K3MT
presents . . .

Mike Villard's
Magic Anti-Jamming
antenna
for shortwave reception

September, 2000

Here's a neat little antenna for receiving on shortwave - that is, HF - frequencies. It's the brainchild of Mike (aka Dr. O. G.) Villard, Professor Emeritus of Stanford, founding father of SRI Inc, and one of the most wonderful colleagues with which it has been my sheer pleasure to be associated.

Mike had been asked by the Chief of U.S. Information Agency, the parent of Voice of America, if there might be some way to counter Soviet jamming of VOA broadcasts. His mind set to work: he made a *pile* **of different antennas that seemed to show some promise, and presented a proposal to USIA to produce two different anti-jam antennas that would be effective. I was at VOA engineering. His proposal became a contract: by the best of luck, engineering thrust** *me* **into the role of "ARCO" - authorized rep of the contracting officer (all other government agencies call this "COTR," but USIA is, well,** *different!***)**

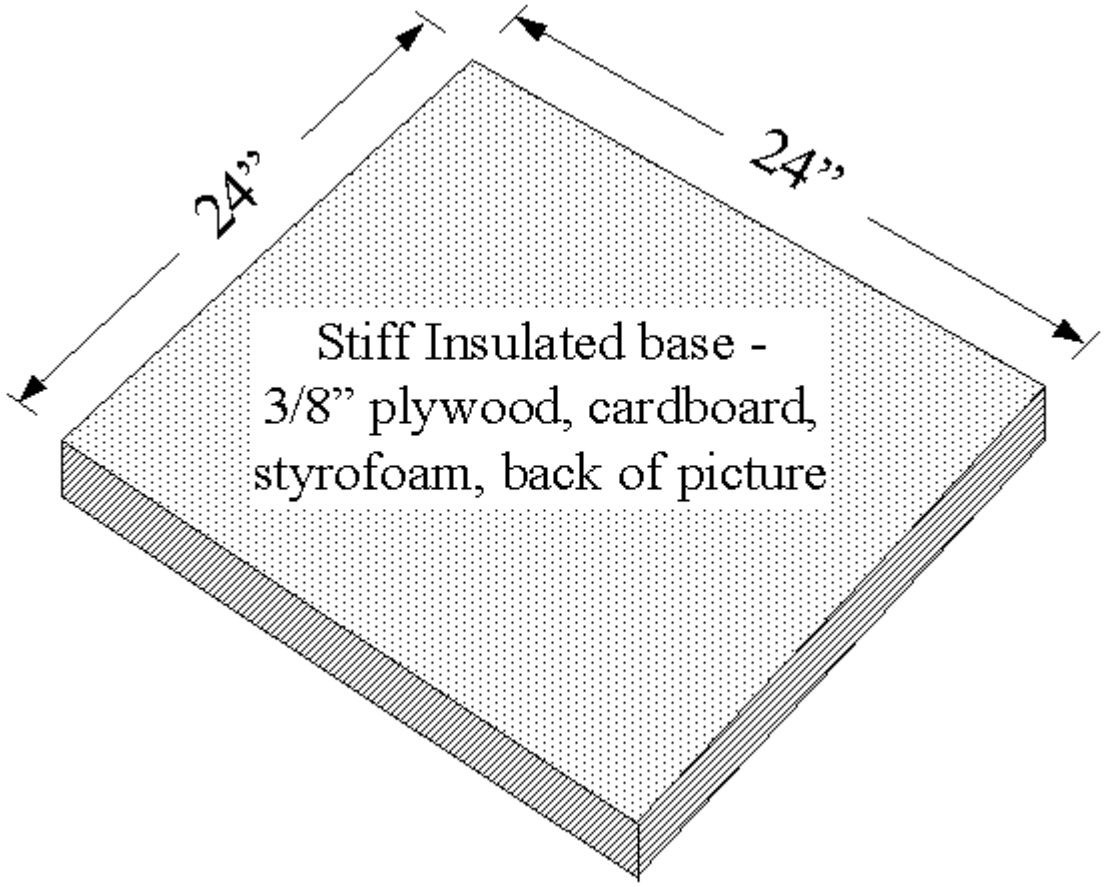
Mike showed me myriad designs that filled his pool house to the max! We selected two promising ones, and spent the rest of the year studying them, improving them, and producing a *really neat* **end product. One counters jamming via sky wave, where the jammer propagates by ordinary HF propagation. The other counters** *ground wave* **jammers - noise transmitters located near the receiver, usually on the outskirts of the city being jammed.**

Ground wave jamming is exactly similar to arcing power lines or other locally produced noise from appliances and the like - even from lightning.

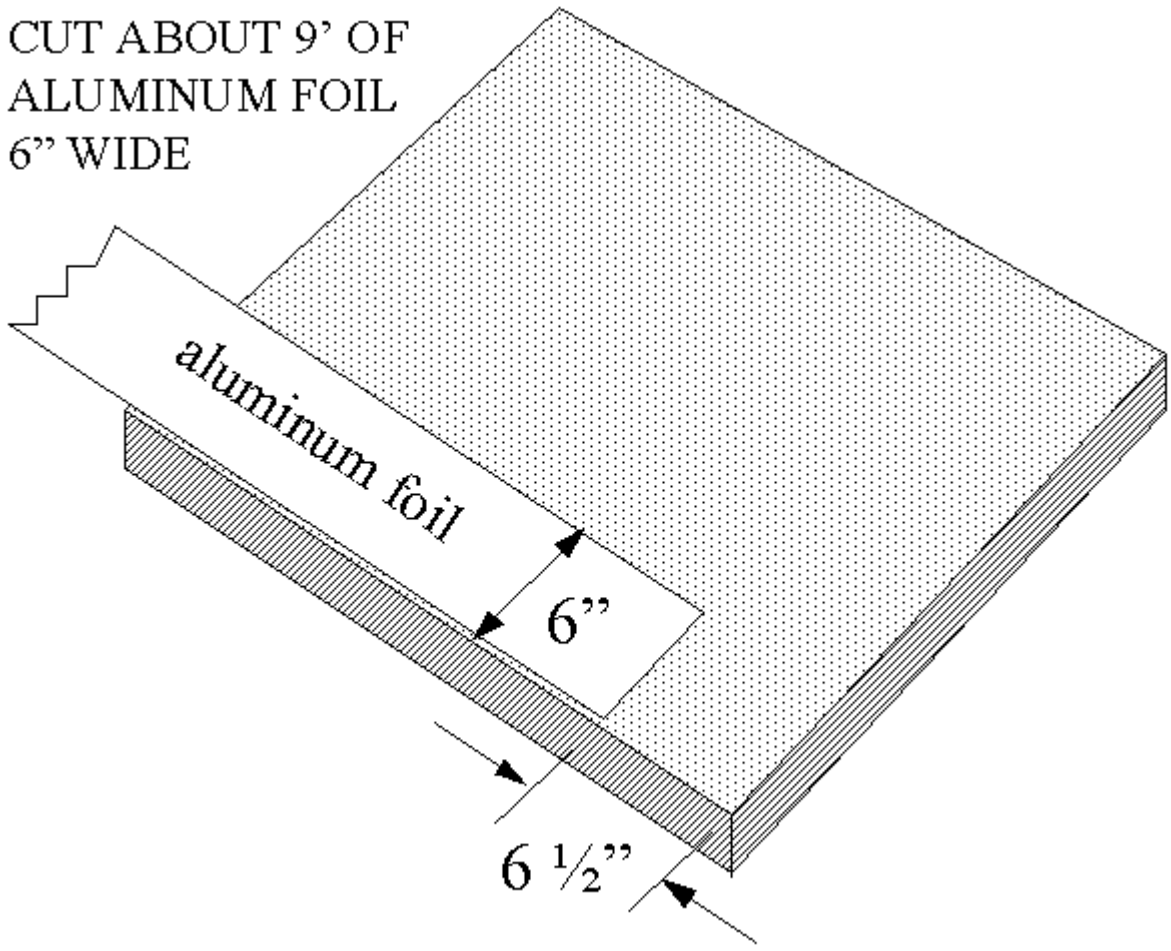
So, without further delay, I present, in picture form, . . .

