VERY LARGE FERRITE LOOPS

Bill Bowers and John Bryant

Over the years, there have been several medium wave and /or Tropical Band ferrite bar loops on the market. These have included the Palomar loop, the Space Magnet, the Dymek DA-9, the Radio West 22" and the Quantum Loop. Of these, only the Dymek and Palomar continue in production today. After testing most of these loops several years ago, it was clear that the loops with the larger ferrite bars gave noticeably better performance than the others, especially when used in a low noise environment. This observation coupled with the "normal" DXers' craving for ever more effective antennas prompted us to investigate loops with much larger ferrite bars.

The Radio West Antenna, with it's 22" bar assembly, was the leader among the commercial loops we tested. Unfortunately, it is no longer available. The next largest commercially available ferrite bar was the 12" x 3/4" rod used in the Dymek DA-9 antenna. This antenna gave very satisfactory performance and was used as a reference for comparison with the much larger loops that we designed and constructed during for this project.

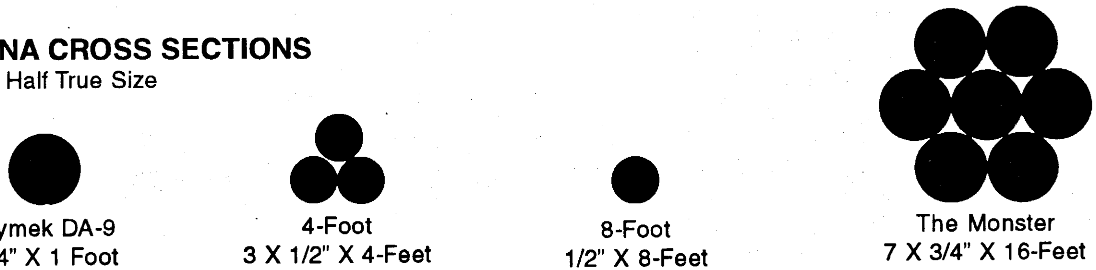
THE ANTENNAS

After a good bit of reading and calculating, we determined that the largest ferrite bar that we could build would be a 16 foot long composite bar constructed from approximately 112 bars of Amidon Type 33 ferrite material, each measuring 12" x 3/4" and arranged in a bundle with a 7 bar cross section. This undertaking turned into a major construction project since the ferrite rods alone weighed well over 100 lbs. Our finished product, now known as "The Monster" rotates and tilts just like most smaller ferrite rod loops. The Monster's frame is constructed primarily of wood, aluminum, and plastic. As design work on The Monster proceeded and its size and weight became obvious, we decided to construct an intermediate size loop as a prototype. This second antenna is the one noted as the 4-foot bar in the discussion below. It was constructed of a bundle of three Type 33 material bars each of 1/2" diameter. Later, as we began to suspect that sharpness and depth of nulls was directly proportional to the slimness of the ferrite bar, we constructed an antenna 1/2" in diameter and 8-foot long. It is also evaluated below.

With the exception of the 8-foot antenna, each antenna was constructed of Amidon Type 33 material which was readily available to us. Type 33 material is most effective in the LF and MW frequencies. For this reason, all of our tests were performed at medium wave frequencies. The rods in the 8-foot loop were Type 43 material which is useful to higher frequencies. Both types of bars had a permeibility of 850.

ANTENNA CROSS SECTIONS

Shown at Half True Size



Dymek DA-9
3/4" X 1 Foot

4-Foot
3 X 1/2" X 4-Feet

8-Foot
1/2" X 8-Feet

The Monster
7 X 3/4" X 16-Feet

ROD ASSEMBLY

The loops that were tested contained ferrite core assemblies as listed below:

ANTENNA	CROSS SECTION	AREA	EFFECTIVE DIAMETER	LENGTH	L/D	MATERIAL
Dymek DA-9	1 X 3/4"	0.44	0.75	12"	16	A-1
4-Foot	3 X 1/2"	0.59	0.87	48"	55	A-2
8-Foot	1 X 1/2"	0.2	0.5	96"	192	N
Monster	7 X 3/4"	5.25	2	192"	96	A-1

A-1: AMIDON R33-075-1200   A-2: AMIDON R33-050-750   N: NEBRASKA SURPLUS SALES, CAT. #ICH-FEROD-8

COILS

The coils on each of the larger loops were wound using 50x36 AWG Litz wire, since we had a generous supply of this wire available. Actually a 36 AWG wire is too large to afford a significant improvement in performance over a coil wound with normal solid wire. Litz wire of 42 AWG or 44 AWG strand is far more suitable for this application, but was not available.

