ARRL Periodicals Archive – Search Results
A membership benefit of ARRL and the ARRL Technical Information Service

ARRL Members: You may print a copy for personal use. Any other use of the information requires permission (see Copyright/Reprint Notice below).

Need a higher quality reprint or scan? Some of the scans contained within the periodical archive were produced with older imaging technology. If you require a higher quality reprint or scan, please contact the ARRL Technical Information Service for assistance. Photocopies are $3 for ARRL members, $5 for nonmembers. For members, TIS can send the photocopies immediately and include an invoice. Nonmembers must prepay. Details are available at www.arrl.org/tis or email photocopy@arrl.org.

QST on CD-ROM: Annual CD-ROMs are available for recent publication years. For details and ordering information, visit www.arrl.org/qst.

Non-Members: Get access to the ARRL Periodicals Archive when you join ARRL today at www.arrl.org/join. For a complete list of membership benefits, visit www.arrl.org/benefits.

QST Issue: Apr 1971
Title: Two-Meter Eggbeater, The
Author: Dave Thornburg, WA2KZV/WA1MJD

Click Here to Report a Problem with this File

The Two-Meter Eggbeater

Omnidirectional Horizontal Antenna of Simple Design

BY DAVE THORNBURG,* WA2KZV/WA1MJD AND LES KRAMER,** WA2PTS/WA1JWN

WHEN OPERATING 2-meter mobile in the East the problem of antenna polarization is encountered frequently. The simple whip is vertically polarized, and most home station antennas not used for fm are horizontal. An omnidirectional horizontally-polarized antenna is desirable. Current 2-meter designs widely used include halos, turnstiles, and Big Wheels. WA2KZV, who had been experimenting with antennas for several years, decided to try a variation of the full-wave loop. The result described here provides the desired radiation pattern, and it is fairly easy to construct. It has performed very well.

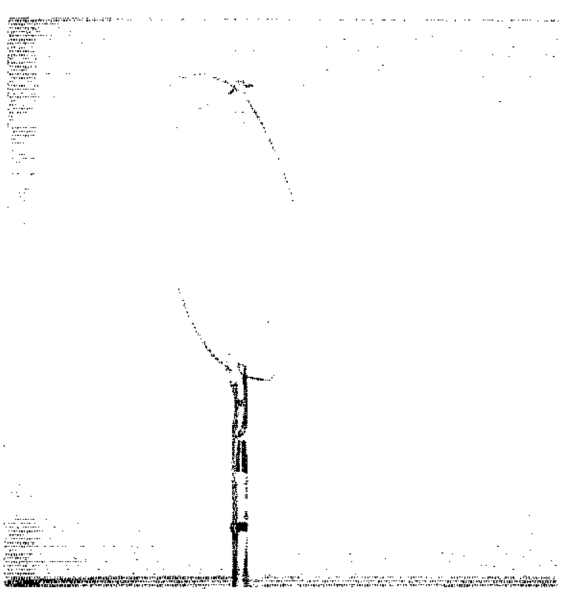
Electrical Description

The antenna is basically two circular full-wave loops, fed 90 degrees apart electrically, and placed at right angles mechanically. Each has two current maxima. With each loop oriented in a vertical plane and fed at the bottom, the polarization of the antenna is horizontal and the current maxima are at the top and bottom. This gives gain toward the horizon, as when separate antennas are stacked. The 90-degree phasing and right-angle placement of the elements give rise to the desired omnidirectional pattern.

The feed impedance of a full-wave loop is approximately 100 ohms. The two loops must be fed equal power, at 90 degrees out of phase, to produce the omnidirectional pattern. A convenient way to meet these requirements is to join the loops with a balanced line a quarter-wavelength long, of the same impedance as that of the loops, and feed one of the loops directly. A 100-ohm balanced line can be made of two pieces of 50-ohm coax, joining the braids at each end and feeding the inner conductors. With this arrangement, the impedance seen at either loop is then approximately half that of either one.

The balanced load must be converted to unbalanced, for feeding with coax. This may be done with a 1:1 balun, or another 100-ohm quarter-wave line may be used as a *Q* section to transform the 50 ohms to 200, and this fed through 50-ohm line and a conventional half-wave balun. This is the method we have used, as shown in Fig. 1.

*3 Elm Street, Natick, MA 01760
**133 Winthrop Street, Apt. 8, Framingham, MA 01701



The "Eggbeater" uses two full-wave loops oriented and fed 90 degrees apart. Its pattern is essentially omnidirectional, with slight bulges perpendicular to the plane of each loop. Polarization is horizontal.

Construction

A photograph of a complete "Eggbeater" is included, but details may be clearer from the drawings. The top insulator is optional, as the top is the voltage node of each loop. The insulating mount is a convenient way of supporting the elements, and it may help to prevent noise resulting from imperfect electrical grounding that might come from a metal mounting at the top. The feed points are supported on simple plastic blocks.

