Bimonthly Report No. 8

March 3, 1964 to May 2, 1964

5549-9-P

5549-9-P = RL-2132

STUDY AND INVESTIGATION OF A UHF-VHF ANTENNA

by

J. E. Herman
S. B. Rhee
A. I. Simanyi
D. E. Oliver

Approved by John A. M. Lyon

John A. M. Lyon

for

COOLEY ELECTRONICS LABORATORY
Department of Electrical Engineering
The University of Michigan
Ann Arbor

United States Air Force
Air Force Systems Command
Aeronautical Systems Division
Contract No. AF 33(657)-10607
Wright-Patterson Air Force Base, Ohio

May 1964

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PAGE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ABSTRACT

Extensions of the rectangular slot filled with ferrite and cavity backed have been made. Experiments have been performed in replacing certain rectangular prismatic regions with balsa wood in place of ferrite. The ensuing effects upon VSWR and radiation patterns have been observed and reported. In addition, numerous experiments have been performed using a log conical spiral backed by an aluminum cylindrical cavity. Ferrite has been placed in numerous locations and data have been recorded for a variety of arrangements yielding very promising, although tentative, results.

1. REPORTS, TRAVELS, AND VISITORS

During this period "The Rectangular Cavity Slot Antenna With Homogeneous Isotropic Loading" by Mr. A. T. Adams was printed for issuance both as a technical report (TR 147) on this contract and as a dissertation submitted for the Doctor of Philosophy Degree. Distribution of Technical Report No. 147 will be effected upon the completion of minor alterations. No trips were made by project personnel in connection with the activities of this project group.

2. PERIOD ACTIVITIES

2.1 Equiangular Spiral

Preliminary experiments were performed on the equiangular spiral having tapered ferrite loading in the form of a conical section. The results of VSWR measurements were encouraging. However, as yet, no radiation patterns have been obtained for this type of loading.

2.2 Ferrite Loaded Rectangular Slot

For the purpose of studying the effectiveness of ferrite at various locations in the aperture, a grid was made to represent the aperture with numbers assigned to the various cells in the grid as shown in Fig. 1. Each cell number then corresponds to a rectangular prismatic bar either of solid ferrite or of balsa wood, as the case may be. The curves in Fig. 1 clearly show the effect of replacing a given numbered

