not that difficult to find: The magnetic loop is a very small antenna, and it has two very marked nulls, something that will help *fox hunters* a lot!

Following standard magnetic-loop practice, the antenna must be used with a variable tuning capacitor, and you may use one of the two typical matching systems—the gamma match or the coupling-loop method. Both work well, but for the 2 meter band magnetic loop I prefer to use the gamma-match system, because once set, the SWR at the operating frequency will stay low. (I don't have space here to get into the specifics of building a gamma match, but standard antenna references such as the *ARRL Antenna Book* (ARRL) and Joe Carr's *Practical Antenna Handbook* (Tab) cover the topic well. In contrast, the coupling loop (fig. 1) is more prone to moving out of the place where it gives the best match, something that may prove dangerous to your rig, as the SWR may go up abruptly when the coupling loop is moved out of place.

Don't be surprised by the small size of even the largest 2 meter magnetic loop (fig. 2). According to antenna theory, a magnetic loop cannot be more than approximately one tenth of a wavelength long. Thus, for the 2 meter band, with a wavelength between 2.08 meters and 2.02 meters from 144 to 148 MHz, the maximum length of the magnetic loop should be around 20.5 cm (8 in.) for the center of the band. That gives a diameter of 20.5 divided by PI, or 3.1416 in round numbers, so the diameter of the magnetic loop is just 6.42 cm (about 2.5 in.).

I have made several of these antennas using either 3 mm ($^1/8$ in.) diameter wire or a 10 mm ($^3/8$ in.) wide cop-

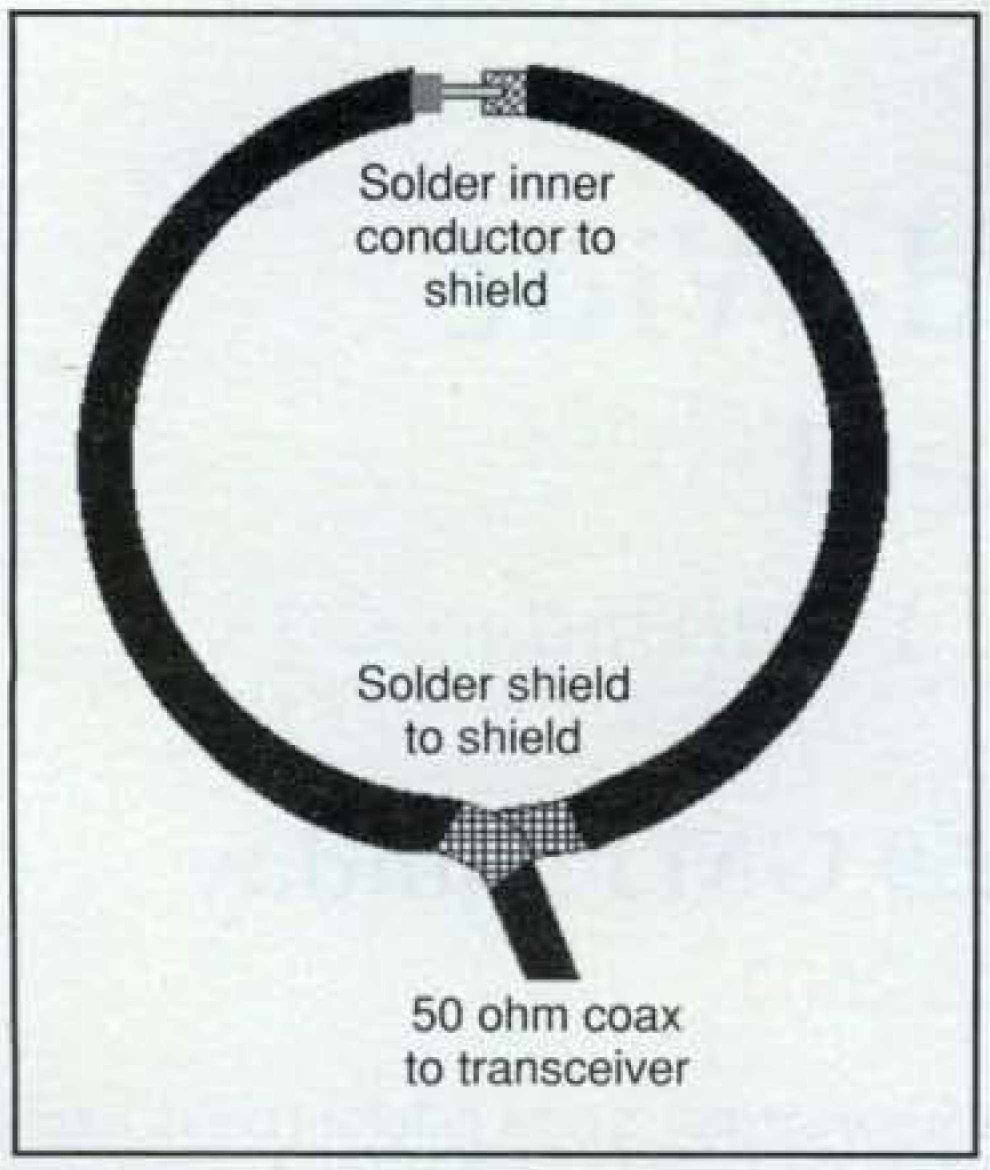

Fig. 1– If you build a magnetic loop and want to feed it using the coupling-loop method (although I recommend a gamma match, because these loops are so small), this is how it should be made.