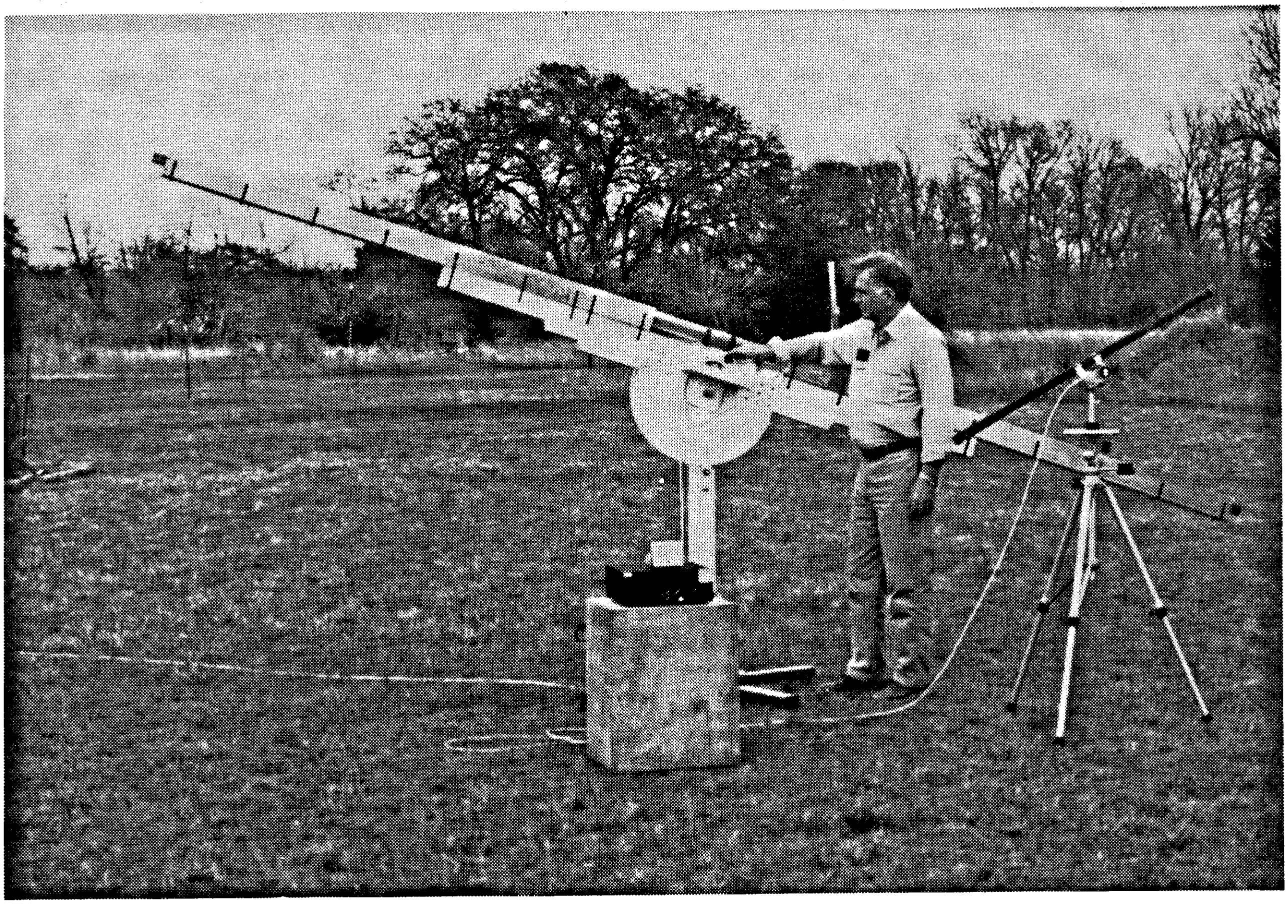
The number of turns in the coil of each antenna was adjusted to give an inductance as close to 0.25 mh as possible. This inductance made it possible to tune down to 530 kHz. with a standard 365 pf variable condenser and up to about 1600 kHz. with the smaller antenna/coil assemblies. However, the distributed capacity of the coils on the larger antennas made it difficult to reach to quite 1600 kHz. with the 365 pf variable capacitor we were using. Therefore, all of our high frequency tests were performed at 1490 kHz.

