Two HF Discone Antennas

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W8NWF loves his discone, a broadband, low-angle antenna. He also believes in building his antennas really rugged! You'll enjoy seeing how he made his discones.

The name *discone* is a contraction of the words disc and cone. Although people often describe it by its design-center frequency (for example, a "20-meter discone"), it works very well over a wide frequency range, as much as several octaves. **Fig 1** shows a typical discone, constructed of sheet metal for UHF use. On lower frequencies, the sheet metal may be replaced with closely spaced wires and/or aluminum tubing.

The dimensions of a discone are determined by the lowest frequency of use. The antenna produces a vertically polarized signal at a low-elevation angle and it presents a good match for 50-Ω coax over its operating range. One advantage of the discone is that its maximum current area is near the top of the antenna, where it can radiate away from ground clutter. The cone-like skirt of the discone radiates the signal—radiation from the disc on top is minimal. This is because the currents flowing in the skirt wires essentially all go in the same direction, while the currents in the disc elements oppose each other and cancel out. The discone's omnidirectional characteristics make it ideal for roundtable QSOs or for a Net Control station.

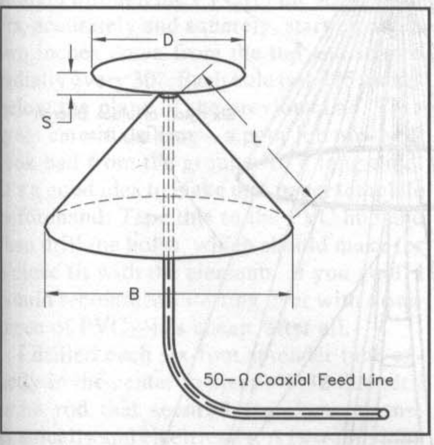

Fig 1—Diagram of VHF/UHF discone, using a sheet-metal disc and cone. It is fed directly with 50-Ω coax line. The dimensions L and D, together with the spacing S between the disc and cone, determine the frequency characteristics of the antenna. L = 246 / f_{MHz} for the lowest frequency to be used. Diameter D should be from 0.67 to 0.70 of dimension L. The diameter at the bottom of the cone B is equal to L. The space S between disc and cone can be 2 to 12 inches, with the wider spacing appropriate for larger antennas.

Electrical operation of this antenna is very stable, with no changes due to rain or accumulated ice. It is a self-contained antenna—unlike a traditional ground-mounted vertical radiator, the discone does not rely on a ground-radial system for efficient operation. However, just like any other vertical antenna, the quality of the ground in the Fresnel area will affect the discone's far-field pattern.

Both the disc and cone are inherently balanced for wind loading, so torque caused by the wind is minimal. The entire cone and metal mast or tower can be connected directly to ground for lightning protection.

Unlike a trap vertical or a triband beam, discone antennas are not adjusted to resonate at a particular frequency in a ham band or a group of ham bands. Instead, a discone functions as a sort of high-pass filter, coupling RF to the "ether" all the way from the low-frequency design cutoff to the high-frequency limits imposed by the physical design. The concept of not having to prune or tune an antenna was alien to my experience with ham antennas and lingered in the back of my mind even after my first discone was up and in use!

While VHF discones have been available out-of-the-box for many years, HF discones are rare indeed. I've seen some articles describing HF discones, where the number of disc elements and cone wires was minimized to cut costs or to simplify construction. While the minimalist approach is fine if the sought-after results really are obtained, I believe that if you want to experience how well an antenna will work, you should build it without compromise!

In this article I will describe two no-compromise discones I built, with some on-the-air observations. I will also include vertical radiation patterns produced by the *NEC/Wires* antenna program by Brian Beezley, K6STI.[1]

History of the Discone

A couple of months after building my first discone antenna, I obtained the July 1949 and July 1950 issues of *CQ* magazine. Both contained excellent articles on discones. The first article, by Joseph M. Boyer, W6UYH, said that the discone was developed and used by the military during World War II.[2] The exact configuration of the top disc and cone was the brainchild of Armig G. Kandonian. Boyer described three VHF models, plus information on how to build them, radiation patterns, and most importantly, a detailed description of how they work. He referred to the discone as a type of "coaxial taper transformer." I recommend reading Boyer's article, since it really helped me understand how the discone functions.

The July 1950 article was by Mack Seybold, W2RYI.[3] He described an 11-MHz version he built on his garage roof. The mast actually fit through the roof to allow lowering the antenna for service. (I wonder how many hams would do that today?) Seybold's construction techniques could still be used today and all materials are readily available. However, I think a more modern approach is to use PVC pipe for the hub, with tubular aluminum radial spreader elements, making a more streamlined and lighter-weight disc assembly.

Seybold stated that his 11-MHz discone would load up on 2 meters but that performance was down 10 dB compared to his 100-MHz Birdcage discone. He commented that this was caused by the relatively large spacing between the disc and cone. I believe the performance degradation he found was caused by the wave angle lifting upward at high frequencies. The cone wires were electrically long, causing them to act like long wire antennas. See **Fig 2**.

