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STUDY AND INVESTIGATION OF A UHF-VHF ANTENNA

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ABSTRACT

Experimental studies of the ferrite-loaded log conical spiral antenna were begun. Both fully and partially loaded studies were made with two different thicknesses of ferrite layers. Early results, ascertained upon VSWR and efficiency measurements only, show that an extension of operation into lower frequencies is possible. Improved radiation efficiency at lower frequencies with slightly reduced efficiency at higher frequencies is a typical observation so far. Optimization of the qualities of the ferrite with the frequency range of a log conical antenna remains an important problem for the immediate future effort. Radiation pattern changes attendant upon the introduction of ferrite are yet to be evaluated.

1. REPORTS, TRAVEL, AND VISITORS

From October 14, 1963 to October 18, 1963, Dr. John A. M. Lyon and John E. Herman attended the 13th Annual Symposium of the USAF Antenna Research and Development Program. "Ferrite-Loaded Slot and Traveling Wave Antennas" by A. T. Adams, J. A. M. Lyon, and J. E. Herman was presented by J. A. M. Lyon.

2. PERIOD ACTIVITIES

During this period, a log conical spiral was obtained from WPAF and was used as a model for the investigation of ferrite powder loading. The theoretical frequency range of operation was 600 mc to 1,500 mc. VSWR measurements showed a low frequency cutoff of about 300 mc as shown in Fig. 1.

Initially, partial loading of the spiral was employed; i.e., a one-inch thick layer of ferrite powder was introduced which extended from the bottom (larger in diameter) halfway to the top. The result was a reduction in low frequency cutoff by a factor of 1.30 as shown in Fig. 1.

Next, the spiral was loaded with a 3/4-inch layer of ferrite powder from top to bottom. This produced only a slight reduction in lower cutoff frequency as seen in Fig. 1. By loading only a single arm, approximately the same result was obtained. Somewhat similar results were obtained for the smaller models constructed during the previous bimonthly period.

Radiation patterns taken for the loaded and unloaded antennas showed very little pattern deterioration [Figs. 2(a)-4(b)]. The unidirectional and circular polarization characteristics were preserved, while the beam width was increased somewhat.

Introduction of the ferrite powder at the higher frequencies produced the characteristic loss in radiation efficiency while at the lower frequencies, the material produced an increase in radiation efficiency. Pattern asymmetries are attributed to the fact that it was difficult to maintain uniform packing of the powder as the spiral was rotated. However, this problem could easily be overcome in future test models.

Apparently the optimum loading condition has not been attained since, in principle, a reduction in lower cutoff frequency by a factor of 2.5 should be possible. Thus, the testing of various loading configurations for the conical log spiral will be continued. (Models of both loaded and unloaded log conical spiral antennas are shown in Fig. 5.)

3. FUTURE RESEARCH EFFORT

During the ensuing two-month period, it is anticipated that the project will operate on a limited budget. In part, this is due to the fact that considerable money has been allocated for the purchase of ferrite powder (on order from Motorola, Inc., Phoenix, Arizona, for approximately three months). Pending delivery of the material, experimental work will also be somewhat limited by the small amount of powdered ferrite that is available.

3.1 Ferrite Loaded Rectangular Slot Antenna

A new set of curves is being prepared which will show the optimization of the characteristics of the ferrite material for best efficiency and greatest bandwidth when used in rectangular slots. The work on this new set of curves will be finished within the next bimonthly period and will be fully reported in the corresponding report.

3.2 Log Conical Spiral Antenna

Experimental work will be continued in the placing of ferrite to improve the operation of the log conical spiral antenna type. Presently, more thorough studies of radiation pattern appear necessary. The manner and effectiveness of various types of loading will be studied critically. An attempt will be made to relate the manner of loading with the basic processes of transmission and radiation of energy. It is presently anticipated that this effort will be based entirely upon a phenomenological approach. If time permits, a log conical spiral capable of operating at a slightly lower frequency range than is presently used will be made so that the full benefits of the currently available ferrite will be obtained with respect to possible extension of the operating bandwidth of the antenna.

3.3 Equiangular Spiral Antenna

A start has been made upon an analysis of the equiangular spiral antenna which is amenable to the introduction of a layer of ferrite.