During the early phase of this project, we conducted experiments on the length of the pick-up coil. We tested coils wound with extremely wide spacing, intermediate spacing and close wound. No significant improvements were noted for any particular coil winding configuration. Our final coils were wound in the center of the rod assemblies with a gap between each turn approximating one wire diameter.

TEST ARRANGEMENT

During testing, the four antennas were not mounted as shown in the photograph. For actual performance testing, the antennas were positioned about 50 feet apart in a semi-circle around the receiver. During those tests, the whole set up was located in the open prairie several hundred feet from any structure.

To equalize the measurements of the signal output of each antenna, a single preamp from a Radio West 22" antenna was used. It was moved from antenna to antenna as the tests were made. The coax from the preamp was connected to a precision RF 20 db step attentuator and then to a Drake R-8 receiver. The R-8 receiver was modified by replacing the built-in S-meter with a large 50 microamp meter connected to the receiver by a 50 foot extension cord.



Co-author Bill Bowers with the Monster and the Four-Footer.

This made it possible to move the S-meter to each antenna location to measure the signal output at the maximum and null position of the antenna. Because of the logrythmic nature of an S-meter circuit, the step attenuator was used to keep the meter in the most sensitive range. Before conducting the final performance tests, the S-meter and the step attenuator were calibrated with known R.F. signals. For these measurements and for the tests, the R-8 was set at A.M., Fast AGC, and 2.3 kHz IF filter.

TEST SIGNALS

We had a number of different ideas for sources to be used as test signals in the final antenna tests. Deciding which type of signal to use in the performance tests was very difficult because we wanted to obtain both the most accurate and the most relevant results. Because of the constantly changing medium wave propagation conditions in the evening, signals from distant stations proved to vary far too much due to normal fading to be used for accurate comparative measurements. The final performance tests were run using signals from three near-by low power stations. To assure maximum accuracy, the test measurements were made between 10:00 AM and 3:30 PM when the signals from these stations were the most constant. Since these signals were virtually 100 percent groundwave, there was no need to tilt our antennas during the tests; this simplified matters considerably.

FREQ.	POWER	CALL LETTERS	LOCATION	DISTANCE
640	1 KW	WWLS	Moore, OK	48 Mi.
890	1 KW	KBYE	OKC, OK	48 Mi.
1490	1 KW	KOKC	Gutherie, OK	40 Mi.

Tests were conducted by tuning the receiver to one of the test stations and then connecting the preamp to the first antenna. We recorded signal strength readings at the maximum signal and then at the deepest null. The preamp was then moved to each of the other antennas and the procedure repeated. When the signal strength was so high that it deflected the S-meter past 3/4 scale, the step attentuator was used to bring it back to a more sensitive range.

RESULTS

The table below records the maximum signal strength measured in microvolts from the preamp when it was connected to each antenna. The signal strengths shown are an average of five readings taken over 3 days.

Maximum Signals in Microvolts

ANTENNA	640 KHz	890 KHz	1490 KHz
Dymek DA-9	1100	250	200
4-Foot	2100	550	400
8-Foot	1900	500	400
Monster	5200	1300	1000

The results were somewhat as expected, but were also in many ways disappointing. The disappointment was that we expected the output of The Monster to be much greater. With the cross-sectional area of The Monster nearly 10 times larger than that of the 4-footer (5.25 square inches vs. 0.59 square inches) and the L/D ratio being almost twice as much, we expected that the output of The Monster would be at least 10 times that of the 4-footer.