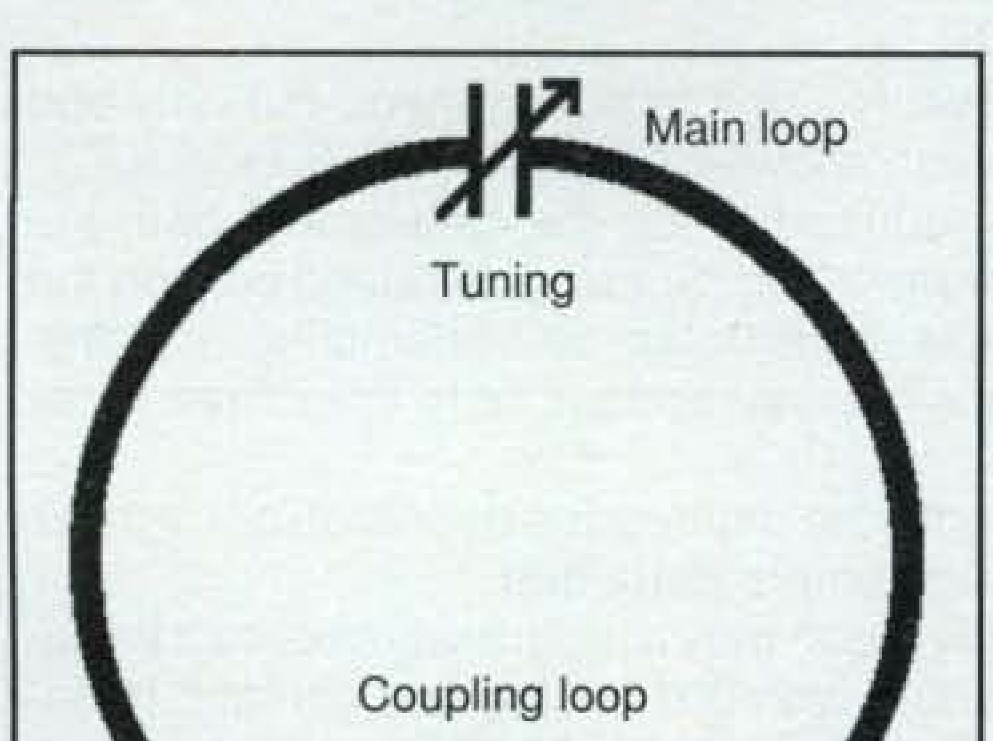

Fig. 2– This is the schematic diagram of a typical magnetic-loop antenna using the coupling-loop method. Again, this is not especially practical for 2 meter antennas due to the extremely small size of the coupling loop required.

per strip. Both construction materials provide excellent results, and as a matter of fact, local hams here have built the 2 meter magnetic loop to replace lost rubber-duckie verticals. The magnetic loops are pretty efficient, and they do have two rather sharp nulls that can be used very effectively during a fox hunt, or to find a source of interference.

Copper-Tape Antenna For Window Use

Copper-foil tape used by glass artists usually comes with an adhesive backing, so it makes an ideal material with which to build a group of low-cost antennas that are taped to glass windows. the easiest of them all is the half-wave vertical dipole, which when properly fed gives excellent results. Two cm wide ($^3/4$ in.) copper-foil tape makes excellent broadband 2 meter antennas!

Of course, you must win the approval of the lady of the house to install a copper-foil window antenna, but once installed it will last for a long time, and you can always use it (even right in the middle of a storm), because the antenna is *indoors*.

I use RG174 coaxial cable to feed my copper-foil dipole that is located exactly behind my workbench. Tuning the dipole for minimum SWR is not difficult at all using a standard VHF SWR meter. Do remember to exit the coaxial feeder at exactly 90 degrees from the dipole center, and run it for no less than 60 cm (about 2 ft.) before making any turns. You may also try feeding a half-wave vertical made of copper foil at the bottom, but that will require a matching network that somehow must be hidden from sight.

