Radio FUNdamentals

BY BILL ORR, W6SAI

THINGS TO LEARN, PROJECTS TO BUILD, AND GEAR TO USE

The "Zig-Zag" Broadband Antenna

In my June 1992 column I discussed a broadband (2 to 30 MHz) HF antenna designed at the U.S. Army Communication and Electronics Command, Ft. Monmouth, New Jersey. *(Note: The zig-zag antenna is copyrighted by Bernard Feigenbaum and is reproduced here for personal amateur use only and may not be used for commercial purposes. The antenna is also patented by U.S. Army [patent No. 4,733,243].)* In brief, it is a vertical zig-zag wire the sections of which are of a predetermined increasing height (fig. 1). The high end of the array is terminated to ground through a 400 ohm resistor. A simple four-wire radial system is used, and power is coupled to the wire by means of a 9:1 ferrite balun and 50 ohm line. The antenna is supported from a line running from a 35 foot high pole, and overall length is about 55 feet. For military use, it is made from a single 500 foot roll of #12 gauge wire. Radiation is vertically polarized, and the antenna is subject to ground losses, as would be any other vertical antenna mounted close to the ground.

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Antenna Suspension

The zig-zag wire is suspended from a ⅛ inch diameter Dacron line a little over 70 feet long. Hook-stops (fig. 2[A]) are attached to the support line at appropriate intervals to support the antenna wire, which has hooks attached to it to engage the hook-stops along the line.

The antenna is constructed in three parts: the support line, the zig-zag wire structure, and the radials. Let's look at the support line first. Dimensions for the line and placement of the loop for the pulley rope and antenna hooks are given in fig. 2(B) and Table I. Note that dimensions for the support line assume a five percent stretch in use; therefore, dimensions are 95 percent of the required values. Cut the line a little long for tie-off at the ends.

One loop is tied in the line for the pulley as indicated, and then small hook-stops made of #18 wire are twisted about the line. These are placed as indicated and may easily be moved about after the antenna is erected in order to adjust tension on the wires. The antenna wire hooks move easily along the support line and rest against the hook-stops when the antenna is erected. Once the support line is made up, it is put aside and the antenna wire is prepared.

Fig. 3 shows the lengths of the complete antenna. The radials and antenna are made of separate pieces of wire. The little wire hooks are made up and placed along the antenna wire at the appropriate points. The radial wires are cut to length and soldered to the antenna, as shown. Two radials terminate at the 400 ohm resistor. The whole assembly should be stretched out on the ground and measurements for hook placement carefully checked.

Table II gives antenna wire dimensions. Length A is terminated at the 400 ohm resistor. Length B consists of the amount of wire to go from hook 1 to hook 2. Length B goes from hook 2 to hook 3, and so on. Each wire length in Table II makes up two adjacent legs of the zig-zag structure.

Antenna Assembly

The first step is to align the antenna, as it is directional off the small end. The antenna support line is staked at the feedpoint (the small end), and the opposite end is attached to the support pulley atop the mast