It is hoped that through the computer, this analysis will then predict the performance of the equiangular spiral with a ferrite layer. It is anticipated that this analysis, together with substantial computer results, will be available for inclusion in the next bimonthly report. The ferrite-covered equiangular spiral was chosen for mathematical analysis since this type gives promise that the traveling wave phenomena, as modified by the presence of the ferrite layer, can be solved with relatively simple mathematical methods.

3.4 Log Zig-Zag Antenna

If time and funds permit during the next two-month period, it is hoped that a start may be made upon the log zig-zag antenna as modified by the introduction of ferrite material. Possibly, because of the limitation of funds, only design data from an experimental log zig-zag antenna will be obtained. The antenna would be tested at a later time to determine radiation pattern, VSWR, and efficiency.

4. SUMMARY AND CONCLUSIONS

Recent work has indicated the possibility of utilizing ferrite material with traveling wave antennas for a reduction in lineal dimensions with some promise of retaining the broad bandwidth of these antennas. The material has been observed to exert some influence on radiation pattern. It has been tentatively concluded that major changes in pattern may be obtained by proper placement of ferrite material possessing the desired characteristics.

It has been concluded that extensive mathematical analysis with digital computers is not justified for all of the traveling wave antenna types worthy of adaption to ferrite modification.

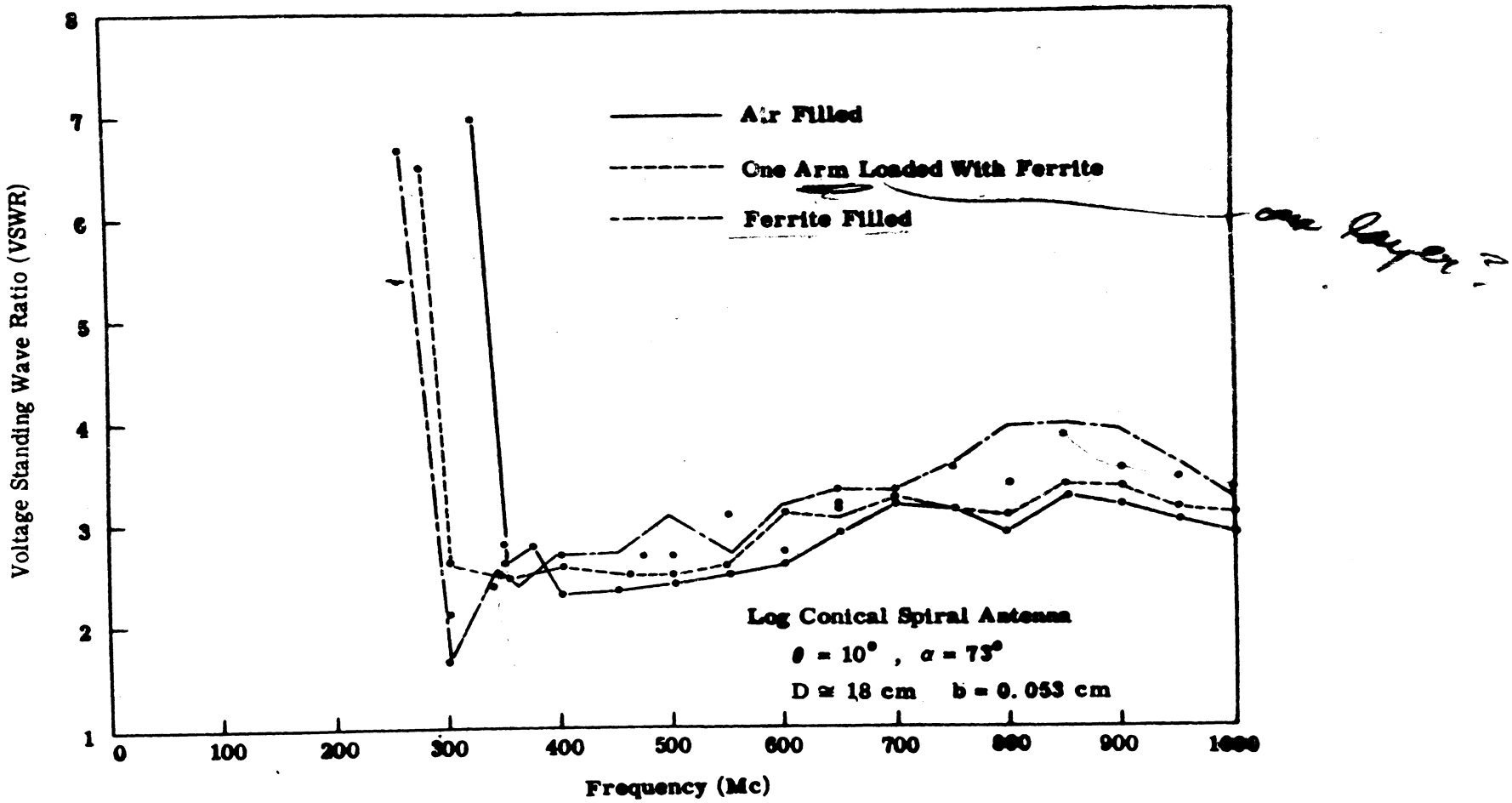

Fig. 1 Low frequency cutoff points for the log conical spiral antenna in the cases of unloaded, partially-loaded and loaded antennas

