a monthly feature by

WILLIAM I. ORR, W6SAI

Antennas

Design, construction, fact, and even some fiction

"You look like *The Great Waldo Pepper*", I remarked as Pendergast leaned his *Moped* cycle against the wall of his shack and removed his World War I aviator goggles. He had a brown ring of dust around his eyes and mouth.

"How do you recognize a happy motorcyclist?", he asked.

"I don't know. How?", I replied.

"By the bugs on his teeth", replied my friend, with a roar. "Come on into the shack and see what the mailman brought me today".

I followed the World War I aviator into the radio room and he picked up a fat envelope and handed it to me, removing his jacket at the same time.

"It's from Tommy White, the last of the Red Hot Antenna men!", I exclaimed. What is this rascal up to now?"

Pendergast bent over the desk and examined the letter closely.

*48 Campbell Lane, Menlo Park, CA 94025

"Well", he exclaimed, "It looks as if K3WBH has come up with a two-band log periodic beam for 144 MHz and 432 MHz. Wasn't he the inventor of the *Whirling Bedspring Beam,* commonly known as *18 dB and a cloud of chicken wire?"*

"The same", I replied. "Let me see his sketch (fig.1)." I looked at the drawing, and said, "Well, it is well known that certain antenna types operate well on the third harmonic of the design frequency. Since a three-to-one relationship exists between the 2-meter band and the so-called-¾ meter band, Tommy took advantage of this and built up a two-band array. Many amateurs are interested in both bands, but have neither the time nor the inclination to festoon their QTH with beams for every band. So this looks like the ideal solution for the two meter operator who occasionally works 432 MHz.

"The basic design is a 2-meter log-periodic beam which has an auxiliary set of directors for the 432 MHz band. Tommy estimates the gain on 2-meters to be about 11.5 dB over a dipole, and about 15.5 dB over a dipole on 432 MHz. Most important, however, the bandwidth without significant deterioration in either gain or s.w.r. is 3 MHz on the 2-meter band and 9 MHz on the 432 MHz band.

"Very clever", said Pendergast, as he examined the drawing.

"Tommy says that the four directors for the 2-meter beam acts as 3/2-wavelength directors on 432 MHz. And to maintain proper director-to-director coupling on the 432 MHz band, additional half-wavelength directors are mounted in between the larger directors", I said.

Pendergast read from the letter, "The beam is built on a ¾-inch square aluminum boom, nine feet long. The parasitic elements for 2-meters are made of ⅜-inch diameter aluminum tubing and the parasites for 432 MHz