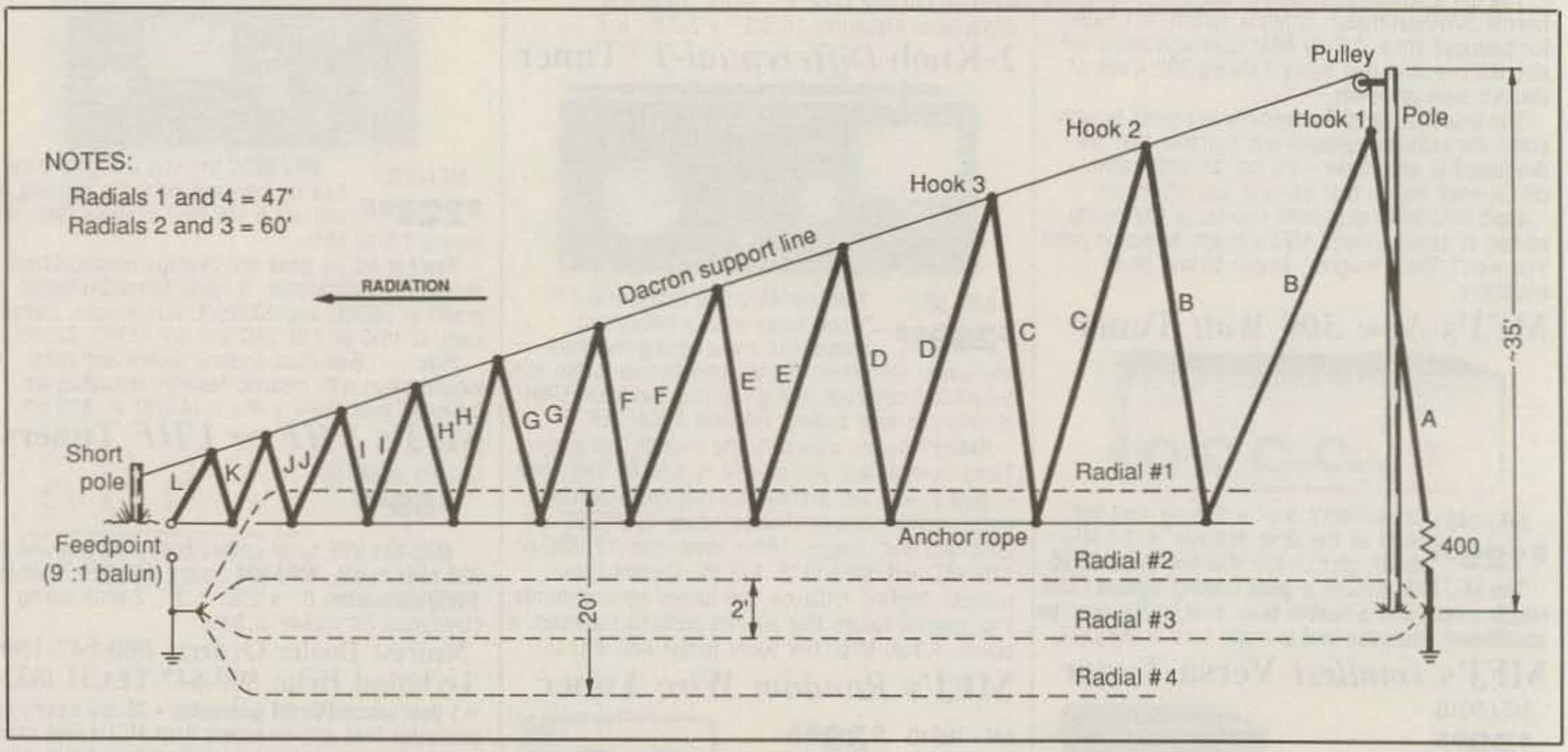


Fig. 1– The broadband "zig-zag" antenna (2–30 MHz) is about 60 feet long and requires a 35 to 40 foot high pole at one end for support. It is fed at the small end with a special balun. The antenna is slung from a support line and anchored at the bottom by a rope passing from one end to the other. Short stakes anchor the rope in place.

