THE GÖTTINGEN HEART ANTENNA

Uniquely shaped antenna gives good performance

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One of the most interesting places in Germany is the valley where the Leine river wanders between the Harz mountains and the university city of Göttingen. To academicians, Göttingen is renowned as the city where 30 Nobel Prize winners have resided. It's also famous for the Max Planck Institutes located in the city and the countryside nearby. These 52 institutes are descendants of the Kaiser Wilhelm Institute organization which was devoted to the study of interesting scientific problems.

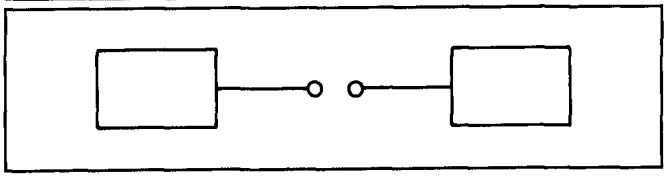
Gerd E.A. Meier, DJ7FY, and Rudolf J. Dvorak, DK4AP, of the Max Planck-Institut for Flow Research in Göttingen recently developed a new antenna. It is known throughout Germany as the Göttingen Heart (Herz) antenna, named for the city where it was developed and its heart shape.*

The antenna is unique. It is broadbanded over a more than 10:1 frequency range, and at the same time gives directive gain that increases with frequency. The antenna handles large amounts of RF power without corona discharge.

The Heart antenna doesn't need a large area to be broadbanded, as does the rhombic antenna, nor does it need the active dipoles that form a radiating cell of a log periodic array. The whole antenna is active on all excited frequencies and is small enough to be rotated on a single mast (see **Photo A**).

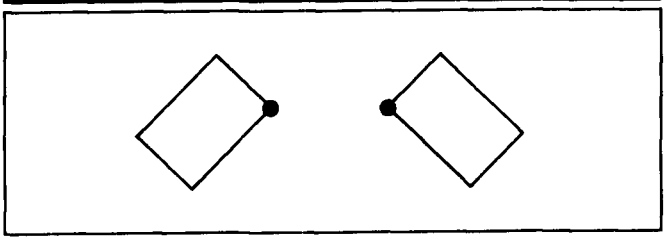
Dr. Meier was intrigued with professor Heinrich Hertz's original spark gap apparatus. Meier discovered through experimentation that two similar plates, when excited with RF energy, displayed not only directivity but some broadband behavior as well (see **Figure 1**). This led to the birth of the Heart antenna. Additional experiments by Dr. Meier and Mr. Dvorak showed that directivity was enhanced by

FIGURE 1



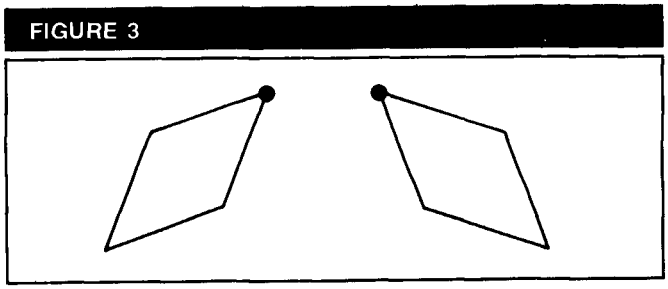
Spark gap with capacitance plates.

FIGURE 2



V configuration.

FIGURE 3



Rhombus plates in V configuration.

* The antenna is protected by EPü Patent number 0124559. An meldetag 15.11.83. Priority 15 Nov 82. Granted 4.03.87 Patent Blatt 87/10.