The loops were made from 3/16-inch diameter 1100-H alloy aluminum, 81 1/2 inches long. After these were passed through the top support the ends were flattened and drilled for the connections. The top support is 1 1/4-inch diameter polystyrene rod. Lengths of the *Q* section, phasing section and balun loop given in Fig. 1 are nominal values, assuming that the propagation factor of the coaxial line used is 0.66.[1] Even if the line used is rated as having this propagation factor, it can vary considerably, and dipping the sections for resonance in the band is recommended. A quarter-wave section of line is shorted with a small loop at one end, and left open at the other. Couple to the loop with the dipper coil to check the resonant frequency. Be sure to check the frequency calibration of your dipper. Some are far off in the vhf range.

All coax used in the Eggbeater construction was RG-58/U. The supporting mast was made from three telescoping sections of 6061-T6 alloy, 3/4, 7/8, and 1-inch diameter, .058-inch wall thickness.

[1] If foam-filled coax line is used, the velocity factor will be 0.81. EDITOR.

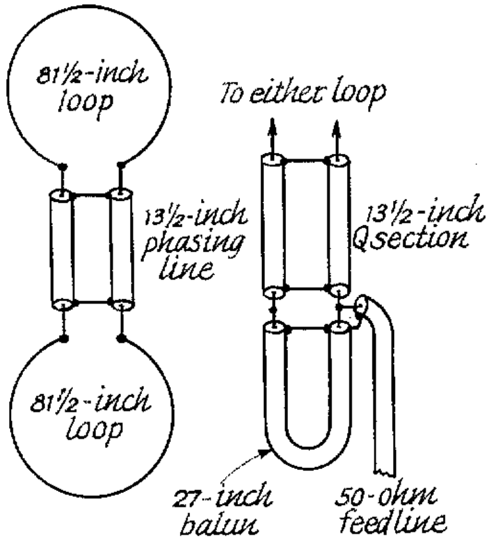


Fig. 1 — The two loops of the Eggbeater are fed 90 degrees apart, through a quarter-wave balanced phasing section. The 50-ohm feed system, right, includes a 4:1 balun and a quarter-wave *Q* section.

Connections and exposed ends of the coax were covered with RTV silicone rubber, sold in stores as bathtub caulk, for water-proofing. Finally, the entire antenna was painted, to help resist corrosion caused by salt spread on New England roads in winter.

Eggbeaters of this type have been built and used by WA2KZV, WA2PTS, and K1DRB, all with very encouraging results. In comparisons with a halo and a reference dipole on two occasions, on different paths, the Eggbeater was superior to the halo, and equal to the dipole when the latter was oriented for maximum signal. In mobile communication, it shows less flutter than the halo.

All three Eggbeaters show low SWR; less than 1.5:1 over the range of 144 to 146 MHz. The frequency response is broad, which is characteristic of full-wave loops. In addition to its excellent performance in mobile work, the Eggbeater should be a good choice for fixed-station service, where uncritical operation and omnidirectional pattern are desired, with horizontal polarization.

For inspiration and help in making measurements, we would like to thank WA1MFY, several operators at W1MX, and K9AQP/1. And last, but not least, Lew Collins, K4GGI/1 deserves credit for the name, "Eggbeater," which reduced the time required for on-the-air explanations of the antenna from a half hour to a half minute.

Some Observations with the Eggbeater

Never one to pass up a new or different idea for vhf mobile antennas, the undersigned built and tested several versions of the Eggbeater. Our loops were 1/8-inch hard aluminum wire, which just happened to come in coils about 2 feet in diameter. This expanded easily to the 27-inch diameter required, and maintained its shape well. A piece of fiber glass rod left over from another project was pressed into service as part of the vertical support. This kept metal out of the core of the loops, and simplified assembly. Half-inch aluminum fitted into the bottom end made up the rest of the support, and also was tried as part of a 1:1 balun, as explained later.

About Lengths

Loops 81 1/2 inches in length, recommended by the authors, worked well, but the impedance was high and the SWR was 2:1 or more, showing the lowest value at the high end of the band. This suggested too-short elements, so 83 inches was tried. The SWR was lower, but still was dropping at the high end — so we started digging for information on full-wave loops.

Perhaps the best available is given by Lindsay,[2] in a classic article on quads. He cites work done in Japan years ago, substantiated in much amateur work with quads and other full-wave loops, which gives the length in feet as

$$L = \frac{1005}{Freq.(MHz)}$$

[2]Lindsay, "Quads and Yagis," May, 1968, *QST*, Fig. II-6.

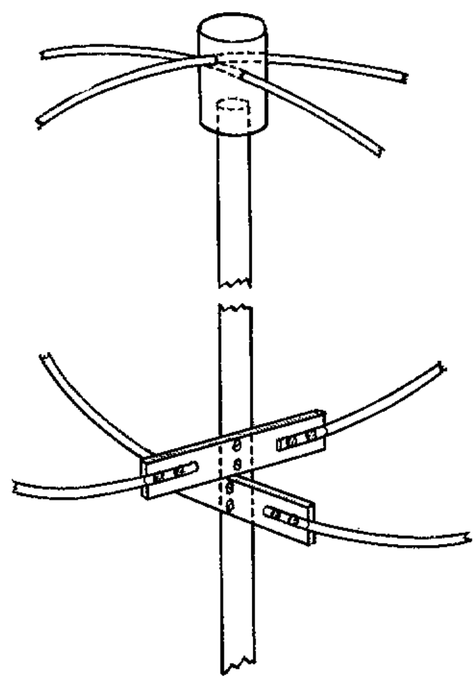


Fig. 2 — Principal details of the support for the mobile antenna. The top insulator and the blocks for fastening the element ends are of polystyrene. The main support is aluminum tubing.

