

A DXER'S PRACTICAL GUIDE TO BEVERAGE ANTENNAS

John H. Bryant

● INTRODUCTION

From my earliest years as a radio enthusiast, I heard rumors of a fabled, almost magic, "signal grabber" known as the Beverage antenna. It was purported to be a single, very long wire (1,000 to 10,000') mounted relatively low to the ground. It was supposed to be a poor man's radio telescope and allowed a DXer to hear virtually any station in the world on almost any frequency, if the monster were pointed precisely at the far away transmitter. In the 1950's, I made one attempt to find information on the Beverage antenna, but met with no success. I did not know then that Dr. Harold Beverage of RCA had published all of the basic research in an article in QST in the early 1920's.

In recent years, many have written extensively on the basic theory and electrical design of these remarkable antennas. The two basic sources of Beverage or "wave antenna" information are recommended: **Beverage and Longwire Antenna Design and Theory**, an extensive booklet published by the National Radio Club (see bibliography), and **The Beverage Antenna Handbook**, Second Edition, written and published by Victor Misek, PE W1WCR. The NRC booklet contains several excellent articles and the best bibliography that I've ever found on Beverages, compiled by Chuck Hutton. Misek's work has all been on shortwave, up to 7 megaHertz, and has especially believable antenna pattern diagrams, as well as excellent descriptions of designs for the electrical components of wave antennas. Misek also describes his extensive experiments on electrically steering wave antennas by phasing two identical parallel antenna elements.

My own "hands on" experience with Beverage began about three years ago. After 4 or 5 years of reading everything I could find about wave antennas, I found that no one addressed several practical concerns such as how to handle several thousand feet (!) of wire, or how to hold it in place easily and cheaply. While on a trip to the Pacific Northwest, I met two of the more knowledgeable Beveragers in North America (Don Moman, CIDX, Edmonton, and Nick Hall-Patch, IRCA, Victoria). They helped me with loads of practical advice. Since that trip, I have been able to DX almost constantly on a 1200 foot long Beverage. (See "The Okie Beverage," Proceedings 1988), and have put up numerous DXpedition Beverages varying in length from 1000' to 4800'!

The purpose of this article is to deal with some of the misconceptions surrounding this fabled antenna, to provide a practical guide to putting up and taking down Beverages, and to describe what DXing with one of these wonders is like.

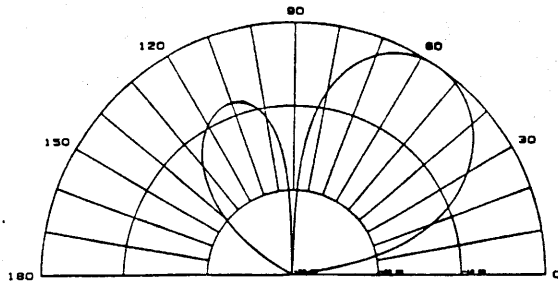
● SOME MISCONCEPTIONS

1. **Get a long enough Beverage and we could hear Canadian medium wave stations at noon here in North Texas.**

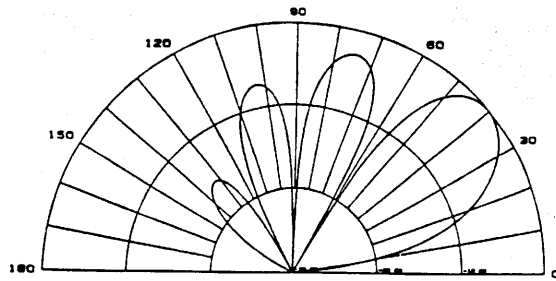
Nothing is impossible I suppose, but my experience is that no antenna, including the Beverage, can overcome propagation conditions. Beverage antennas are not THAT good. They are very quiet antennas with fairly good gain. Their effectiveness is due, at least in part to their directional nature; they are directional enough to only "see" part of the sky, thus reducing pickup of both man-made and natural noise. I believe that at least some of the legends which have built up around this antenna derive from urban-based DXers using Beverages only on DXpeditions where the improved rural RF environment itself was responsible for a significant part of their improved reception. Beverage antennas are good, maybe the very best, directional MW and low frequency SW antenna, but they are not magic.