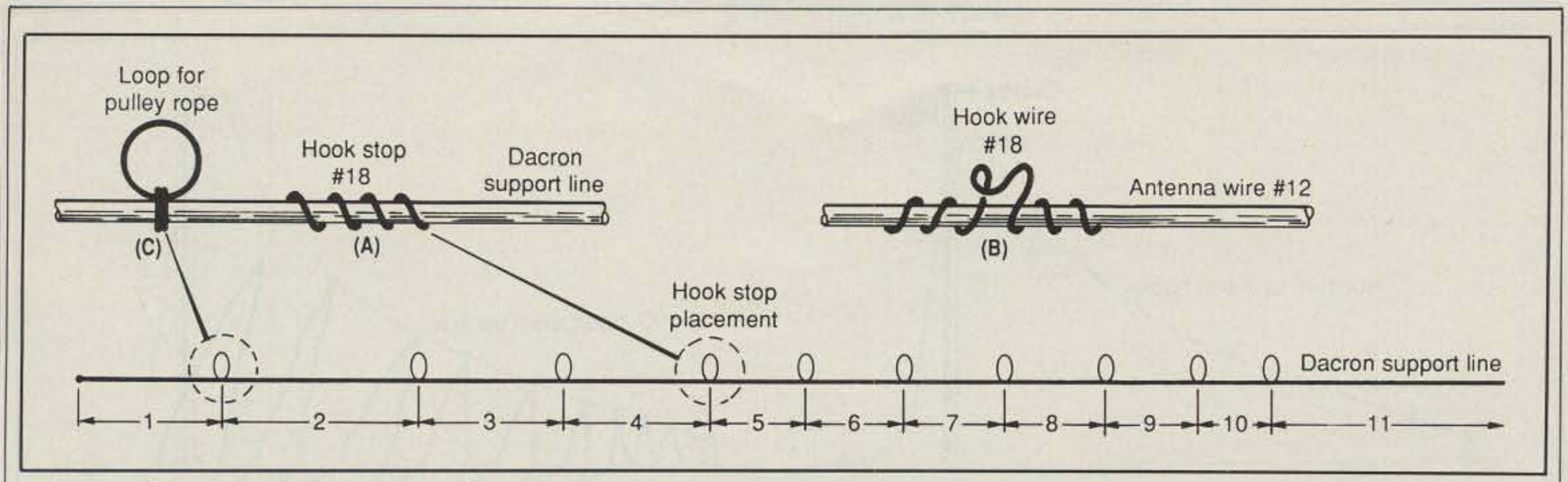


Fig. 2– (A) The antenna wire is held in position along the support line by means of small hooks which may be moved back and forth along the line to provide proper tension on the wires. (B) The hook wire fastens the antenna wire to the support line. (C) Hook stops are placed along the line in accord with Table I. Note that dimensions assume a 5 percent stretch in the line and are therefore 95 percent of the required value. Loop for pulley rope is shown.

Support Line Dimensions	
Segment	**Length**
1	2′ 0″
2	13′ 7½″
3	10′ 7¾″
4	8′ 3¾″
5	6′ 6″
6	5′ 1″
7	3′ 11¾″
8	3′ 1¼″
9	2′ 5″
10	1′ 10¾″
11	12′ 10″

Table I– Dimensions for the support loop (see fig. 2[C]) for the zig-zag antenna setup.

(fig. 4[A]). The support line is pulled up until it is about 4 feet above the ground in a convenient position to attach the antenna wire to it (fig. 4[B]). The antenna wire is carefully laid out along the ground and hooked on the support line at each wire stop. Once this is done, the antenna is raised by hauling in the rope passed over the pulley tower.

The whole thing looks pretty sloppy at this point, and a mid-support mast is put in position to reduce sag. The antenna wire hangs down in loops, and these must be anchored down at the right points. This is best done by means of an anchor rope woven along the bottom of the loops. The rope (fig. 5) is held in position with short ground stakes.

The last step is to lay out the ground radials and attach the balun transformer. The balun is taped to a 24 inch ground stake which supports the small end of the antenna.

Making the Balun

The 9:1 balun is shown in fig. 6(A). It is composed of a 7-turn trifilar winding of #14 wire on a 2.4 inch core (61 mix). An Amidon FT240-61 core is suggested. The three wires are wound on simultaneously and connected as shown in fig. 6(B). The balun can be weatherproofed by placing it in a cylindrical box made of PVC plastic water pipe. End pieces are epoxied on the pipe section and suitable connectors placed on one end. A suggested substitute balun is the UU-375 unbalanced-to-unbalanced transformer made by Palomar Engineers (Box 462222, Escondido, CA 92046).

The Ground Radials and Termination Resistor

Four short radials run parallel to the antenna wire on each side of it. The inner radials (numbers 2 and 3) are returned to the base of the mast and connect to one end of the terminating resistor. The other end of the resistor attaches to the antenna wire. The design calls for a 400 ohm resistor, noninductive, capable of dissipating about one half the output power of the transmitter. For the typical 100 watt transmitter I would suggest a 50 watt, wire-wound resistor. This resistor type has inductance and can't be considered noninductive. However, the inductance value is low, and my personal opinion is that it won't upset antenna operation to any great degree. The alternative is a noninductive resistor, and a 50 watt unit isn't cheap. Minimum power is dissipat-