In the chapter on Multiband Antennas, *The ARRL Antenna Book* contains a construction article for a 7 to 29.7-MHz discone using a 36-foot high support mast.[4] This design had a 26 foot, $7^{1}/_{4}$ inch diameter top disc. Eight 1-inch OD aluminum tubing spreaders were used as spokes for the top disc, with wires connected between them. This substantial disc assembly was mounted to the vertical mast using two circular metal plates sandwiching a phenolic insulator. The 24 cone wires also served as guys for the mast.

The WARC Bands Made Me Do It!

Like many other ham radio operators, I went through a period of time when I put raising youngsters before my hobby. At the end of 1991, I asked my wife, Sandy, if she would give me a hand stringing up one end of a simple "V" wire antenna (remnants of a 1970-vintage rhombic). I was back on the air again and really enjoying it!

The upper HF bands were hot at that time and I was eager to try out the new WARC bands. My enthusiasm for hamming continued to build as I started using 17 and 12 meters. However, I still had to adjust the antenna-matching network every time I changed bands or tried to QSY a good amount. I also knew my "V" was doomed to come down someday, because its apex was rather precariously attached to the mast holding up our TV antenna. I started thinking about a broadband (and preferably multiband) antenna.

While reviewing all my radio handbooks, I came across "The Low-Frequency Discone" in *The Radio Handbook*, 14th edition, by William I Orr, W6SAI.[5] This article contains a drawing showing three different HF discones, a construction sketch for a 20-meter discone, and a graph showing the wonderful broadband SWR from 13.2 to 58.0 MHz. That convinced me to build one cut for just below 14 MHz. I was convinced that it would work well for the 20, 17, 15, 12 and 10-meter bands.

I decided not to stretch the antenna size to include 30 meters because I hadn't proved my particular style of construction. I felt it was more important to be successful on a smaller scale first.

My First Discone: the A-Frame Discone

A word of warning: building an HF dis-

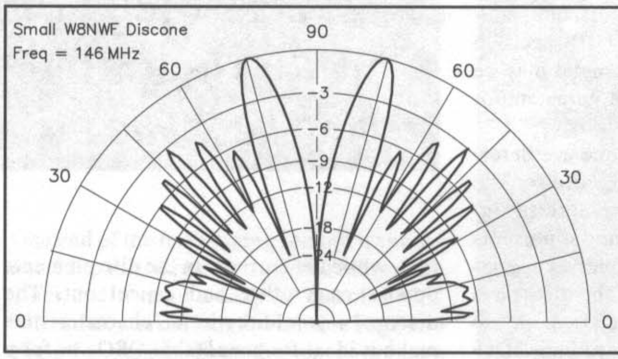

Fig 2—Computed elevation plot over average ground for W8NWF's small discone at 146 MHz, ten times its design frequency range. The cone wires are acting as long-wire antennas, distorting severely the low-elevation angle response, even though the feed-point impedance is close to 50 Ω.

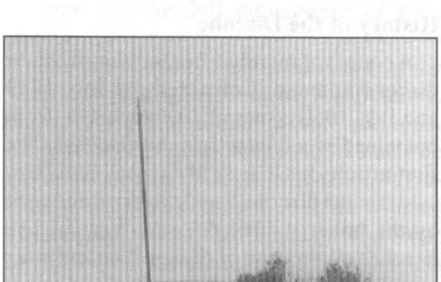

Fig 3—Photo of W8NWF's original A-frame mounted HF discone.

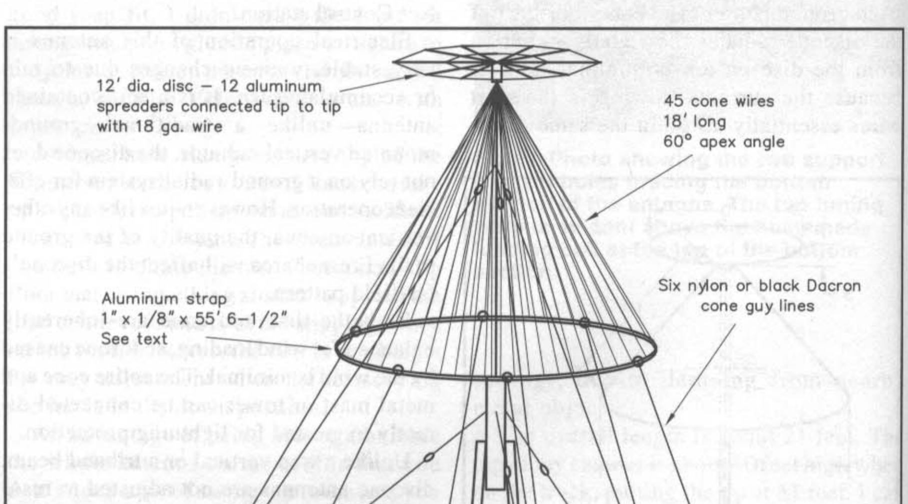

Fig 4—Detailed drawing of the A-frame discone for 14 to 30 MHz. The disc assembly at the top of the A-frame is 12 feet in diameter. There are 45 cone wires, each 18 feet long, making a 60° included angle of the cone. This antenna works very well over the design frequency range.

cone will take more than an afternoon! The good news is that you won't spend any time adjusting and tuning it. I recommend making a project out of it and savoring every minute of the planning and construction, as I did.