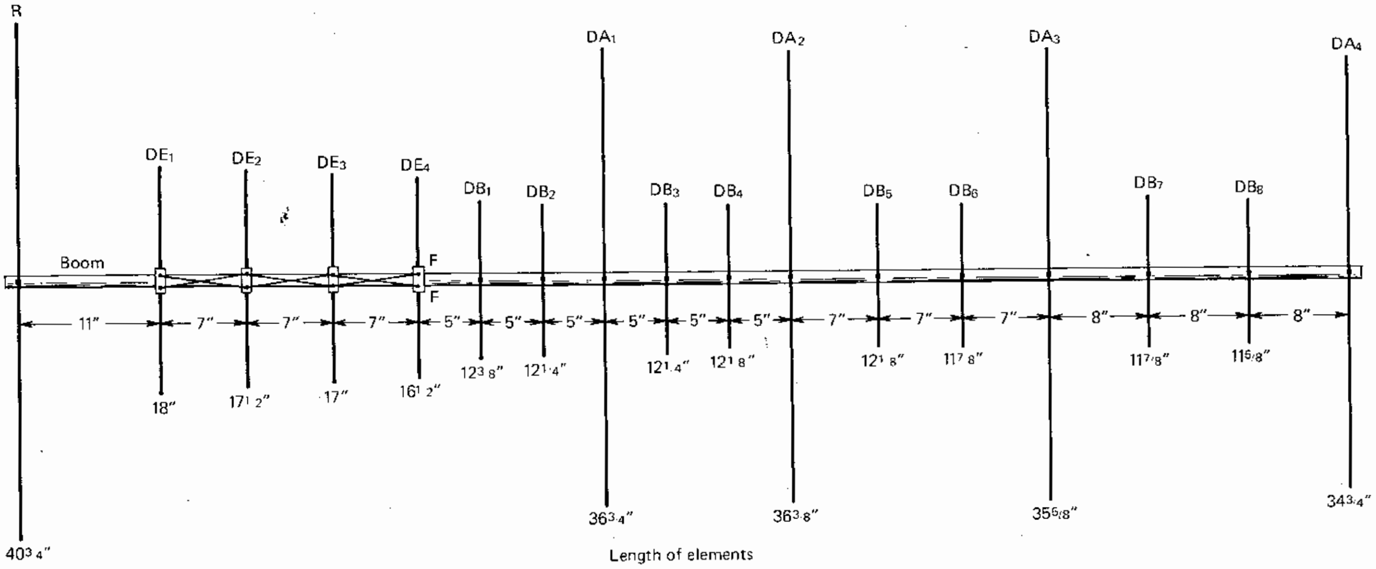

Fig. 1—The two-band VHF beam of K3WBH. This interesting version of the log-periodic yagi antenna provides superior gain on both the 144 MHz and 450 MHz bands. It is built on a 9 foot boom made of ¾"-square aluminum tubing. The 2 meter elements are made of ⅜"-diameter tubing and the 450 MHz elements are made of ¼" aluminum rod. All elements are mounted atop the boom with tubing clamps. Do not run the elements through the boom. Number 8 aluminum wire is used for the criss-cross connections for the driven elements (DE-1 through DE-4). Spacing between the inner tips is 2 inches. The antenna is fed with TV "ribbon" line at points F-F.

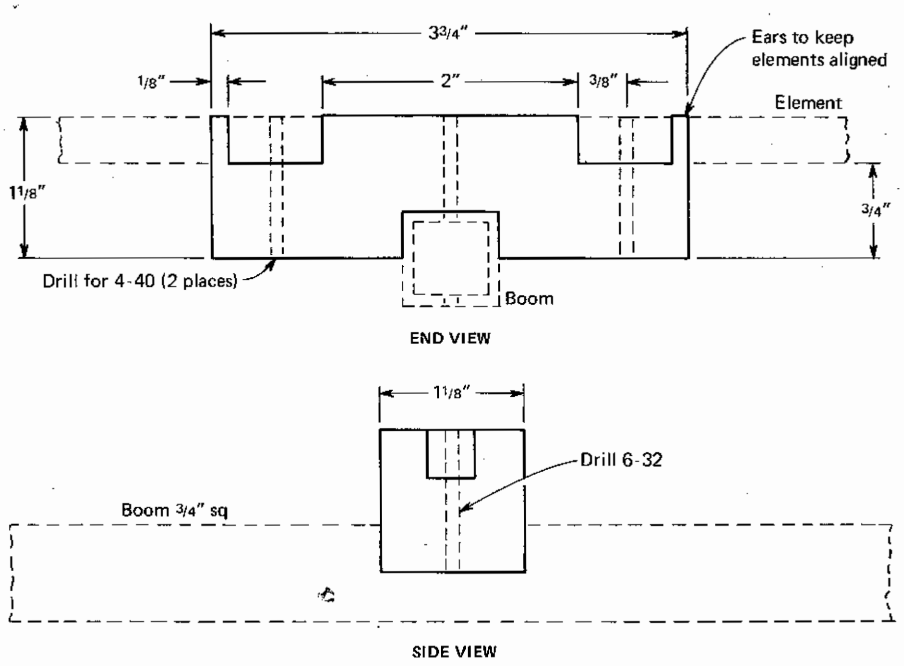

Fig. 2—The log-periodic elements (DE-1 through DE-4) are mounted on insulating blocks (four required). The blocks can be cut from cycolac, phenolic or other good v.h.f. insulating material. They are drilled so they may be attached to the boom with a 6-32 bolt. The element is held to the block with additional 4-40 bolts.

are cut from ¼-inch aluminum rod. The elements are mounted atop the beam with tubing clamps. The log-periodic elements are mounted on saddle blocks made of *cycolac*® or other insulating material (fig. 2). Number eight aluminum wire is used for the criss-cross feedline for the log-periodic section. Short lengths of plastic tubing are slid on the phasing line at the cross-over points before

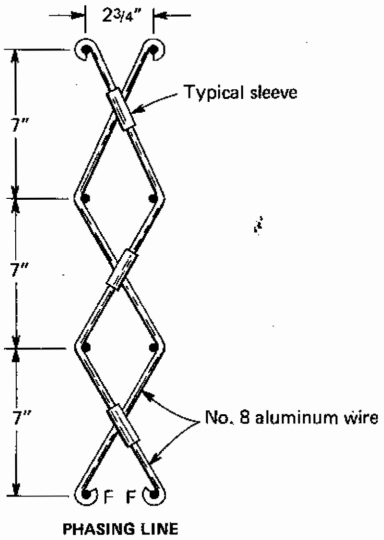

Fig. 3—The feedline for the log-periodic array is made up of #8 aluminum wire. The inner tips of the driven elements are drilled for 6-32 bolts. Spacing between the bolts is 2¾". Insulated sleeving is passed over the line to prevent shorts at the crossover points.

assembly to prevent contact between the wires (fig. 3)".

"What about feeding the antenna?", asked my friend.