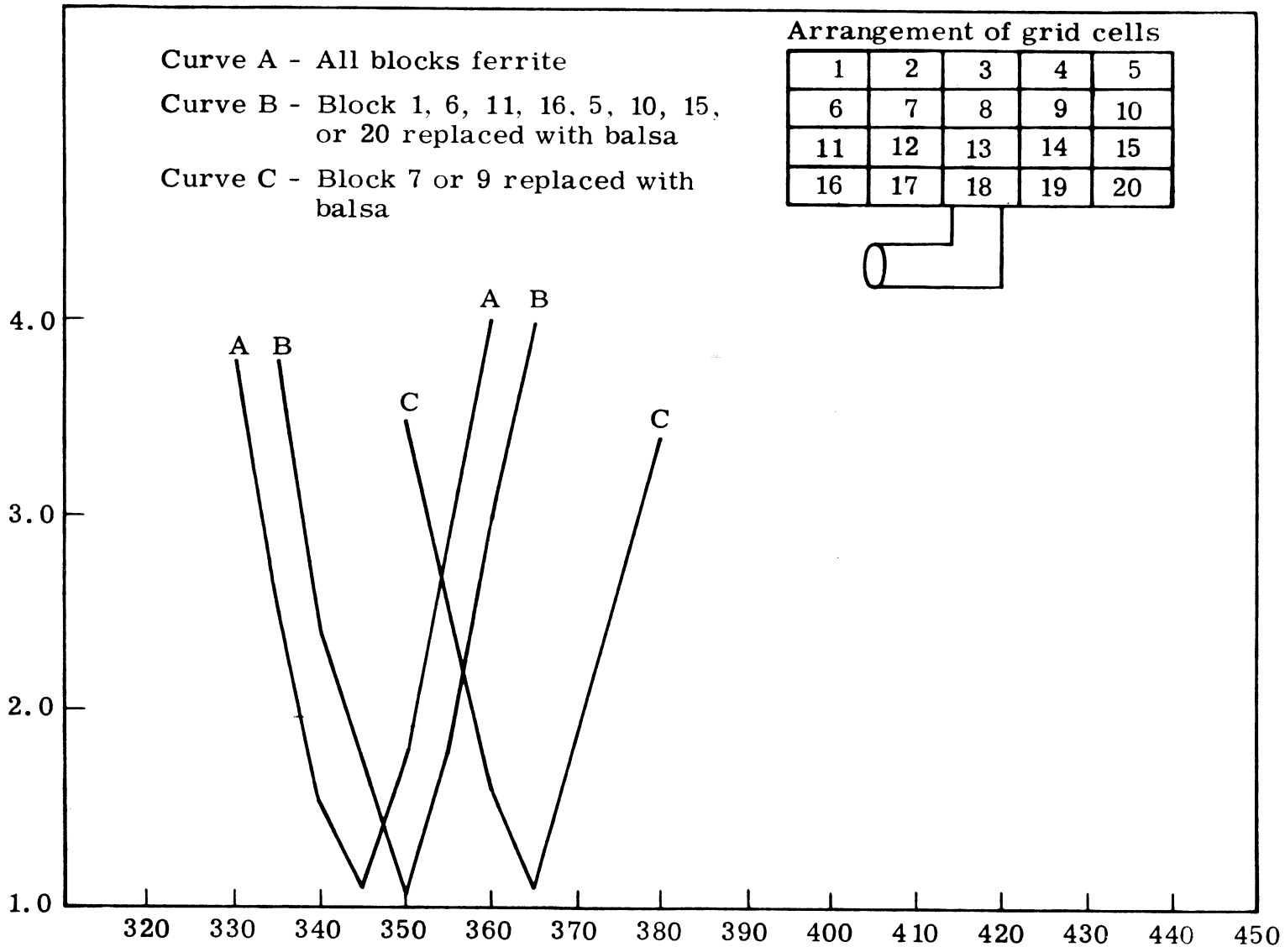

Fig. 1. Effect on VSWR of replacement of single cells of ferrite in a rectangular aperture.

cell or prismatic bar with balsa wood. Results indicate that filling a cell on either of the outside edges of the aperture with balsa wood instead of ferrite will result in a shift in the frequency band of approximately 5 Mc upward. The individual curves shown in Fig. 1 identify the location of the balsa wood replacement used.

Figure 2 shows results obtained by the replacement of entire rows of cells with balsa wood. For example, for one curve Cells 1, 2, 3, 4, 5 have been replaced with balsa wood. The elimination of ferrite in this region or this whole layer has resulted in a VSWR characteristic as shown in Fig. 2. Other replacements of whole layers are also shown in this figure. In connection with one curve the blocks of balsa wood inserted in locations 1, 2, 3, 4, 5 were taped as a flat layer with metal tape and, in addition, metal tape was placed over the face of these blocks which terminates in the physical aperture. In this way, the aperture and the waveguide feed were reduced with a new metal boundary forming the top of the waveguide and the metal tape in the aperture reducing the height of the slot. It is deduced that very little energy is propagated in this horizontal layer of balsa wood.