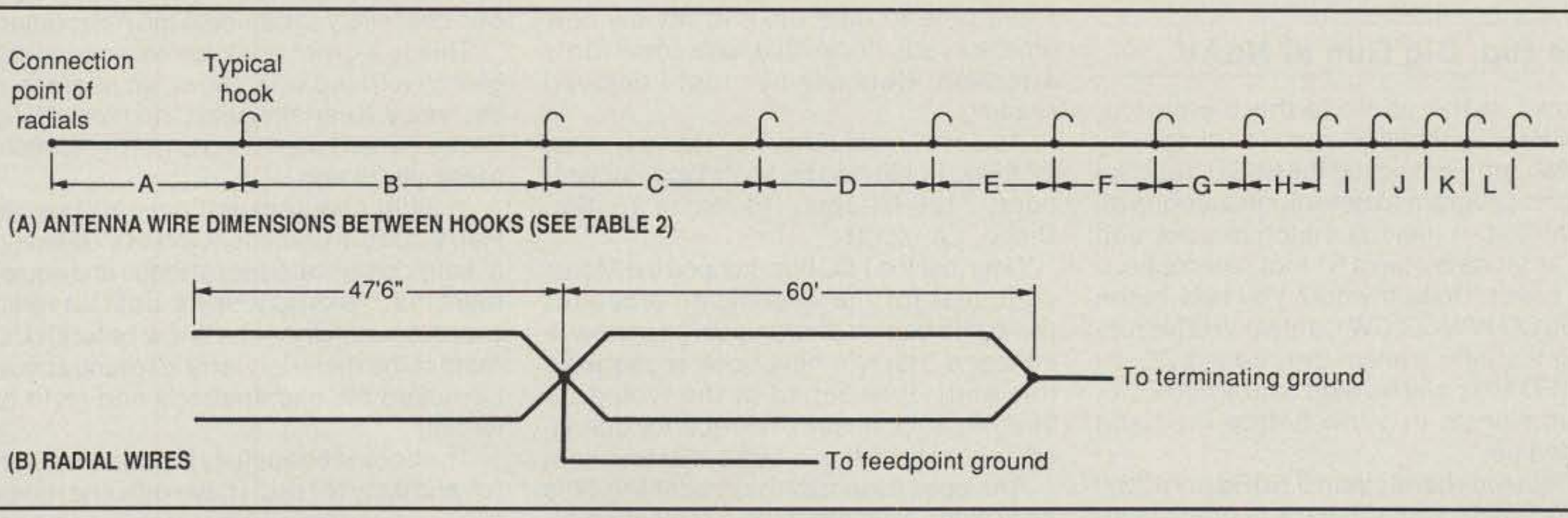


Fig. 3– Antenna wire dimensions between hooks are tabulated in Table II. Dimensions of radial wires are given in drawing (B). A more elaborate radial ground system should provide improved results and decrease ground loss.