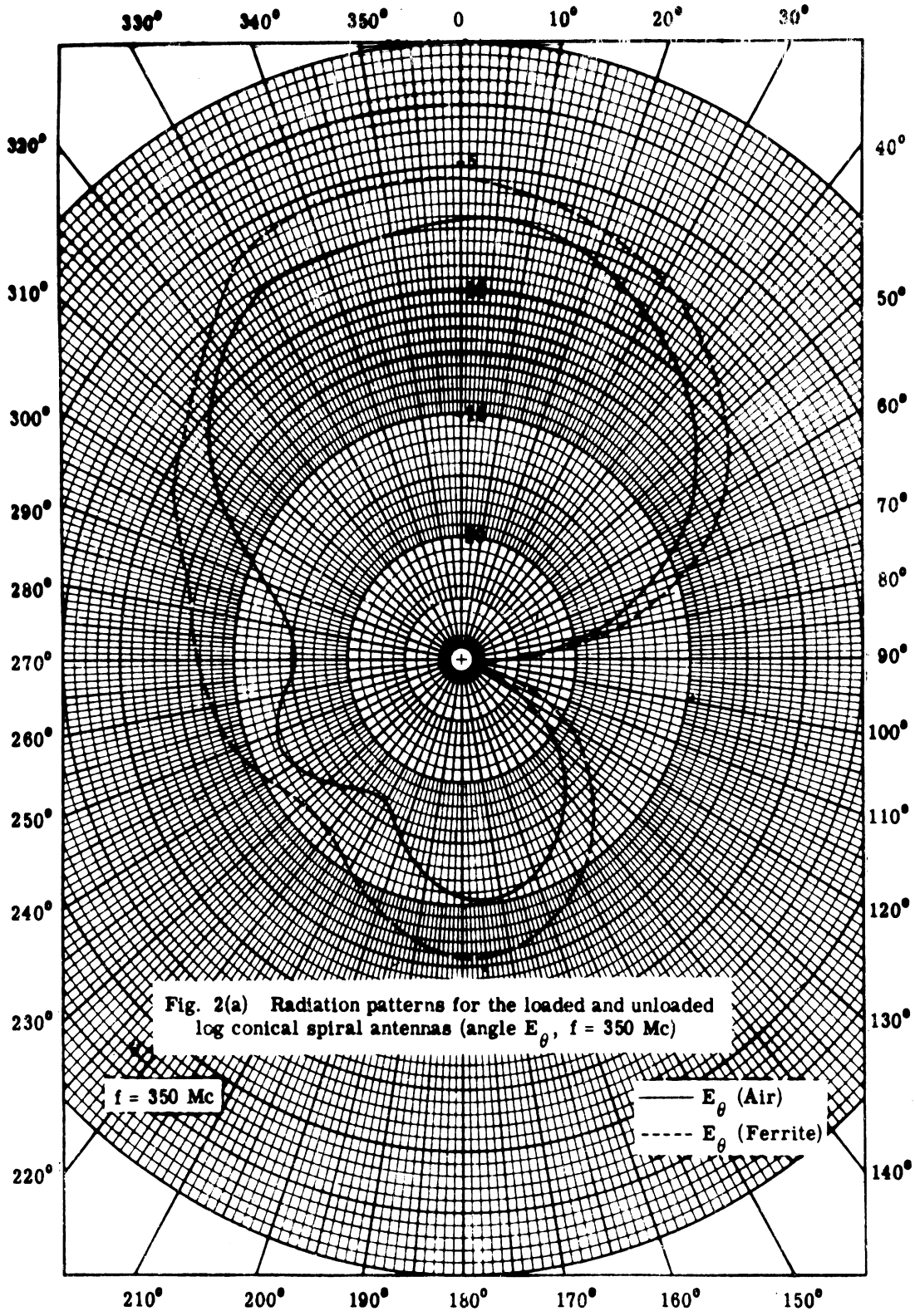

Fig. 2(a) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_θ, f = 350 Mc)