2. Beverage antennas are highly directional.

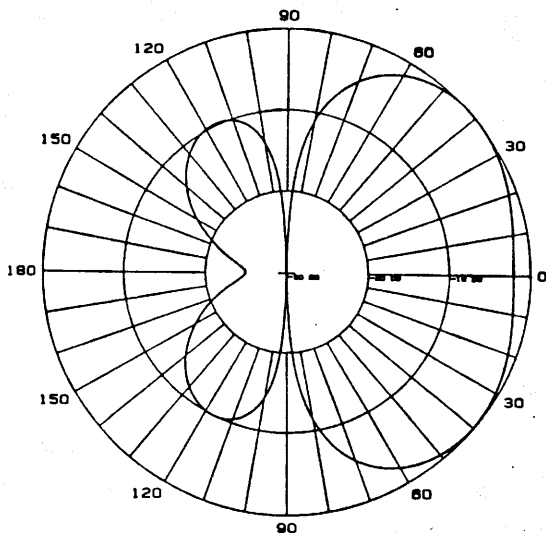
By this most people mean that the forward lobe or "beam" of the antenna is quite narrow (10 or 20 degrees). This is not true in my experience. Figure 1 and Figure 2 are azimuthal and elevation patterns of one wave length and two wave length long terminated Beverage antennas. I am aware that many authorities have drawn similar diagrams which indicate a much sharper lobe in the forward direction. However, on SW, Misesk's diagrams (as shown here) most closely match my experience.



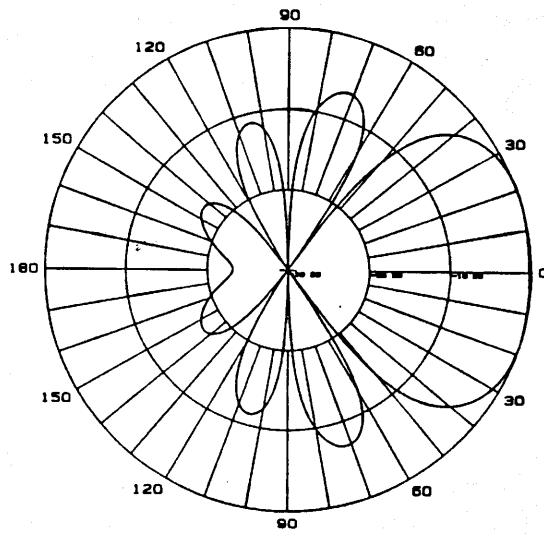
ELEVATION PATTERN



ELEVATION PATTERN



AZIMUTHAL PATTERN



AZIMUTHAL PATTERN

FIGURE 1

One wavelength long
Beverage antenna
(Terminated)

FIGURE 2

Two wavelength long
Beverage antenna
(Terminated)

What may be of very great interest to all Tropical Band DXers is the presence of extremely deep and sharp nulls, particularly at lengths of 2 wave lengths long and above. I should also note that some of my more formal experiments operating three Beverages simultaneously spaced 30 degrees of azimuth apart, indicates a decided "sweet spot" right down the length of the wire on MW frequencies. I am not sure whether this would happen at Tropical Band frequencies.

3. Beverage antennas will not operate on SW frequencies.

This myth is promoted by some senior MW DXers and some of Mr. Beverage's former associates. It simply is not true. I believe that the genesis of this myth is that most research (until the past generation) on wave antennas was done at medium and low frequencies. It is true that wave antennas of maximum performance on MW (above 1500' long) do not work well on the Tropical Bands. THEY ARE TOO LONG! Not too many authorities deal with wave antennas being too long for a particular frequency, and those that do differ on the maximum effective length for a particular frequency. However, all state the length limiting factor to be "phase cancellation." As the radio wave travels toward the receiver in the air, it induces a wave in the wire, which travels more slowly (velocity factor) than the airborne wave. The longer the antenna, the more the wavefront in the wire lags behind the one in the air. When a 90 degree phase difference is passed, the airborne wave begins to cancel out the one in the wire. If they arrive at the feed point 180 degrees out of phase, theoretically there is no signal left in the wire.

Just how long a Tropical Band Beverage should be is still somewhat confusing to me. Over an extended period, I have learned the following things about performance vs. length:

PHYS. LENGTH FEET (meters)	ABOVE 60 METERS	BAND 60 METER	BAND 90 METER	BAND 120 METERS	MEDIUM WAVE
1600'(560m)	poor	poor	fair	excellent	excellent
1200'(366m)	poor	fair	excellent	excellent	excellent
1000'(300m)	fair	excellent	excellent	excellent	very good

This would indicate that around six wave lengths (electrical) or five wave lengths (physical) is the appropriate length. Mizek favors Beverage antennas which are about 2 wavelengths long. We obviously need much more information about the performance of Beverage antennas which are under 1000' long.

● TO THE FIELD

There are probably as many ways to erect a Beverage antenna as there are serious DXers using them. However, I have collected suggestions into three broad categories which relate to the three types of Beverages which I have used. The first of these is the semi-permanent (and most expensive) Okie Beverage. The second is the temporary but inexpensive QC Beverage, and the last is the ultimate in fast and portable versions, the Beverage Onna Bush.