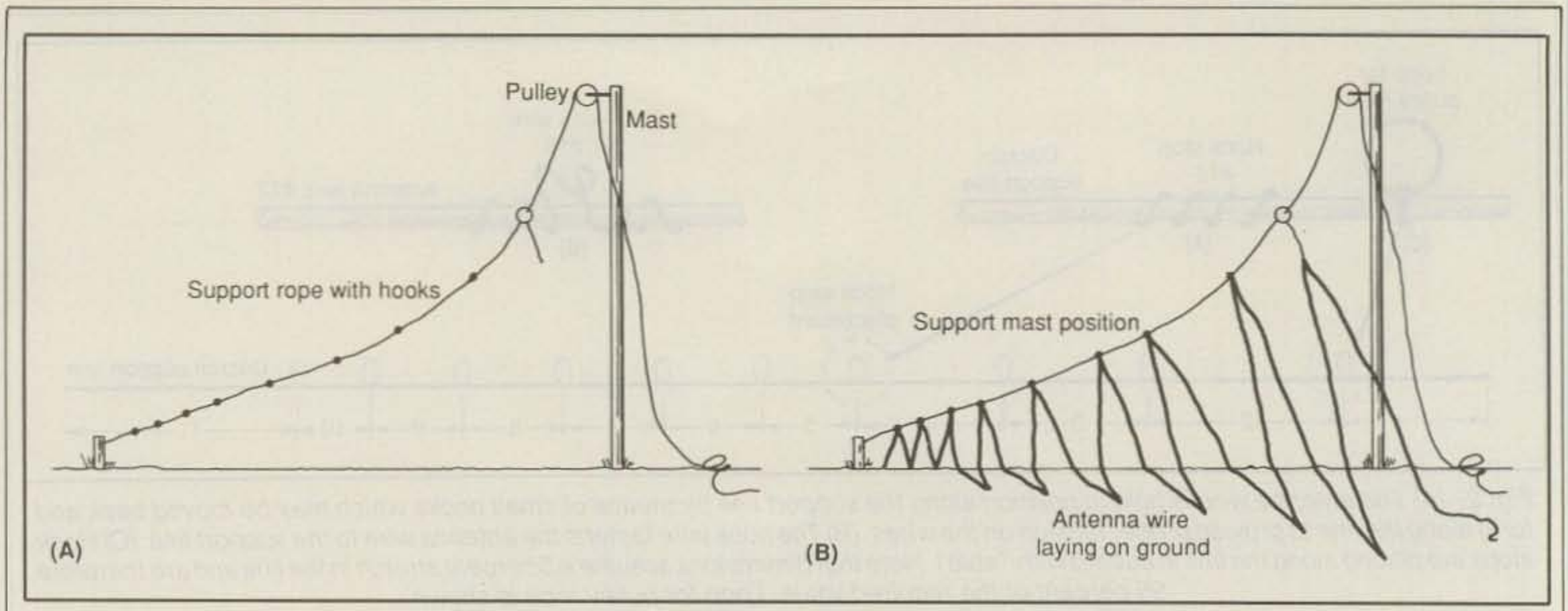


Fig. 4– (A) Support wire with hooks installed is partially pulled up mast, ready for antenna installation. (B) Antenna wire is laid out in approximate position on the ground, ready for attachment to support rope. A short support mast may be neded at the center of the antenna to reduce support rope sag.

Antenna Wire Hook Placement	
Segment	**Length**
A	35′ 6″
B	59′ 9″
C	46′ 8¼″
D	36′ 5¾″
E	28′ 6″
F	22′ 3¼″
G	17′ 5″
H	13′ 7¼″
I	10′ 7½″
J	8′ 3¾″
K	4′ 7¾″
L	1′ 0″

Table II– Antenna wire dimensions. Each wire length makes up two adjacent legs of the zig-zag structure.

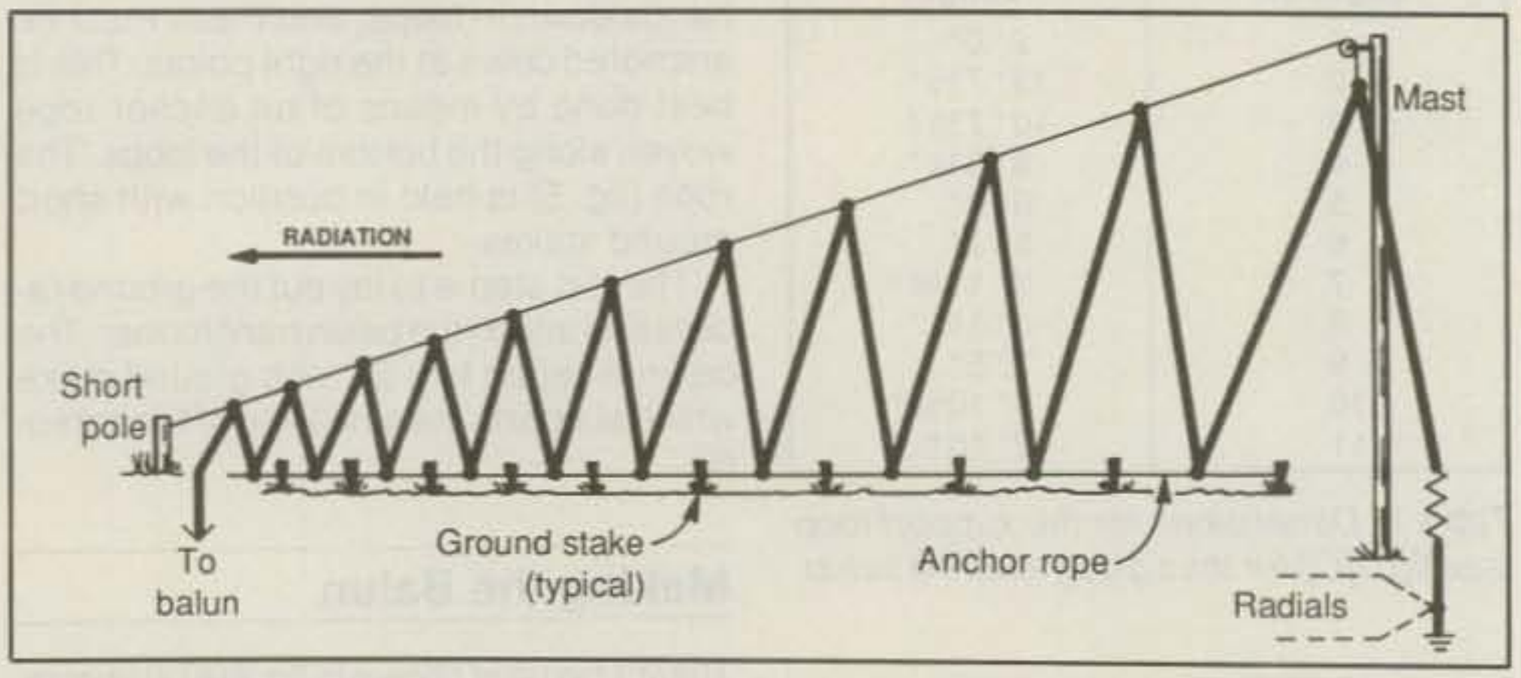


Fig. 5– Anchor rope passes along bottom of array to keep tension in the wire. Rope is staked down at appropriate intervals. Bottoms of the antenna "V"s should be about 1 to 2 feet above ground level.

ed in the load resistor at the higher operating frequencies. The dissipation level rises as the operating frequency is lowered.