"Well, the antenna can be fed with 300 ohm TV-type line. But Tommy recommends open-wire "ladder line" if much 432 MHz operation is contemplated. A four-to-one balun, of the type shown in the various v.h.f. handbooks, can be placed at the station end of the transmission line to match the system to 50 ohms".

"A stacked pair of these antennas should do a nice job", observed Pendergast.

"Tommy is trying that now", I replied. "He's using vertical stacking, with a separation between the bays of 80 inches. And he's using ladder line for the phasing harness. Perhaps we'll hear from him if the experiment is a success".

"Hey", shouted Pendergast. "We could make up an array of these, four high and eight wide on a steerable az/el mount and go after two-band EME (moonbounce)! Or maybe UFO bounce!"

"UFO bounce?", I asked.

"Certainly", said Pendergast. "If they are really there, let's prove it by bouncing a signal off them!"

"Pendergast, you amaze me sometimes", I said. "I like your class".

My friend squirmed in his chair and blushed slightly. "Let's talk about high frequency antennas", he said abruptly. "What do you have of interest?"

"Once again the RSGB magazine, "*Radio Communication*", has come through with some original thinking about high frequency antennas. In the October, 1976 issue there's an interesting article by G3YDX on the design of a capacity loaded mini-quad element for 14 MHz. He didn't have the space to erect a full size 14 MHz Quad, so a capacity-hat loading technique was applied to the Quad loop so that the overall size could be reduced to something less than 12 feet on a side (fig. 4)."

"How did G3YDX adjust the resonant frequency of the loop?", inquired Pendergast, as he produced his notebook from a pocket of his motorcycle jacket.

"He coupled a grid-dip meter to the drive point with a single turn loop and then adjusted the tips of the inner wires", I replied.

"Four bamboo spreaders, each eight feet long, were used to make up the framework," I continued. "The first arrangement, shown in fig. 4, showed resonance at too high a frequency. The final configuration—shown in fig. 5—hit resonance in the 20 meter band.

"When tested close to the ground, the loop compared with a ground plane antenna in many respects, except that it possessed a deep null in the plane of the elements.

"The next step was to build a parasitic reflector element. It was the same size as the driven element, but with a small, shorted stub added at the center of the bottom wire of the loop. The boom G3YDX used was an aluminum pipe about 8′6″ long. A gamma match was used to match the coaxial line to the array (fig. 6).

"How high did G3YDX place his mini-quad in the air?", asked Pender-

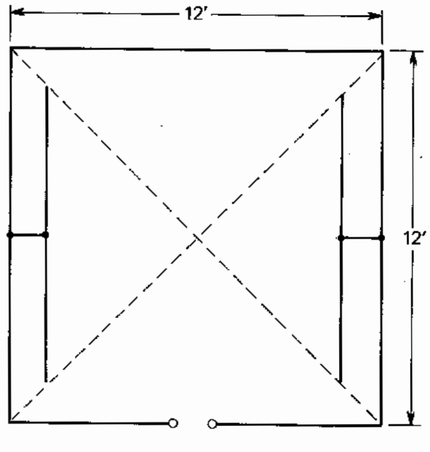

Fig. 4—The original mini-quad loop. Addition of the small "top hat" wires lowered the resonant frequency, but not enough to reach the 14 MHz. band. Loading wires were attached to the crossarms of the Quad assembly.

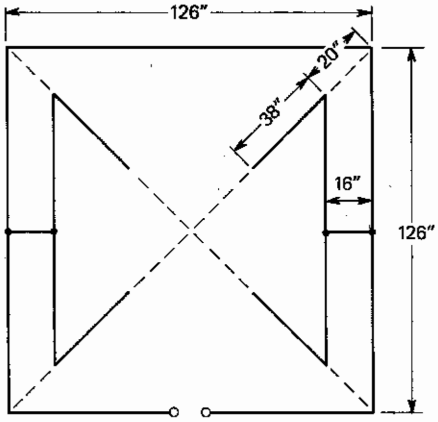

Fig. 5—Larger "top hat" wires permitted the mini-quad loop to resonate in the 14 MHz band. Connection to the quad loop is made at the center points of the sides. Loop is fed at the bottom.

gast, as he copied the illustrations into his notebook.

"Boom height was about 30 feet", I replied. "The quad was adjusted to resonance at 14,190 kHz then the stub was adjusted to provide the best front-to-back ratio. With a local station as a monitor, the best ratio turned out to be about 24 dB."

"That sounds pretty good to me", remarked my friend.

"Front-to-back readings can be misleading", I cautioned. "The front-to-back ratio of any beam can be affected by nearby objects, particularly when a close-in signal is used for test purposes. Reflection of the signal from hills or buildings can be misleading. I would much rather test front-to-back ratio on a DX signal, but that is a tough thing to do, considering the time it takes to rotate the array and the fading normally observed on DX stations".