My first discone was one that would fulfill my need to cover 20 through 10 meters without using an antenna-matching unit. The cone assembly used 18-foot long wires, with a 60° included apex angle and a 12-foot diameter disc assembly. See **Fig 3** and **Fig 4**. I assembled the whole thing on the ground, with the feed coax and all guys attached. Then with the aid of a lot of friends, it was pulled up into position.

I used a 40-foot tall wooden "A-frame" mast, made of three 22-foot-long 2×4s. I primed the mast with sealer and then gave it two coats of red barn paint to make it look nice and last a long time. The disc hub was a 12-inch length of 3-inch schedule-40 PVC plumbing pipe. The PVC is very tough, slightly ductile, and easy to drill and cut. PVC is well suited for RF power at the feedpoint of the antenna.

For the 12-foot diameter top disc, I purchased three 12-foot by 0.375-inch OD pieces of 6061 aluminum, with 0.058-inch wall thickness. These were cut in half to make the center portions of the six telescoping spreaders. I also bought four twelve foot by 0.250-inch OD (0.035-inch wall thickness) tubes and cut these into 12 pieces, each 40 inches long. This gave extension tips for each end of the six spreaders.

See **Fig 5** for details on the disc hub assembly. I started by drilling six holes straight through the PVC for the six spreaders, accurately and squarely, starting about two inches down from the top and spaced radially every 30°. Each hole is 0.375 inches below the plane of the previous one. Take great care in drilling—a poor job now will look bad from the ground for a long time! It's a good idea to make up a paper template beforehand. Tape this to the PVC hub and then drill the holes, which should make for a close fit with the elements. If you goof, I would recommend starting over with a new piece of PVC—it's cheap, after all.

I drilled each six-foot spreader tube exactly in the center to clear a 6-32 threaded brass rod that secured the elements mechanically and electrically. A two-foot long by 1/4-inch OD wooden dowel was inserted into the middle of each six-foot length of tubing. The dowel added strength and also prevented crushing the element when the nuts on the threaded rod were tightened.

The 40-inch long extensions were inserted four inches into each end of the six-foot spreaders. I marked and drilled holes to pin the telescoping tips, plus holes big enough to clear #18 soft-drawn copper wire. This was for the inner circumferential wire for the disc. I also drilled a single hole for

