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THE UNIVERSITY OF MICHIGAN

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VOR PARASITIC LOOP COUNTERPOISE-II: INTERIM REPORT NO. 4

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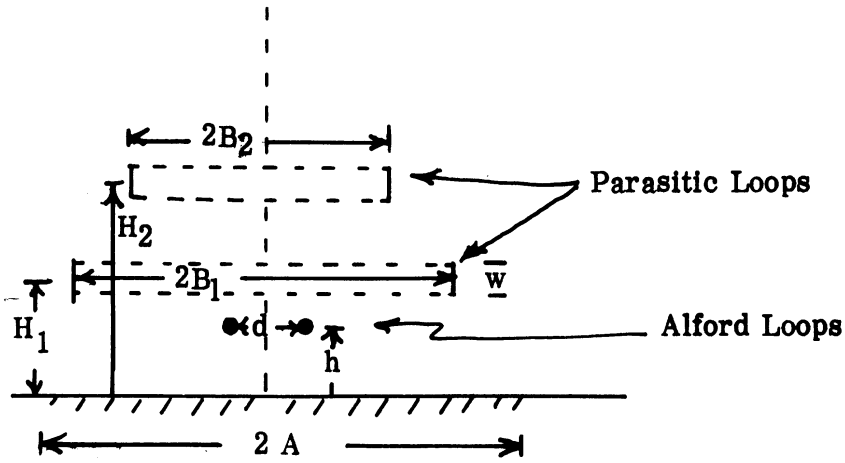
Introduction

This is the Fourth Interim Report on Contract FA69-WA-2085, Project 330-001-03N, "VOR Parasitic Loop Counterpoise Systems-II" and covers the period 1 May to 31 July 1970.

During this period we have developed the design parameters for a non-uniformly excited double parasitic loop counterpoise antenna having satisfactory radiation pattern characteristics. The optimum antenna parameters have been obtained on the basis of the results of theoretical and experimental model investigations. The mechanical design and construction of the full scale components of the antenna, to be installed at the VOR station at Manheim Road at the NAFEC facilities has also been started. In the following sections we describe the various design aspects of the full scale antenna.

Design Parameters of the Optimum Parasitic Loop Counterpoise Antenna

A schematic diagram of the double parasitic loop counterpoise antenna is shown on the following page. The basic loop counterpoise antenna consists of two Alford loops separated by a distance d and placed at a height h above the counterpoise as shown in the sketch. The two parasitic loops of diameter $2B_1$ and $2B_2$ are placed at heights H_1 and H_2 respectively above the counterpoise. The parasitic loops are made of metallic strips of width w. The Alford loops are excited with equal amplitude and opposite phase signals so that the horizontal pattern of the antenna is a figure-of-eight.



Schematic Diagram of the Double Parasitic Loop Counterpoise Antenna.

In our last interim report (3051-3-T) we derived theoretical expressions for the far field radiation pattern of the present antenna configuration. For this reason we do not again discuss the theory here. Detailed numerical calculations of these expressions have been performed in order to obtain the design parameters for the antenna having satisfactory pattern characteristics. The optimization procedure for the antenna has been governed by the requirement that the field gradient at the horizon be large and the sidelobe level in the axial direction be as small as possible. On the basis of our numerical studies the following normalized parameters have been obtained for an optimum double parasitic loop counterpoise antenna:

$$kh = 2.7755,\ kA = 52.1686;\ kB_1 = 1634,$$
$$kB_2 = 11.31,\ kd = 1.84,\ kH_1 = 3.48,$$
$$kH_2 = 12.767,\ \text{frequency (f)} = 1090\ \text{MHz}.$$

The antenna yields a theoretical field gradient of about 20 dB/6° at the horizon at the model frequency of 1090 MHz. Our results of model measurement indicate that above field gradient can be achieved.

Thus, the full scale dimensions of the parasitic rings at the operating frequency 109 MHz are as follows.

$$2B_1 = 46.8' \qquad H_1 = 5'$$
$$2B_2 = 32.5' \qquad H_2 = 18'\ 4''$$
$$w = 10''\ .$$

The other full scale parameters of the antenna would be the same as those used in the VOR station on Manheim Road at the NAFEC facilities.

Mechanical Design of the Full Scale Antenna

The parasitic rings are to be each supported by 16 redwood 4 x 4 poles. These poles will be positioned on the principal I beams that support the 150' counterpoise. The 16 poles to support the 32 1/2 -foot diameter ring will be 20 feet tall with the rings positioned 18 feet 4 inches above the counterpoise. Each of the 16 poles will be guyed with Mylar rope to stiffen the pole and to minimize variations in the position of the ring. To aid in supporting the tall poles associated with the small diameter parasitic ring, redwood 2 x 4's will be attached to the top of the 20' 4 x 4 poles and strung back to the fiberglass cone presently installed at the Manheim Road facility. The 2 x 4's will be anchored to one of the circular fiberglass channels located inside the fiberglass cone to ensure that they are being attached at a rigid point on the cones. As noted there will be 6 guy ropes supporting each pole; 3 ropes will be attached to the pole seventeen feet above the surface of the counterpoise. The remaining three will be attached to the pole approximately 14 feet above the counterpoise. Each of the ropes will have 200 to 250 pounds of tension in them to minimize swaying and movement of the poles.

The parasitic rings will be fabricated by employing two aluminum tubings bent to the desired radius of curvature. An expanded aluminum material 1/8" thick and 10" wide will be attached to these two aluminum tubings. To minimize the possibility of corrosion and the deterioration of the metallic rings they will be painted with a white enamel and appropriate coatings to ensure a reasonable length of life. As for the redwood poles they are being coated with a wood preservative in order to minimize the possibility of moisture penetrating into the wood and deteriorating the operational characteristics of the parasitic rings themselves. The larger ring will be supported on 6' poles with the ring located 5' above the counterpoise and attached to the poles. Their construction will be of a similar nature to that discussed above. Each of these poles will be guyed by three ropes. Their attachment point to the pole will be approximately 4' above the counterpoise level. Provisions are made so that the heights of both the parasitic rings may be adjusted if necessary.

A 30° sector of the highest parasitic ring (32-1/2 foot diameter ring) has been installed at The University of Michigan and various rope configurations were employed to determine the best configuration. The results of this test showed that Mylar rope with 3/16" diameter could be employed. The 3/16" rope has a tension of 250 pounds on it to take out the initial stretch associated with this material and at the same time provide the necessary compression in the redwood poles to make them rigid so as to minimize wind effects.

Preparations are now being made to set up the full scale mock-up that has been constructed so that the parasitic rings may be installed here at The University of Michigan to ensure that there will be a minimum of problems associated with assembling the system at the Manheim Road site.

Conclusion

The above summarizes the current status of the contract. During the coming period the far field produced by a double parasitic loop counterpoise antenna located above a perfectly conducting flat earth will be calculated at some specified distances from the antenna. At the present time we are anticipating the completion and fabrication of the parasitic rings by the end of August and their move to New Jersey early in the first part of September with plans for installation of the parasitic rings at the NAFEC facilities at that time.