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The Perverted Double Vee Antenna

— double your pleasure from 40m through 10m

A 70-foot free-standing tower with multi-element yagis for 40, 20, 15, and 10 meters, plus a rugged rotator to handle the Christmas tree, is the dream of almost every ham. But, oh, the expense, the complications involved in erecting such a monster, and don't even mention the XYL's screams of terror at the thought of that half ton of aluminum and steel hanging heavy over the heads of her beloved family, threatening to crush everyone and everything come the next windstorm, tormado, or hurricane.

Be not of weak faith! The dream may become a reality, if what you actually want is an antenna system with gain, directivity, excellent front-to-back ratio, rotatability, low cost, and relatively simple and safe construction — the perverted vee is your answer. Here follows a description of a phased almost vertical/almost horizontal trapped multiband dipole, one which will satisfy all of the above criteria.

There is an abundance of information available on the theory and performance of phased (driven) arrays — vertical, horizontal, and inverted vee systems.[1-8] I cannot add substantially to these data, but I suggest that you review what may be conveniently available to you. It is important for you to know that phased arrays work and that there is nothing very mysterious or complicated about constructing and adjusting them. The perverted vee is a phased array.

The Antenna

A study of the diagram in Fig. 1 shows the array to consist of two trapped dipoles, ABC and EFG, supported at a common tie point at the top of a 50' mast or tower. Feedpoints B and F are held away from the mast by suitable nylon cord. The lower ends, A and G, are pulled back into the base of the mast. The resulting configuration is that of two vees lying on their sides, with their tops facing each other. The dimensions of each vee and the trap values are such that resonance can be attained on 40, 20, 15, and 10 meters.[9,10] Spacing between feedpoints B and F is approximately 34'. This represents ¼ wave on 40 meters, ½ wave on 20 meters, 3/4 wave on 15 meters, and a full wave on 10 meters — classic spacings for phased arrays. Without becoming too technical or too involved in the details concerning trap construction, a few words regarding the traps are in order. Accepted theory and practice indicate that the L/C values given here will allow each dipole to work on the frequencies of interest and with acceptable vswr indications. Home brew traps can be made using ordinary coil stock or by winding 12-gauge or 14-gauge wire on wooden dowels, plastic rods, tubes, etc. The capacitors can be of the ceramic doorknob variety, high-voltage disc ceramics, or about 10 inches of RG-8/U. Whatever your preference, they must be grid dipped or noise bridged to resonance at 14.1 MHz.

My original attempt at home brewing suitable traps with coil stock and RG-8/U was successful, but I was not confident about their long-term stability and durability. Adequate weatherproofing was a problem. But, very recently, there have become available ideal commercially-made traps which fill the bill perfectly. They are the model 4-FG traps by Pace-Traps, Middlebury CT. I replaced the original traps with the Pace-Traps, having only to make minor adjustments in the wire element lengths to restore resonance of the