The HLA
Villard's Noise Rejecting
Horizontal Loop Antenna

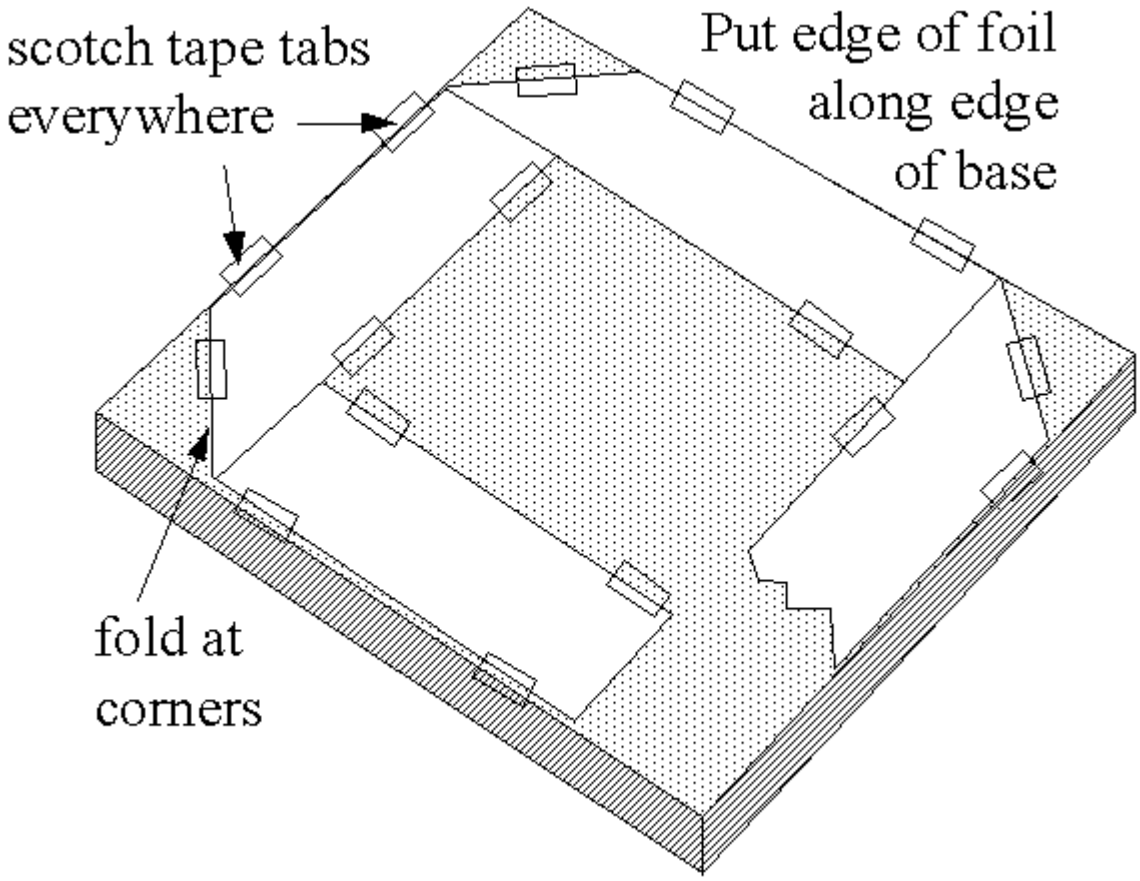
Get a 2' x 2' base - plywood, cardboard, stiff foam plastic, even the back of a wall-hung picture.



Cut a 6" wide piece of aluminum foil. Lay it on the base, with its edge along the edge of the base. Note the 6 1/2" gap where the foil begins.

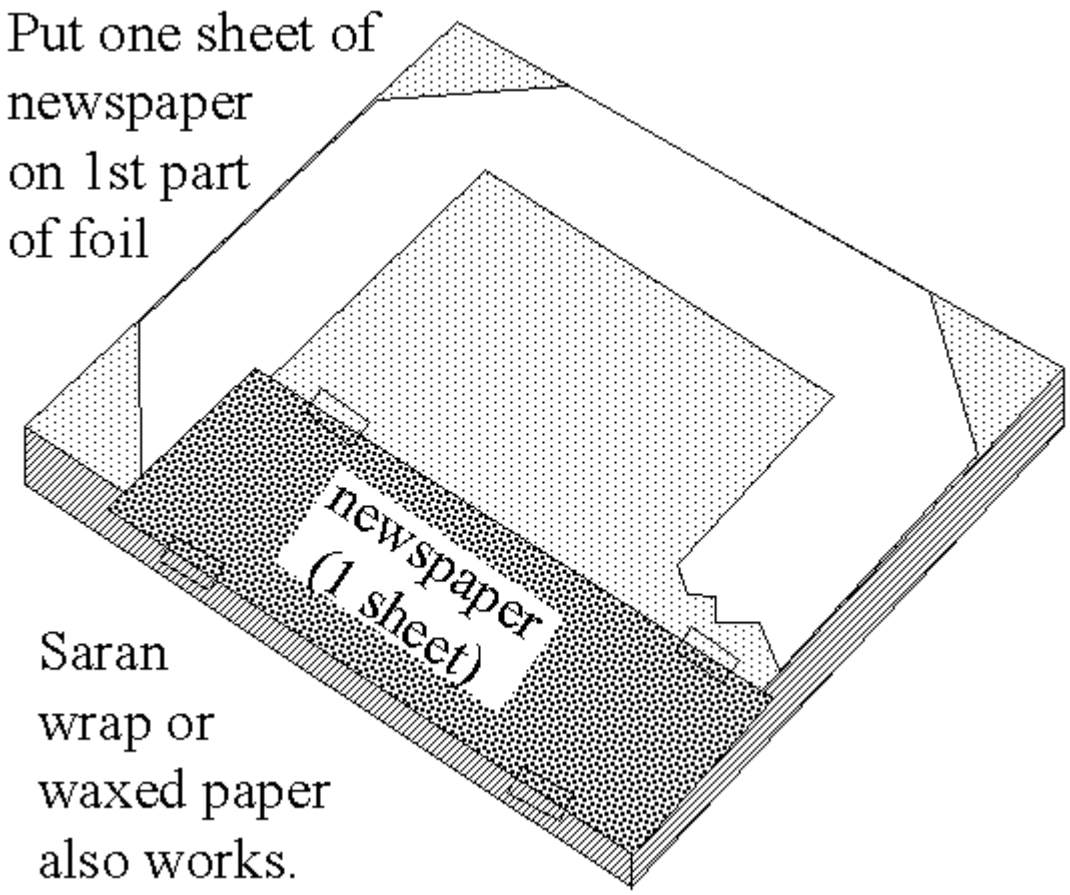


Fold the foil over itself as shown. Use tabs of scotch tape to hold the foil in place. Continue taping it down on three, and part of the fourth, side:

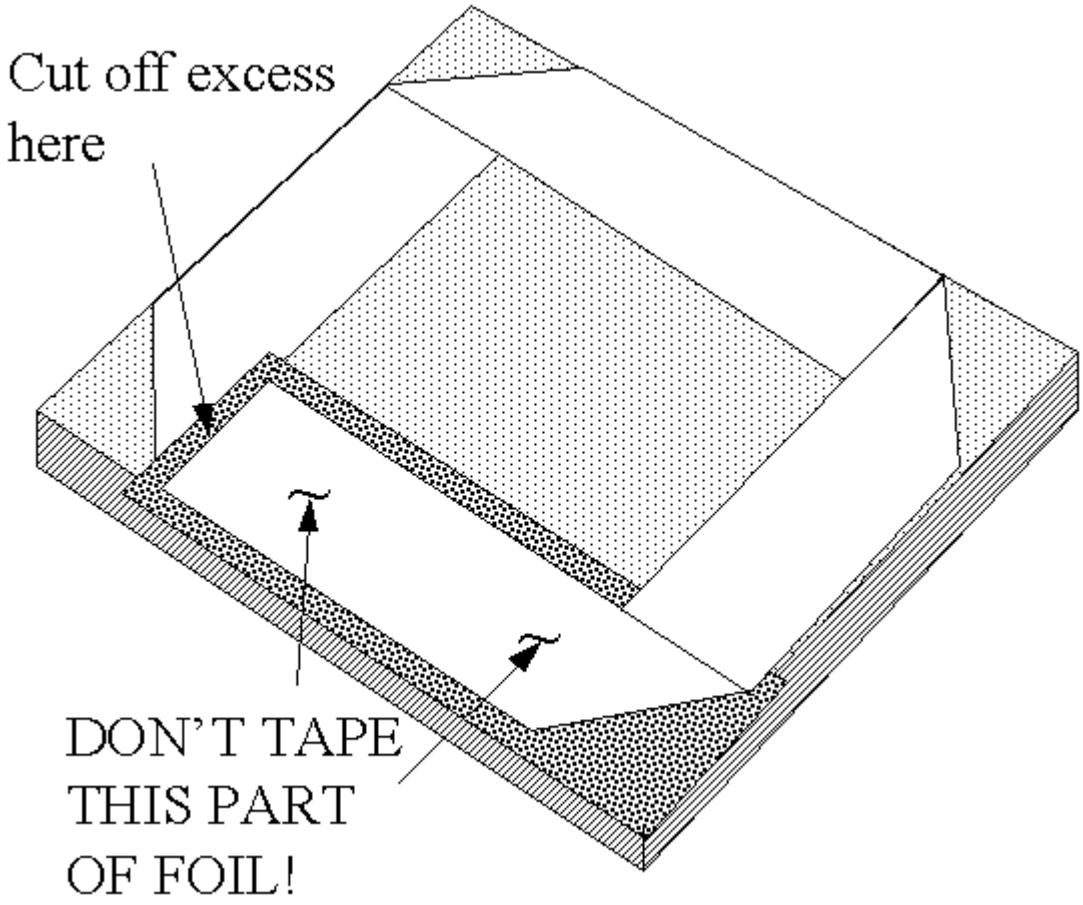


Cut a piece of newspaper 7" wide and 12" long. You can use saran wrap, waxed paper, or lots of other thin, insulated material for this - even a handkerchief! But thick insulation could prevent tuning the antenna to low HF frequencies.

Put the insulating sheet over the first part of the foil and tape it in place, per the drawing.



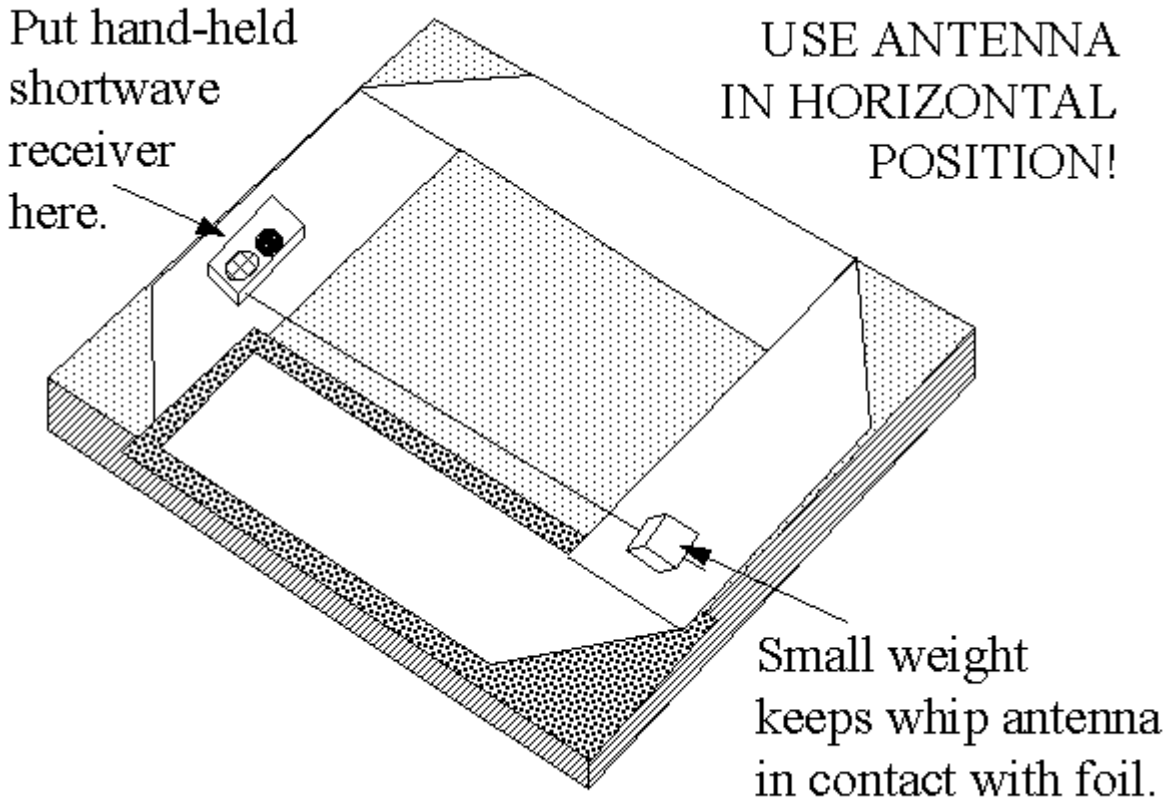
Leave the fifth flap of foil loose, so it can be lifted up when necessary. Cut off excess foil so it does not short circuit against the foil beneath the newspaper.



