BY ARNIE CORO, CO2KK

Connecting Your Station To The World

1… 2 … 3… 4… TEN + —Five low-cost Antennas for Y2 MAX Year!

Arnie Coro, CO2KK, is well-known to hams and shortwave listeners the world over. Besides being very active on the amateur bands, Arnie is the host of two programs on Radio Havana, including "DXers Unlimited," a weekly program about DXing and hobby radio. He was a regular contributor to CQ VHF, *and we're very pleased to have him join our roster of Contributing Editors at* CQ. *—W2VU*

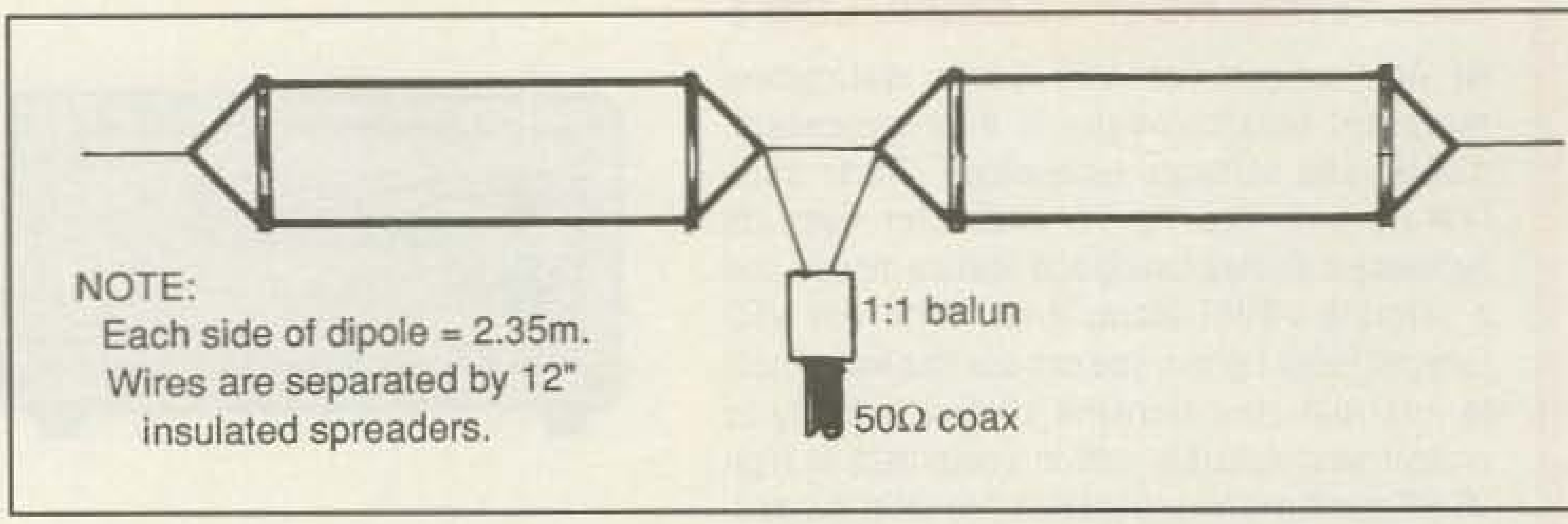


Fig. 1– The Fat Dipole for 10 meters has a bandwidth greater than 3 MHz, making it usable across the entire 10 meter band. With an antenna tuner, it will work on 12 meters as well.

Ten meters! One-point-seven megahertz of radio frequency spectrum assigned to amateur radio, giving you the opportunity to work DX using low power and simple antennas now that solar Cycle 23 is racing towards its peak, which is widely expected to be sometime during the year 2000.

Due to the very low ionospheric absorption prevalent at the upper end of the HF band near 30 MHz, a simple antenna with an appropriate low takeoff angle and a low- power rig are all you will need to see your number of countries worked on 10 go past the 100 mark in a few weeks during solar maximum years.

Antennas for 10 meters need not be expensive or difficult to homebrew, as these 4+ simple projects will demonstrate.

No. 1: "The Hacksaw Special"

Shopping around for a CB quarter-wave ground-plane vertical is not too difficult. There certainly are many different commercially built 1/4-wave antennas for the 27 MHz band which use aluminum pipe or tubing for the radiating element, and three or four dropping wires for the radials that form the ground plane. The fastest and perhaps one of the most inexpensive 10 meter band antennas that is capable of producing the low takeoff angle radiation required for working DX is precisely a converted 11 meter CB antenna.