The MN 4.0 program of K6STI can be used to analyze antenna patterns.

The Big, Big Gun at N6AV

Shown in the photo is the 6-element, 28MHz Yagi built on a 40 foot boom by N6AV. Jerry employed the K6STI Yagi Optimizer program to determine antenna dimensions. A gamma match is used, and the antenna is atop a 51 foot self-supporting tower. Does it work? You bet! In the 1990 CQ WW DX CW Contest W6BA, running a single transmitter, called CQ on 28.060 MHz and worked nearly 200 European signals in a row before the band folded up.

Gain runs better than 9.5 dBd from 28.0 to 28.7 MHz. Front-to-back averages better than 25 dB across this range.

Jerry's next project is a 5-element Yagi for 21 MHz on a 41 foot boom. (Stay clear of this guy!)

Book Reviews

From time to time I like to review new amateur radio books that have come to my attention. Here are two that I enjoyed reading.

All About Ham Radio, by Harry Helms, AA6FW. Published by High Text Publications, 7128 Miramar Rd., Suite 15, San Diego, CA 92121.

Now that the FCC has dropped the Morse code test for the Technician amateur, there has been a sharp upsurge in new licensees. Harry's new book recognizes this shift. It is aimed at the would-be Technician licensee and recently licensed Technician. It is a bull's-eye hit.

The book assumes the reader has little knowledge of amateur radio or electronics. Written in a humorous, conversational style, *All About Ham Radio* covers what amateurs actually do, what they talk about, and the mysteries of our lingo, which is usually incomprehensible to the newcomer. The book also discusses in detail equipment, antennas, repeaters, and other exotic gear likely to befuddle the newcomer.

This is a great book for an amateur to give to a friend who shows an interest in the hobby. (I certainly wish I had something like this when I was trying to get my license, many years ago.)

In eight chapters and over 300 pages Harry does an excellent job of explaining a really complicated set of ideas and equipment that make up today's amateur radio experience. Although I knew beforehand most of the material Harry is talking about, I enjoyed his explanations and style of writing.

The book is beautifully produced, colorful, and easy to read. I have only one minor observation about it. Harry refers to equipment he describes as "walkie-talkies." Good grief! That term went out with the