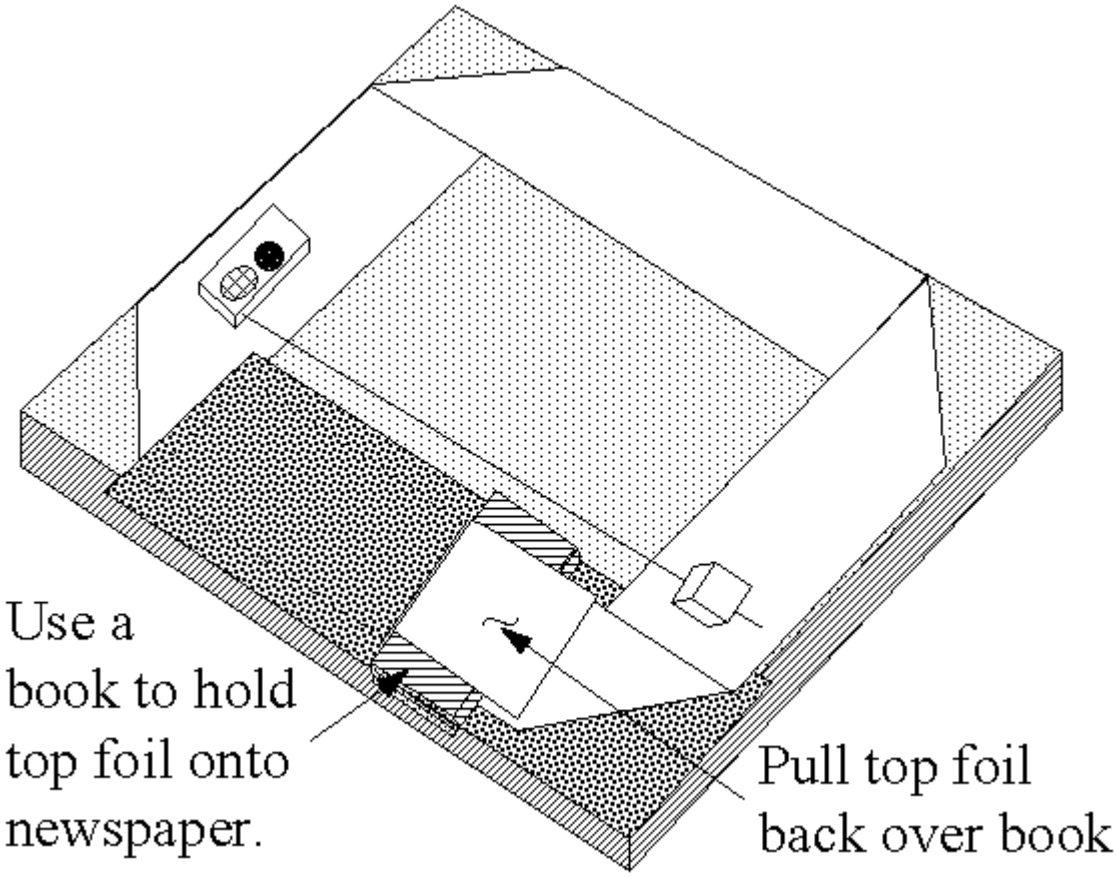
When using a battery-operated, pocket size shortwave receiver, set the antenna on a table, couch, bed, or on the floor. Keep it hoizontal.

Put the receiver on the foil as shown. Don't worry about electrical connection: the capacity between the receiver and the foil will do the trick nicely.

Pull the whip antenna out, and lay it on the other side of the foil loop. Use a small weight to make sure the whip contacts the foil.

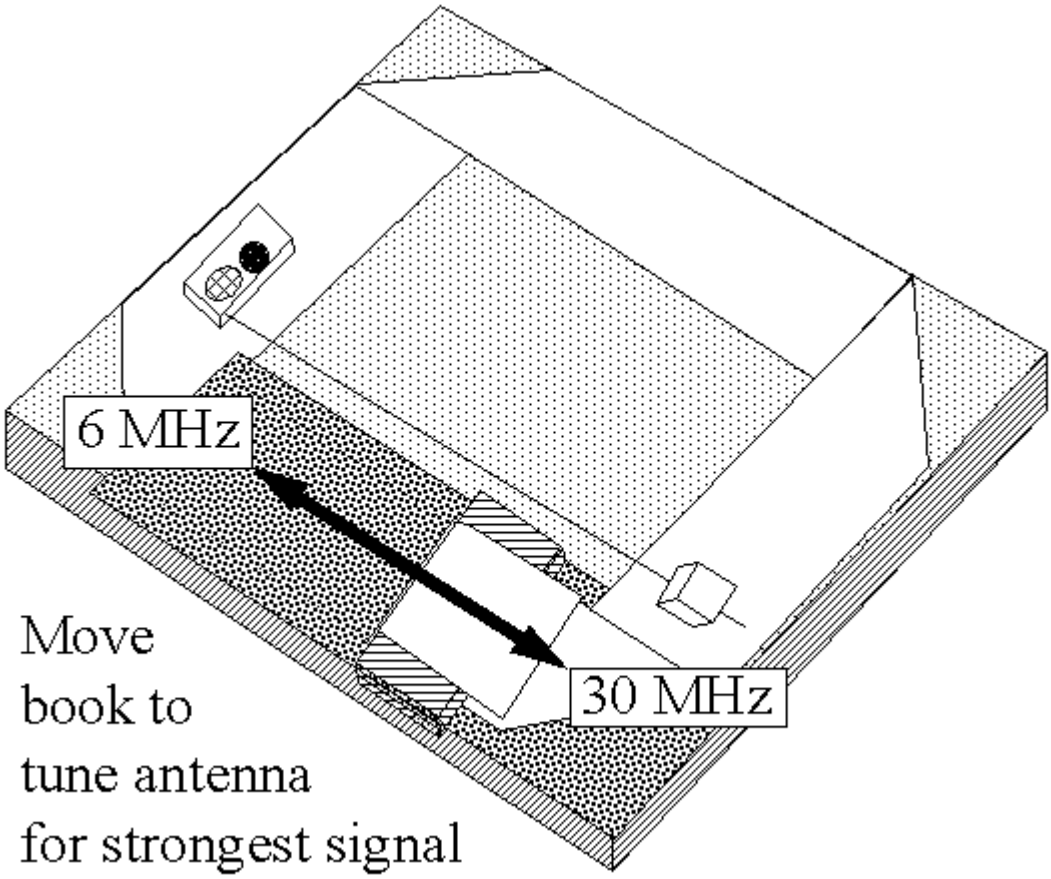


Use a book to press the loose foil flap down against the newspaper. Pull excess foil up and back over the book. The book will be the antenna tuner.



Tune the antenna to the right frequency by sliding the book back and forth while keeping excess foil up and over the book.

To tune the antenna, set the receiver about the middle of the desired band, with the volume control fairly high. Tune for strongest signal, or strong increase in noise from the receiver.