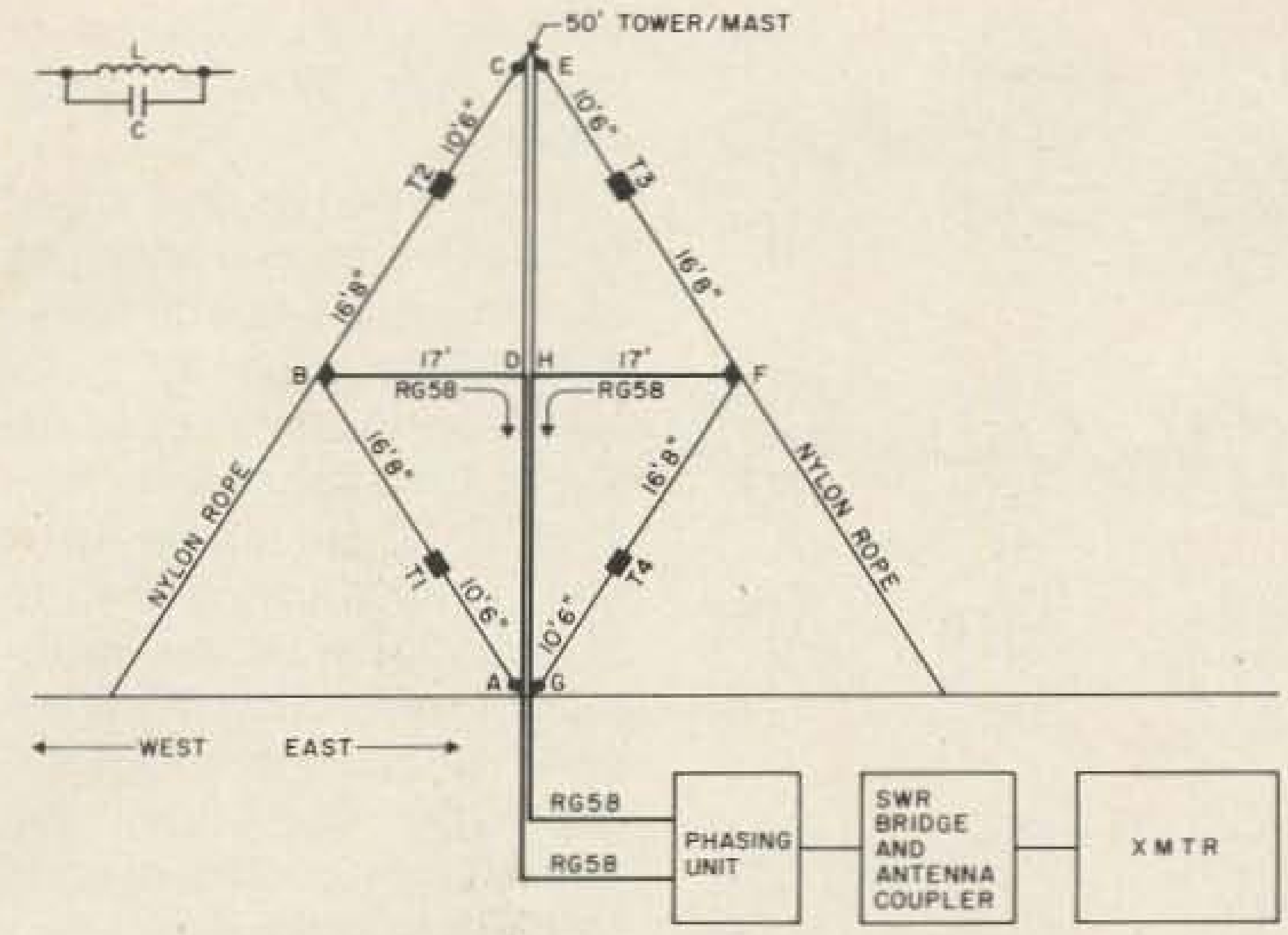


Fig. 1. Perverted vee phased array. Antenna #1 – ABC; antenna #2 – EFG. T1-4 – traps to resonate at 14.1 MHz; L – 10 turns, 6 tpi, 2½" diameter, 12 gauge; C – 25 pF (CL8505-25Z).