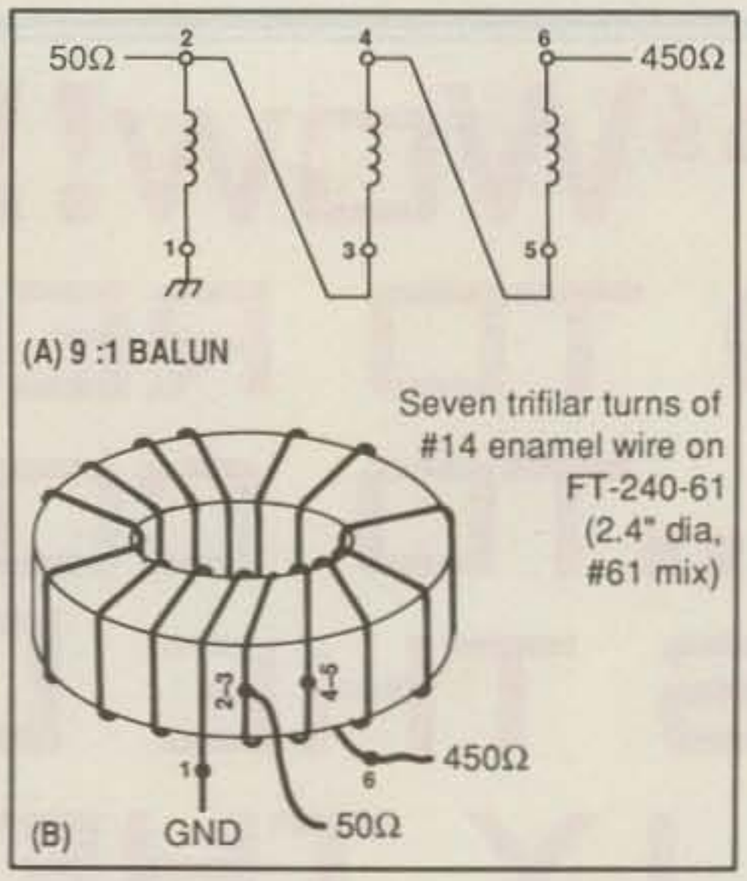
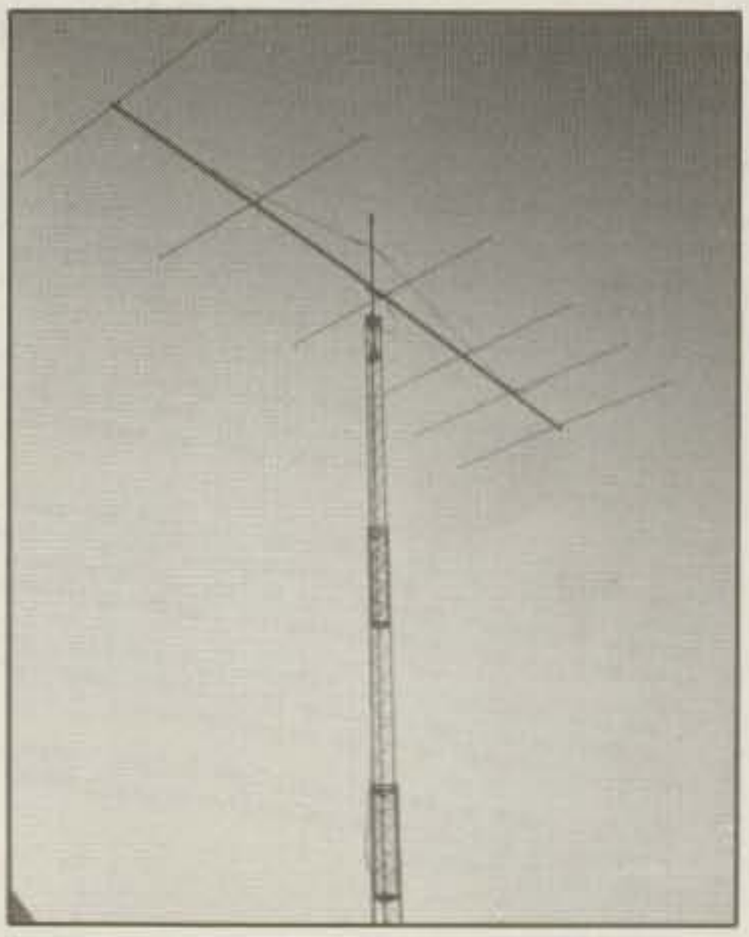


Fig. 6– (A) Schematic of special balun. Three trifilar windings are required, connected in series. (B) Balun is wound on 2.4 inch diameter ferrite core. Amidon FT240-61 is suggested. Core is 61 mix. Three windings are wound on simultaneously with marked ends to differentiate windings.

HRO and the BC-610. Harry is really talking about HTs, hand-helds, or handie-talkies. Right, Harry?

AA6FW's book is available at major radio distributors, or directly from the publisher for $19.95 plus $3 shipping/handling, and appropriate sales tax for California residents.

A second book of interest is *Aerials*, by "Kurt N. Sterba" and "Lil Paddle." Published by Worldradio, 2120 28th St., Sacramento, CA 95818.



The 6-element, 28 MHz Yagi of N6AV is built on a 40 foot boom and supported atop a 51 foot tower! Too bad the sunspot cycle is declining! In a few months all Jerry will be able to talk to is himself! Soon the beam will be replaced with a 21 MHz Yagi on a 41 foot boom.

This 92-page book is a compendium of 53 essays written for *Worldradio* magazine by a husband and wife team of enthusiastic amateur radio operators who have a firm grasp of the obvious. The book is a collection of some of the best essays.

Aerials, according to Walt Maxwell, W2DU, who wrote the introduction, "contains hard-hitting, sharply-aimed rebuttals targeting many ludicrous statements and claims appearing in amateur radio literature and equipment catalogs." I agree. The style of writing used by "Kurt" reminds me of the hard-bitten drill sargeant in the movie *An Officer and Gentleman*. But I have met "Kurt." He is soft and friendly as a kitten and obviously kind to his mother.