Try to find the highest possible quality antenna to start with, and proceed to resonate the vertical radiator to the part of the 10 meter band you plan to operate most of the time. A good center frequency to cut the antenna to is 28.5 MHz, which should give reasonably low SWR from the low end of the band up to around 29 MHz. If you plan to operate on 10 FM, then the radiator should be resonated to around 29.2, which still will give acceptable SWR down to 28.5, allowing SSB DX to be worked, too. (You're cutting to 1/4 wavelength here, so use the formula 234/f [MHz] to find the dimension for your center frequency of choice).

Do not use steel whips for this project. They are too thin, and thus their bandwidth is much more limited. CB antennas with telescoping elements are the best, as they can be resonated by changing the overall length with just loosening a small clamp, adjusting the upper section, and retightening the clamp.

A more typical "conversion" will need a hacksaw and some elbow grease. Once you have decided on which part of the band to tune your antenna, proceed to measure the 1/4 wavelength plus about 5 percent, and do a first trial cut.

Install the antenna as high and in the clear as possible, placing the four radials at an angle of between 30 and 45 degrees. Use the highest possible quality 50 ohm coaxial cable (more on this later) and run an SWR test at the projected center frequency. A well-done sweep, starting at the low end of the band and going all the way to 29.7 MHz, will give you a very good idea of what the next step should be.

Work slowly, and by all means avoid the 1:1 SWR syndrome. You will not achieve a "perfect" match and you don't need to. Your converted CB 1/4-wave vertical should show an SWR of around 1.2:1 to 1.4:1 at resonance, and that's all you will really need when running rigs in the 100 watts or less class.

Next make the radials using No. 12 or No. 14 bare copper wire. They should be cut about 5 percent longer than the radiating element (see formulas in Table I).

As with all vertical antenna systems, it's always a good idea to provide some kind of static discharge path to ground. You