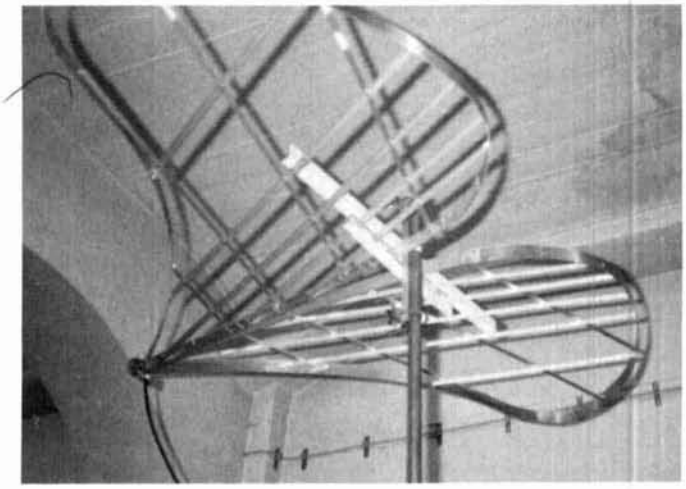
optimizing the V configuration of the plates, as shown in Figure 2. They also found that by changing from rectangular-shaped plates to rhombus-shaped ones (Figure 3), the antenna became broadbanded as the input impedance flattened out.

It was at this point that Mr. Dvorak found it necessary to "cut and try" many profiles. He noticed that as the curves of the antenna shape became smoother, there were less variations in the feedpoint impedance, and the VSWR ratio remained below 2:1. Moreover, as the frequency increased, so did the forward gain. At the same time, the antenna had approximately 16-dB loss off the back. The antenna's SWR was flat over the 10:1 frequency range and directive.

The antenna wing profile

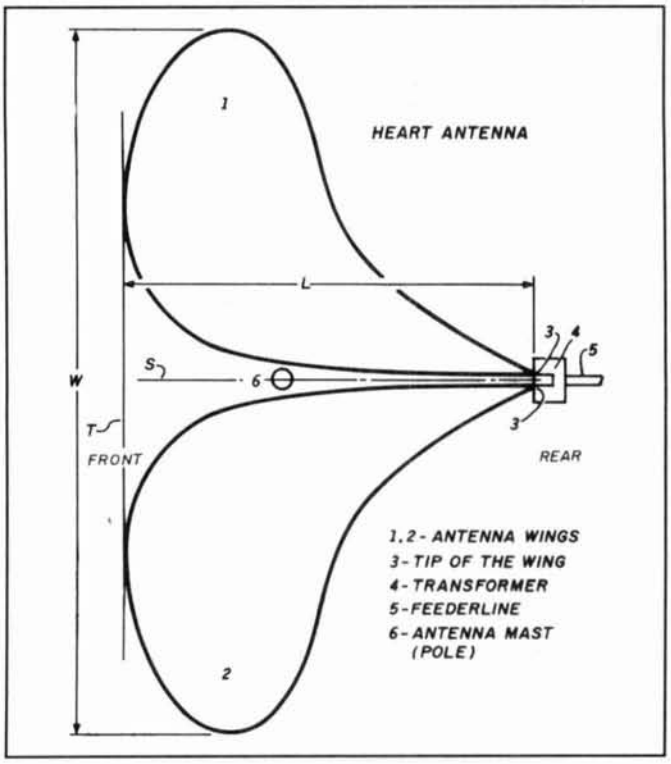
Figures 4A and B give the physical dimensions of the Heart antenna. Because this antenna is symmetrical, only one profile, or Heart wing, is shown in Figure 4B — a grid pattern.