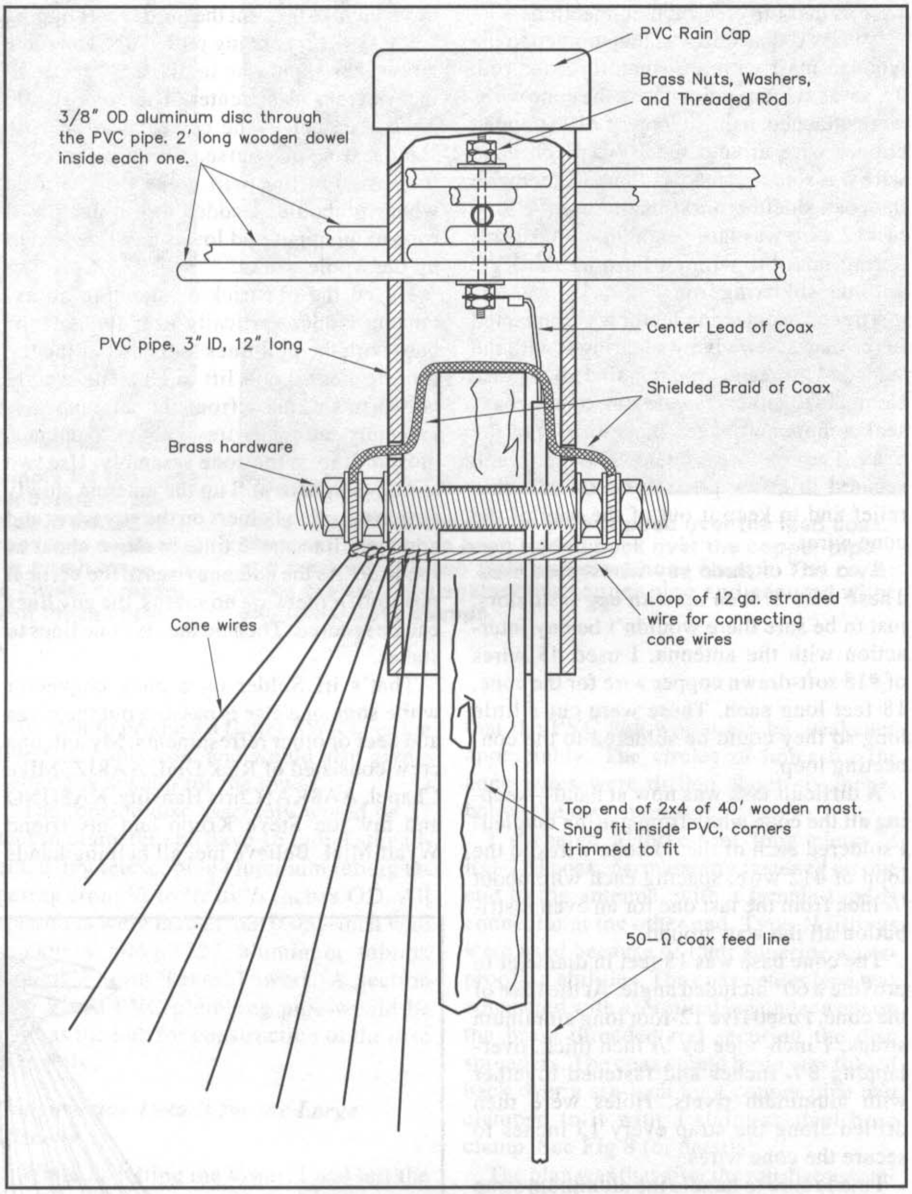

Fig 5—Details of the top hub for the A-frame discone. The three-inch PVC pipe was drilled to hold the six spreaders making up the top disc. Connections for the center conductor of the feed coax were made to the disc. The coax shield was connected to the cone-wire assembly by means of a loop of #12 stranded wire encircling the outside of the PVC hub.

#18 wire about 1/4 inch from each extension element tip, through which passed the outer circumferential wire. Finally, I inserted all six-foot elements into the PVC hub and lined up the holes in the center so the brass rod could be inserted through the middle to secure the elements.

My next step was to "chisel to fit" the top of my wooden mast to allow the PVC to slide down on it about six or seven inches. For convenience, I placed my whole mast assembly in a horizontal position on top of two clothesline poles and one stepladder.

The disc head assembly was placed over the top of the mast, but wasn't secured yet. This allowed for rotation while adding the disc spreader extensions. A tip for safety: tie white pieces of cloth to the ends of elements near eye level. Just remember to remove them before raising the antenna!

For a long-lasting installation, I used an anti-corrosion compound, such as Penetrox, when assembling the aluminum antenna elements. As the extensions were added, I secured them in the innermost of the two holes with a short piece of #18 wire. Then I ran a wire through the remaining holes looping each element as I went. This gave added support laterally to the elements. Next I added a #18 wire to the tips of the extensions in the same fashion. This provided even more physical stability as well as making electrical connections.

The PVC disc hub was then pinned to the wooden mast with a $^3/_8$-inch threaded rod. This was also the point where the cone wires were attached, using a loop of #12 stranded copper wire around the PVC. Each cone wire was soldered to this loop, together with the coax shield braid. I made sure the loop of #12 wire was large enough to make soldering possible without burning the PVC with the soldering iron.

The coax center conductor was connected to the disc assembly by securing it with the same 6-32 threaded rod that tied all the disc elements together. I made sure to use coax-seal compound to keep moisture out of the coax. The coax was run down the mast and secured in a few places to provide strain relief and to keep it out of the way of the cone wires.

Two sets of three guy wires were used. These were broken up with egg insulators, just to be sure there wouldn't be any interaction with the antenna. I used 45 wires of #18 soft-drawn copper wire for the cone, 18 feet long each. These were cut a little long so they could be soldered to the connecting loop.

A difficult task was now at hand—keeping all the cone wires from getting tangled! I soldered each of the 45 cone wires to the loop of #12 wire, spacing each wire about $^1/_4$ inch from the last one for an even distribution all the way around.

The cone base was 18 feet in diameter to provide a 60° included angle. At the base of the cone, I used five 12-foot long aluminum straps, 1 inch wide by $^1/_8$ inch thick, overlapping $8^1/_4$ inches and fastened together with aluminum rivets. Holes were then drilled along the strap every 15 inches to secure the cone wires.

I made sure to handle the aluminum strap carefully while fastening the cone wire ends; too sharp of a bend could possibly break it. I fastened six small-diameter nylon lines to the cone-base aluminum strap to stabilize the cone. These cone-guys shared the same guy stakes as the mast guy lines. After cutting the nylon lines, I heated the frayed ends of each with a small flame to prevent unraveling. I also applied several coats of clear protective spray to the disc head assembly, after checking that all hardware was tight. A rain cap at the top of the PVC disc hub completed construction.

Putting It All Up

The reward for all the hard work was close at hand! Speaking of hands, if you built the antenna I just described, you are going to need a lot of them now to raise the antenna. Have the whole process fully thought out before trying to raise it.

You should have the spot selected for the base of the mast and some pipes driven into the ground to prevent the mast from slipping sideways as it is being pulled up. The three guy stakes should be in place, 23 feet, $1^1/_2$ inches from mast center. The guys should have been cut to the correct length, with some extra, of course. Be sure the coax transmission line will come off the mast where it should. I added a long length of rope to an upper and lower guy line to pull up the whole works.

I used the old trick of standing an extension ladder vertically near the antenna base with the pull lines looped over the top rung to get a good lift angle. The weight added to the mast from the antenna disc assembly and cone wires is about 26 pounds, most of it from the cone assembly. Use two strong people to pull up the antenna slowly so that the other helpers on the guy wires and cone guy lines have time to move about as required. As the antenna rises to the vertical position, if there are no snafus, the guy lines can be secured. Then tie the six cone lines to stakes.