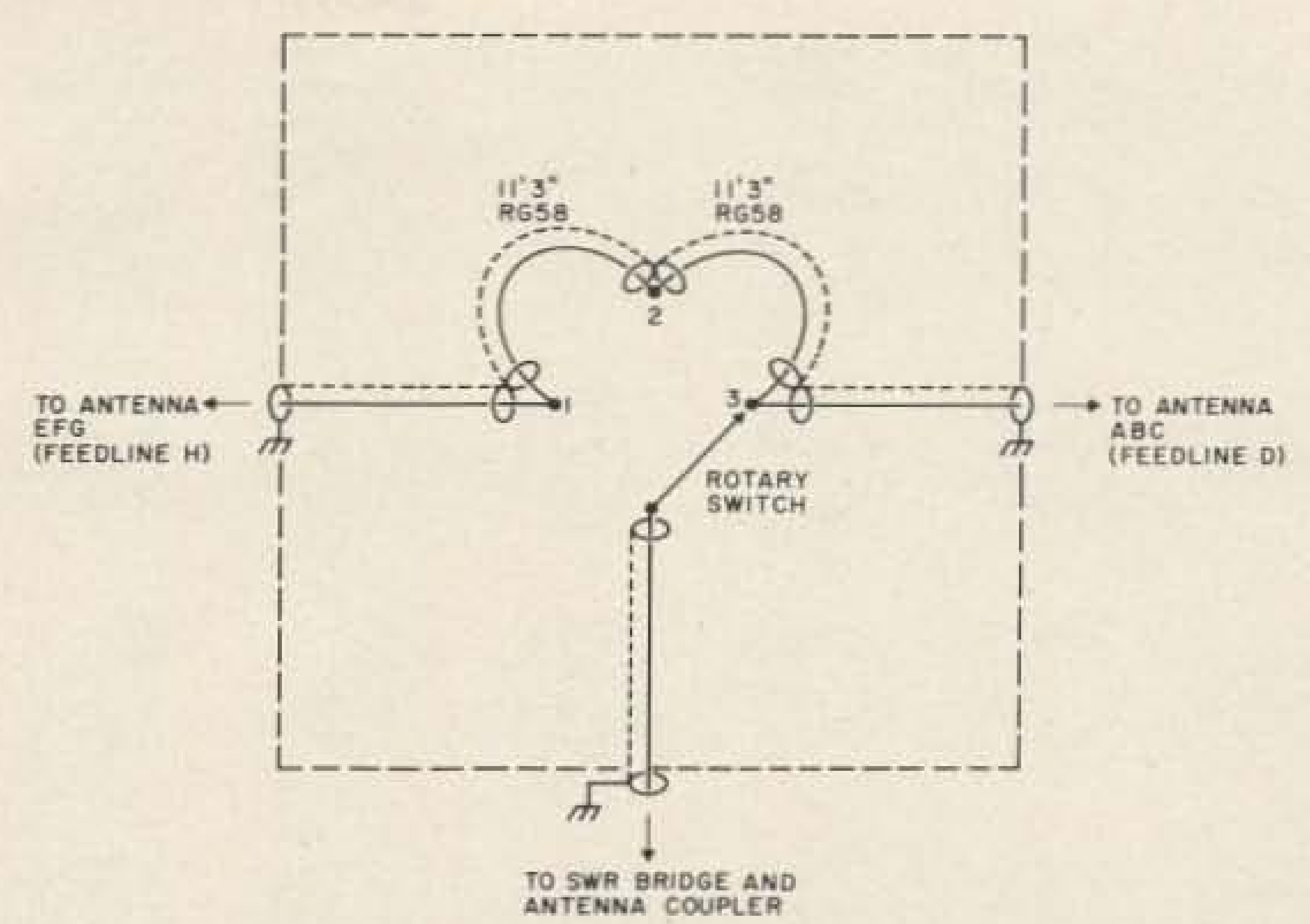


Fig. 2. Phasing unit.

antennas.

The Phasing Unit

The phasing unit (Fig. 2) is as simple a design as possible, requiring only a single-pole, 3-position switch, two 11'3" lengths of RG-58 solid (not foam) coaxial cable, 3 SO-239 chassis connectors, and a suitable small enclosure. An aluminum "Tite-Fit" box measuring 3½" x 6" x 8" is recommended.

The 11'3" lengths of phasing lines are not terribly critical. An inch, more or less, will not seriously affect the performance of the perverted vee. These lengths were arrived at from the formula for 1/8-wave coaxial phasing (delay) lines for 40 meters – 123 x .66/7.2 MHz. (.66 is the velocity factor for solid dielectric coax.)

The total of the two 11'3" lengths of coax, 22'6", provides electrical lengths of ¼ wave (90 degrees) on 40 meters, ½ wave (180 degrees) on 20 meters, 3/4 wave (270 degrees) on 15 meters, and 1 wave (360 degrees) on 10 meters. In switch position 2, Ø degrees phasing (broadside directivity) is accomplished, as both antennas are fed simultaneously in phase.