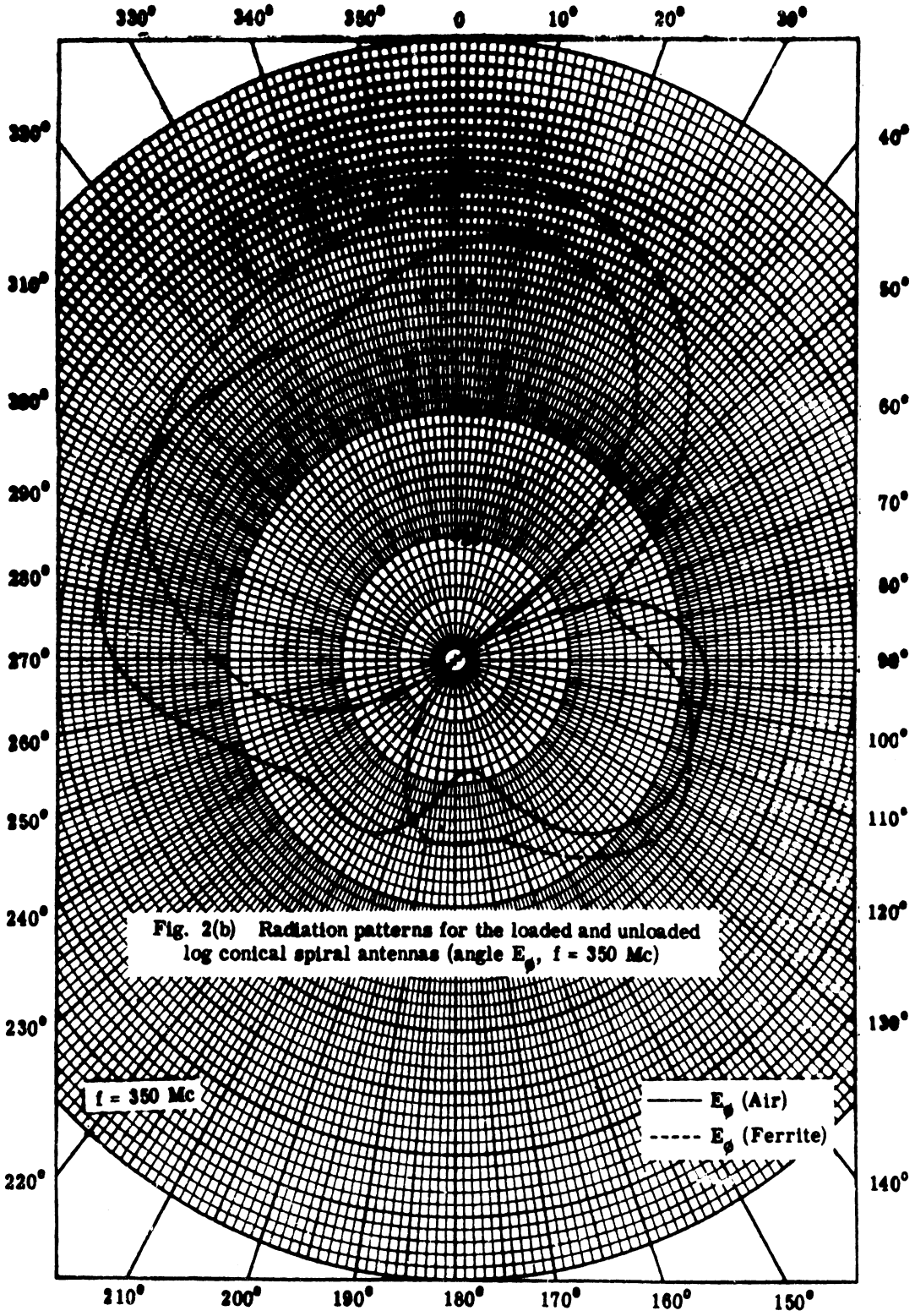

Fig. 2(b) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_ϕ, f = 350 Mc)