● THE OKIE BEVERAGE

The Okie Beverage is my semi-permanent 1200' wave antenna which runs over my rural lot and across two adjacent fenced horse pastures. It runs under two power lines with residential transformers and is within 500 yards of at least 15 homes.

When dealing with 1000 or more feet of wire, it is essential to have some form of mechanized help. The thought of hand wrapping that much wire around a spool is staggering. By far the most popular aid is one of the many models of metal or plastic reels meant to store garden hose.

Photo 1 is a picture of my original Beverage wire reel, a \$25 plastic model purchased from Sears. It will easily hold up to 5000' of insulated 16 gauge wire. Rewinding 1000' of wire is about a 5 minute task. For 5000', you need a good friend to help and about 20 minutes of hard work.

Photo 2 features my Beverage mentor, Nick Hall-Patch. His hose reel is mounted to a detachable wooden axle which is in turn, mounted to his DXing pick-up. This arrangement is more satisfactory than my hose reel, since it may be operated while standing and is a more secure foundation for vigorous winding.

A more sophisticated approach developed by Don Moman, the Executive Secretary of CIDX and a rabid Beverager, uses a re-winding mechanism fabricated from an old 12 volt gear reduced DC motor. This may be over-kill at lengths of less than 1000' (unless it's raining) but some form of automated take-up seems almost essential at lengths beyond 1000'.

Photo 3 depicts Proceedings 1989 co-editor Guy Atkins, operating his Beverage reel. It is powered by a rechargeable 3/8" electric drill! The reel, obtained from a local electrical supply house, sits directly atop a lazy-susan plate fabricated by Guy from hardware store parts. Guy reports no problems with this arrangement. The fully charged drill is capable of re-winding several 1000' reels of wire. Further ideas concerning "wire management" are discussed in the remainder of this article.

PHOTO 1
HOSE REEL
as
Beverage Winder

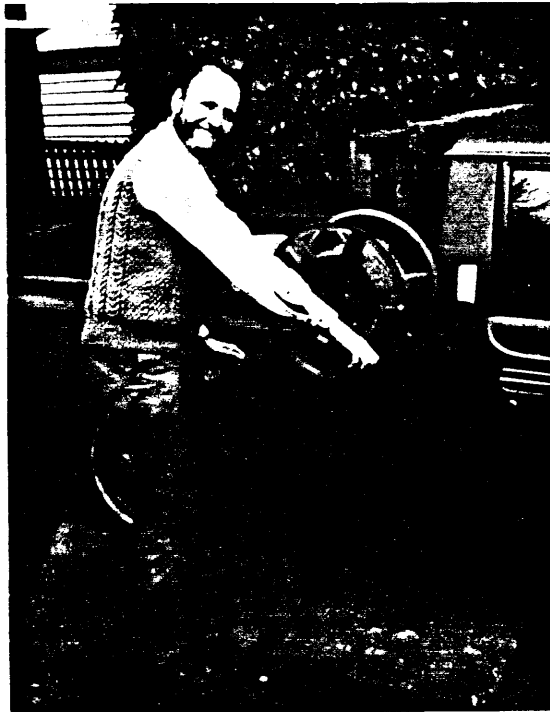
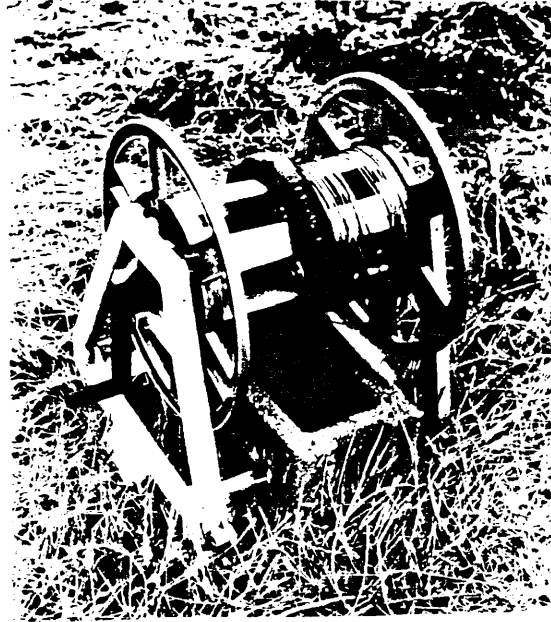