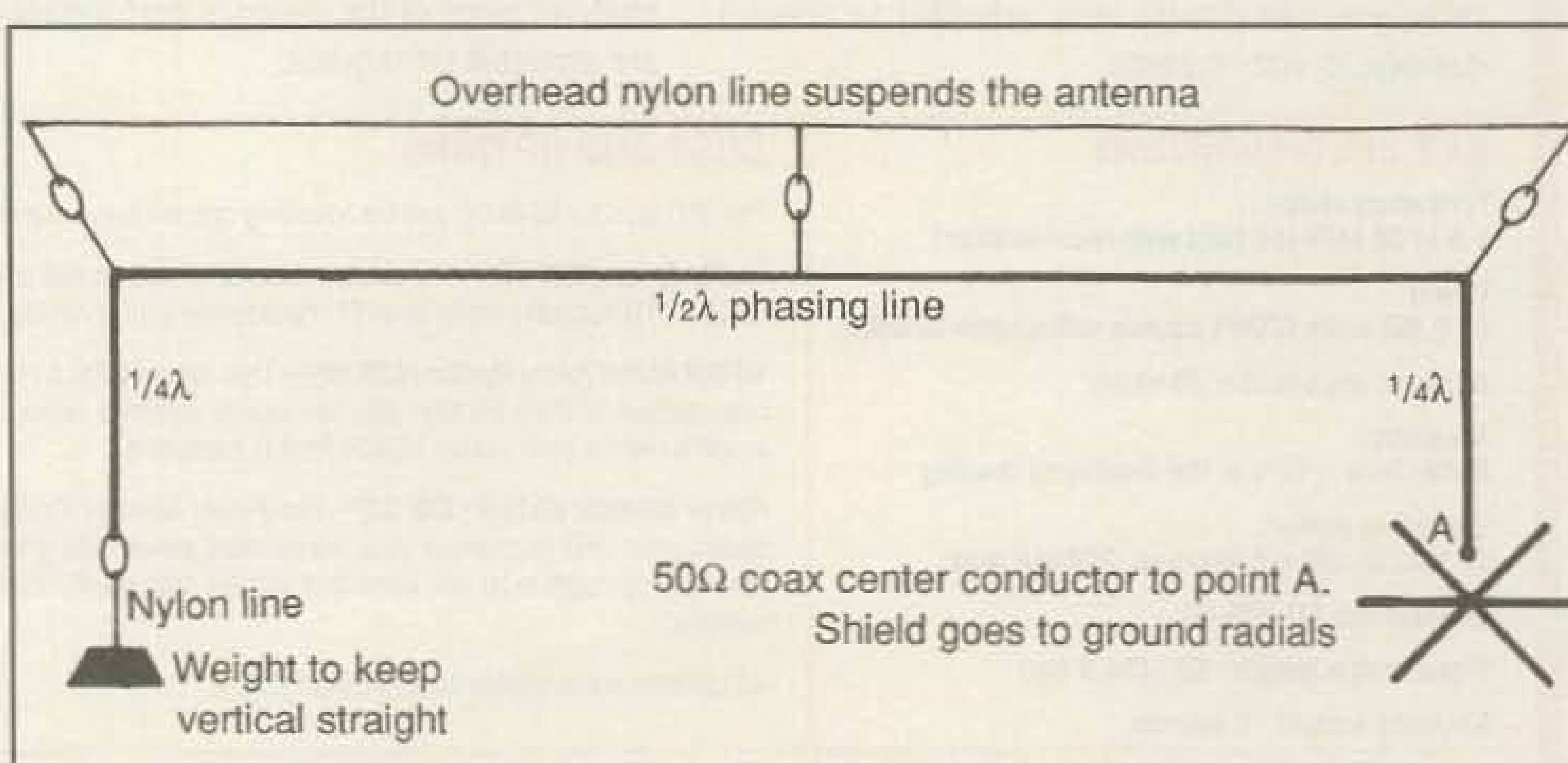


Fig. 2– The Half-Square Antenna Array. Note: This is the RIGHT way to feed a half square. Other methods you may have seen, including those using an LC tuning network, will not work well—and neither will the antenna. Feed it this way and you should get excellent results.

Antenna Data

Hacksaw Special

Use the standard formula to calculate the length of the 0.25 radiating element—that is, 234/f(MHz) = length in feet, or 71.5/f(MHz) = length in meters.

You will want to make the first "cut" a little longer, and carefully check the antenna's resonant frequency until the lowest SWR is obtained.

The typical converted CB $\frac{1}{4}$-wave vertical with drooping radials will show an SWR of 1.5:1 or lower at resonance.

Remember that the radials must be 5 percent longer than the radiating element.

Broadband Fat Dipole

Minimum antenna height above ground or roof = 3 meters (approx. 10 ft.)

Overall length of the antenna = 5 meters (approx. $16\frac{1}{2}$ ft.)

Spacing between upper and lower wires forming the dipole = 30 cm (1 ft.)

Wire used = No. 14 or No. 12 (may be PVC insulated or bare copper)

Use a 1:1 balun to feed this dipole.

The points where the wires join should be soldered with a heavy-duty soldering iron or a blowtorch.

Half-Square Array

Vertical elements of the antenna (2) use the formula 278/f (MHz) = length of the element in feet.

For the typical 28.5 MHz center frequency, the antenna's vertical elements are 2.97 meters (approx. $9\frac{3}{4}$ ft.)

Horizontal element of the antenna (1) use the formula 447/f (MHz) = length in feet.

For the typical 28.5 MHz center frequency the antenna's horizontal element will be 5.1 meters (approx. 15.6 ft.)

Feed impedance when antenna is about 3 meters (10 ft.) from the ground typically will provide a very good match to a 50 ohm transmission line when the Half Square Array is fed at one of the corners using the decoupling method explained in the main text.

This antenna can be installed as a "sloper" providing both horizontal and vertical polarized waves, but the lower end must be at least 3 meters (about 10 ft.) from the ground.

EMGP (Electromagnetic Ground Plane)

First the ground system or counterpoise: Use no less than 16 quarter-wave radials, and if possible use a wire mesh of about $\frac{1}{8}$-wavelength radius soldered to the bottom of the vertical part of the antenna.

Here are the dimensions for the 28 MHz EMGP:

Vertical part = $\frac{1}{12}$ of a wavelength = 85 cm (approx. $33\frac{1}{2}$ in.)

Horizontal part = $\frac{1}{6}$ of a wavelength = 1.7 meters (approx. 67 in.) (This will need fine adjustment to resonance.)

Gamma match element length = 47 cm (approx. $18\frac{1}{2}$ inches) (It will also need fine adjustment, so start with about 55 cm and move the matching point until lowest SWR is obtained.

Separation between the gamma match and the radiator = 5 cm (approx. 2 in.)