PHOTO A



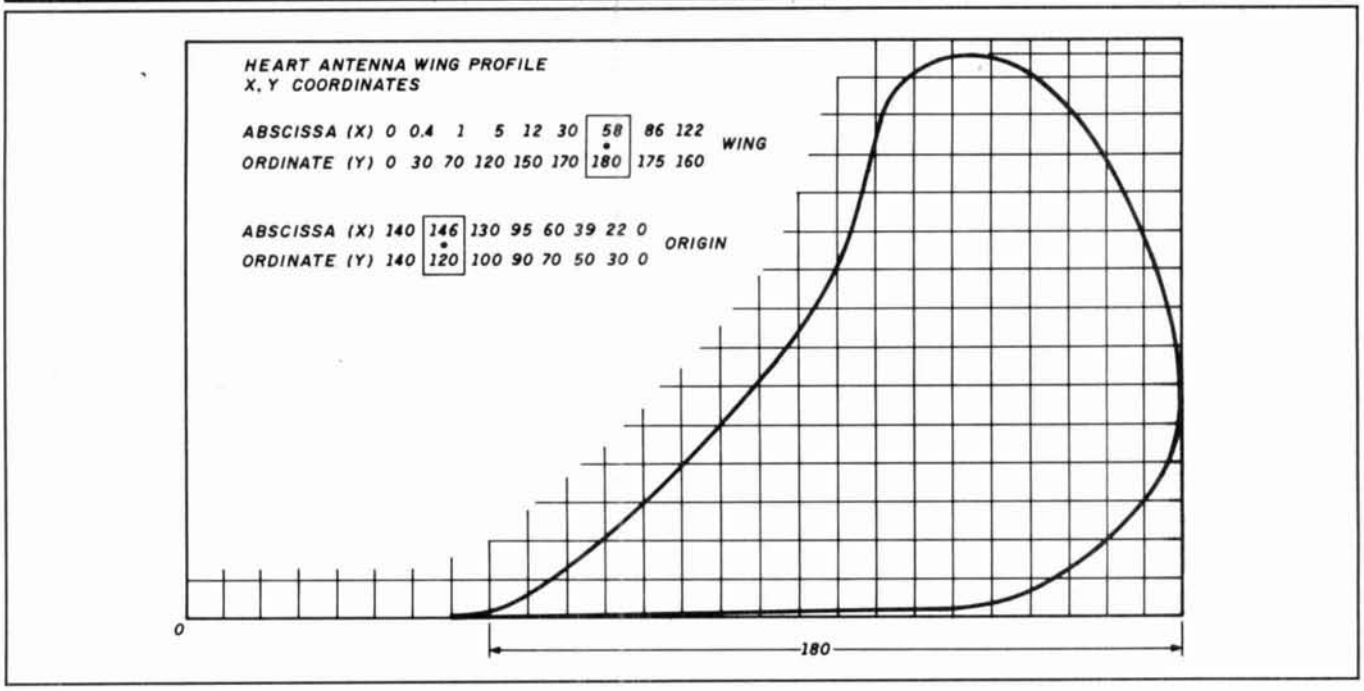
Active on all excited frequencies, the antenna is small enough to be rotated on a single mast.

FIGURE 4A



Symmetrical Heart antenna (showing both wing profiles).

FIGURE 4B



Heart antenna profile with X, Y coordinates.

You'll find that it's simplest to lay out a profile using graph paper. The grids on the paper make it easy to draw the curve shown in **Figure 4B**. Once you've made your sketch, you can transfer the profile to your building material.

Always cut the profile to the lowest frequency of operation. The length (L) shown in **Figure 4B** is one-third of the longest desired operating wavelength, so you'll find the following relationship useful:

$$L = 1/3 \text{ maximum } \lambda$$

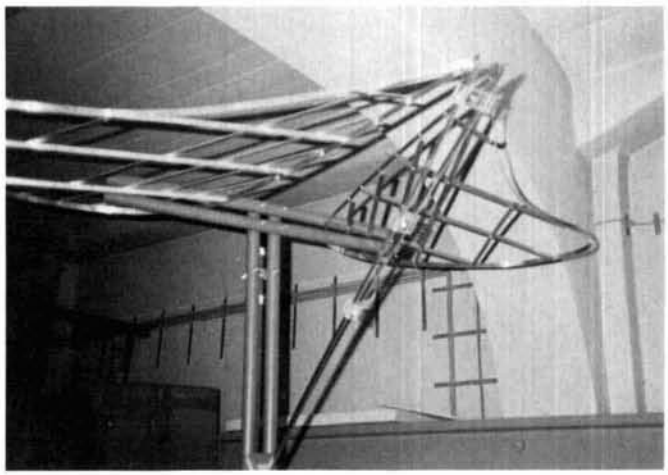
Construction materials

You can use common materials for antenna construction; they aren't critical electrically. This antenna has been built from aluminum foil, potato chip bag foil, chicken wire, wire mesh, foil-backed insulating foam sheathing, and aluminum angle stock (see **Photos B** and **C**). It is important to note that different material thicknesses and apertures will place certain restrictions on antenna performance, depending on the