PHOTO 2
NICK HALL-PATCH
Winding His Wire

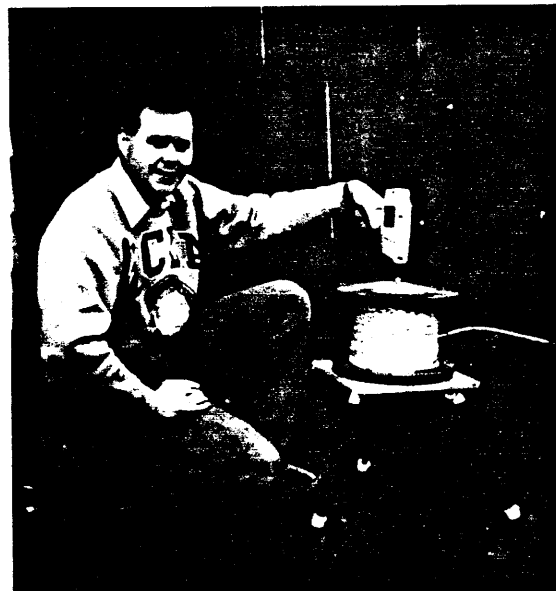


PHOTO 3
GUY ATKINS
Drilling His Wire

The second major element of the Okie Beverage, and its distinguishing characteristic, is the system of poles used to support the wire from 6-10' off the ground. Most DXers using this type of Beverage tend to use 2" X 2" stock lumber. Eight foot lengths of good quality material generally cost about \$2.00 per pole in 1989. People just erecting DXpedition Beverages often use 1" X 2" lumber instead. Using light gauge insulated wire, you can count on a pole placed every 100-150', so 10 poles are adequate for a 1000 footer. The wire is held in the top of the pole in a vertical saw cut 2" or so deep or by a small bent nail.

One major challenge, whether erecting a permanent or temporary Beverage is how to plant the poles. Don Moman made pole sockets by cutting light gauge 1 1/2" diameter pipe into foot-long lengths and welding foot long, 1/4" diameter, "railroad nails" to them. He pushes the spike in the ground and the pipe forms a socket for the shaped 1 X 2 poles.

Photo 4 shows Nick Hall-Patch's version of the same idea. He used a railroad nail, 2" plastic pipe and two large hose clamps. Nick reports that the cost of his pole base is about \$2.50 each.

Since I knew that the Okie Beverage would be semi-permanent and have to stand up to some pretty rugged weather, I designed the pole base shown in Photo 5 and Figure 3 to be fabricated in a local welding shop. It is made from 2" X 2" steel tubing and 5/8" diameter reinforcing bar. It is important to let the shop know that the INSIDE dimensions of the square tubing MUST be at least 1 3/4" X 1 3/4". My welder makes these things up for me in lots of 10 at \$5.00 per unit.

You should note that, with these pole systems, the poles at each end of the line must have support ropes to transfer the tension from the wire to the ground. I usually use 1/8" nylon rope.

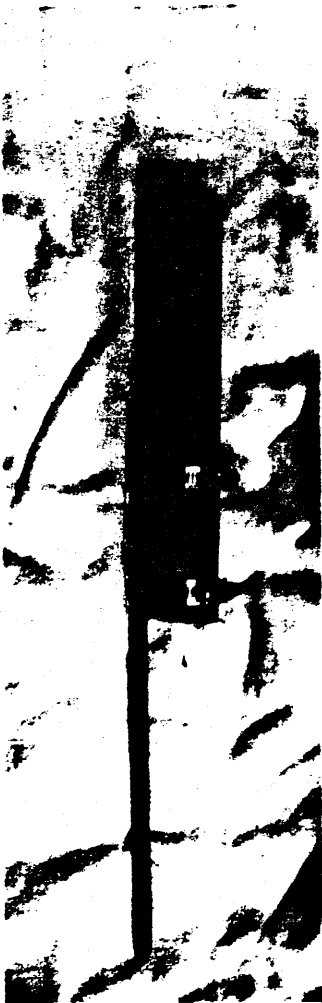


PHOTO 4
POLE SOCKET
(Hall-Patch)



PHOTO 5
POLE SOCKET
(Bryant)