In Fig. 3 a very interesting situation is depicted. One curve shows that if the ferrite of Cells 1, 6, 11, and 16 on one side of the slot as well as the ferrite in Cells 5, 10, 15, and 20 on the other slot are replaced by balsa wood and the cells are then covered with aluminum tape, the resulting VSWR curve is moved upward on the frequency scale

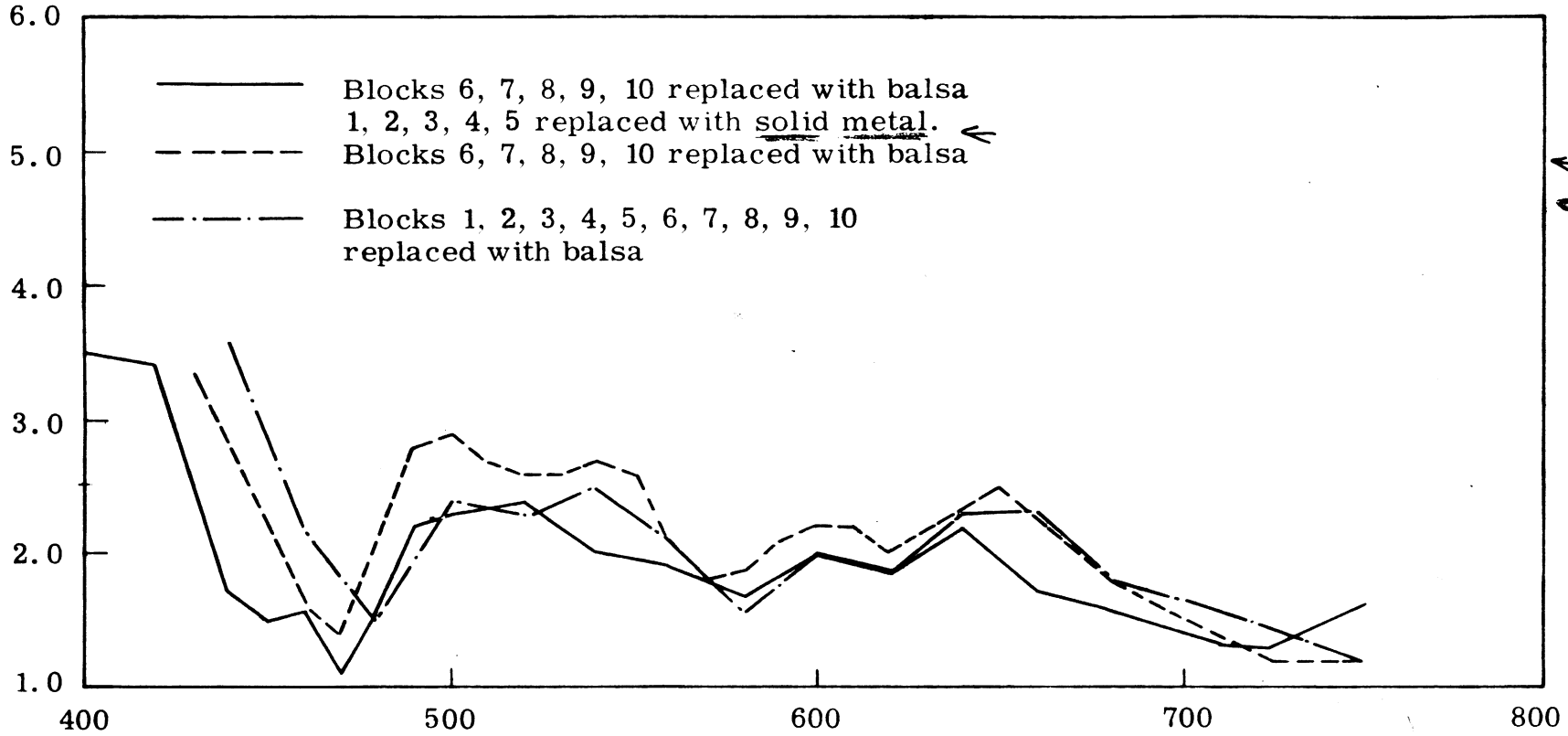

Fig. 2. Effect on VSWR of replacement of horizontal rows of cells of ferrite in a rectangular aperture.