"How about the bandwidth of the mini-quad?", asked Pendergast.

"Well, because of the reduction in size, the s.w.r. bandwidth of the array is somewhat reduced. Look at fig. 7. The antenna exhibits a 2-to-1 s.w.r. bandwidth of better than 200 kHz. This is very good, considering the bandwidth of other so-called mini-beams. When adjusted to 14,190 kHz, the mini-quad will still operate at the c.w. end of the band. The front-to-back ratio is poor, and an antenna tuning unit is recommended, because the s.w.r. is rather high—above 3-to-1. Nevertheless, the beam still functions at 14.0 MHz.

"About the gain. A reduction in antenna size means a reduction in bandwidth, but it necessarily does not mean a reduction in power gain. It is very difficult to measure antenna gain without precise instrumentation and a good antenna range. However on-the-air tests run over a long period of time by G3YDX suggests that this mini-quad is within a half-decibel of the power gain of a full-size Quad antenna. G3YDX lists an impressive bunch of DX stations with whom he tried the mini-quad against his ground plane. The increase in signal strength on both transmission and reception is impressive. In most cases it amounted to an "S-unit", or better. And in one or two difficult, long skip contacts, it was the difference between a QSO and not being heard at all".

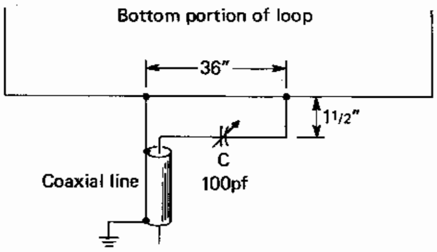

Fig. 6—Gamma match for the mini-quad loop. Gamma wire is 36" long and spaced about 1½" away from the loop. The series resonating capacitor is set at about 100pF.

Pendergast continued to sketch the information in his notebook. He paused and remarked, "I would think that a mini-antenna of this type would be hard to tune up".

"Well, it is important that the elements be tuned carefully. With any miniature antenna, small changes in dimension, or in assembly, can cause rather large frequency changes in resonance. G3YDX mentions that bamboo poles, even when coated with varnish, are not very good insulators in wet weather and he suggests that fiberglass fishing poles should make much better insulators.

"The inner wire sections of the elements can be supported by nylon cord, or taped to the poles. Since this places the high voltage sections of the elements in very close proximity to the supporting structure, it can be seen that fiberglass poles would provide the best insulation."

"Well", said my friend, closing his notebook with a snap, "This is certainly an interesting antenna for the DX chaser who doesn't have much room to erect a good beam antenna. I like it!"

"One more item before you trot off", I said. "You might be interested in this new development from Amphenol (fig. 8). This is a quick-disconnect coupling ring for the common PL-259 coaxial plug. You remove the standard coupling ring from the plug and screw the new ring (Amphenol part number 83-693) onto the connecting body of the plug. Presto! You have a quick-disconnect plug that snaps on and off the standard SO-239 receptacle".

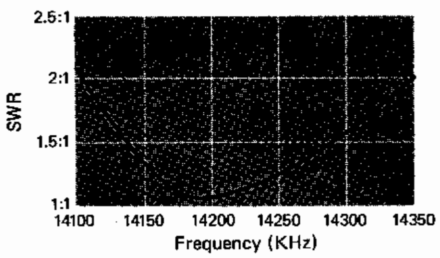

Fig. 7—Bandwidth response of the mini-quad beam. The bandwidth between the 2-to-1 s.w.r. points is better than 200 kHz. Reflector is spaced 8½' from the driven loop.

"What will they think of next?", murmured Pendergast, as he replaced his World War I aviator goggles and advanced towards his *Moped* cycle." Just the gadget for the happy CBer". ■

Note: Additional information on Quad antennas may be obtained from the handbook, *"All About Cubical Quad Antennas"*, by Willian Orr, W6SAI. Available from Radio Publications, Box 149, Wilton, CT 06897. Price: $4.75 plus 35¢ postage and handling. *"Radio Communication"* is a publication of the Radio Society of Great Britain, 35 Doughty St., London WC1N 2AE, England.

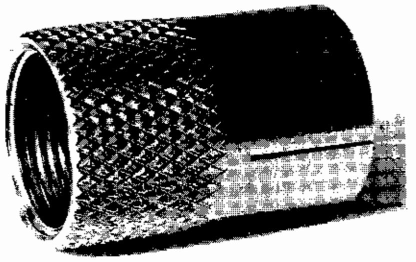

Fig. 8—The new Amphenol quick-disconnect coupling ring for the PL-259 plug. Designed to take the place of the existing ring, this new gadget provides a quick break-away for experimental work.