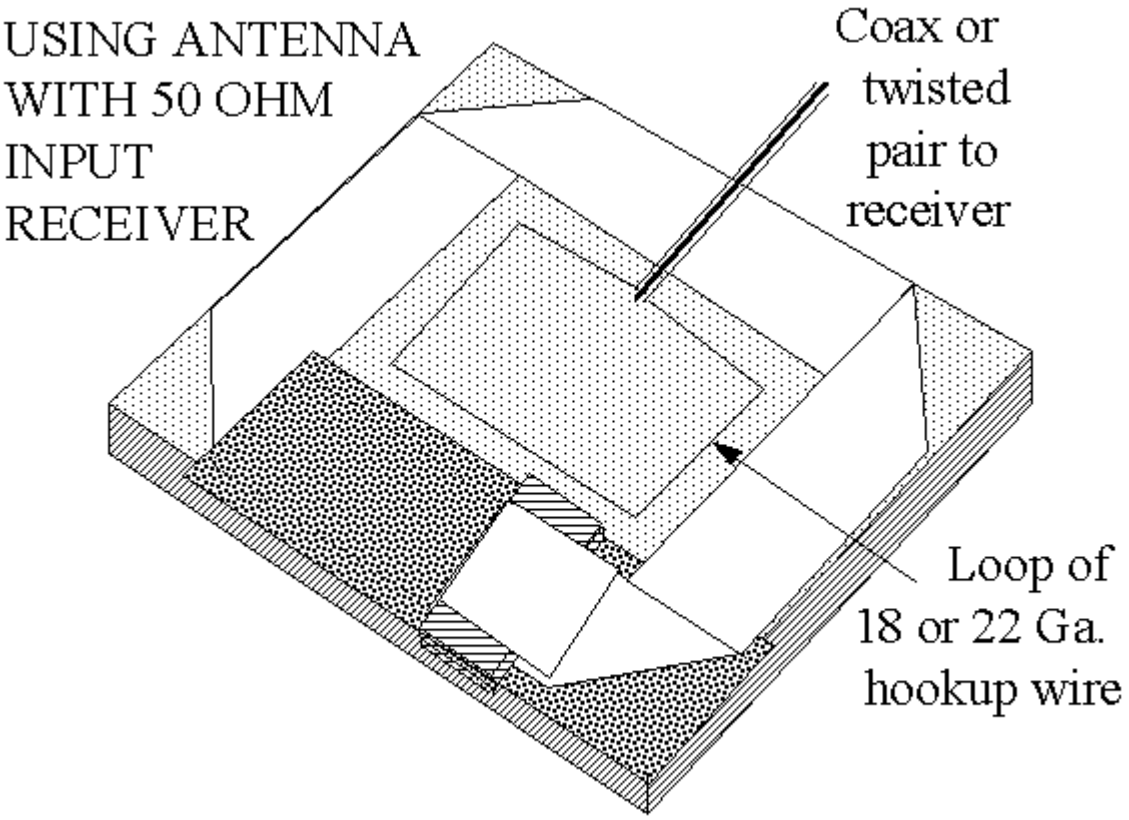


If you use a table model receiver (or an amateur transceiver,) make a single turn loop of about #18 insulated hookup wire by taping the wire in place one inch inside the foil loop. Bring the wire away from the antenna on the middle of the side opposite the tuner. Don't connect this loop to the foil - it isn't necessary.

The pickup loop can be brought to the receiver by twisted pair or by RG-58 or similar coaxial cable.

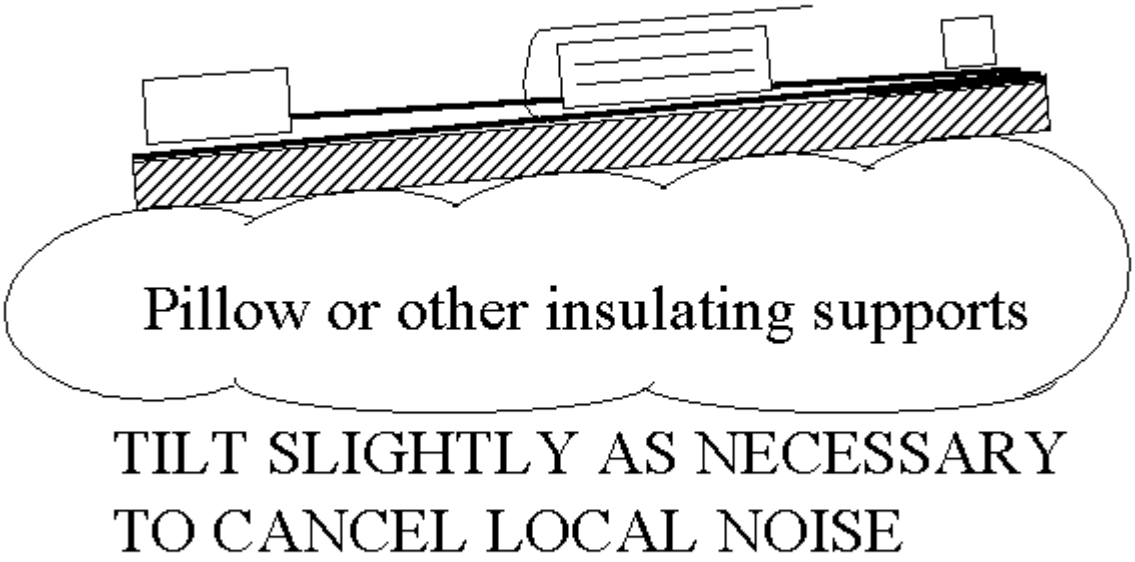
CAUTION

THIS ANTENNA IS NOT DESIGNED FOR TRANSMITTING!!



Now here's the *really neat* **part of Mike's design - how to cancel noise. Put the antenna on some insulating support so it can be tipped up on one side or corner. One of the early investigators working with us (Cheryl Hagn) pointed out that a pillow serves very well for this support!**

While listening to the interfering noise, tip the antenna a bit to reduce the noise. Many times, with just a minute or so of adjusting, the noise from power lines, nearby TV sets, etc. can be reduced 20 dB, and further noise canceling can be obtained with a bit more care.

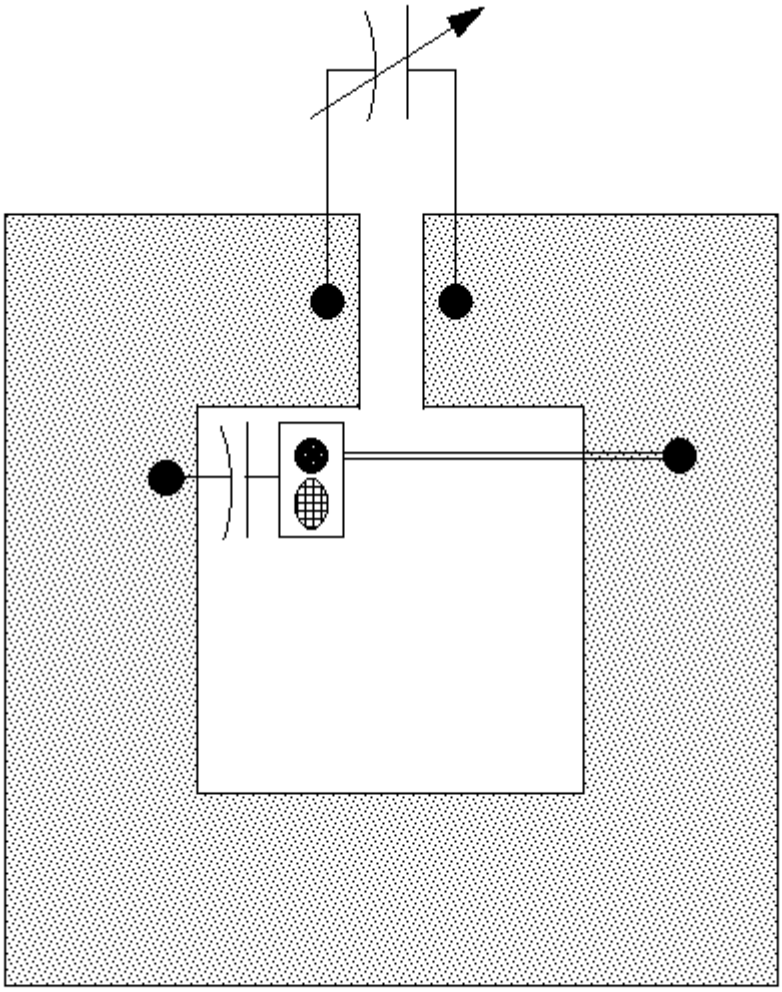


Great! You now own the "HLA" antenna for noise canceling. I finish with a simple schematic diagram showing what you built.