That's it! Solder on a coax connector while someone else is passing out the pizza and beer or other refreshments. My antenna crew consisted of Rick Dial, AA8JZ; Mike Chapel, AA8KA; Chris Hanslits, KA8UNO and my son Steve Krupp and his friend Wyatt Miel. Believe me, all helping hands were very much appreciated.

First QSOs

Even before I could get my transceiver set up on the picnic table beside the antenna site, my son had parked his car nearby and had connected the coax to his CB. (I hope that someday he will get his ham ticket.) My own first QSO using the discone was with Marty, WB9DCM, in Orlando, Florida, on 17-meter SSB. We talked for about 10 minutes and exchanged 57 reports. Then I said to AA8JZ, "Why don't you give it a try?" He got on CW and started a QSO with someone in England. That's when I noticed he was operating on 30 meters. I said, "That antenna wasn't designed for 30 meters. What's the SWR?" Rick replied that "It looks a little higher than you'd like to see, but it's working, isn't it?"

The next day I checked the SWR on 10 through 20 meters. I found a maximum SWR of only 1.6:1. Not bad, so I checked 30 meters and found it to be about 5:1 there. I later found it was possible to load up even on 75 meters using an antenna matching unit. I talked to stations on both East and West coasts. It was really a pretty small antenna for 75 meters!

During the year that I had it up, I used the antenna mainly on 17 meters, my choice of

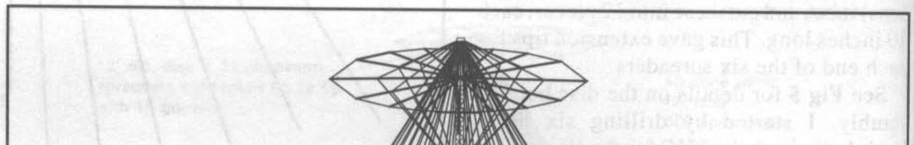

Fig 6—The large W8NWF discone, designed for operation from 7 to 28 MHz, but useable with a tuning network in the shack for 3.8 MHz.

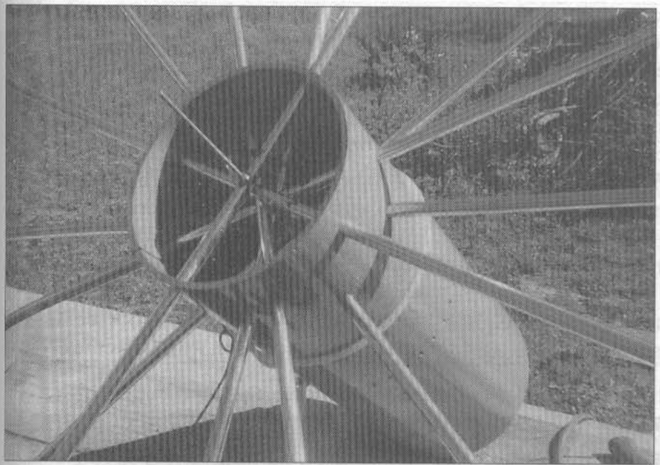

Fig 7—Photo showing details of the hub assembly for the large discone, including the threaded brass rod that connects the radial spreaders together. The 10-inch PVC pipe is drilled to accommodate the radial spreaders. Each spreader is reinforced with a three-foot long wooden dowel inside for crush resistance. Note the row of holes drilled below the lowest spreader. Each of the 36 cone wire passes through one of these holes.

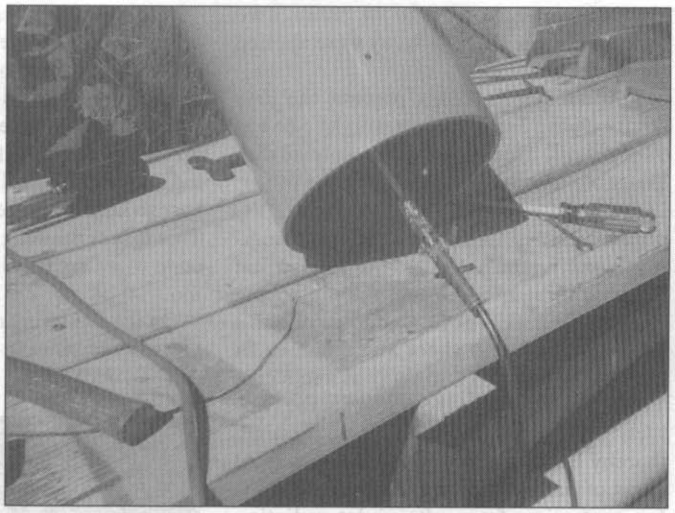

Fig 8—Details of the copper pipe slipped over the feed coax. The coax shield has been folded back over the copper pipe and secured with two stainless-steel hose clamps. The cone wires are also laid against the copper pipe and secured with additional hose clamps.

bands while the sunspot cycle was still pretty good. I was very pleased with the convenience of operation and with the good signal reports on all five bands.

Now, A Really Big Discone

I wondered how far the idea of covering all bands with one antenna could be carried. The thought of one discone antenna built for the 160-meter band and useful all the way up to 10 meters was intriguing. I'm afraid it's not very practical because of the pattern deterioration discussed earlier.