BFD (Broadband Fan Dipole Antenna)

Note that this antenna requires the use of a 4:1 balun and an antenna tuner.

The 5 elements on each side of the dipole are all of the same size—that is, 3 meters (approx. 10 ft.) long, and they are separated at their ends in such a way that the antenna is 1.5 meters (approx. 60 in.). This gives a radiating element that has a 2:1 ratio of length to width.

The two coaxial cables used for the pararell shielded transmission line are of 75 ohms impedance, and their shields are tied together at the antenna end, but left floating.

At the connection to the 4:1 balun, the two cables' shields are also connected together, and then connected with a low-impedance braid to the station's ground.

Table I– Data for the 10 meter antennas described in the text.

can do this by building a simple spark gap at the base of the antenna, or by using one of the popular "coaxial gas-tube surge protectors" properly installed with an adequate grounding system.

No. 2: The Fat Dipole

Another low-cost, highly effective, broadbanded antenna for 10 meters is the so-called *Fat Dipole*, which I will recommend to those of you who enjoy both working CW at the low end and chatting via NBFM repeaters at the high end of 10. Instead of having to install *two* antennas, building a Fat Dipole (fig. 1) will let your rig work at a comfortably low SWR at both ends of the band.

Use No. 12 or No. 14 copper wire, 2.5 m (8 ft., $1\frac{1}{2}$ in.) on each side. Electricians' PVC insulated wire used for home installations is a good low-cost choice, and in this case the slightly different velocity factor shown by insulated wire as compared with bare copper will not make a difference in the antenna's resonant frequency of performance. Follow closely the dimensions shown in the graph, but again, this is not a critical antenna at all. The wires should be spaced 30 cm (12 in.) apart using spreaders made from fiberglass rod or PVC pipe.

Feed your Fat Dipole with 50 ohm low-loss cable, and as always, make sure that connections between the downlead and the antenna are not only properly soldered, but also are properly *sealed against humidity*. There is nothing more annoying than seeing how an otherwise perfectly working antenna starts to show a progressive increase in SWR due to poor protection against the weather. As many of you know too well, once a length of coaxial cable spoils due to water seeping between the braid and the center conductor's insulation, there is no choice but to send it to the local recycling facility.

The Fat Dipole will show a very reasonably low SWR from 28.0 MHz up to 29.7 MHz, and a good way to install it is by making it slope at an angle between 20 and 45 degrees. A sloping Fat Dipole will provide an excellent "mix"of vertical and horizontal polarization, so it will work well both with local CW and SSB stations that use horizontal antennas and NBFM stations using verticals. For DX signals there is not much difference at all, as Faraday rotation will make the polarization of the waves reaching your receiver change quite a bit during a QSO. The antenna will work best if its lowest point is at least 3 m (10 ft.) above the roof or ground. There are many possible geometries for the Fat Dipole, but the one shown here has proven to work very well and is the easiest to build of them all!

No. 3: The Half-Square Array

Now we are talking not about a single-element 0 dBd or even less gain antenna. The *half-square array* is a low-cost approach that can be built using wire elements and Dacron or other insulating material ropes (fig. 2). It's a nice antenna for portable work, too, as it goes up in just a few minutes. Among the advantages of the half-square array is that it is a *self-completing* antenna system, which means in technojargon that it does not need a ground plane to operate properly.

A half-square array for 10 meters uses about the same space as a conventional half-wave horizontal dipole, but it provides two distinct advantages: (1) it has no less than 3 and up to 4 dB gain over the dipole; and (2) it radiates a vertically-polarized, low take-off angle wave. Number 2 here is very important if you are really going to get involved in working DX on 10 during Y2 MAX.