The newspaper and two foil flaps make a capacitor. The book allows you to vary the amount of overlap of foil, so you made a variable capacitor which is attached to the ends of a single turn loop, made of a very wide, flat conductor.

The receiver, sitting on the foil, has a good deal of capacity between its internal circuit board (or chassis) to one end of the loop. Its whip antenna is connected to the other end, so the voltage developed across the loop is injected into the receiver.

Tuning the loop causes the voltage at one frequency to be maximized. This causes the increase in signal strength.



THE TUNED WIDE STRIP LOOP

HOW DOES THE ANTENNA REJECT NOISE?

Noise from local sources - arcing power lines, fluorescent tubes, TV sets, etc - travels to your receiver along the ground. Its *horizontally* polarized components are attenuated very rapidly, so only its *vertically* polarized part gets through.

Mike's HLA is horizontally polarized. Therefore it doesn't respond to the noise. But skywave signals arrive at your receiver *randomly* polarized, so their horizontal part enters the antenna. As their polarization varies, though, the signal will "fade." But this happens with *any* shortwave receiving antenna. So Mike's HLA suffers from fading no more than any other. It's forte is noise cancellation.

SOME ADDITIONAL THOUGHTS

There's really nothing magic about the dimensions shown. HLA antennas can be made both larger and smaller, with foil that is wider or narrower. The tuning range will vary if the size is changed. What I've shown has been built in my lab and works from 6 to 30 MHz.

If you decide to make a bigger HLA, just keep in mind that the total circumference of the outside edge of conductor should be kept to well under one-third wavelength. Otherwise, the result will no longer be a small, horizontal loop above ground, but will have other (maybe even interesting) properties.

We've made HLA's from material other than aluminum foil. Sheet aluminum, sheet steel, window screen wire (but not fiberglass, which was the reason for my first failure to get one to work!) or lots of other conducting material will work fine. When using strips of metal, Cheryl discovered you don't need to electrically bond the pieces together. She just put weights at the corners, and the capacity through the oxide layers was essentially a very good connection at RF frequencies.

The HLA was designed to cancel vertically polarized noise. To do so, it was engineered to be kept within about a tenth of a wavelength above ground - not elevated much at all. You can, of course, put them up much higher, but I offer no data on performance when the loop is elevated - other people can attest to the qualities of elevated, horizontal loop antennas.

I hope you find this antenna interesting and useful. Some time ago, I had built one and was using it for reception on 15 meters, while using a grasswire for transmitting. In contact with a ham in Europe, I noticed the lights blinking on and off slightly. When I quit with the QSO, I went upstairs to ask my XYL what the heck she was doing - only to find myself in the middle of a raging thunderstorm! The grasswire, being rather impervious to lightning, and the HLA cancelling QRN from the lightning, kept me from realizing that a storm was even in progress!

For more unusual antennas, visit my web page.

And check out my Books

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K3MT

K3MT
presents . . .

The *GRASSWIRE*
another approach to hidden HF antennas

April, 1997

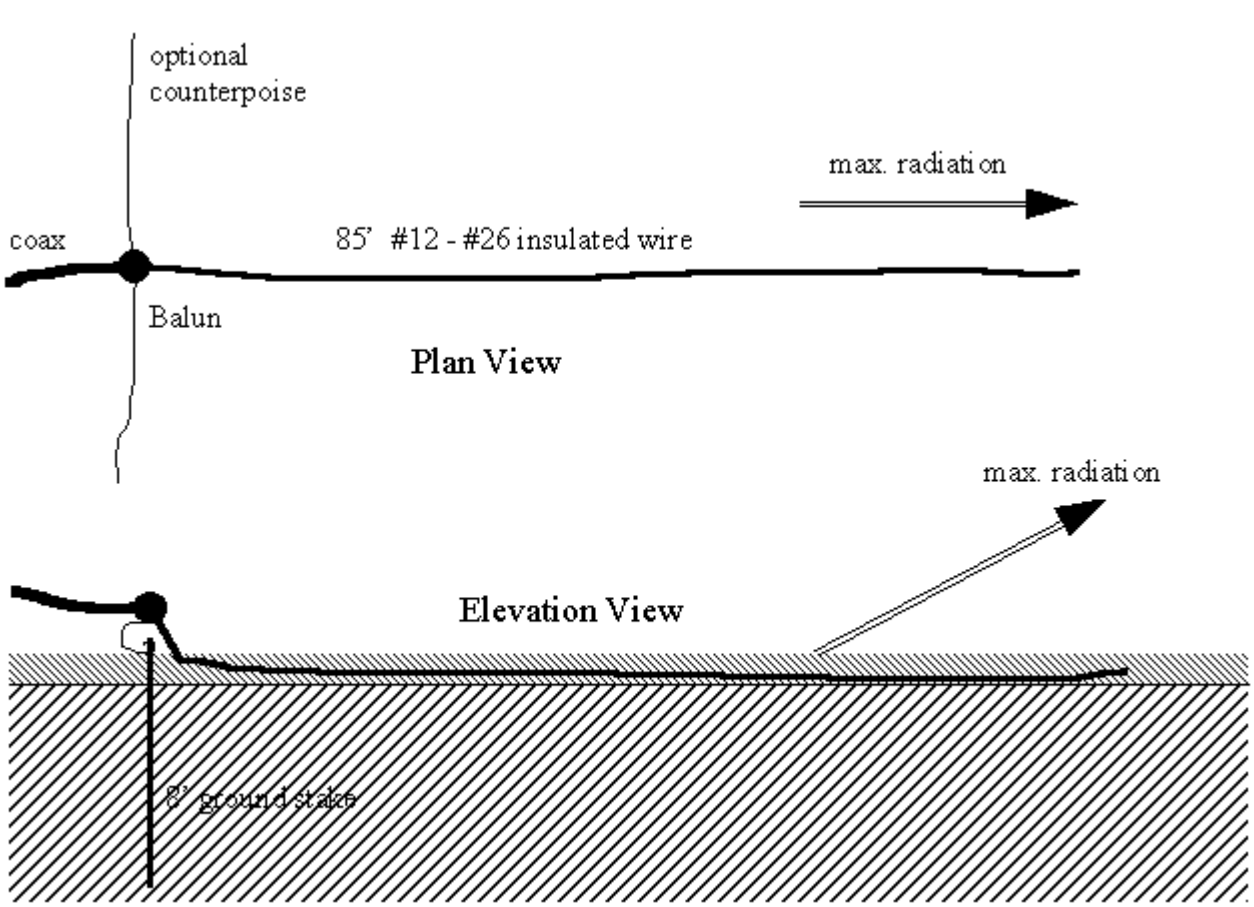
Deed restrictions got you down? Neighbors intimidating your tower plans? Need a really *easy* portable HF antenna? Then the *grasswire* may be the answer! Virtually invisible, lightweight, and compact (you can carry one in your hip pocket), this antenna works! It has been used by K3MT in various installations for more than 10 years.

Read on - and listen to the "experts" telling you that this is hogwash, that an antenna like this can't work. But it does. And *true* experts, who have taken a decade or more to come to grips with the intricasies of Maxwell's Math, know *why* it works.

This antenna will *not* out-perform a yagi, or a decent dipole up a half wavelength. Not in gain or signal strength, at least. But it will survive an ice storm, wind storm, and is practically immune to lightning. And it doesn't need a large tower or tall support. I deploy one from my hip pocket at times - the balun to match it is larger than the antenna!