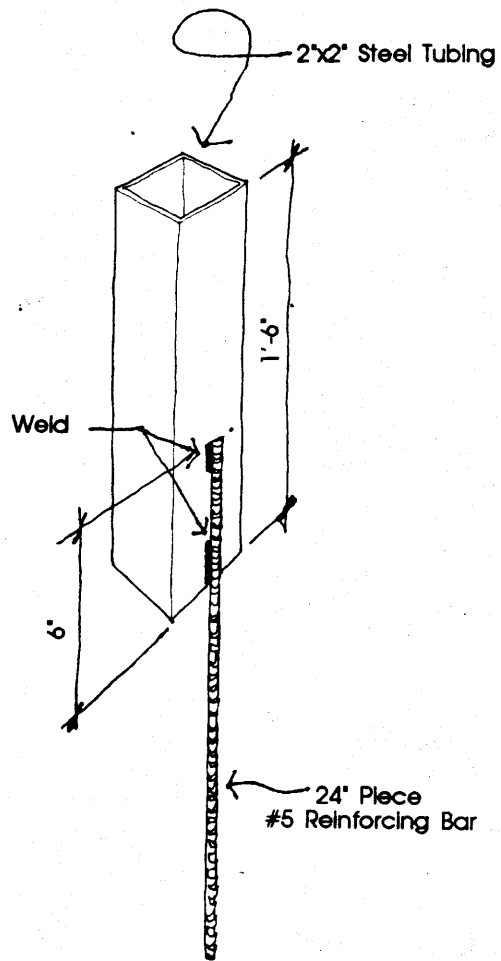


FIGURE 3
SHOP DRAWING
Pole Socket

● TERMINATION AND IMPEDANCE MATCHING

If you wish any Beverage to be omni-directional (as shown in Figure 1 and 2), rather than bi-directional, you will need to terminate the far end of the Beverage by grounding it through a resistor equal to its characteristic impedance, usually 500-600 ohms. The better the ground and the more accurate the match, the more nearly omni-directional the antenna becomes. For single wire non-steered Beverages, both Hall-Patch and I are fairly relaxed about termination. We use 560 ohm carbon resistors and 3' smooth steel ground rods, 1/4" diameter. We only install one rod per Beverage. However, to maximize directivity and nulling, more elaborate termination is usually necessary. Refer to Misek's Beverage Handbook.

If you are going to use coax as a lead in, or if your receiver has only a 50 ohm antenna input port, you really should fabricate an impedance transformer. These are covered in Misek's book and in the Proceedings 1988 article by Hall-Patch and Bryant. You are cautioned that running a 500-600 ohm Beverage into 50 ohm impedance causes signal loss of about 10 db.

● ERECTION

Erecting the Okie Beverage is rather simple, with one small trick. Lay out and erect the poles first, then haul the wire from the receiver end to the far end. Arrange to have someone tie off the wire when you reach the far end. THEN PUT THE WIRE UNDER ABOUT 15-30 POUNDS OF TENSION WHILE IT IS ON THE GROUND. Tie it, under tension, to the top of the far post, fix the termination arrangements and walk back along the wire lifting it to the top of the poles. It is much easier to pre-tension the wire in this manner, rather than walking back trying to hold the tension in the wire as you go.

One final caution: If you haul the wire out from the receiver end with it tied to your belt as I do, remember to go OVER any fence you encounter. Going under it, as I have done, wire attached, can ruin your afternoon when you discover your mistake. The Okie Beverage with the welded steel pole bases has withstood winds of over 60 mph and numerous storms without a problem. Twice in three years we have had major ice storms, breaking the wire in 2-3 places, and causing me to field solder with a propane hand torch. The Okie Beverage is between 6-10' off the ground and, therefore, is relatively safe to install where people/animals must pass under it.

● THE QC BEVERAGE

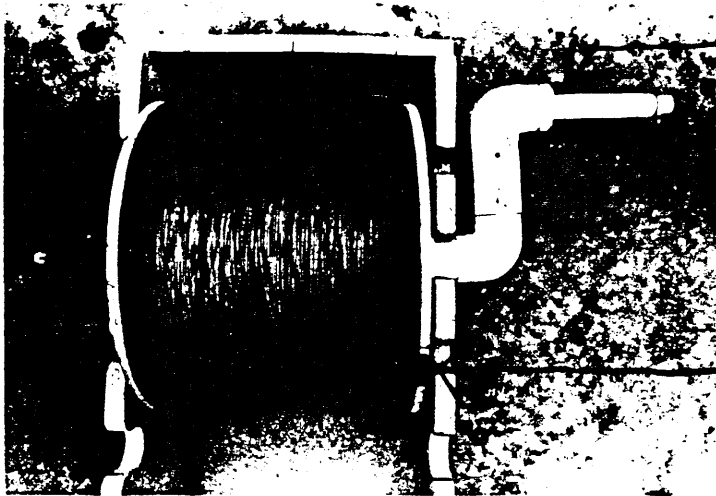
The Quick and Cheap(QC) Beverage is my own invention for DXpeditioning with multiple Beverages. I was fortunate enough to find over 12,000' of insulated 20 gauge wire at almost no cost, and began to dream of a "wagon wheel array" of Beverages for DXing and experimentation. At \$70 per Beverage for the poles and holders of the Okie Beverage, I could not afford multiple wire arrays, even with "free" wire. Further, the thought of erecting 4-12 Okie Beverages for a weekend day DXpedition sounded like more than my soon-to-be 50 year old legs could handle. So, I began to think of a new approach.