There is magic in the use of the two 11'3" phasing lines, giving the directive patterns shown in Fig. 3. You get all of that with only two short pieces of coax and one simple three-position, single-pole switch and no waiting for the rotator to grind its way around from east to west or north to south.

The Feedlines

Direct your attention once more to the RG-58 feedlines between the antennas and the phasing unit. Each of the two feedlines must be the electrical equivalent of the other. That is, they must be the same length. There can be no Mickey Mousing around on this point. It is strongly recommended that you use an antenna noise bridge or grid-dip meter to closely match the two lines once you have cut them to the same physical lengths. Although the total length of each line doesn't have to be more than just enough to reach the shack and phasing unit, I suggest that you make them multiples of 45 feet (½ wave at 40 meters). The reason for this suggestion is, of course, that it will make it possible for you to get valid vswr and resonance indications when you are adjusting the antenna wire lengths.

Don't be unduly concerned about using RG-58 (solid dielectric) coaxial cable, even if you are using a 2 kW PEP amplifier. Bear in mind that each feedline will be carrying only one-half the total output of your transmitter amplifier and that the average SSB or CW power in each line will be roughly half of that. In other words, if your 2 kW amplifier has an rf output of 1,200 Watts PEP, only 600 Watts PEP will be fed to each coaxial line. Since the average power is about half of the PEP power, each line will carry only about 300 Watts average power, which is well within the ratings of RG-58.

Swr Bridge and Antenna Coupler

Under the best of circumstances, no antenna will be perfectly flat – vswr 1:1; I guess I should say that most practical antennas will show some vswr other than 1:1. A pair of antennas, such as the perverted vee or any other phased array, will almost certainly show other than a "flat" condition to the transmitter output circuit, and the antennas will require a means of flattening out vswr ratios of as much as 2.5:1. If you already have a transmatch, matchbox, L-network, pi-network or some other such "line flattener" and swr bridge, use it between the phasing unit and transmitter (or linear amplifier), and adjust it whenever necessary for vswr 1:1 to the final rf stage.

A simple L-network will do the job. The circuit of one which I have used with excellent results is shown in Fig. 4. It will flatten out mismatches of up to 3:1.