There was still the article in *The ARRL Antenna Book*—the discone covering 40 through 10 meters. I kept wondering about building a larger one. An opportunity finally came my way—a woman living nearby wanted to sell her 64-foot self-supporting TV tower.

My new tower had eight sections, each eight feet long. Counting the overlap between sections, the cone wires would come off the tower at about the 61.5-foot mark. The tower was installed on a cement base, which I made larger than normal since we have rather sandy ground.

I took some liberties with the design of this larger discone compared to the first one, which I had done strictly "by the book." There were two major changes. The first change was to make the cone wires 70 feet long, even though the formula said they should be 38 feet long. Further, the cone wires would not be connected together at the bottom. With the longer cone wires, I felt that 75 and 80-meter operation might be a possibility.

The second major change was to widen the apex angle out from 60° to about 78°. This should produce a flatter SWR over the frequency spectrum and would also give a better guy system for the tower.

The topside disc assembly would be 27 feet in diameter and have 16 radial spreaders, using telescoping aluminum tubing tapering from 5/8 to 1/2 to 3/8 inches OD. All spreaders were made from 0.058-inch wall thickness 6063-T832 aluminum tubing, available from Texas Towers. A section of 10-inch PVC plumbing pipe would be used as the hub for construction of the disc assembly.

Construction Details for the Large Discone

While installing the tower, I had left the top section on the ground. This allowed me to fit the disc head assembly precisely to it. Detailed preparation always makes final assembly a simpler and more pleasant job! **Fig 6** shows the overall plan for the large discone.

The 10-inch diameter PVC hub was designed to slip over the tower top section, but was a little too large. So a set of shims was installed on the three legs at the top of the tower for a just-right fit. Drilling the PVC pipe for the eight 5/8-inch OD elements was started about an inch down from the top. I purposely staggered the drilled holes in the same fashion as the hub for the smaller antenna. See **Fig 7**.

Again, three-foot sections of 1/2-inch wooden dowel were used to strengthen the 5/8-inch center portion of each spreader. Instead of using a loop of #12 wire for connecting the cone wires, as had been done on the smaller discone, I drilled 36 holes in the PVC hub. These holes are small enough so that the PVC hub would not be weakened appreciably. The circles of holes for the cone wires were drilled about six inches below the disc spreaders.

I prepared a three-foot long piece of RG-213 coax, permanently fastened on one end to the antenna, with a female type-N connector at the other end. Type-N fittings were used because of their superior waterproofing abilities. The coax center lead was connected with a terminal lug under a nut on the brass threaded rod securing the disc spreaders. The coax shield braid was folded back over a six-inch long copper pipe and clamped to it with a stainless-steel hose clamp. See **Fig 8** for details.

The plan was that after the top disc assembly had been hoisted up and attached at the top of the tower, individual cone wires would be fed, one at a time, through the small holes drilled in the PVC. They were to be laid against the copper pipe and secured with stainless-steel hose clamps.

The 1/2 and 3/8-inch OD spreader extension tips were secured in place with two aluminum pop-rivets at each joint. Again, antioxidant compound was used on all spreader junctions. A hole was drilled horizontally near the tip of each 3/8-inch tip all around the perimeter to allow a #8 aluminum wire to circle the entire disc. A small stainless-steel sheet-metal screw was threaded into the end of each element to secure the wire.

In parallel with the aluminum wire, I ran a length of small-diameter black Dacron line, securing it in a couple places between each set of spreaders with UV-resistant plastic tie-wraps. The reason for doing this was to hold the aluminum wire in position and to prevent it from dangling, in case it should break some years in the future. Two coats of clear protective spray were applied for protection.

A truss system helps prevent the disc from sagging due to its own weight. See **Fig 9** for details. This shows the completed disc assembly mounted on the top of the tower. I used a three-foot length of two-inch PVC pipe for a truss mast above the disc assembly, notching the bottom of the pipe so that it would form a saddle over the top couple of spreaders. This gave a good foothold. I cut a circle of thin sheet aluminum to fit over the 10-inch PVC to serve as a rain cap. The cap had a hole in the center for the two-inch PVC truss mast to pass through, thereby holding it down tight. A few light coats of paint were sprayed over the PVC for protection from ultraviolet radiation from the sun.

Sixteen small-diameter black Dacron ropes were connected at the top of the truss support mast, with the other ends fastened to the disc spreaders, halfway out. Another rain cap was added to the top of the two-inch PVC truss mast. Eight lengths of the same small diameter Dacron rope were added halfway out the length of every other spreader. These ropes were meant to be tied back to the tower, to prevent updrafts from blowing the disc assembly upward. I used small egg insulators near the spot where the eight bottom trusses were tied to the disc spreaders, just to be sure there was no RF leakage in rainy weather.

Hoisting the completed disc assembly to the top of the tower was done easily, with the assistance of my son Steve, his friend Wyatt, and my wife Sandy. The trickiest part was to get the disc assembly from its position sitting flat on the ground to the vertical position needed for hoisting it up the tower without damaging it. The disc assembly weighs about 35 pounds. My son Steve volunteered to go to the top of the tower to receive the disc as it was hoisted up by gin pole, and to mount it on the tower top. All went very well, and all the holes lined up too!