THE GRASSWIRE - IN BRIEF

What is it? Put simply, it is an end-fed, longwire antenna that is laid right on the grass. Hence the name. The original grasswire used by K3MT in the summer of 1988 was just 204' of #18 AWG magnet wire laid along the property line, anywhere from 1" to 6" above the ground. This sketch shows plan and elevation views of a typical installation. Both an 8' ground rod and optional counterpoise wires are shown. Use one or the other. Both are not needed.



These antennas are largely resistive, with values ranging from 150 to 500 ohms or so on average ground. They have been used successfully on the average soils northwest of Washington, DC, on the sandy soils of the Cape Canaveral, Florida area, in the rocky, shale soils of the mountains in Somerset county, PA, and on river bottomland of Allegheny County, PA. One was used with great success by K3MT/VP9 in Southampton, Bermuda - the object of nightly pileups on 30 m CW for four nights.

REFLECTION AND THE BREWSTER ANGLE

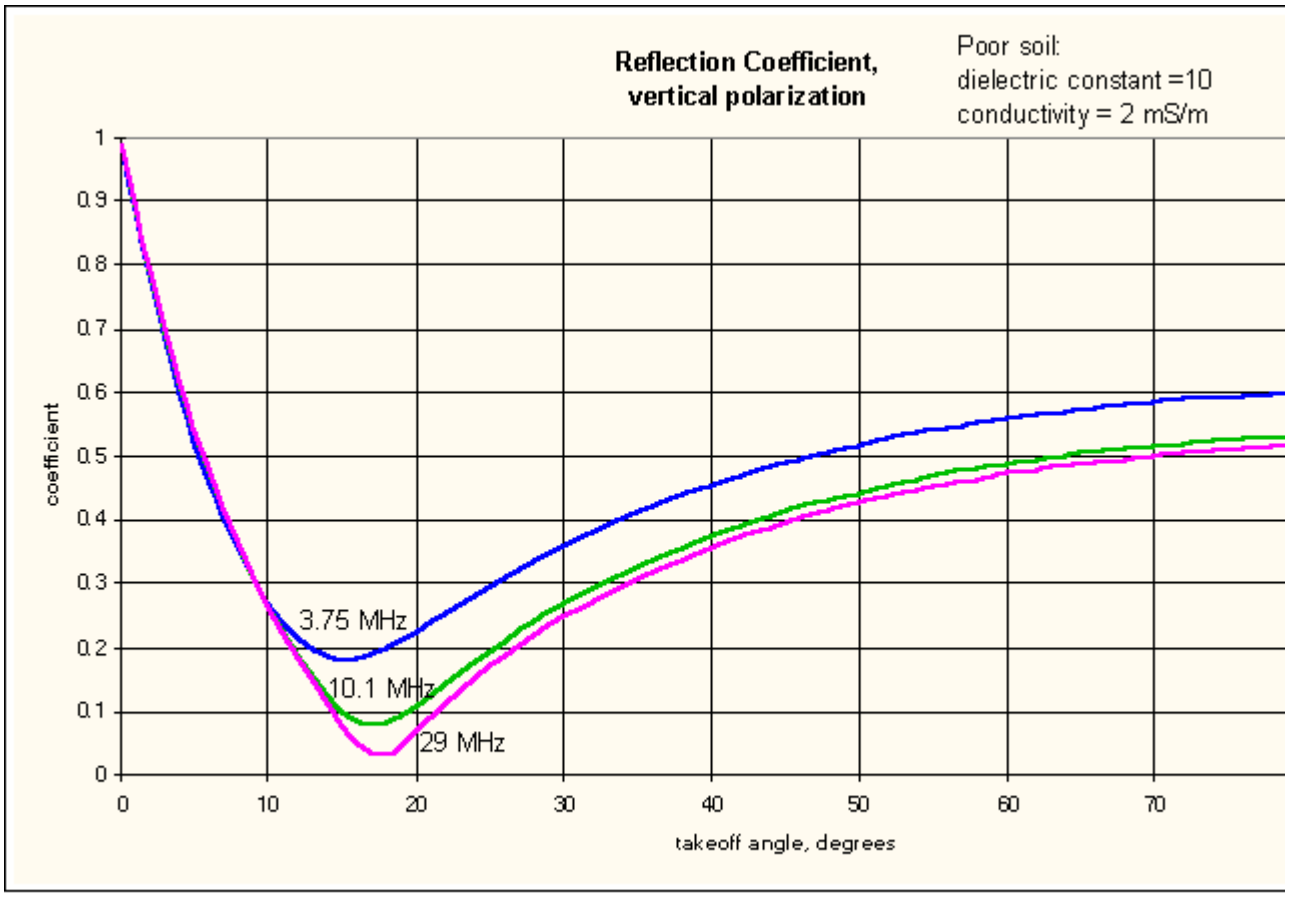
The skeptic in you will doubt that such low antennas can work. After all, its image in the ground radiates and cancels out all radiation. True - if the ground is perfect. But nothing is perfect! The grasswire radiates *vertically polarized* off the *end* of the wire. Extensive monitoring tests with wires laid along the great circle route toward WWV, and perpendicular to that line, demonstrate the end-fire nature of the antenna. So why does it work?

When a plane wave reflects from an air-earth boundary, an incoming ray reflects, giving an outgoing ray. These two, and the line normal to the boundary plane, form a *plane of incidence.* Solutions of Maxwell's equations differ for the case of the E-field being perpendicular to this plane (i.e., horizontally polarized), and the case when the E-field vector is *in* the plane of incidence. You will probably

call the latter "vertical" polarization, although this is technically not correct. Electromagneticists (a.k.a those who practice Electromagical effects) refer to these cases as *normal* incidence (horizontal polarization) and *planar* incidence (vertical polarization.)

For the normal incidence case, reflection is nearly total, with a nearly 180 degree phase reversal. Thus very low antennas neither respond to, nor generate, appreciable amounts of horizontally polarized radiation. But for the planar incidence case, the reflection varies in strength considerably. At some *takeoff angle* (angle between outgoing ray and the ground) the reflection becomes quite weak, and has a 90 degree phase shift. Near this angle, the sum of direct and reflected rays will have a magnitude as if the antenna were in free space! Of course, at other angles, ground reflection largely cancels the direct ray, and the antenna does not radiate well at all.

A *reflection coefficient* is calculated as the ratio of the electric field in the incoming ray to the electric field in the reflected ray. It varies from one (total reflection without loss) to zero (no reflection at all.) It depends on the takeoff angle, frequency, and the soil parameters (dielectric constant and conductivity.) Here are plots of planar incident (vertical polarization) reflection for typical "good" and "poor" soils.



Notice that, at 10 to 25 degrees, the ground reflection is very weak. It also is shifted 90 degrees in phase from the incident ray. Therefore, radiation from the grasswire, off the ends will be about the same as if the ground were not present.