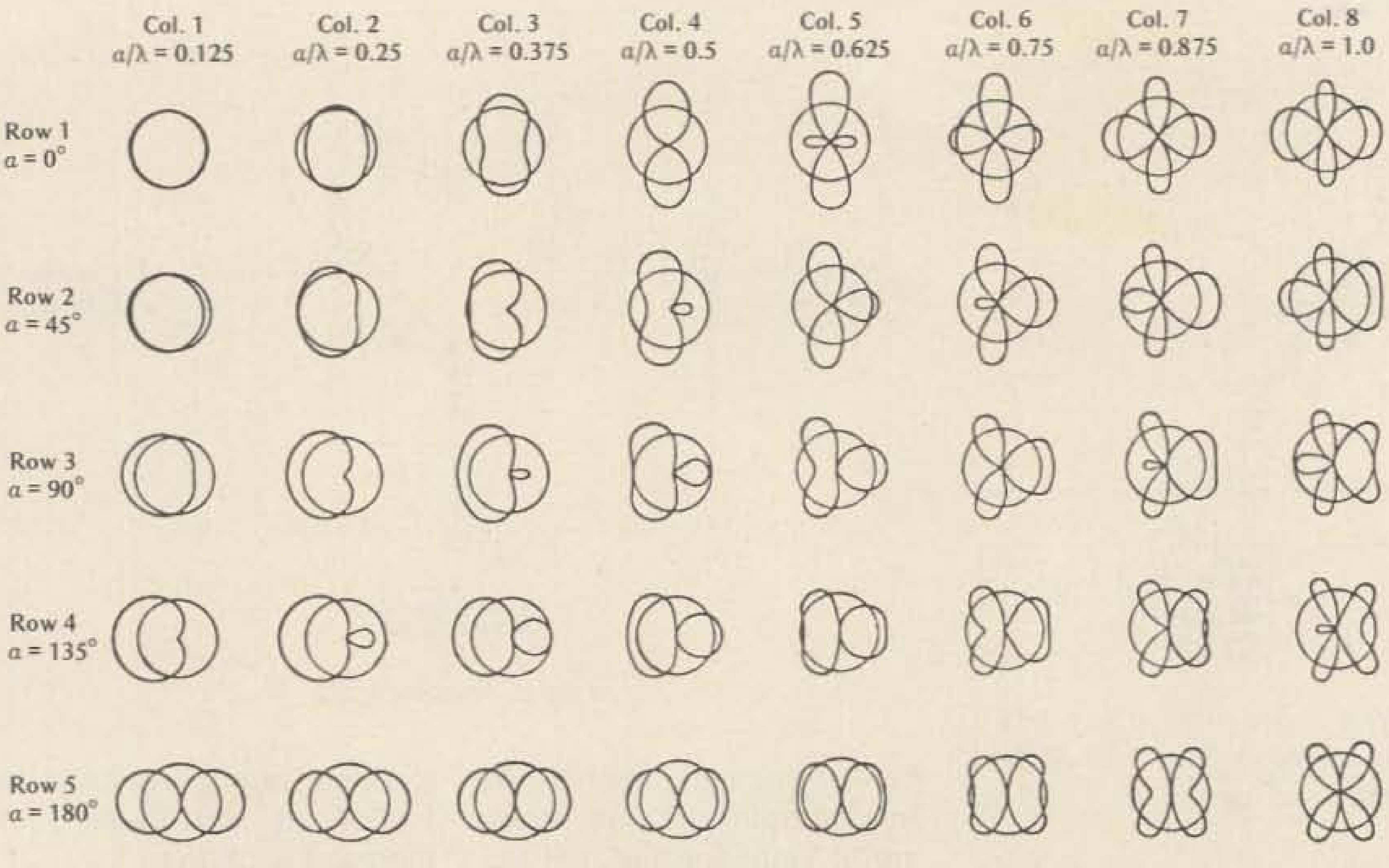
Construction

Because the perverted vee is a system composed of two trapped dipoles, usual procedures for trapped dipole construction should be followed. Materials which you will need for construction of the antenna elements are listed in the parts list.

Begin by cutting the appropriate lengths of antenna wire. You might as well cut all the lengths for both sides of the perverted vee at the same time, with an extra 3" at each end of each length for fastening to traps and insulators. So, you will cut 4 lengths of 11' each and 4 lengths of 17'2" each. Scrape or sand the coating off the ends of the wire lengths to a distance of about 6" for final soldering.

If you decide not to use commercial traps, refer to construction details in the *ARRL Handbook*.[11] Unless you are an excellent craftsman and have had experience building antenna traps, you will save a lot of time and possible trouble by buying a set of 4 traps.

Now put one dipole together and then the other, using the first as a model. I started mine by tying a short piece of cord to one of the end insulators and then to the farthest corner of my backyard fence. Then I put one



Switch Position	Approximate Horizontal Patterns 40 meters	20 meters	15 meters	10 meters
1	Col. 2, Row 3	Col. 4, Row 5	Col. 6, Row 3 Reversed	Col. 8, Row 1
2	Col. 2, Row 1	Col. 4, Row 1	Col. 6, Row 1	Col. 8, Row 1
3	Col. 2, Row 3 Reversed	Col. 4, Row 5	Col. 6, Row 3	Col. 8, Row 1

Fig. 3.

end of 11' precut length of wire through the insulator, pulling through the insulator 3" of wire and making the wrap. The other end of the wire is fastened to a trap in a similar manner. Next comes the 17'2" length. Fasten one end to the trap, as before, and the other end to the center insulator. Continue on the other side of the center insulator with another 17'2" length of wire, a trap, an 11' length of wire, and an end insulator. One dipole is finished, and, if you're lucky, you will find a convenient fence post to tie the finished end of the dipole to with a piece of cord, the same way as you started.