I had prepared three six-foot long metal braces going over the outside of the PVC to fasten to the tower legs. They really beefed things up. Once that was accomplished, we had pizza and refreshments, as the last glimmer of evening sunset glowed on that beautiful tower and disc assembly!

In plastic irrigation pipe buried between the house and tower base, I ran 150 feet of 9086 low-loss coax to the shack. For cone wires, I was able to obtain some #18 copperclad steel wire, with heavy black insulation that looked a lot like neoprene. The cone system takes a lot of wire: 36 × 70 feet = 2520 feet, plus some extra at each end for termination. You'd be well advised to look around at hamfests to save money.

As I connected each cone wire at the top of the tower, a helper would place the other end at its proper spot below. The lower end of each cone wire is secured to an insulator screwed into a fencepost. See **Fig 10**. There are 36 treated-pine fenceposts, each standing about 5$^1/_2$ feet tall, 45 feet from the tower base to hold the lower end of the cone wires. This makes mowing the grass easier and the cone wires are less likely to be tripped over too.

On the final trip down the tower, the eight Dacron downward-truss lines were tied back to the tower about six feet below the disc assembly. The tower has three ground rods driven near the base, connected with heavy copper wire to the three tower legs.

Performance Tests

On the air tests proved to be very satisfying. Loading up on 40 meters is easy—the SWR was 1:1 across the entire band. I can work all directions very well and I receive excellent signal reports from DX stations. I often switch to my long (333 foot) center-fed dipole for comparison while listening. I find

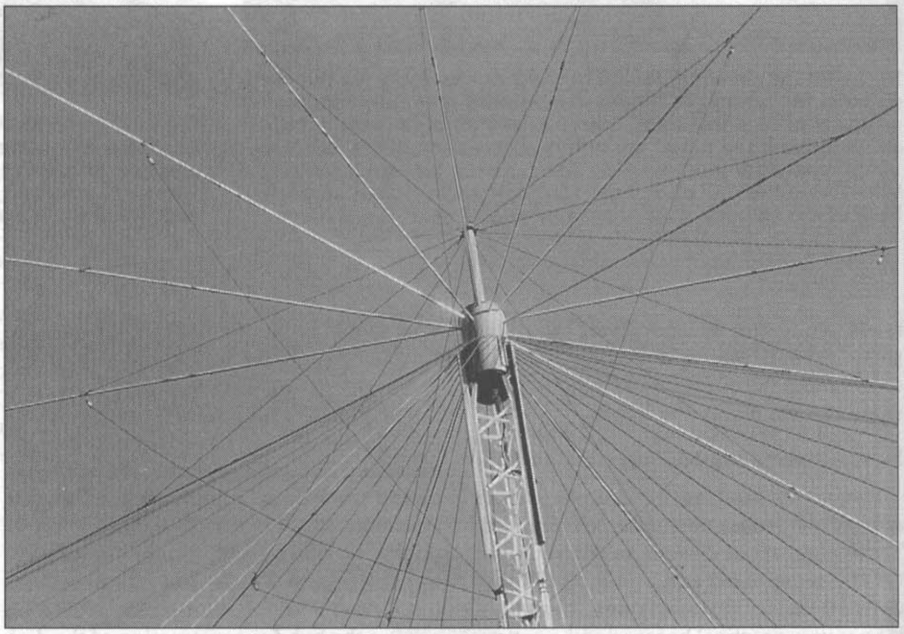

Fig 9—Photo of the spreader hub assembly, showing the truss ropes above and below the radial spreaders. This is a very rugged assembly!

Fig 10—Photo showing some of the fence posts used to hold individual cone wires to keep them off the ground and out of harm's way. The truck in the background is carting away the A-frame discone for installation at KA8UNO's QTH.

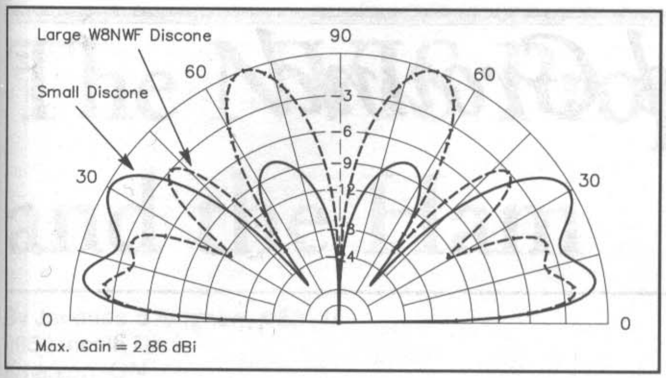

Fig 11—Computed patterns showing elevation response of small discone at 28.5 MHz compared to that of the larger discone at 28.5 MHz. The cone wires are clearly too long for efficient operation on 10 meters, producing unwanted high-angle lobes that rob power from the desirable low-elevation angles.

