A SONIC SATELLITE POWER SYSTEM MICROWAVE POWER TRANSMISSION SIMULATOR

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ABSTRACT

A simulator is described which generates and transmits a beam of audible sound energy mathematically similar to the SPS power beam. The simulator provides a laboratory means for analysis of ground based closed loop SPS phase control and of ionospheric effects on the SPS microwave power beam.

INTRODUCTION

Novar Electronics Corporation is in the final stages of constructing and testing a Satellite Power System Microwave Transmission Simulator. In a ground based laboratory environment, the simulator generates and transmits a beam of audible sound energy which is mathematically similar to the microwave beam which would transmit energy to earth from a Solar Power Satellite.

SIMULATOR DESCRIPTION

Figure 1 shows the major functional parts of the simulator. The Sonic Spacetenna (Figure 2) is 1.3 meters in diameter and contains 3200 independent transmitting elements. These elements are connected in a 64 row by 64 column matrix. Each column is driven by a driver which multiplexes each of the 64 rows 32,000 times per second. This enables the simulator's computer to control the amplitude, phase, and frequency of each of the 3200 transducers. The simulator is designed to transmit a coherent sonic power beam at 12 kHz. Any illumination taper, e.g., Gaussian, can be programmed and the resultant ground pattern studied. A computer, RAM Memory, 300 MB disc drive, and line printer are incorporated to provide a very high degree of experimental flexibility.

SIMULATOR CAPABILITIES

A unique feature of Novar's Sonic Simulator is its ability to provide actual photographs of the transmitted power beam. Figure 3 shows a scanning system which provides an intensity modulated raster of the sonic beam. By adding a phase signal to the intensity modulator, the phase coherence can also be photographed. This technique, developed at Bell Labs in the earty 1950's[1] will provide photographic records similar to Figure 4.

As soon as the Sonic Simulator is operational (mid-February, 1980), its initial use will be to generate a collimated coherent sonic beam to verify that the beam divergence and sidelobe characteristics are in satisfactory agreement with the aperture illumination equations which have been used to define the SPS microwave beam.

The concept of "ground based" phase control implies a closed loop phase control system which makes corrections in deviations in SPS beam pointing and focusing from ground based measurements of the received power beam. In other words, ground based phase control is a servo control system which like any servo system has a measureable transfer function, frequency response, step response, noise factor, resolution, loop stability, etc. Novar is using its

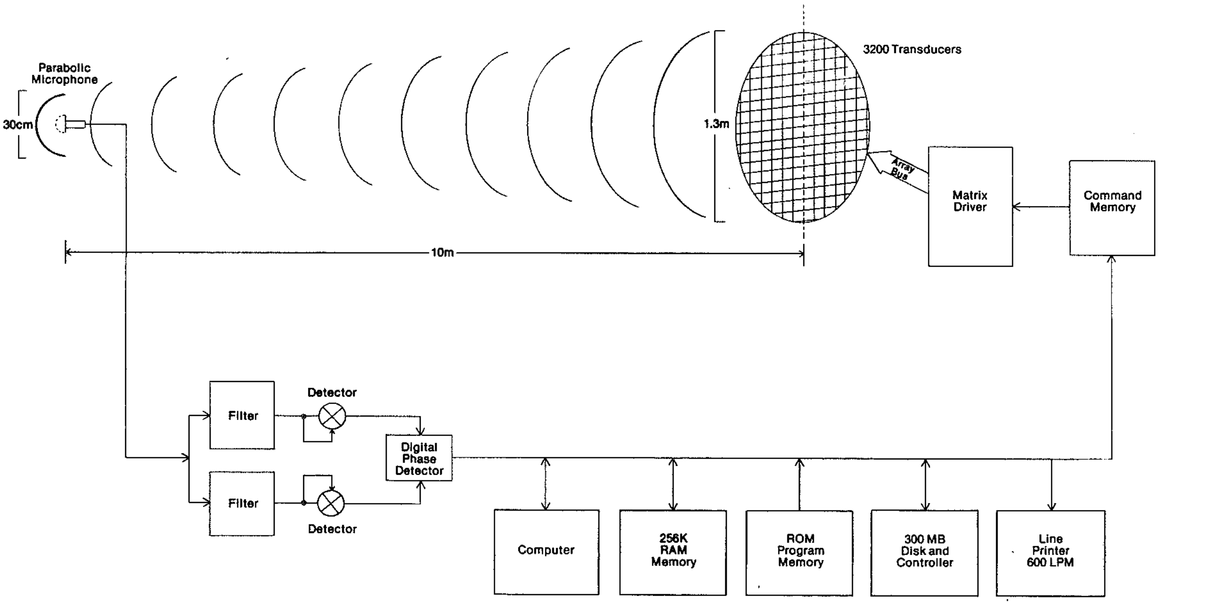

FIGURE 1
SONIC SPS PHASE CONTROL SIMULATOR
MAJOR FUNCTIONAL BLOCKS

interferometer phase control technique to focus and point the sound beam. The open and closed loop characteristics of the Sonic Simulator will be measured. A descriptive servo loop diagram and transfer function will be developed and all measured characteristics will be tested for agreement with control system theory. The next step will then be to analyze and mitigate the effects of unwanted interfering inputs such as air currents in the laboratory and the reflection of the sonic beam off walls.