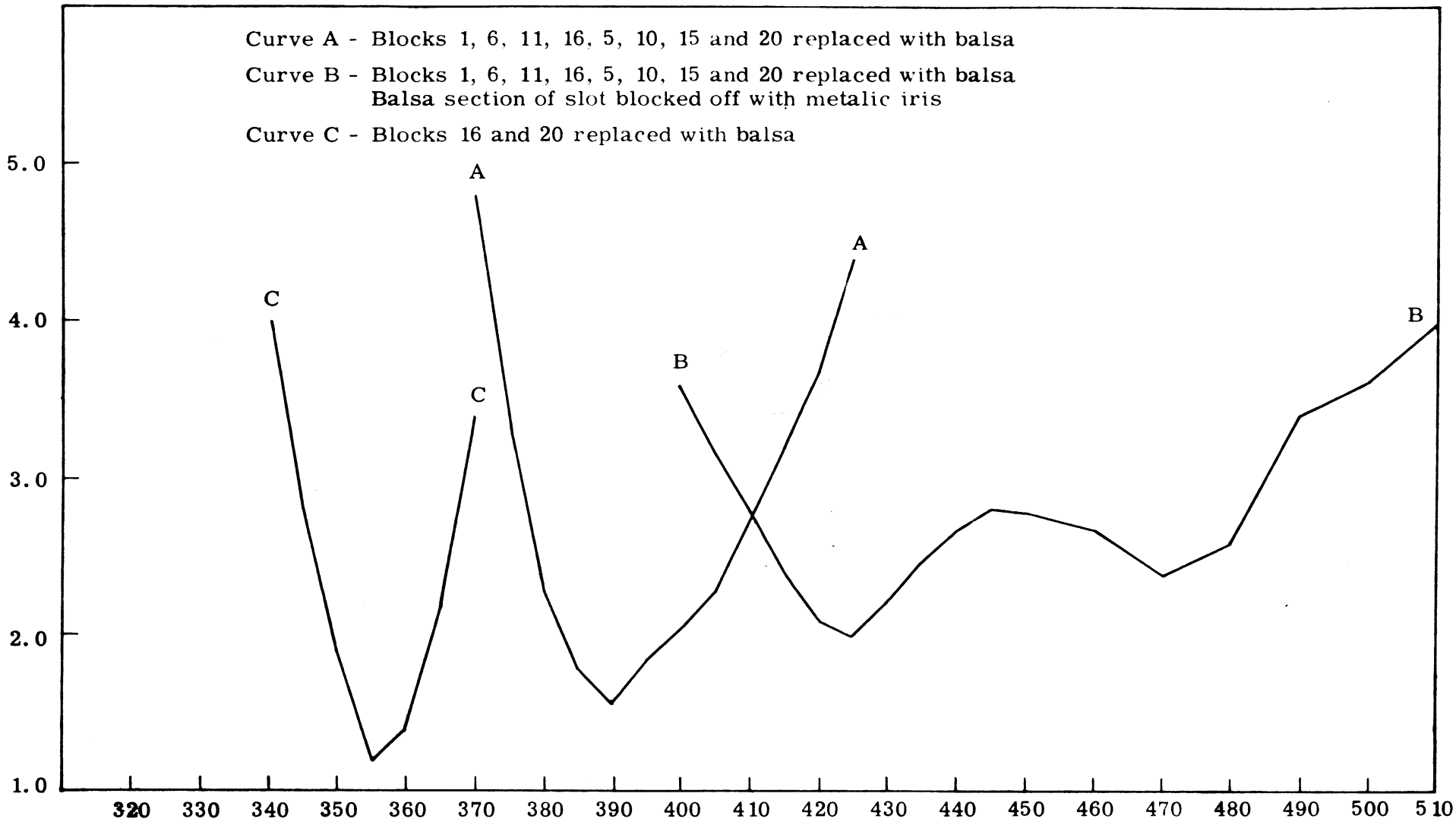

Fig. 3. Effect on VSWR of replacement of vertical columns of cells of ferrite in a rectangular aperture.

and is wider. One of the curves shows the VSWR for the aperture completely filled with ferrite. Another curve also useful for comparison is the VSWR curve taken for the replacement situation just described except that the aperture has not been reduced by the use of the metal tape irises covering Cell Nos. 1, 6, 11, 16, 5, 10, 15, and 20.