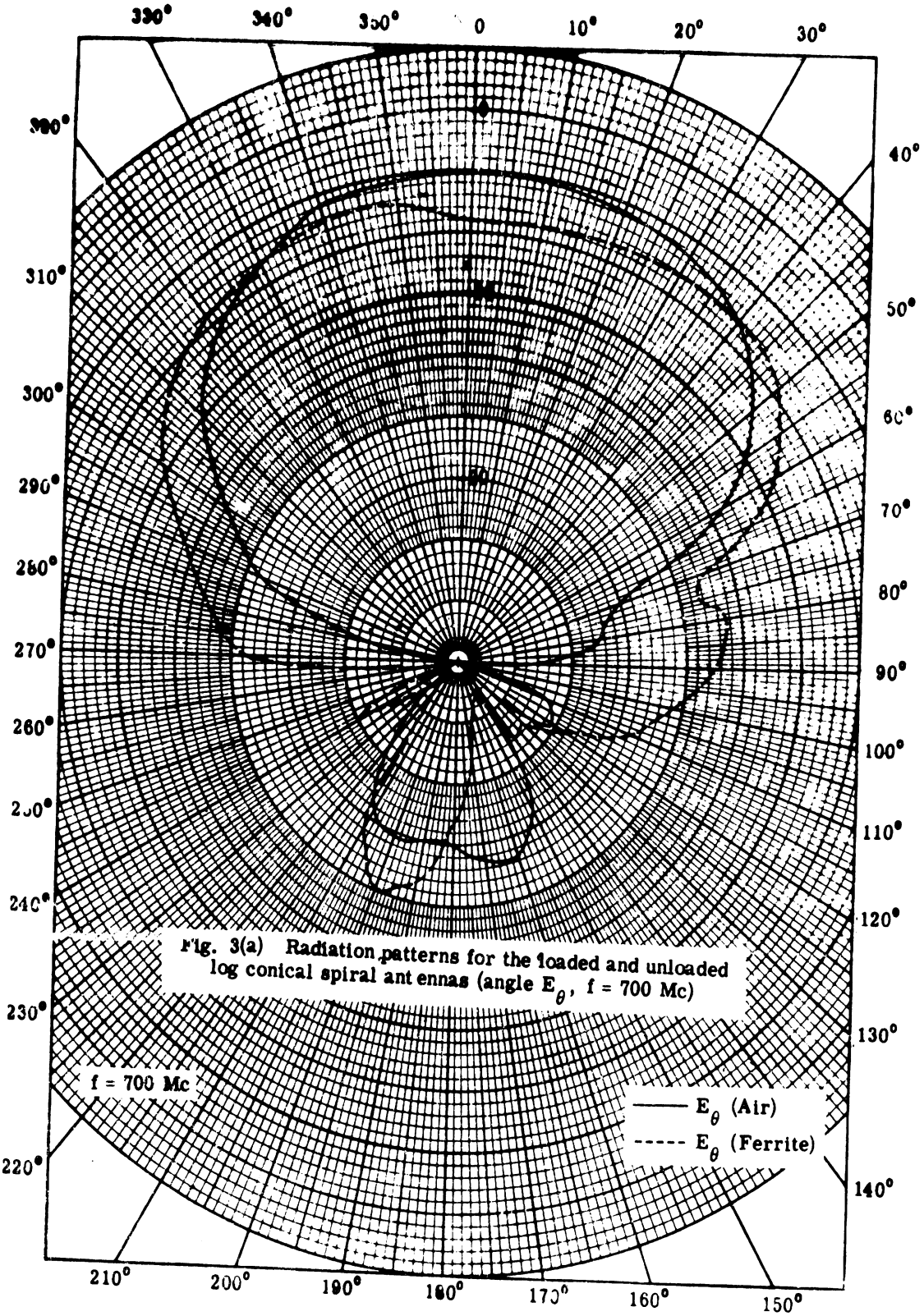

Fig. 3(a) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_θ, f = 700 Mc)