The other dipole can now be assembled right alongside, and it will be easy to make it identical to the first.

While the dipoles are hanging there taking a set, it would be a good time to prepare the RG-58/U feedlines – two feedlines, electrically identical to each other and long enough to reach from the antenna feedpoints to the shack. As I mentioned previously, it is a good idea for the feedlines to be multiples of half wavelengths at 40 meters – 45', 90', or 135' (I hope you won't need more than 90'; if you do, you should substitute RG-8/U).

The length of an electrical half wavelength of coaxial cable such as RG-58/U or RG-8/U (solid dielectric) is found by using the formula 492 x .66 (velocity factor)/F MHz. By substitution and solution for 7.2 MHz, the result is 45.1'. 45' is a good number to start with, as actual measurement with a grid-dip meter or antenna noise bridge usually shows this length to be slightly long. But, since it will take at least 42' of feedline to reach from the feedpoint of the dipole to the base of the mast, and it is unlikely that your shack is only 3' from the base of the mast, it is best to consider a minimum feedline length of 90'.

Assuming that this length will satisfy your need, cut a piece of coax to measure 90'. Measure it electrically and prune it to resonate as a full wave at 7.2 MHz. If the second feedline is of the same manufacture, you will be safe in cutting it to the same length as the first. Double check with the grid dipper or bridge to be sure. Remember, except for the convenience of being able to measure resonance of the antenna at some point remote from the feedpoint itself, length of the feedline isn't important, but predictability and reliability of performance of a phased array, such as the perverted vee, depend on the two feedlines being electrically identical to each other.

Once the feedlines are cut to final length, attach them to the dipole feedpoints, B and F, making sure that the coax shields are connected to the elements B-A and F-G and the coax center conductors to elements B-C and F-E. A piece of tape on the antenna wire next to the center insulator will help you identify the shield-fed side. It is a good idea to wrap a piece of tape around each length of coax 17' from the feedpoint. This will give you a convenient way to space the dipole centers 17' out from your mast. Tie a 35' length of nylon rope to each center insulator.

Now let's test and adjust the dipoles for resonance, one at a time, starting with dipole ABC. Raise end C (coax center conductor side) to the top of the mast (you do have a pulley or S-hook up there, don't you?), leaving a 4" to 6" space between the insulator and the pulley. Find the piece of tape you put at 17' down the coax from the center insulator and attach it to a place on the mast about 24' or 25' above the ground. A TV standoff insulator or a few wraps of electrical tape will serve the purpose. Take the other end of the 35' nylon rope tied to point B and walk away from the mast with it until the coax B-D becomes fairly horizontal. A little slack is okay, but make it as tight as good judgment says you should. Tie down the end of the nylon rope. Pick up the loose end of the dipole, A, and fasten it to the bottom of the mast with a short piece of nylon rope (4" to 6").

Dress the coax hanging from point D down the side of the mast, and use a few wraps of tape to secure it to the bottom of the mast. Take the rest of the coax to the shack and connect the end to your swr bridge, the bridge to your transmitter. Set the transmitter vfo to 14.2 MHz, load the transmitter for enough output to "drive" the swr meter to full scale forward, and check swr. From this point on, usual antenna adjustments for lowest swr indications should be followed, adjusting only the 16'8" lengths of the dipole at the feedpoint side of the traps.

Once the antenna is resonated at 14.2 MHz, set the transmitter to 7.2 MHz. Adjust the outer ends of the dipole, at insulators A and C, for lowest swr. The dipole should now be adjusted for resonance on 40, 20, 15, and 10 meters. It is not likely that the antenna will show 1:1 swr on any, much less all, frequencies; but the dipole will be resonant, and that is the important thing. Excessive swr will be flattened out in the antenna coupler.

Dipole EFG should be put up and adjusted in the same manner as dipole ABC, but you must take down, or at least collapse, dipole ABC while adjusting dipole EFG. If for no other reason, take this on faith.