This is for hf loops. In vhf service the ratio of loop circumference to conductor diameter becomes important. First we convert the formula to inches, using

$$L = \frac{12060}{Freq.(MHz)}$$

Then we multiply by the "shape factor," which for our dimensions is 1.04

$$L\ (inches) = \frac{12060}{145\ (MHz)} x\ 1.04 = 86.5$$

Accordingly, we made two 86 1/2-inch loops, threading the ends so that 8-32 nuts could be used on each to hold lugs for connecting the feed system.

As suggested, we dipped the coaxial phasing, matching and balancing sections. The authors' recommendations of 13 1/2 and 27 inches are correct for coax of the propagation factor that RG-58/U is supposed to have, but it is well to check for sure. Two samples of RG-58/U from different manufacturers had to be cut to between 12 and 12 1/2 inches for the quarter-wave sections, and 24 to 25 inches for the balun, for resonance at 145 MHz.

First, a single 86 1/2-inch loop was fed through a 4:1 balun and 50-ohm line. It showed an SWR of 1.7+ across the band, indicating an impedance of about 115 ohms. This is close to the value for a full-wave loop given by Kraus.[3] Two loops at right angles, phased and fed as in Fig. 1, showed 1.5:1 across the band, as reported by the authors.

The very broad frequency response of the Eggbeater is reminiscent of experience years ago with the first Big Wheels. Both antennas are so broad that anyone who has worked with parasitic arrays extensively is almost convinced that these full-wave systems can't be working. As far as SWR checks are concerned, they might well be mistaken for dummy loads! In such antennas, small changes in element length make little observable difference in results.

Baluns

Our antennas were fed at first with the system shown in Fig. 1. Later the 1:1 balun idea was tried. The metal support, the top of which is just below the feedpoint of the loops, was used as one side of the balun. The outer sheath of the RG-58/U was cut at 19 inches down from the loops. A short length of No. 20 wire was wrapped around the outer conductor, and soldered in place. This was then soldered to a lug bolted to the aluminum support. Checks for rf on the outside of the coax showed that this balun was doing its job reasonably well.

The effective length of such a quarter-wave balun depends on how it is made. If the coax is taped to the metal support the length will have to be determined by experiment. If the coax and the support are separated, and held at a constant spacing with a minimum of insulation between them, the balun will be approximately a full quarter-wavelength. In view of the variables involved in the 1:1 balun, the authors' method (Fig. 1) seems the better choice.

Another and neater 1:1 balun, not tried in this instance but used with turnstiles in the past, involves running the coax inside a metal support. A self-tapping screw with a sharp point can be run through the support, at a point a quarter-wavelength down from the top, far enough to puncture the coax insulation and contact the braided outer conductor.

None of these baluns is particularly critical, nor does use or nonuse of them make a large difference in the performance of most mobile antennas. Too many fudge factors enter into typical amateur mobile installations to make the effect of such fine points very apparent. Especially with an antenna as uncritical as these full-wave loops, and with the short lines used in mobile setups, almost anything goes. – *W1HDQ*

[3] Kraus, *Antennas*, Fig. 6-12. McGraw-Hill, 1950.

Strays

After a recent showing of "Ham's Wide World" to members of the Theodore Roosevelt ARC, club sponsor and science department chairman, W8MPD, arranged to show the film to some of the English and communications classes. One teacher then made the assignment to his students to write an essay about the film. Here are some excerpts from their papers: If I had to rate this movie, 1 being bad, and 10 being good, I would rate it 2. First of all because it had no relevance to our English class and secondly, because I have no interest in ham radio. What's wrong with the telephone? . . . One of the faults of the movie was that there was too much beep-beep-beeping. This took away from watching the movie and was distracting. . . . Although I would not want to spend every Saturday with a ham set as some loyal hams do, this is definitely a hobby to look into. . . . It was a great movie with a lot of fast-moving speakers. The only bad part was that all of the actors in the movie were real hams. . . . Anyone who didn't know very much about hams certainly would after watching it. . . . When it first started, I didn't know what they were talking about. But by the end of the film I did. . . . There were two parts that I really enjoyed, they were when the young boys went out on a Saturday morning and tried to reach other people. The other part was when they were explaining about the cards. . . . It is good that schools have a radio club because then the students will be aware of the usefulness and the fun they can have using ham radio.

After many years of enjoying the cool breezes of Wisconsin W9PTJ transfered to Arizona. The day he reached into the mail box and found his new license the temperature was 118 degrees. The new call? You guessed it – W7HOT!