Since both antennas were constructed using the same Amidon Type 33 material, initially, there was no clear explanation for the lower output of The Monster. One factor that was not fully investigated was the possibility that the preamp input impedance may have loaded the higher Q Monster coil more than that of the 4-footer. Also, the preamp may have been over-loaded or non-linear when dealing with the stronger signals coming from the Monster. We were puzzled by these results during the tests but did not identify these potential causes until after testing was completed.

All of the antenna outputs dropped at the high frequency end of the spectrum. This is contrary to classic antenna theory and is probably due to losses inherent in the Type 33 ferrite material. Amidon suggests that Type 33 only be used up to about 1000 kHz. This signal drop-off may have also been due to the greater propagational losses inherent in the higher frequencies. This should have been checked with an air core loop and was not.

NULLS

All DX'ers know the advantages of using a moveable antenna which generates deep nulls and can therefore eliminate strong interfering stations. In our testing, the nulls were carefully and repetitively measured. It is important to note however, that a simple list of the minimum micro-volt signals at a null would have been very misleading. The maximum signal generated by that antenna on that station must also be considered in comparison with the minimum signal from that same station and antenna. For this reason, the table below lists the ratio of maximum signal/minimum signal. This approach means the larger the number listed below, the deeper the null achieved.

NULLING ABILITY: MAX. SIGNAL/MIN. SIGNAL

ANTENNA	L/D	640 KHz	890 KHz	1490 KHz
Dymek DA-9	16	40 to 1	32 to 1	28 to 1
4-Foot	55	81 to 1	66 to 1	57 to 1
8-Foot	192	95 to 1	82 to 1	67 to 1
Monster	96	90 to 1	82 to 1	59 to 1

The result of these tests clearly indicate that the deepest nulls are obtained by the antenna with the highest L/D ratio (or the most "slimness") of the ferrite rod assembly. However, there is more to the null story that the null numbers would indicate. In the case of the Dymek antenna, nulls look respectable numerically, but when a deep null was achieved, there was usually nothing but noise remaining. After all, these tests were being run in the middle of the day. However, with all the larger antennas, there were always one or more other stations audible in the same null during these same mid-day tests! This was particularly true when using The Monster.

VARIOUS CONCLUSIONS

GAIN: It is obvious that we confirmed the supposition that raw gain goes up with the size of the ferrite bar used. However, as we have noted, the gain increase obtained with The Monster was not as much as we expected. We will be pursuing this issue further.

"EFFECTIVE " or "USEFUL" GAIN: A general attitude in antenna design is that after a certain point, antenna gain is useless; and may even be counter-productive by causing receiver overload. The general idea is that if the antenna has enough gain so that the "noise of the band" is heard, every signal peaking above that noise floor will also be heard. The saying is that "Everyone in the boat goes up with the rising tide."

Although the above is certainly true, you must first be sure that you are actually hearing band noise. The Dymek antenna is a beautifully built commercial grade antenna based on a 12" x 3/4" rod. It has produced prodigious results in the hands of astute DXers. However, the difference in "hearability" or "effective gain" between the Dymek antenna and the 4-foot bar antenna was very striking! Signals that were weak and noisy with the Dymek became armchair copy with far less noise with the 4-foot bar. As we noted, when nulling strong stations with each of these antennas, we also noted significant differences. During these daytime tests, we often noted an "open channel" under the dominant signals with the Dymek and yet found one or more copyable signals in the same null with the 4-foot bar. This was even more apparent, of course, using The Monster.

DEEP NULLS

We were initially surprised that the nulls of The Monster and the 4-foot bar were similar. Eventually, we came to understand that the sharpness and depth of the nulls are somewhat proportional to the slimness of the bar. The 8-foot by 1/2" bar antenna was constructed primarily to test this hypothesis. Note that the slimness ratio of the 8-foot x 1/2" bar was 192, as compared to 55 for The Monster. As illustrated in the null figures, this very long 1/2" diameter antenna did, in fact, produce the deepest nulls.