Many radiation patterns have been recorded for the cases discussed in the three figures already mentioned. However, it can be said that the replacement procedures so far have not resulted in any significant change in the shape of the radiation pattern of the rectangular slot. So far, no measure of changes in radiation efficiency have been measured.

2.3 Log Conical Spiral Antenna

The physical situations which were tested are shown schematically in the upper right-hand corner of Fig. 4. The basic log conical antenna (No. 207) used in these tests utilized subminax coaxial cable No. RG196. The antenna was wound on four supporting balsa wood strips. The two curves shown in Fig. 4 enable a comparison to be made of the VSWR for this antenna when mounted (as shown in Fig. 4) in an aluminum cavity of cylindrical shape with air both surrounding the antenna conductor elements and filling all remaining space in the cavity. In the second situation, the antenna was again mounted in the cavity, but in this case, ferrite powder "A" filled all of the intervening space both inside and outside the conical antenna and of course, inside the

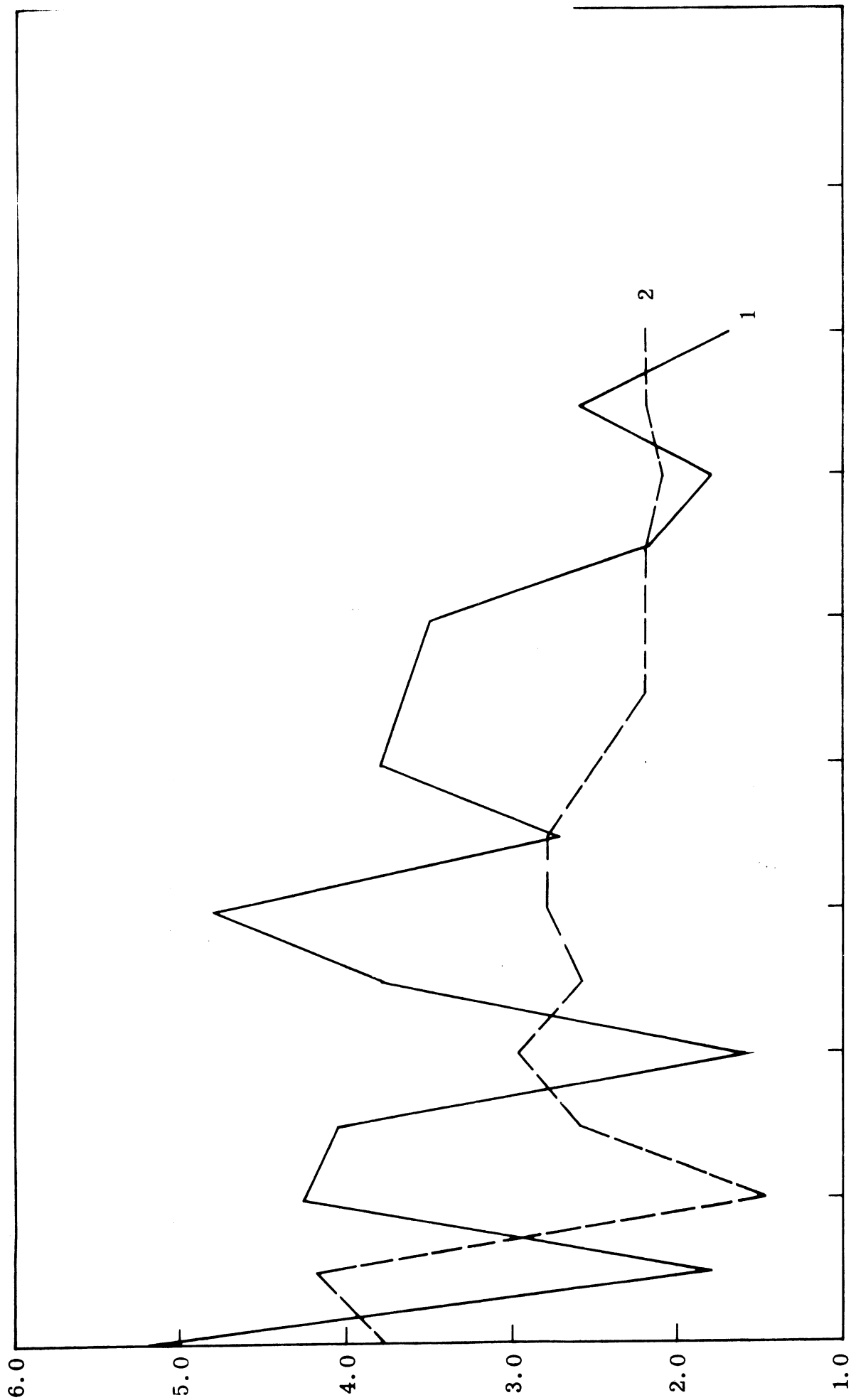

Fig. 4. Ferrite loaded log conical antenna in a metal cavity compared with the air filled case.

cylindrical cavity The level of ferrite was made to be flush with the outside flange of the cavity and was just sufficient to cover the top of the conical antenna together with its feed. The improved VSWR characteristic with ferrite is quite apparent from the curves. In the air case a typical axial beam radiation pattern was observed over a frequency range of 700 to 1100 Mc. In the ferrite powder case a typical axial beam radiation pattern was observed over a frequency range of 250 to 1100 Mc. A comparison of the efficiencies of the two cases is not available.

3. FUTURE RESEARCH EFFORT

3.1 Equiangular Spiral Antenna

Radiation patterns for the various types of loading with cavity backing will be taken in the near future.

3.2 Ferrite Loaded Rectangular Slot