The first challenge was the wire management system. I went to the electrical supply store and obtained several 18" wide cable reels that were 12" in outer diameter and had 4" diameter cores. I then fabricated fixed axles and turning cranks for 3 of these reels from standard 1 1/2" PVC pipe and fittings. Refer to Photo 6. This shows one of the reels holding about 10,000' of 24 gauge insulated wire. I also built a cable reel rack from scrap 5/8" particle board. The reel rack was made with enough length and multiple notches to hold at least 2 cable reels at once, thus allowing easy transfer of wire from one reel to another. (See Photo 7 which shows FT editor Kirk Allen with the rack and reels). The system was also designed so that the reel rack could be placed in my truck. We also developed a 2 X 2 arm extending beyond the rider's side of the truck rear. The cantilevered arm holds 2 good grade pulleys. When paying out antenna wire, we can drive slowly, with one DXer riding the tailgate as reel minder, and another as driver. The wire can either be paid out directly behind the truck, or can be run through the pulleys and will fall in the roadside ditch. See Photo 8.

Two cautions:

A. We have found that it takes a person minding the reel as we drive along. The heavy wire-laden reel can build up momentum as it turns and, if the truck slows but the reel doesn't, a monumental wire snarl develops.

B. No matter how smooth the face of the reel box is where it holds the PVC axle, IT MUST BE LUBRICATED! We didn't do so the first time and wore through an axle in less than 1000'. A good layer of petroleum jelly solved that problem. Friction can be a problem at every point when you are driving at 5-10 mph and paying out thousands of feet of wire.



New Internal Axle and Removable Crank From 1 1/4" PVC Pipe

Used Cable Reel 12" Outer Diameter
4" Inner Diameter

PHOTO 6
THE QC BEVERAGE WIRE REEL

Holding 10,000 of
24 Gauge Insulated Wire



PHOTO 7
REEL RACK AND 2 REELS
and The Ever-Handsome Kirk Allen



PHOTO 8
INTO ACTION

Note Reel Rack in Rear of Truck
and 2x2 Cantilevered Pole Across
Rear of Truck Used to Lay Wire

The "wire management" problem was solved. That left the problem of stakes or poles to hold up all of these Beverages. I remembered an article by a medium wave DXer who used aluminum tomato stakes for antenna supports with no noticeable ill effects. That got me to thinking about metal stakes and rods. Photo 9 and Figure 4 both illustrate an antenna stake made from a scrap 2 X 4 block and a 4' long piece of 1/2" diameter reinforcing rod. The reinforcing rod is stocked, pre-cut, at most concrete plants. Ask for "#4 bar dowel rods X 4'-0" long" and they should know what you want. Mine cost \$.60 each in 1988.

That did it--the Quick and Cheap Beverage. Every 1000' of Beverage cost me \$6.00 for stakes and a small share of the \$10 cost for reels. And IT IS VERY QUICK. We temporarily tie the receiver end of the Beverage to a reinforcing bar driven into the ground at the future receiving site, and head the truck toward the appropriate point on the horizon paying out the 1000 or so feet of wire behind us with me riding the tailgate. When we get to the end, I hop off, drive a ground rod and stretch the QC Beverage tight. I then walk back down the Beverage with the truck proceeding beside me. Every 100' or so, I get a "re-bar" stake off the tailgate, drive it with a couple of blows from a hand sledge, drop the block on the top, place the wire in the saw cut and proceed on. This technique allows two of us to erect one 1000' Beverage every 15 minutes and not hurry while doing so. When they are all laid out, the truck sits in the middle as the DX shack. Taking up this wagon wheel of Beverages is also very fast, for it is done entirely from the tailgate in even less time.

The only negative aspect of the QC is that, being a thin waist-high wire, it will not work in a field occupied by other folks or (more likely in Oklahoma) cows wandering around. Luckily, there are plenty of fields in this part of the country just crying for a bunch of Beverages.