OTHER LOOPS

This project was not designed to evaluate commercially available loops. We did not do so. However, since there is considerable interest in the performance of these antennas as compared to the larger ones that we have tested, the following general observations are reasonably accurate.

THE RADIO WEST 22" LOOP: The performance of the Radio West 22" antenna tracked that of the 4-foot antenna, but with somewhat less sensitivity and depth of nulls. Like the other ferrite loops at the null position, there were usually one or more signals audible during our daytime tests where the Dymek DA-9 often only produced what we thought of as "band noise" before we knew any better. The difference in performance between the Radio West 22" bar and the 4-footer was significant enough for any owners of these fine antennas to seriously consider adding length to their Radio West bars.

THE KIWA AIR CORE LOOP: The Kiwa Air Core loop became available after our testing program of commercially available loops was completed. Because of the wide interest in this innovative antenna, a few preliminary comparative tests were performed. First of all, we must mention that the Kiwa Loop has set a new standard for both beauty and professional quality mechanical design. The regeneration control of the amplifier is quite effective in providing a great deal of selectivity. It does, however, make the operation of the Kiwa loop somewhat more complex than the other antennas. If you are looking for a station on a specific frequency, the regeneration control can be peaked to give very narrow band width and maximum sensitivity. If, on the other hand, wandering around the band is in order, the regeneration must be decreased to a minimum and some retuning is necessary.

Compared with the 4-foot bar, the Kiwa loop gave noticeably BETTER performance above 1.2 MHz.! On the lower portions of the band, the 4-foot bar gave somewhat better signal strength and nulls. We were pleasantly surprised that any 1-foot diameter air core loop could 'keep up with' a very large ferrite antenna.

It is not fair to draw any final conclusions on these latter general comments. More detailed tests comparing an optimized 4-foot ferrite bar antenna with the Kiwa loop will be conducted and reported in the medium wave press.

THE BOTTOM LINE

After many configurations and tests, it is clear that bigger is better, but in this case, not all that much better. We will continue to experiment with The Monster for some time to come. Bill is determined to prove that classical theory is correct, even at this giant, off-the-design-chart, scale. John has plans to mount a John Deere tractor seat on the vertical column of the Monster so that we can ride it! We could control the thing with our feet and spin and point it just like a WWII antiaircraft gun! On the other hand, a 16 foot bar antenna that requires half the local high school football team to move around the yard probably is well beyond the law of diminishing returns. Whether one can afford the ferrite or not, The Monster is just not a practical DXer's antenna.