Although magnetic tuning experiments on ferrite filled slots have been started, additional physical arrangements are necessary before any radiation pattern work can be done. Several practical difficulties still remain and it is hoped that simple solutions can be found so that initial results can be reported soon.

Spot measurement of efficiency corresponding to some of the experiments mentioned above will be made shortly. Such information is necessary for a correct evaluation of any benefits to be obtained for the arrangements studied.

3.3 Log Conical Spiral Antenna

It is anticipated that efficiency measurements will be made utilizing a substitution method for this type of antenna. Possible modifications of the reflection or "hat" method of measuring efficiency to be used in the case of circular polarization will be given consideration.

3.4 Helical Antenna

A study on the periodic loading of a helical antenna has been started. Initial data on related experiments should be available soon.

3.5 Electric Bias Study

Electric Bias using electric polarization may be helpful in antennas operated over a very narrow frequency range. The means of producing the bias are attractive since it is expected that a light weight high voltage supply could be utilized. In the near future simple experiments to assess the amount of nonlinearity of permittivity will be made. The problem is to obtain sufficient nonlinearity of a ferroelectric powder.

4. SUMMARY AND CONCLUSIONS

The further results described here concerning the log conical antenna continue to be encouraging with respect to improvement of the broadbanding quality. VSWR and radiation pattern measurements are reassuring. Final conclusions with respect to broadbanding must be drawn only after sufficient data have been obtained upon the radiation of efficiency.

On the basis of the few experiments reported, general conclusions cannot yet be made of the effects of positioning of ferrite of the aperture. Some of the experiments have not been sufficiently sensitive to demonstrate effects expected.