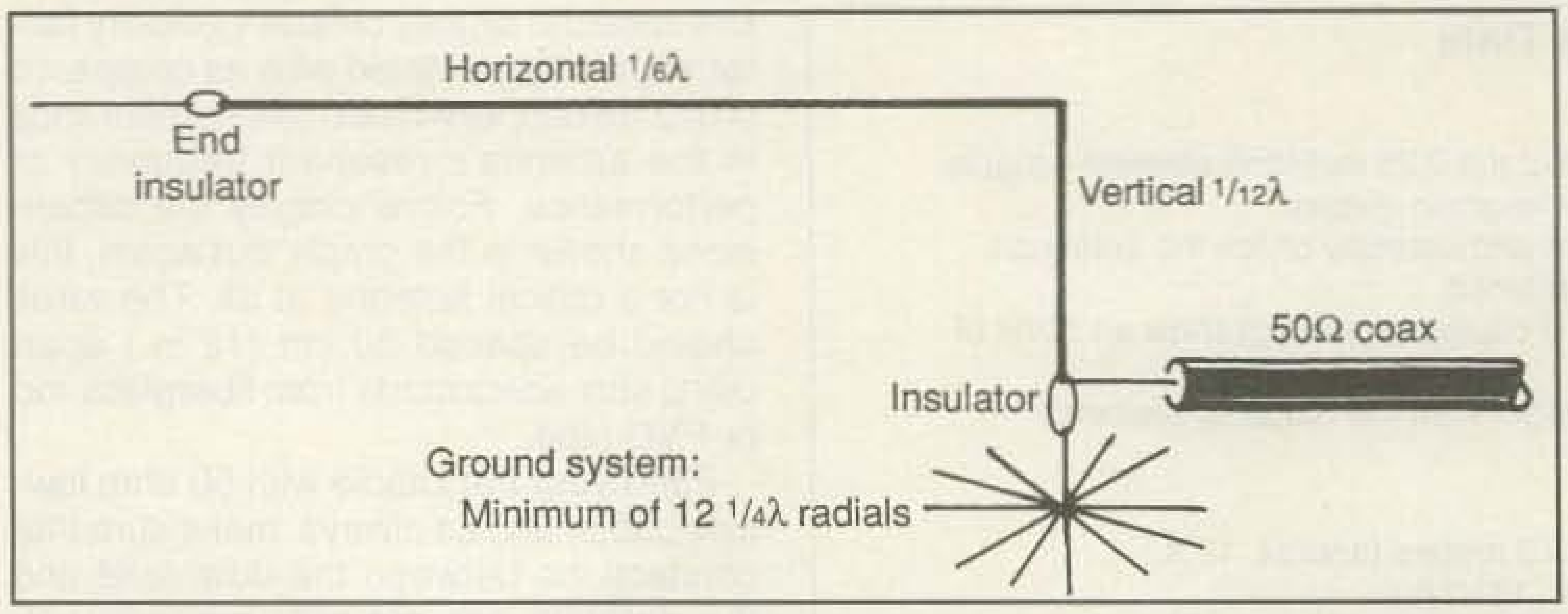


Fig. 3– The low-profile Electromagnetic Ground Plane (EMGP) antenna. Note that the ground plane is essential and the length of the horizontal portion will need to carefully be tuned to resonance.

Why Ten?

Propagation gurus are forecasting the solar maximum to occur around the middle of this year (2000). The peak solar flux will make Cycle 23 somewhat similar to previous Cycle 22 or a little less. Solar flux figures above 150 units are needed to keep 10 meters going, and they are expected to be available for extended periods from the last quarter of 1999 all the way up to year 2002 or a bit further.

That's why building a low-cost 10 meter antenna for your station can be such a highly rewarding project, and the more we radio amateurs make good use of 10 meters the less chance there will be of intruders and illegal stations setting foot in our widest HF band of them all.

Here's an important note: Many people feed half-square arrays the *wrong* way, and that has led to many complaints of poor performance not only for this antenna, but also for its close relative, the *Bobtail Curtain.* Therefore, pay close attention to the instructions in fig. 2 for feeding your half square, and use an appropriate system for decoupling the 50 ohm coaxial line from the antenna elements.