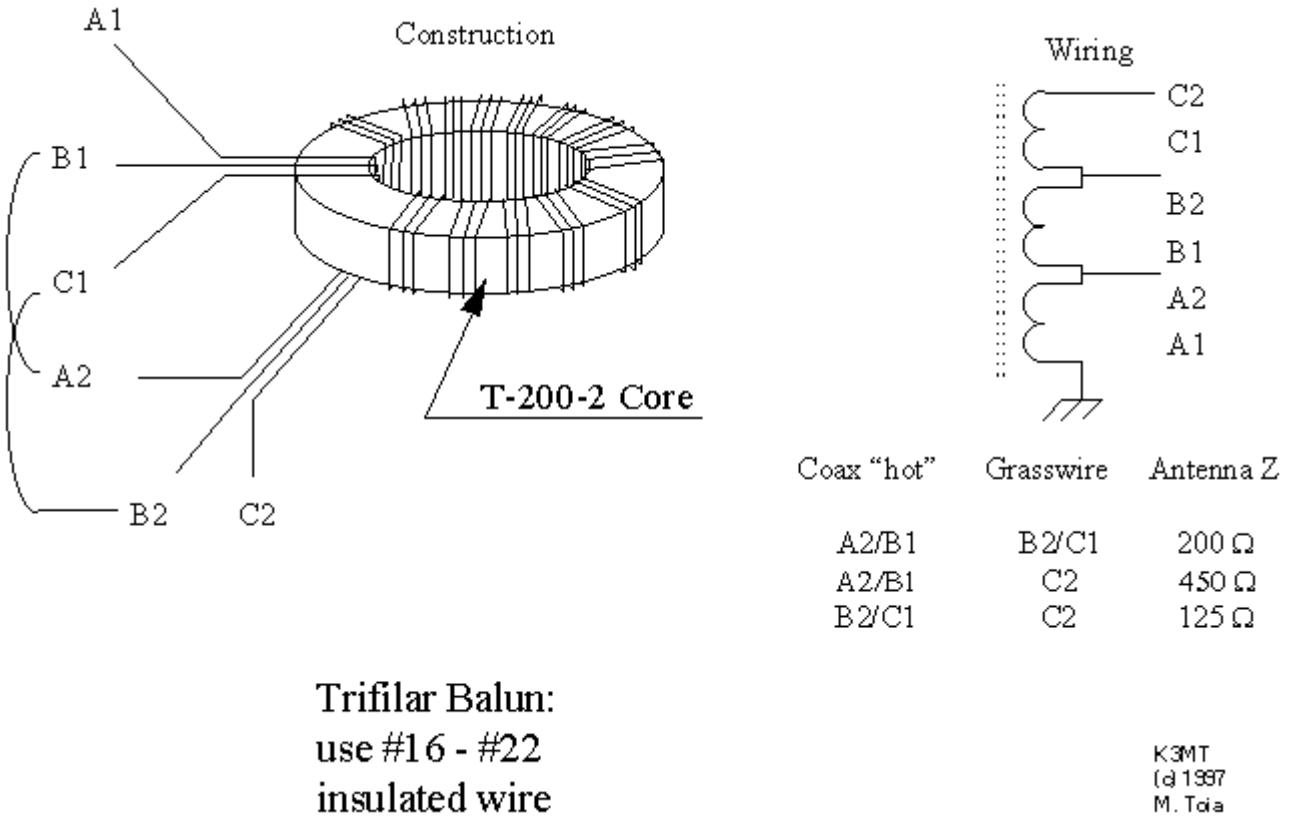
But launching a ray at, say, 15 to 20 degrees takeoff angle, in a direction toward Europe, can be useful! That's what a grasswire does. It is lossy in all directions, but least lossy when exciting the ionosphere for a long-haul DX contact. To demonstrate the point, here's an extract of K3MT's log, for October of 1988, (ahh, glory! Yes, the SSN was good then!) using a grasswire:

Date	GMT	CALL	his/my RST	FREQ	Power	
OCTOBER						
27	1554	SM6DYK	579 / 559	28004	80	
	1601	SM0LBR	569 / 439	21007	100	RAY - STOCKHOLM
	2001	W4JBQ	579 / 569	7029	40	JOE - FT WRIGHT, KY
	2141	W8LNJ	579 / 459	28015	80	DAVE - DALLAS, TX
28	0227	W8AO	589 / 569	3547	15	BOB - SILVER LAKE, OH
	1720	G3RFE	579 / 559	21016	100	TOM - BARROW
	1932	G0CBW	569 / 559	14029	50	MEL
	1945	VE2FOU	589 / 559	7032	100	ANDRE - IBERVILLE
	2026	KB7UX	569 / 539	21040	100	RUSS - CHINO VALLEY, AZ
	2100	I2JIN	589 / 559	14022	40	BOB - COMO
	2123	G3JVC	569 / 559	14022	40	JOHN - LONDON
29	2105	WA200JXT	599 / 599	28015	80	ND

Not bad, for a wire on the ground. Notice that contacts were made on 80, 40, 20, 15, and 10 meters. The signal reports are not fantastic. But contacts were made, and ham radio was enjoyed! Five countries were worked in 3 days. And the best part of this setup: *the neighbors never knew that a ham station was on the air!*

FEEDING THE GRASSWIRE

Since this antenna is largely resistive, a simple trifilar balun is all that I have ever had to use. This sketch shows how to make a balun that works:

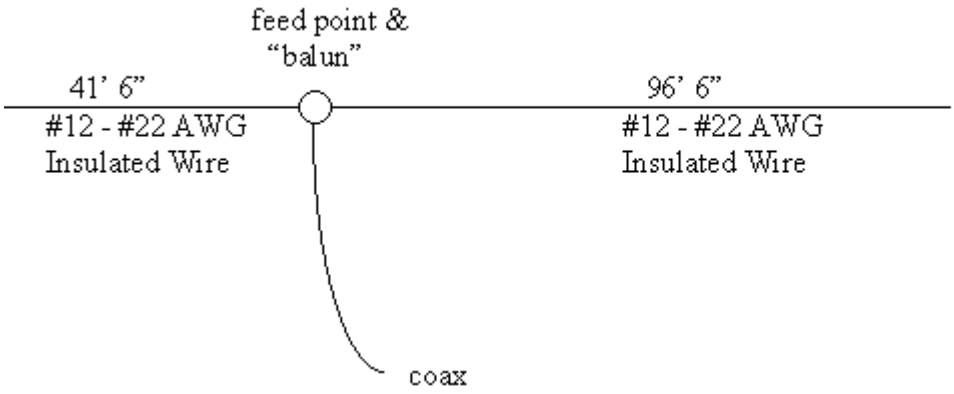


Typically I pull the insulation off of some indoor telephone wiring cable. Four insulated #22 copper wires are inside: discard one of these and use the remaining three. Wind about 16 turns on the core, without allowing the wire to twist (keep the three conductors parallel at all times.)

Notice that this "balun" really matches an unbalanced antenna to an unbalanced transmission line. It is basically a wide-band, three-winding autotransformer. Impedance ratios are as shown on the drawing. Generally it is necessary to connect the coax to either A2/B1 or B2/C1, and the antenna to B2/C1 or to C2. This may change from one band to another, and usually does.

WINDOM IN THE GRASS

I have elsewhere described a windom antenna. While it is usually hung from a pole or in a tree, it works when used in a "grasswire" mode. Just lay it on the ground. Dimensions are repeated here for ready reference.



Off-center fed Windom
lay on grass
Trifilar "balun" transformer

K3MT
(c) 1997
M. Tola

When I travel, I take one of these made of #22 insulated hookup wire. Since I often set up beside motel parking lots, and often after a day's work, the longer wire is black, and the shorter one is red. This helps me determine which way to point the windom. Remember, though, that it fires *off the long end*. Of course, it fires the other way, too, but usually works best off the long end.

I hope this has given some of you a good case of curiosity. Go out and try one of these ground - mounted wires. They're easy to build. Even the balun is easy to build.

If you must, contact us: we can supply a core, a whole balun, or a whole grasswire windom setup.

For more unusual antennas, visit my web page.

And check out my Books for a dozen topics about HF antennas. that includes the grasswire and other beverage antennas.

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