Walt says many of "Kurt" and "Lil"'s statements "are bound to rattle some cages and cause much gnashing of teeth among those of you who have been taken in by the myths." Right on! But the book introduces some myths of its own. In one essay the statement is made that "if you show an SWR of 2:1 and your transmitter has a 50 ohm output, and you are using 50 ohm cable, you will find either your antenna is 25 ohms or it is 100 ohms."

I suggest "Kurt" spend two-bits and buy himself a Smith Chart, normalized on 50 ohms, and draw a 2:1 SWR circle on it. He'll find that there are as many combinations of antenna impedance that will produce a 2:1 value of SWR as there are points on the circle. (This is all explained in the ARRL *Antenna Book* and in some of my antenna books.)

But I digress. The book is a lot of fun to read, and you'll find yourself in agreement with the proposed solutions to many of the perplexing mysteries facing the antenna enthusiast.

I was dismayed to read that "Kurt" spilled the beans on one of the most well-guarded secrets in amateur radio. He urges the reader to find a second-hand Johnson "Matchbox," kilowatt antenna tuner at a hamfest or fleamarket and snap it up. "Kurt," you shouldn't have said that! The rare "Matchbox" will quickly disappear and my chances of finding one will evaporate!

"Kurt" and "Lil Paddle" are not the authors' real names. Both writers work in companies whose policies require that all writing must be cleared through them. What hidebound company censor would understand these essays? Or understand amateur radio, for that matter? Hence the anonimity.

A tongue-in-cheek dissertion on the antenna game, *Aerials* is good reading. Get the book, grab an ice-cold 807, and settle down and enjoy.

Aerials is available at some radio distributors or on order from Worldradio, Box 189490, Sacramento, CA 95818. Price is $10, plus $2 shipping/handling. California residents add applicable sales tax. Overseas, add $4 postage/handling.

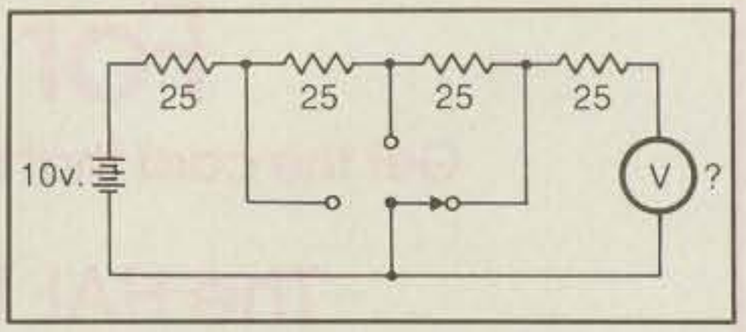


Fig. 7– "Dead Band" puzzle. What is the reading of the voltmeter when switch is placed as shown?

The Dead Band Quiz

I always thought a majority of my readers worked for the Circus, Moscow Center, or the CIA. Now I know I am right. The following sleuths have a staggering amount of information about "Moscow Rules," a little quiz I gave about John LeCarre's novel, *Tinker, Tailor, Soldier, Spy:* WA2CBU, NI3P, KM7U, WB9UHX, K2WR, W3HHG, WB5MTV, KG5IT, and VE1CBF, the latter no doubt a member of Canadian Intelligence.

Thanks to the above undercover agents who knew all about Vladimir, Max, and the rest of the shadowy bunch in that masterful novel/TV production.

Also thanks to P29MB and KB0HIB, who know a great movie when the see it: *High Road to China.*

This Month's Quiz

I've divided this quiz into two parts. The first part is for the technically minded Extra class amateurs; the second part is for us less fortunate individuals.

Question 1: Examine the circuit of fig. 7. With the switch in the position shown, what is the reading of the voltmeter (V)? (Quiz first appeared in *QST*, Feb. 1959.)

Question 2: Where does this little poem come from? What are the last two words of it? Who says it?

They seek him here,
They seek him there,
The Frenchies seek him everywhere.
Is he in Heaven, or in Hell?
That deuced ____ ____!

Okay, guys, have at it! Good luck, and may the Force be with you!

Recommended reading: Here's a thrilling story of the Spanish Armada that King Philip of Spain sent in 1588 to conquer and subdue England. I guarantee you won't put it down! *The Voyage of the Armada* by David Howarth, the Viking Press, NY (1981). Probably out of print, it may turn up in a second-hand bookstore.

If you think today's politics are confused and the results unreal, read about the catastrophy that King Philip unleashed on Spain. And think what might have happened if the ships of the Spanish Armada were equipped with today's hand-helds so as to be able to communicate with each other! The end of the story may have been different. 73, Bill, W6SAI