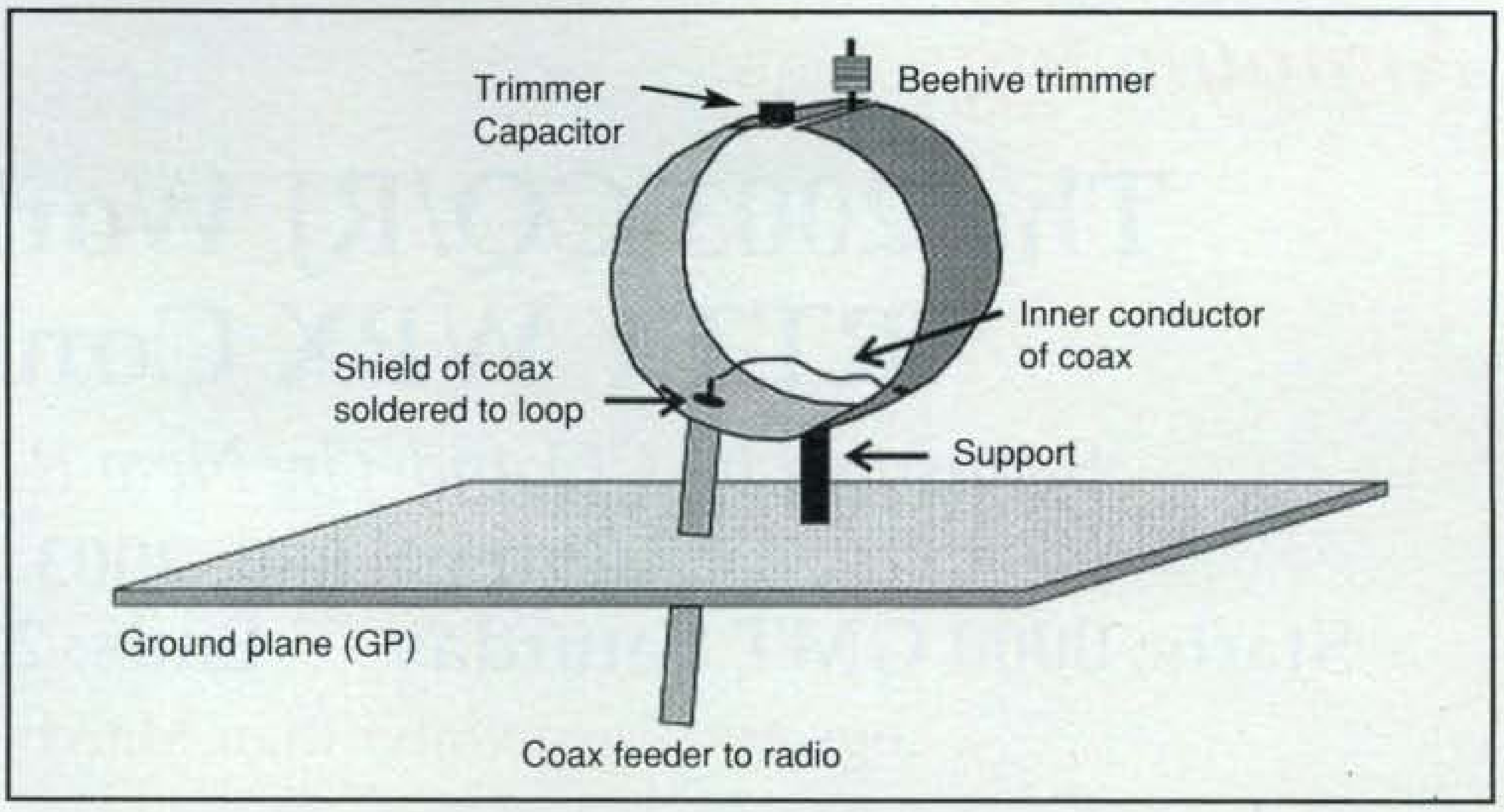

Fig. 3– A 2 meter magnetic loop made using wide copper laminate in order to increase the bandwidth. Notice the use of a ground plane below the antenna, the trimmer capacitor required to tune the antenna to resonance, and the gamma-match feed system used. In order to fulfill the magnetic-loop design criteria, the antenna may not exceed one tenth of a wavelength.

A Full-Size Circular Loop

Sure, it's pretty easy to build this antenna. I have mine sitting behind a wooden window. The loop is made using No. 12 or No. 10 bare copper wire and is fed either for vertical or horizontal polarization. I made two loops (fig. 3), one of which is fed at the bottom for horizontal polarization and the other fed to provide vertical polarization. Changing from one loop to the other takes less than a minute !

The full-size loop is 208 cm (82 in.) long, and it does require a quarter-wave coaxial matching section made from 75 ohm cable in order to match the loop's approximately 110 ohm impedance to the 50 ohms typically used by 2 meter radios. One advantage of this low-cost, homebrew, full-size 2 meter band loop is that it is quite effective for direction finding if you carefully wind the quarter-wave matching section as a coil using a 25 mm (1 in.) diameter PVC pipe section as a coil form. Before using the coaxial choke balun, the nulls were not as sharp!

Last But Not Least . . .

. . . A rectangular loop that matches 50 ohms. With appropriate tweaking , a full-size rectangular loop can be made to provide an almost-perfect match to a 50 ohm coaxial line. However, please don't forget to include the vitally important decoupling coaxial choke balun right at the feedpoint. My rectangular loop, seen in photo B just before soldering the feedline, was tested at the same window position as the circular loop, and there was no measurable change in performance. This loop was made using No. 8 copper wire that came from a burned-out power transformer, making it an antenna from recycled materials.

As you can see, there are plenty of alternatives to your rubber-duckie antenna. All it takes is patience, careful construction, and little or no money! Have fun!

73, Arnie, CO2KK