PHOTO B

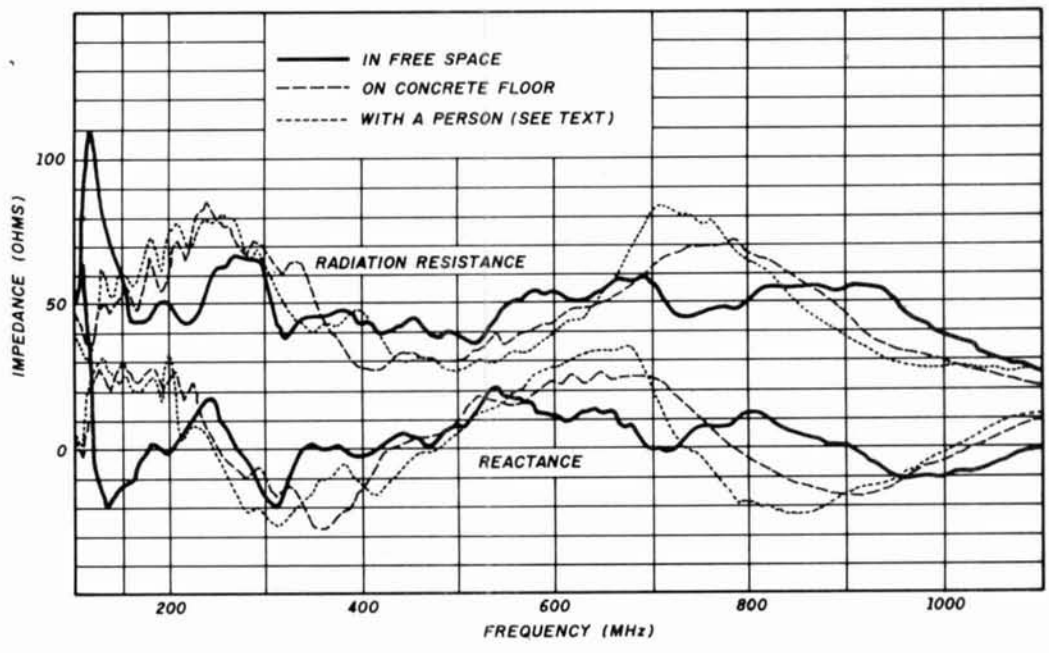
Common materials can be used to build the antenna. Here you see the Heart antenna made of aluminum sheet stock.

PHOTO C



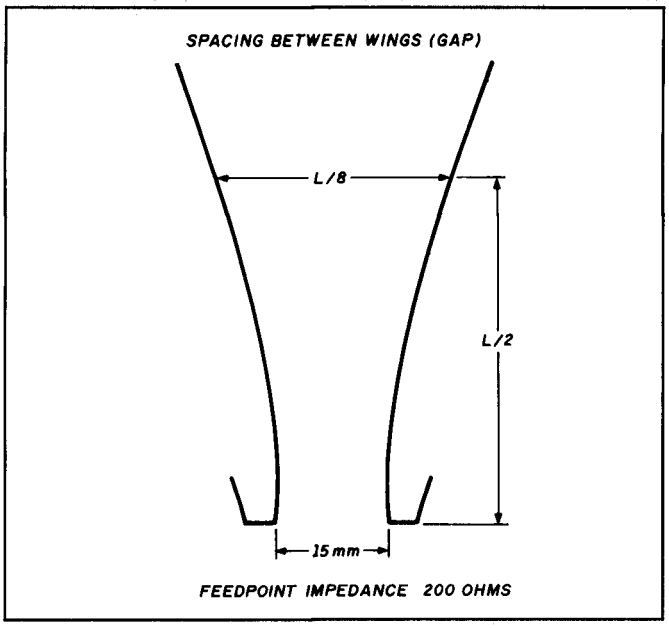
Another version of the Heart antenna constructed from aluminum strips.