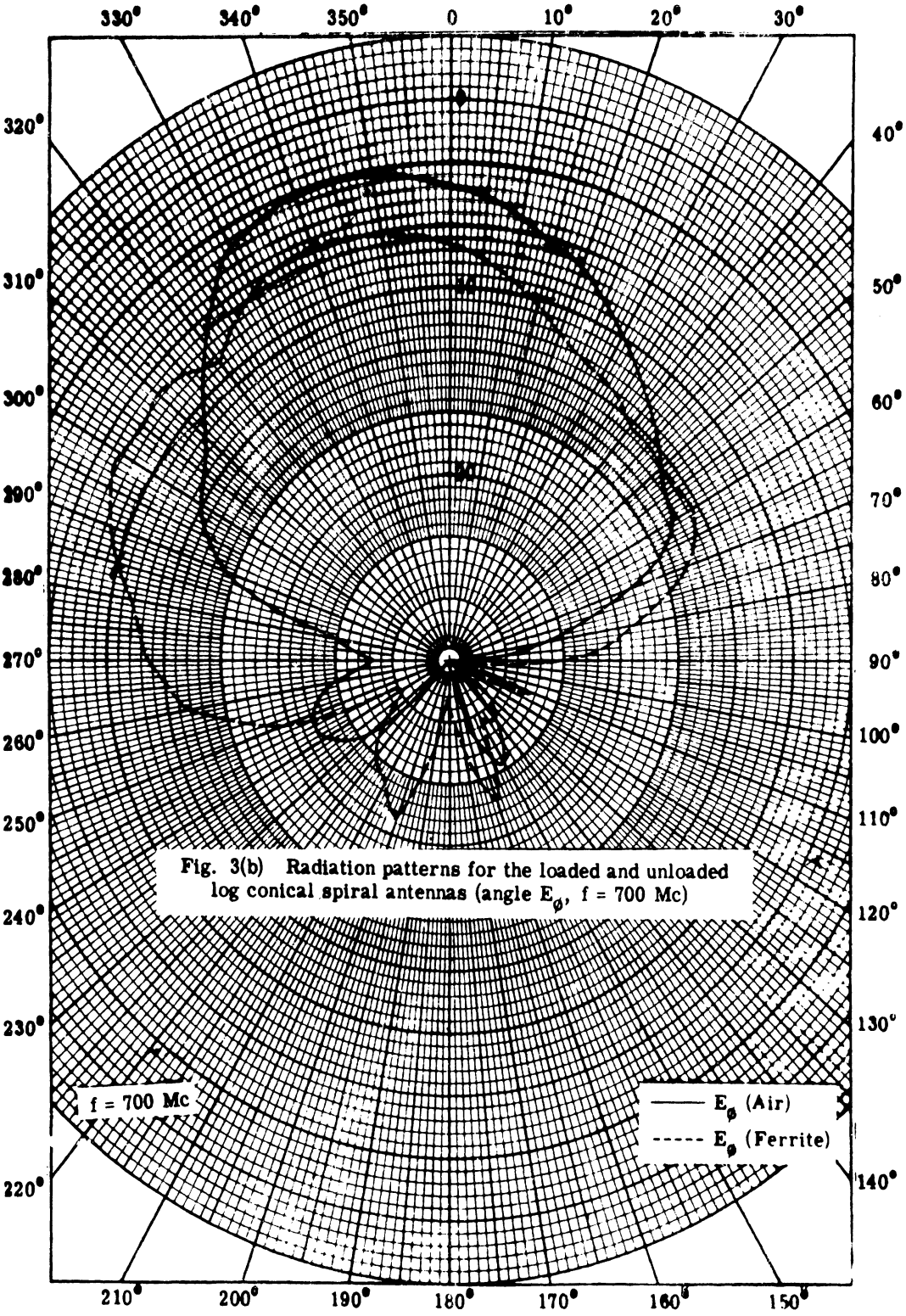

Fig. 3(b) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_ϕ, f = 700 Mc)