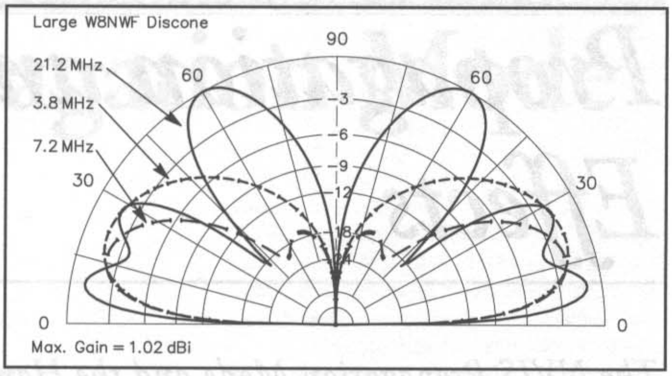

Fig 12—Computed elevation-response patterns for the larger W8NWF discone for 3.8, 7.2 and 21.2-MHz operation. Again, as in Fig 11, the pattern degrades at 21.2 MHz, although it is still reasonably efficient, if not optimal.

the dipole is much noisier and that received signals are weaker. During the daytime, nearby stations (less than about 300 to 500 miles) can be louder with the dipole, but the discone can work them just fine also.

I am happy to report that this antenna even works well on 75 meters. As you might expect, it doesn't present a 1:1 match. However, the SWR is between 3.5:1 and 5.5:1 across the band. I use a Ten-Tec 229 matching unit to operate the discone on 75. It seems to get out as well on 75 as it does on 40 meters.

The SWR on 30 meters is about 1.1:1, but since I haven't operated much CW lately, I have nothing to report for that band. On 20 meters the SWR runs from 1.05:1 at 14.0 MHz to 1.4:1 at 14.3 MHz. The SWR on the 17, 15, 12 and 10-meter bands varies, going up to a high of 3.5:1 on 12 meters. My on-the-air results are not as good as with the smaller discone. Of course, part of the reason is the decline of the sunspot cycle in 1994 and 1995.

Naturally, I had to try it on 160 meters, just for fun. I used the antenna-matching unit and could manage to load it. Reception for nearby stations was down about 4 or 5 S units compared to my dipole, and transmitting gave similar results. Listening to DX was a different story—I could hear DX stations Q5 that couldn't be heard at all on the dipole, because of the noise. I did receive a 53 report from CT1ESV on 160 meters using the discone.

My original intention for this antenna certainly did not include 160 meters, and it clearly does not transmit as well as an antenna designed specifically for that band. Sometimes, however, I use the discone to receive on 160 meters, while using the dipole for transmitting.

Radiation Patterns

From modeling using *NEC/Wires* by K6STI, I verified that the low-angle performance for the bigger antenna is worse than that for the smaller discone on the upper frequencies. See **Fig 11** for an elevation-pattern comparison on 10 meters for both antennas, with average ground constants. The azimuth patterns are simply circles. Radiation patterns produced by antenna modeling programs are very helpful to determine what to expect from an antenna.

The smaller discone, which was built by the book, displays good, low-angle lobes on 20 through 10 meters. The frequency range of 14 through 28 MHz is an octave's worth of coverage. It met my expectations in every way by covering this frequency span with low SWR and a low angle of radiation.

The bigger discone, with a modified cone suitable for use on 75 meters, presents a little different story. The low-angle lobe on 40 meters works well, and 75 meter performance also is good, although an antenna matching unit is necessary on this band. The 30-meter band has a good low-angle lobe but secondary high-angle lobes are starting to hurt performance. Note that 30 meters is roughly three times the design frequency of the cone. On 20 and 17 meters there still are good low-angle lobes but more and more power is wasted in high-angle lobes.

The operation on 15, 12, and 10 meters continues to worsen for the larger discone. The message here is that although a discone may have a decent SWR as high as 10 times the design frequency, its radiation pattern is not necessarily good for low-angle communications. See **Fig 12** for a comparison of elevation patterns for 3.8, 7.2 and 21.2 MHz on the larger discone.

What Have I Learned?

A discone antenna built according to formula will work predictably and without any adjustments. One can modify the antenna's cone length and apex angle without fear of rendering it useless. I believe the broadband feature of the discone makes it attractive to use on the HF bands. The low angle of radiation makes DX a real possibility. I am also pleased to report that my discone is much less noisy than my dipole on receive.

Probably the biggest drawback to an HF discone is its bulky size. There is no disguising this antenna! However, if you live in the countryside you should be able to put up a nice one. One last reminder: this antenna will transmit harmonics or other undesirable signals from your transmitter, so keep your signal clean.

Notes and References

[1] *NEC/Wires*, Version 1.54, by Brian Beezley, K6STI, 3532 Linda Vista, San Marcos, CA 92069.

[2] Joseph M. Boyer, W6UYH, "Discone—40 to 500 Mc Skywire," *CQ*, Jul 1949, pp 11-15, 69-71.

[3] Mack Seybold, W2RYI, "The Low-Frequency Discone," *CQ*, Jul 1950, pp 13-16, 60.

[4] "An HF Discone Antenna," *The ARRL Antenna Book*, 16th Edition (Newington: ARRL, 1991), pp 7-17 to 7-20.

[5] William I. Orr, W6SAI, editor, "The Low-Frequency Discone," *Radio Handbook*, 14th Edition (Editors and Engineers, 1956), p 369.