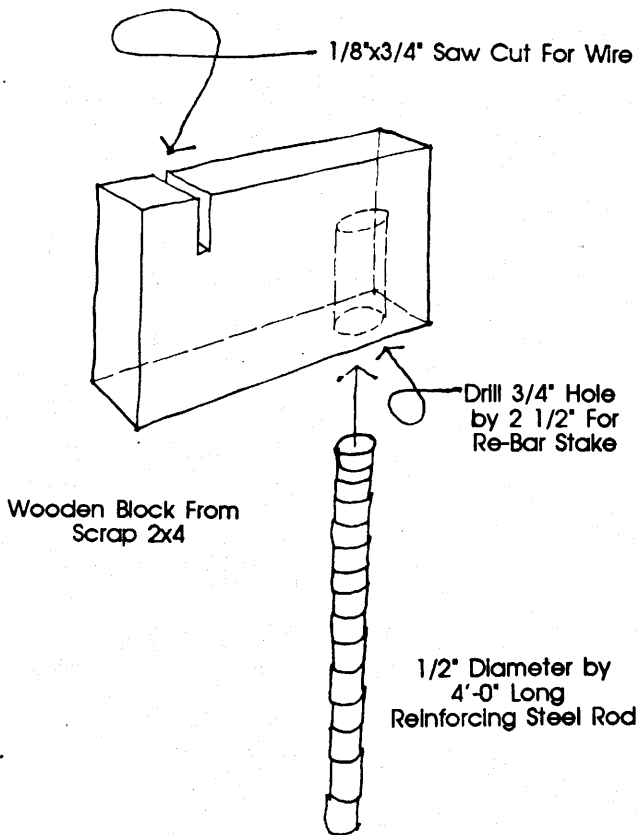


FIGURE 4
QC BEVERAGE STAKE



PHOTO 9
THE QC BEVERAGE STAKE
From Re-bar and Wooden Block

● BEVERAGE ONNA BUSH

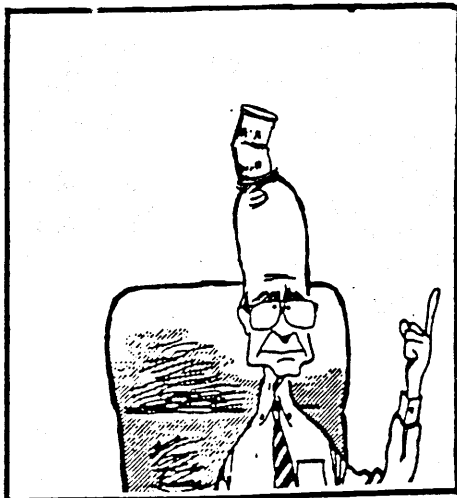
The Okie and QC models solved all of my Beverage problems save one. When I traveled by air, I was limited to a meager 100' Travel'n L antenna. This was particularly irksome when we headed for our favorite haunts in the San Juan Islands near Victoria, BC. A Beverage in the San Juans pointed down the Pacific at Jakarta is as near heaven as I plan to get for a while. I got to thinking about how my two Canadian Beverage mentors, Moman and Hall-Patch, really do most of their Beveraging. More often than not, they tend to ignore the formal thing with metal sockets, spikes and 1 X 2 poles. Many times, they just string wire in the brush along side a conveniently pointed roadway, put a ground rod in the roadside ditch and DX away. It seems to work for them.

That is where my thinking stopped until I saw one of the new "cord wheel" orange plastic wheels sold for storing extension cords. The "cord wheel" is a giant bobbin-shaped wheel with a turning crank on one outer edge and a sliding handle on the inner edge. See Photo 10. My unit (10 1/2" diameter outer rim, 6" diameter inner rim) is just perfect for holding 1000' of twin conductor, 24 gauge, insulated speaker wire. For air travel, I take along a shortened 2' long ground rod. Both it and the Beverage Onna Bush fit neatly among my shorts and socks in my folding carry-on suit bag.

● ERECTING THE BEVERAGE ONNA BUSH

1. Find a 1000' of straight road pointed within plus or minus 20 degrees of the Great Circle Route to your DX target area. The road needs to be lined with weeds from knee to waist high or with trees with fairly low branches or a combination of both.
2. Park your car/truck/van/armored personnel carrier where you want to use it as a portable DX shack. Attach the antenna FIRMLY to the car/shack, get the ground rod and cable reel and head out down the road on foot. When you get the antenna fully unwound, you'll know it (careful here!)
3. Put the antenna wire under a moderate amount of tension - about 15 pounds worth or so. Put the ground rod in the ground and tie the antenna mechanically to the base of the rod. Make sure that the electrical connection to the rod is through the resistor.
4. You now have the Beverage on the ground stretched between the car/shack and the ground rod. Walk back to the car picking the wire up and tossing it on top of the road side bushes. It's best if the wire doesn't touch the ground, but mine often touches in a couple of places between clumps of sunflowers. That's one of the reasons that I prefer insulated Beverage wire.
5. When you get back to the car/shack, clip your antenna lead on to the near end of the Beverage and DX away. (See impedance matching note earlier in this article.)