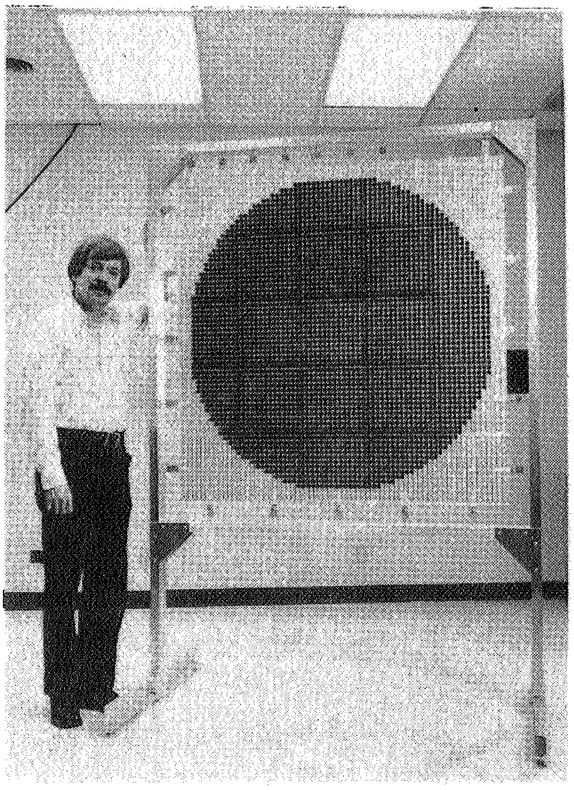

FIGURE 2
SONIC SPACETENNA

The Sonic Simulator can be readily forced to deal with the same noise characteristics as the ionosphere would introduce into the real world SPS phase control system. This would be accomplished by altering the propagation of the simulator's sonic beam through the use of sculptured reflecting surfaces and controlled air turbulance.

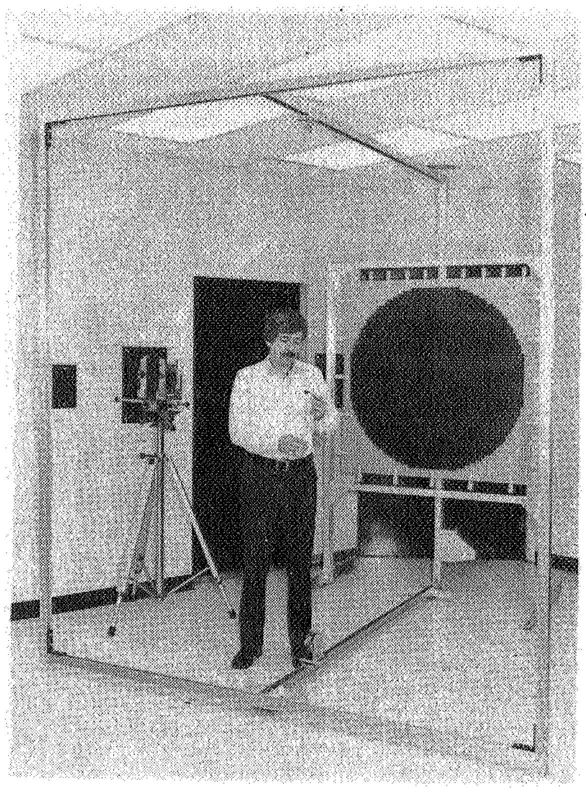

FIGURE 3
PHOTOGRAPHIC SCANNING SYSTEM
-A precision mechanical scanning system provides an actual photograph of the sonic beam. The camera lens remains open in a darkened room while the sound-to-light modulator (device being pointed at) provides a light output proportional to the intensity of the sonic beam. The modulator is scanned up and down and forward and backward to provide a photograph of a cross section of the beam.

Ionospheric effects will impact an SPS Phase Control System similar to the way that noise and offset error impact any closed loop servo system. Therefore, conventional control system synthesis techniques should be able to reduce SPS phase control errors due to ionospheric effects.

Analytical techniques will be developed to permit the validation of these sonic propagation models against measured ionospheric parameters. This would, for example, lead to the quantitative correlation of ionospheric electron density patterns with the sound reflecting surface's roughness and placement.

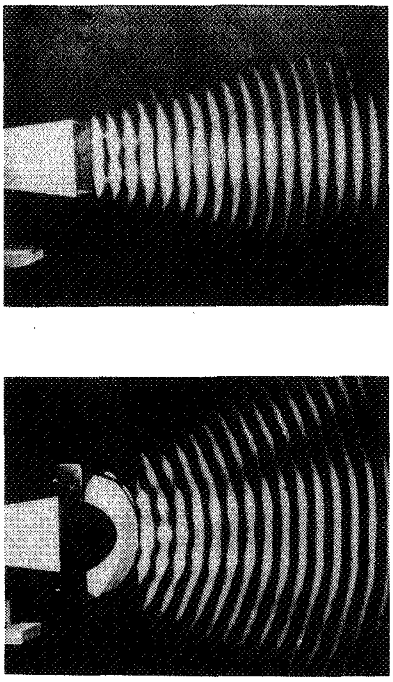

FIGURE 4
REPRESENTATIVE PHOTOGRAPH OF A MECHANICALLY SCANNED SONIC BEAM (Bell System Technical Journal, 1951)

CONCLUSIONS

It is expected that a number of conclusions can be provided regarding the applicability of the sonic simulation technique to the future development of the SPS power transmission system. If conclusions are favorable, we would expect that the sonic simulator will provide a low cost alternative to many of the time consuming orbiting satellite experiments that would otherwise be necessary.

REFERENCE

1. W. E. Kock and F. K. Harvey, "A Photographic Method for Displaying Sound Waves and Microwave Space Patterns," Bell System Technical Journal, Vol. 30, July 1951, pp. 564-587.