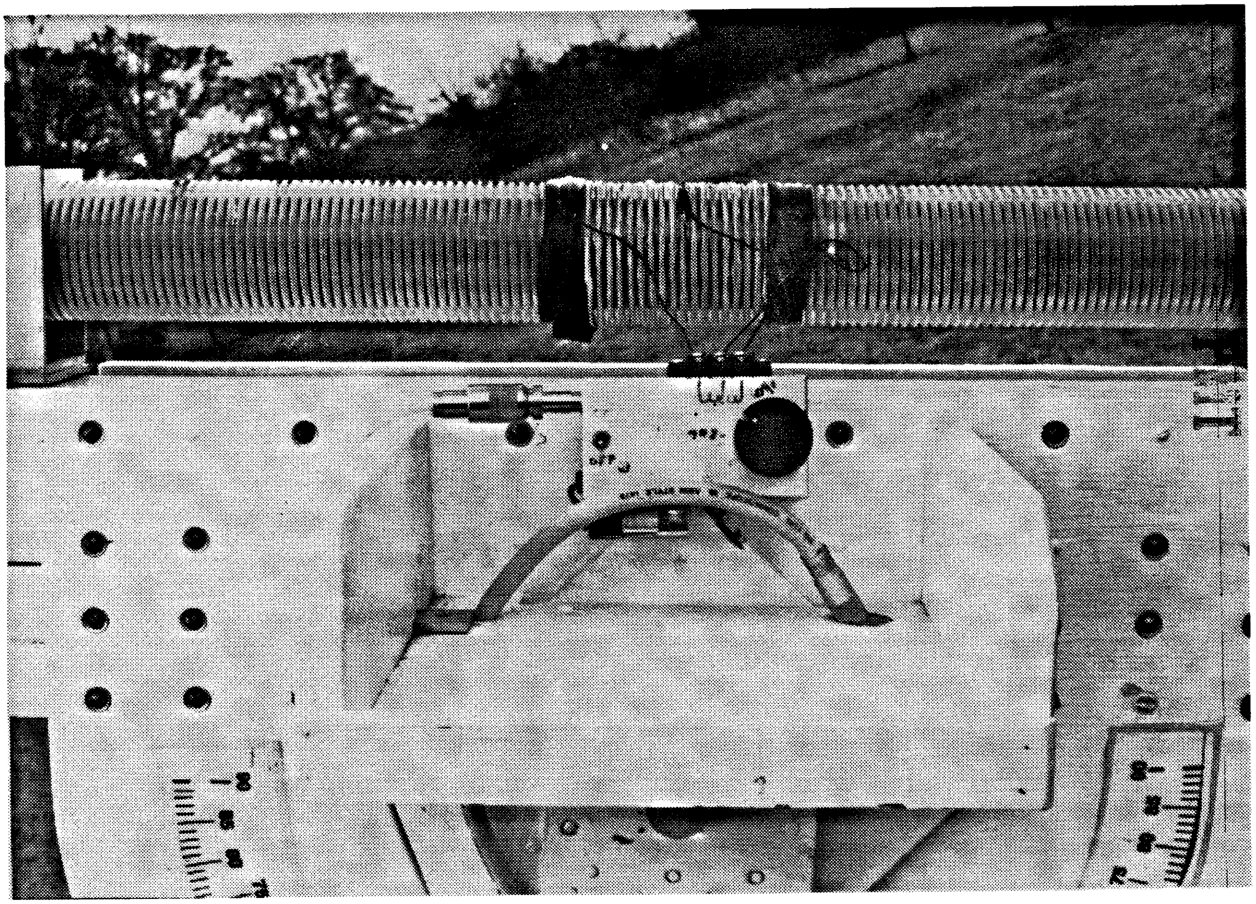
However, we are both fascinated with the capabilities of the 4-foot bar that we initially built as an intermediate prototype. It generates very good nulls, has very good gain and is a manageable size in the shack or on DXpedition. John has done some informal comparisons between the 4-footer and his wagon wheel array of 450′ Beverage antennas. The bar may not have quite the same gain in every case, but it is most certainly in the same league. We like the 4-footer so well that we now each have one in our shacks. We also hope to construct a 4-footer of ferrite of the correct type to work well on the Tropical Bands. Such an antenna would be able to null at least some local noise while possibly having very good gain. There is also a very good possibility that a ferrite bar Tropical Band antenna would be inherently quieter than many more conventional antennas.

AUTHORS' END NOTES:

Cost: The Amidon 7.5" x .5" Type 33 rods used on our first 4-footer now cost $20.00 each (AMIDON phone: 310-763-5770). A less expensive alternative would be to use their 4" x .5" rods at $6.00 each. The Amidon 12" x .75" Type 33 rods cost $20.00 each a number of years ago but are not now available. Amidon is willing to fill pre-paid special orders of the .75" rods for $75.00 each with a minimum of 10 rods.

A better alternative for rods may be the Nebraska Surplus Sales (1502 Jones Street, Omaha, NE, 68102-3112. Phone: 402-346-4750). Their 8" x .5" Type 43 rods cost from $9.00 to $12.00 based on quantity. The Type 43 material works quite well at both MW and Tropical Band frequencies.

4-Footer Construction Notes: Our design for the 4-footer consists of 18 eight inch long Nebraska Surplus rods bundled in a 3 rod cross section as shown early in this article. It is extremely important to stagger the ends (joints) of the rods. It is also important to bind the rods together so that no air gap developes between the ends of individual rods. The coil should consist of from 20 to 24 center-tapped turns, depending on the tuning capacitor available. We plan to publish a fully detailed construction article as soon as development is complete.



Central portion of the Monster showing coil and preamplifier shelf.