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CYLINDRICAL AND CONICAL ARRAY INVESTIGATIONS

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The successful implementation of a circular array producing a fan beam in elevation and capable of scanning 360 degrees in azimuth has resulted in studies aimed at extending the approach to yield three-dimensional data using a pencil beam. A shipborne anntenna is generally required to operate from a few degrees below the horizon to elevation angles of up to 90 degrees. A cylindrical array has its optimum performance at the broadside position and degrades equally as the beam is scanned vertically in either direction from this position. In contrast, the conical geometry should have its optimum behavior in a direction normal to the cone angle, typically at an angle of 25 degrees. If this can be verified, then it is clear that the latter type of antenna will extend the coverage in the elevation plane. This study is aimed at a better understanding of the properties of these types of arrays.

Theoretical analysis and computed radiation patterns can give some indication of the performance which can be expected from an array. Even though realistic phase and amplitude error distributions can be assumed and inserted into the computer programs, the actual performance data is still relatively unknown. Inherent errors in the fabrication of the various array components must be obtained by actual measurement of the experimental models. Even though, it is difficult to predict the performance of the composite of many components when they are assembled into a small partial array.

Techniques for stepping (scanning) the beam or a circular or ring array are well-known from experimental models and good agreement with predicted values can be obtained. The characteristics of cylindrical and conical arrays of many elements have not been widely investigated using experimental models. Extensive analysis of planar array beam pointing angle error and beam deterioration with scan angle has been done, but relatively little analysis of curved aperture array behavior has transpired. The cylindrical and conical surface array exhibits a symmetrical configuration in azimuth as regards to amplitude and phase distributions and hence the effect of large phase and amplitude errors on the beam pointing angle, side lobe level, and beam shape should be investigated to determine the tolerable limits of these parameters.

The cylindrical array can be considered as a ring array composed of linear array elements, or a stack of ring arrays. The partial array to be described is made up of 44 linear arrays, each with 32 elements, arrayed on a circle of diameter 16 feet as shown in figure 1. Two different approaches can be used to feed the radiating elements. The first method uses 1:22 power dividers to feed alternate rows of elements in the triangular configuration. Since each of the 64 partial rings has only one phasor board, individual control of the phase at each radiating element is not possible. This results in phase errors as the beam is scanned in the elevation plane and the beam deteriorates. This scheme yields limited elevation beam data, but can give some indication of the effects of these errors on the elevation beam characteristics.

The other method uses a 3-bit phasor at each radiating element and gives good control of the elemental phase. This partial array can be scanned in azimuth using conventional linear phase scanning techniques in lieu of step scanning for angles up to about 25 degrees. This array can be used as a test bed to investigate angular accuracy, beam behavior and performance of the array using short pulses and wide band signals. An indication of the magnitude of the phase tolerances can be obtained in addition to data useful in the design of future systems.

Similar feeding and scanning techniques have been extended to an array on a conical surface consisting of 750 printed circuit dipole elements as shown in figure 2.

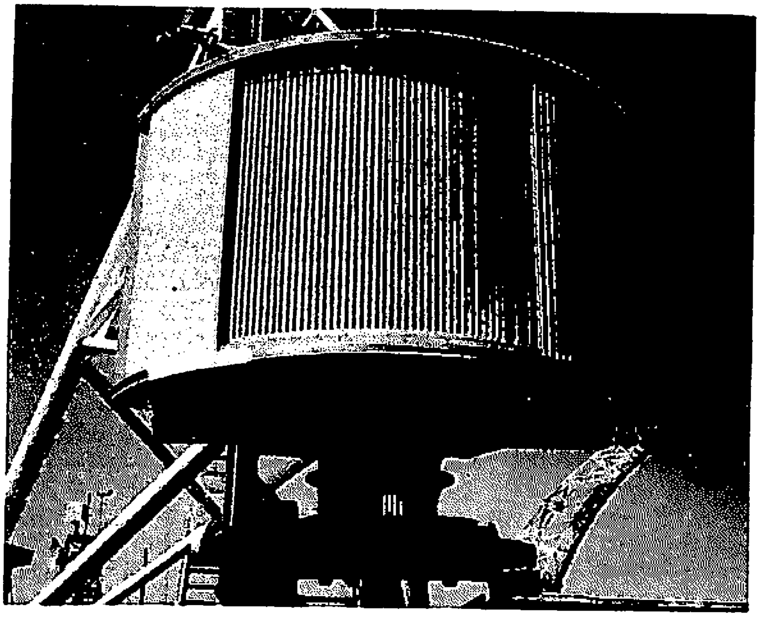

Figure 1. Partial cylindrical array antenna.

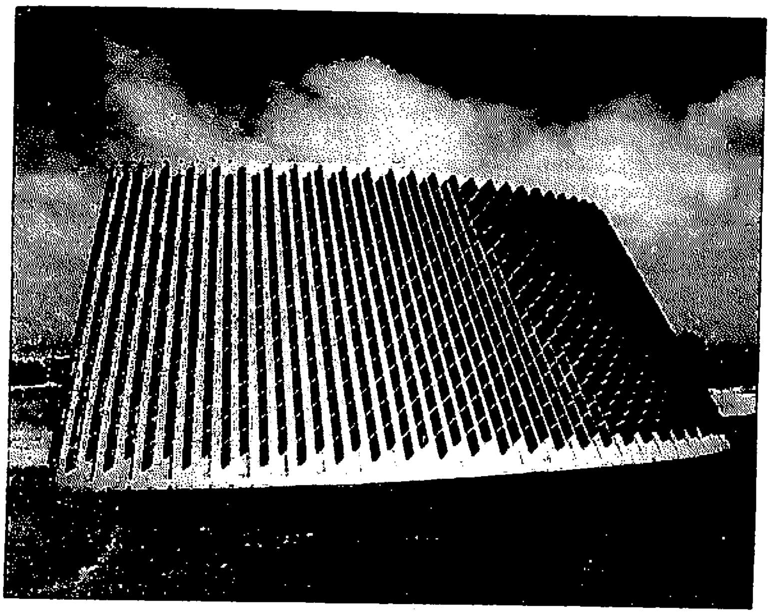

Figure 2. Partial conical array antenna.