Once dipole EFG is resonated, leave it in place and reerect dipole ABC. The two dipoles must be exactly opposite each other for predictable results, and the feedpoints should be about 34' apart, give or take a foot. For the sake of neatness and safety, tape the two feedlines together from the base of the tower to where they enter the shack. A couple of wraps of electrical tape every 8' or so will do nicely.

As I mentioned previously, the phasing unit is a simple but most effective device. I credit my good friend and mentor, Jerry Swank W8HXR, for first showing me this circuit. The only "tricky" thing about its construction is to be sure that you connect the shields of the two pieces of coax together and to ground. Use short pieces of RG-58/U between contacts 1 and 3 and the SO-239s. These pieces of coax should be the same length.

With the switch in position 1, dipole ABC lags dipole EFG. In position 2, both dipoles are fed simultaneously for in-phase operation. In position 3, EFG lags ABC. Fig. 3 shows directivity for the system on the various bands.

Performance

To state gain, front-to-back, and front-to-side figures in decibels for a practical antenna system can be, and usually is, misleading. Whenever I see such data, I wonder if the system in point is compared with an isotropic source, real dipole (horizontal or vertical), or vertical (ground plane, ground mounted with radials). And there is the consideration of angle of radiation of the main lobe(s). The best I can tell you about the perverted vee is that you can expect gain of 3 to 5 decibels in the main lobes and attenuation of 10 to 30 decibels in the nulls. The comparison is made against a single-element dipole such as ABC.

The perverted vee is an efficient radiator and an excellent DX system. As a vertical, it provides good low-angle radiation and directivity. Compared with ground-mounted or ground plane vertical phased arrays, it performs well with less dependence on Earth reflections, radials, etc. Compared with phased inverted vees or horizontal dipoles, it is far less complicated to put up, requiring only a single supporting mast or tower. And like an inverted vee, it will provide reliable middle- and short-distance communications.