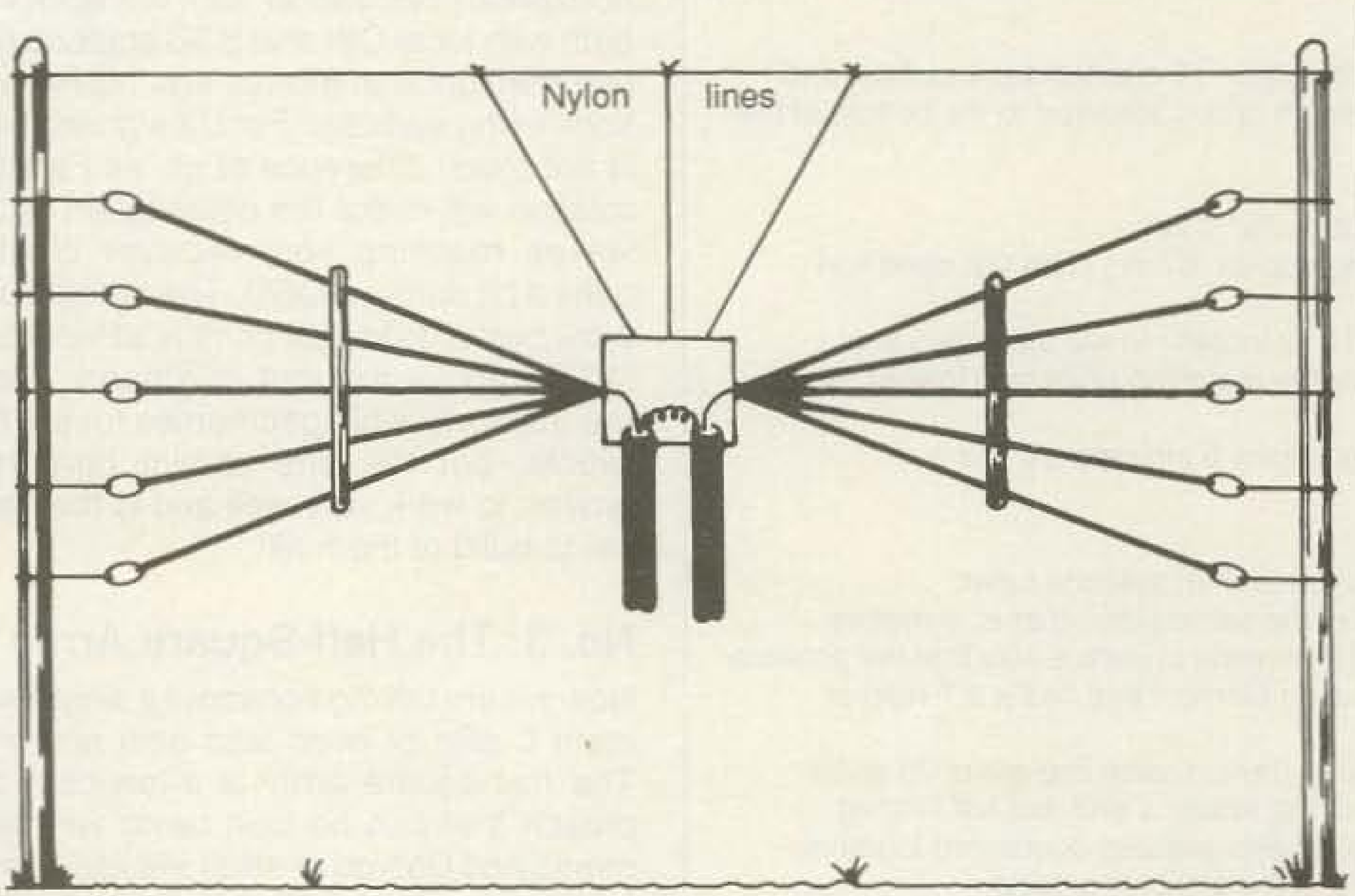
There are two approaches to decoupling: One is by using an adequate length of ferrite rings which are placed one next to the other for no less than 30 cm, or about 12 in. This is perhaps nice, but it is also expensive. The poor man's approach is to wind some 6 to 8 turns of the coaxial cable right next to the feedpoint, using a 100 mm or 4 in. PVC pipe as a coil form.

Antenna elements are made from No. 12 bare copper wire, and here I do recommend bare and not insulated wire, as dimensions for 1/4-wave resonance do change when using insulated wire due to the difference in the velocity factor.

As you can see, the half-square array (in this low-cost version) hangs from insulated ropes, but there is no objection to using self-supporting vertical elements made of aluminum tubing and insulated-form ground using conventional ceramic or polymer insulators.

Install your half square as high as possible, and if you have enough space, two of these antennas and a switching device will give you 360-degree coverage. If only one half-square can go up, then try to place it so that the maximum radiation, which is broadside to the vertical elements, favors those areas you need to work most.

You can make *fat vertical elements* (see the Fat Dipole) if you need an antenna with wider bandwidth, but DXers usually cut their arrays for the lower part of the band, centered around 28.3 or 28.4 to work both CW and SSB DX. If you ever need to work FM at the high end, a simple antenna tuner will bring the SWR down to keep those finals cool.



NOTES:

1. The shields af the two coax lines are joined at the feedpoint and left floating, not connected to the antenna element.
2. The rectangle is made of aluminum angle and serves as support for the two coax cables and the antenna elements.
3. Coax inner conductor is connected to the 5 wires forming the fan dipole.