I know that this system sounds way too easy, but it works magnificently. The Beverage Onna Bush receives DX signals at least as well as my much more sophisticated Beverages. The set-up time and the simplicity of this system cannot be beaten. Using a modified version, Kirk Allen and I put up three Beverage Onna Bush antennas in less than 1 1/2 hours. Their total length was just over 11,500 feet!!!



Another Kinda
BEVERAGE ONNA BUSH



PHOTO 10
AUTHOR WITH CORDWHEEL

● COSTS AND SUCH

The only item mentioned in this article not locally available to most people is the insulated antenna wire. Shopping around for wire is very important because prices vary radically. The best place I've found for insulated speaker wire is: Omnitron Electronics, 700 Amsterdam Ave., New York, NY 10025. Phone is 800-223-0826 (local 212-865-5580). In the spring of 1989, their prices for 1000' of dual conductor speaker wire were: \$24.95 (24 gauge), \$54.95 (18 gauge) and \$89.95 (16 gauge). Shipping is extra, of course. Fair Radio Sales, 1016 East Eureka Street, P.O. Box 1105, Lima, Ohio 45802 (419-223-2196) often has even more reasonable prices on government surplus wire of all sorts.

Using the Omnitron wire prices and the other costs quoted in this article, the semi-permanent 1000' Okie Beverage cost \$99.50. A single 1000' waist high Quick and Cheap Beverage cost \$20.50 and a portable Beverage Onna Bush using insulated twin conductor 24 gauge speaker wire costly \$32.00, including the plastic "Cord Wheel" storage reel.

● PROOF OF THE PUDDING

What's it like listening to one of these Beverages? Well first, it is usually the quietest antenna I have available. The only time this is not true is when there is a major noise source centered in the front lobe of the antenna. It matters not whether it's man-made noise a mile down range or a thunderstorm mass 500 miles away--if the noise source is in the center of the major lobe, the Beverage is VERY noisy.

Secondly, the Beverage has a superb signal-to-noise ratio, much better than anything else I've used. The easiest way to describe this is an example: most of the 80 and 90 meter Ecuadorians come in here on my highest inverted L antenna at about S-7 or 8. With a moderate width IF filter, I hear good audio, but quite a bit of background noise, as well. Flip the switch to the Okie Beverage and the S-meter doesn't move much, but the noise goes away entirely. Or, take a well modulated transpolar Indonesian on 90 meters--on an average day, the S-meter might read S-3, and the audio would be noticeable but not understandable. At least half of that S-3 is noise. Flip to the Okie Beverage and the syllables of Bahasa Indonesian seem to rise out of the mud SIGNIFICANTLY.

I have never been able to get audio out of a weak DX signal with the Beverage when the signal was so weak that I could not even detect it as a het using my other antennas. However, there have been innumerable instances of having a het on another antenna and having DX-able audio on the Beverage. There have also been many occasions of hets on the Beverage when nothing was detectable on any other antenna. This kind of information is invaluable when planning for the next good opening.

All in all, I figure that about 30% of last year's DX catches were directly attributable to using a Beverage.

If you don't have room for a Beverage at home, what can you do between DXpeditions? Well, I've had up a 90 meter full wave Delta loop sloper (Clark, Proceedings 1988) for several months now and there are times when it out-performs the Okie Beverage on 90 meters, and equals it on 60.

If you do not have the space for a full wave horizontal quad or Delta sloper either, you might give the loaded Deltas in this book a try.

● FURTHER AREAS OF RESEARCH AND DEVELOPMENT

Short Beverages

Both Misesk and several of the senior MW DXers have reported very good success with Beverages of around 500'. However, published results of these efforts are relatively slim, especially as related to Tropical Band DXing.

Null Steering with Phased Beverages

The most excitement in recent years in MW DXing has been phasing various antennas to achieve either beam steering or null steering. The possibilities of null steering to reduce or eliminate co-channel or adjacent channel interference on the Tropical Bands is equally as exciting. As far as is known, only Misesk in the hobby community has explored this concept on Tropical Bands.

FINAL CAUTION: THE BEVERAGE IS A VERITABLE ELECTROSTATIC SPONGE.

I have blown one solid state RF circuit by leaving the Beverage attached when thunderstorms were more than 3 miles away. Be very careful with this stuff--it can bite. In the spring storm season, I disconnect the Okie Beverage from the house except when I'm actually DXing.

● **CONCLUSION**

Don Moman commented early on in this affair: "Our hobby is listening to radios, not putting up antennas." There for about a year, I was doing both as a hobby. I hope that this article will encourage others to start experimenting with these wonderful antennas. I hope that our collective experience has shown that serious Beveraging is both easy and cheap. You can maximize your time listening to super DX with a minimum of time spent wandering around trying to hang wire.

● **BIBLIOGRAPHY**

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