FIGURE 5



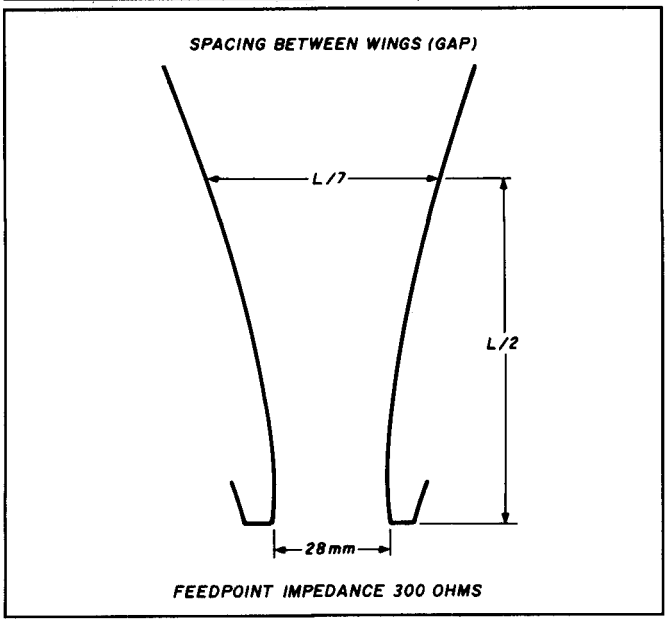
Impedance versus frequency of a symmetrical Heart antenna. (Antenna is made from sheet aluminum 1.5 mm thick.)

FIGURE 6



Profile wing spacing for 200-ohm feedpoint impedance.

FIGURE 7



Profile wing spacing for 300-ohm feedpoint impedance.

frequency and desired impedance at the feedpoint.

It's best to match the antenna with a step-down balun or an exponential line. An impedance transformation from 300 to 75 ohms, or 200 to 50 ohms, usually gives the best results and yields the highest efficiency. **Figure 5** shows feedpoint impedance versus frequency.

The spacing (gap) between the wings and the wing thickness determines the feedpoint impedance. A feedpoint impedance of 200 to 300 ohms is best. You can obtain a 75-ohm impedance by using close gap spacing between the wings, but this becomes very critical. The small distances involved are also affected by the wing thickness. **Figures 6** and **7** give the wing spacing for 200 and 300-ohm feedpoint impedances. These spacings are most efficient when the wings are made of thin materials — like foils less than 0.3 mm thick.

The gap must be larger for thicker materials or mesh wire with reinforced rims. Larger gap spacing — especially at half wavelengths — gives better gain at lower frequencies, but spoils impedance matching. The antenna impedance doesn't change when in close proximity to other objects. To prove this to yourself, you can place a foil Heart antenna on the floor, have someone stand on the antenna wings, and note the results.

Verification of results

Dvorak verified gain and impedance measurements with computer-controlled measuring equipment. He and Dr. Meier also submitted the antenna system to Gunter Schwarzbeck, DL1BU, the technical referent for the German Amateur Radio Club (DARC). Schwarzbeck, famous for his many critiques on radio antennas and measurements among European radio Amateurs, performed an impartial review, measurements, and a critical analysis. The Heart was tested thoroughly on a commerical antenna range. I have used the antenna here in the States and find it to be one of those antennas that wants to work and gives good results due to its simple construction.

In closing, I wish to thank Dr. Meier and Mr. Dvorak for making information about the Heart antenna available. You can address inquiries about the Heart antenna system to: Meier Messtechnik, Am Menzelberg 6, D-3400 Göttingen, Federal Republic of Germany. hr

BIBLIOGRAPHY

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3. "Herz ist Trumpf," *Funk Magazine*, February 1985, pages 40-42.
4. Personal interview and correspondence with the inventors.