Fig. 4– The Broadband Fan Dipole (BFD) Antenna System. This unique antenna system uses two coax feedlines, with the shields joined together at both ends. In the shack they're tied to ground, and at the antenna they're connected to each other but to nothing else. The center conductor of each cable attaches to one set of five 3 meter long wires that make up the fan dipole. The antenna works on 15, 12, 10, and 6 meters.

No. 4: The Low-Profile EMGP

"No space for an antenna here!" "Can operate HF in the car, but at home it's only handie-talkie territory. . . ." Ever heard those comments? If they sound familiar, here is the answer to make them null and void: It's the *EMGP*, or *electromagnetic ground-plane,* low-profile antenna (fig. 3). This one does need a full set of radials, or better yet, a ground mesh of no less than 1/8 of a wavelength around the feedpoint. But as you all well know, ground radials or even copper-wire mesh can easily be buried or just placed over a rooftop.

The EMGP's total vertical length is less than one meter, actually just 84 cm (33 1/2 in.) at 28 MHz. The amazing fact about this low-profile vertical is that when properly installed and tuned it makes 10 meter operation possible at locations where no other antenna will go unnoticed.

For the EMGP I recommend using 4 mm copper wire, or even 6 mm refrigeration-type copper tubing. Keep in mind that this antenna has a low feedpoint impedance that can be somewhere between 8 and 12 ohms, so all connections should be really well soldered, and the ground-plane system is essential. A wire mesh of no less than two meters diameter centered at the base of the antenna is ideal, but some 20 or 30 quarter-wave radials will work well, too. I tested a combination of a 1/8-wavelength diameter wire mesh *plus* twelve 1/4-wave radials and the antenna matched very well, providing some nice contacts during last spring's first 10 meter openings.

This is a "hands-on" antenna. It requires careful tuning using appropriate instruments—essentially a high-quality SWR meter and my favorite cable attachment when working with single-band antennas, which is a length of high-quality 50 ohm coaxial cable cut to exactly one full electrical wavelength, taking into account the velocity factor of the cable. I attach the SWR meter to the transceiver's output with a very short length of cable, and then connect the antenna via the one wavelength cable, thus avoiding some of the typical problems that occur when measuring SWR close to the antenna's feedpoint and using a random length of cable.

Adjust the EMGP's gamma feed to minimum SWR at your preferred operating frequency, and run an SWR-versus-frequency sweep. You soon will realize that this is *not* a broadband antenna system! However, I'm sure you will agree with me that for an antenna less than 90 cm high (that's a bit less than 3 ft.) and providing low takeoff angle vertically polarized radiation, there is not much more to ask for!

Finally, the Plus (+)

Four easy-to-build, low-cost antennas for 10 meters gave this article its name. However, I couldn't resist adding the *BFD* antenna. The *Broadband Fan Dipole* (fig. 4) is not only an easy-to-build, nice-looking skywire, it also will let you operate on 15, 12, of course on 10, and even on 6 meters!

The BFD does require the use of an antenna tuner and a 4:1 balun, but it provides a nice broadband system covering 20 to 60 MHz, or a 3:1 frequency range.

It is easy to build following the illustration. All ten elements are the same length —3 m (9 ft., 9 in.) each, made from No. 14 wire. For this antenna it's okay to use PVC-insulated household electrical wire, which is inexpensive and plentiful. The two coaxial lines' shields of braids are connected together at the top (antenna end) and left floating. At the tuner's end they are also connected together, but they are then connected to the station's ground. I use an air-core 4:1 balun and a simple PI network antenna tuner that someday may be the basis for an article for *CQ*, too. Please note: To be most effective, the lowest element of this antenna should be at least 3 m (10 ft.) above the ground or roof.

73, Arnie, CO2KK

First Time? Ask For Help!

If this is your first antenna project, try to get advice from other local amateurs. You will want to install the coaxial cable connectors properly, something that requires a heavy-duty soldering iron, patience, and some practical experience. Connections between the feedline and the antenna must be both mechanically and electrically well done, and you will need to learn how to properly seal the coaxial cables from the weather. Special silicone compounds and elastic tapes used by cable TV technicians are ideal for weatherizing your antenna systems. Do remember that once water makes its way into the coaxial cable, there is no choice but to send it to recycling!

A side benefit to asking other hams for help: You just might make some new friends!