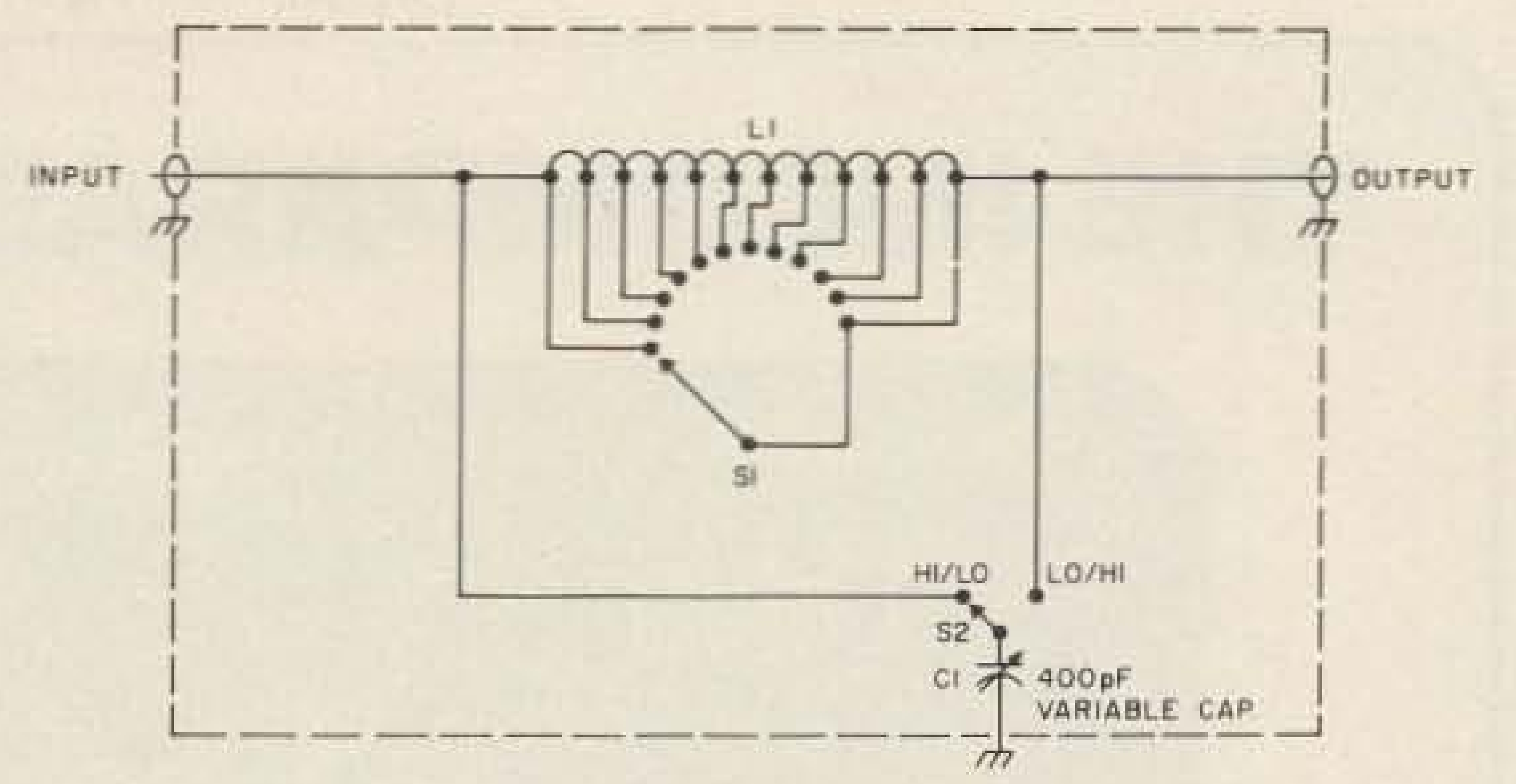


Fig. 4. L-network. C1 — 400 pF air variable capacitor; L1 — coil, 11 turn, 8 tpi, 2½" diameter, 11 gauge; S1 — 12-position rotary (phenolic okay to 300 Watts); S2 — SPDT rotary (phenolic okay to 300 Watts).

So, there it is, "an antenna system with gain, directivity, excellent front-to-back ratio, rotatability, low cost, and relatively simple and safe construction," with 4-band capability, as well. It's a whole lot cheaper than a linear amplifier (which does nothing to improve reception).■

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Parts List

120' antenna wire (I prefer 14-gauge enamelled copper. It is easy to handle, and the enamel coating prevents oxidation.)
70' nylon cord, 1/8" diameter
4 end insulators (ordinary 3" porcelain or 1" x 3" x¼" strips of Lucite,™
2 center insulators to accommodate RG-58/U (B&W, Hy-Gain, Pace, Greene, etc., or your favorite home brew type).
4 traps, resonated to 14.1 MHz (Pace-Traps or home brew)
2 TV standoff insulators (mast type)
1 50' push-up TV mast (if you don't already have one, or a 50' tower or 2 50' trees to string a catenary between)

LETTERS

from page 65

League's killing of CB on 220, the League's Code of Ethics to be forced upon everyone, and the League's futile efforts toward WARC '79, I realized who stood for amateur radio and who stands for themselves.

Your March editorial is a good point. When forced to show how much impact the Code of Ethics has had considering the amount of publicity they gave it, the League couldn't! Only a few distributors of gear had joined up, the main group of manufacturers telling the League to go jump! Your editorial also brought out into the open some new facts concerning the group known as HFers. While the League warns us of the sinister intentions of this group, only you have the courage to raise the point that by far these operators are the cream of the crop. While their actions are illegal (which most of CB was until the FCC legalized it), these operators attempted to do something about crowded band conditions, idiotic and dangerous operations, and the general improvement of their surroundings. Unfortunately, they have been held back in their growth to bigger and better things by the policies expounded by the ARRL. Rather than encourage them to advance beyond what they have now, the League drives everyone into Novice courses, the end result being that they can now use legally their Yaesus, Kenwoods, etc., on small portions of intensely crowded bands. Does the League encourage them to advance to General and above? No, they petition the FCC to widen the Novice band on 80,

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