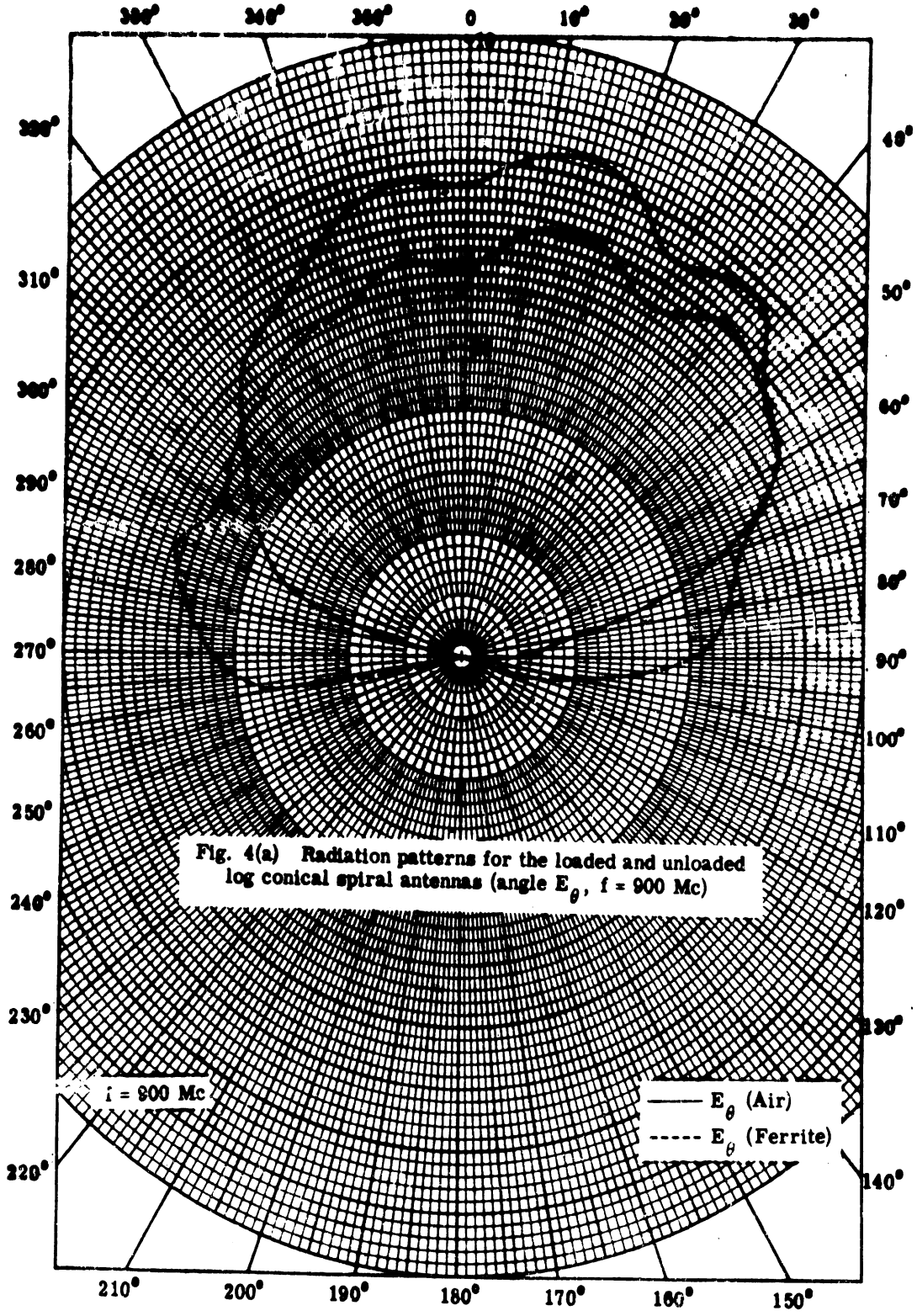

Fig. 4(a) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_θ, f = 900 Mc)

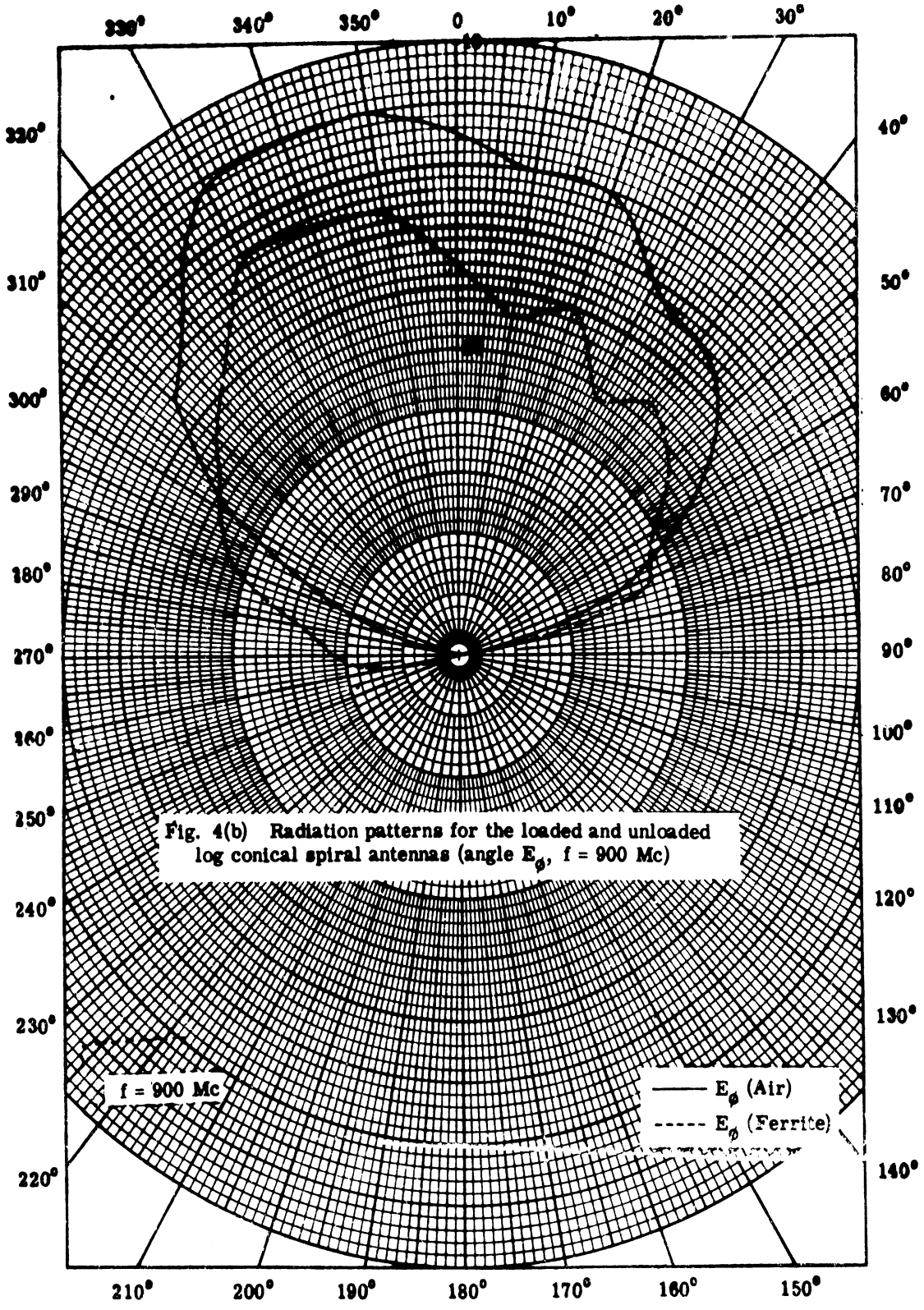

Fig. 4(b) Radiation patterns for the loaded and unloaded log conical spiral antennas (angle E_ϕ, f = 900 Mc)