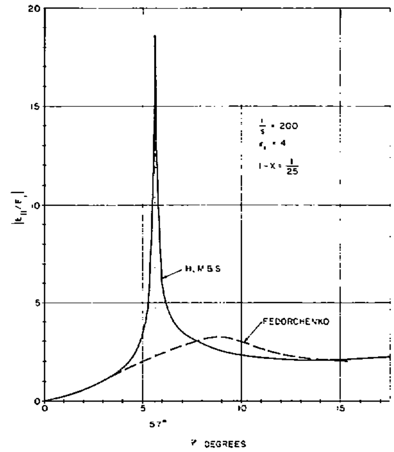

Fig. 4—Angular dependence of the field ration.

A. HESSEL
N. MARCUVITZ†
J. SHMOYS
Polytechnic Inst. of Brooklyn
Dept. of Electrophysics
Brooklyn, N. Y.

† Presently with Office of the Director of Defense Research and Engineering, Dept. of Defense, Washington, D. C.

Radio Reflections from Meteor Trails*

Hershberger[1] raised the question of whether a multiplicity of resonances had been observed in radio reflections from meteor trails at frequencies near the plasma frequency similar to those observed from positive columns in the laboratory. Now that a theoretical description of the process leading to the laboratory observations is available[2] one can determine whether such resonances might be observable.

The theory requires a non-uniform distribution of electron density and it seems from experimental evidence that the appropriate boundary condition is zero space charge perturbation at the periphery of the plasma column.[3] Thus it may be that the diffuseness of a meteor trail with electron number density varying as $n = n_0 \exp(-r/r_0)^2$ causes an absence of subsidiary resonances.

On the other hand the dispersion relation which gives rise to the waves

$$(\omega_p^2 - \omega^2)n_1 = + \frac{\gamma k T_e}{m} \nabla^2 n_1,$$

where ω is the signal frequency, ω_p the plasma frequency, T_e the electron temperature and n_1 the electron density perturbation, results from the neglect of terms involving the electric field. Under normal conditions in a laboratory discharge these terms are in fact negligible due to the Debye length being only an order of magnitude or two smaller than the plasma radius. For a meteor trail however, within one collision time *i.e.*, 10 μs, the electron temperature will decay to the gas temperature *i.e.*, at most 500°K. For neglect of the electric field terms in the dispersion relation we require $\lambda^3 < \lambda_D{}^2 a$, where λ_D is the Debye length, λ the effective wavelength of the plasma waves and a the plasma radius. For an operating wavelength of 5 m the Debye length is $\sim$0.025 cm near the plasma frequency, and requires the plasma waves to have a wavelength <0.4 cm for a column of radius 1 m. This restriction on the wavelength of the plasma waves might well give rise to the situation where the structure of the subsidiary resonances would not be discernible.

R. N. FRANKLIN
Radar and Telecommunications Branch
R.M.C.S., Shrivenham, Swindon
Wilts, U. K.

* Received September 20, 1963.

[1] W. D. Hershberger, "Proposed experiment for eliciting multiple resonances from the ionosphere," IRE TRANS. ON MICROWAVE THEORY AND TECHNIQUES, vol. MTT-10, p. 396; September, 1962.

[2] F. Crawford, "The mechanism of Tonk-Dattner plasma resonances," *Phys. Letters*, vol. 5, pp. 244–247; July, 1963.

[3] G. H. Bryant and R. N. Franklin, "Experiments on Electrostatic Plasma Resonances," to be published.

A Novel Duplex Feed*

For observing lunar occultations of radio sources, a dual-frequency feed has been designed to use on one of the 90-ft paraboloids ($f/D = 0.4$) at this observatory. The requirement was to add a long-wavelength ($\sim$3 meters) feed on the same axis as the existing 21-cm waveguide feed-horn.

The quad, or "unfolded folded-dipole," seemed to lend itself to this application, as shown in Fig. 1. The quad is a square loop

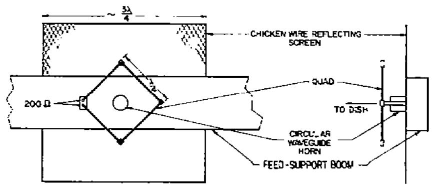

Fig. 1—A novel duplex feed.

with a circumference of one wavelength, placed about $\lambda/8$ in front of a reflecting screen. It is easily coupled to a 50 Ω coaxial system by means of a $\lambda/2$ balun. When made of thin rods, its tuning is rather sharp, with a bandwidth of a few per cent. The impedance of the quad is hardly affected by the presence of the horn in its center. Careful tests showed that the quad has a negligible effect on the shape and side-lobe level of the main antenna beam at decimeter wavelengths.

The system arrived at seems to be a simple and effective feed for any two widely-differing wavelengths.

ALAN T. MOFFET
Owens Valley Radio Observatory
California Inst. of Technology
Pasadena, Calif.

* Received October 9, 1963.

An Investigation of the Properties of Synthesized Nonuniformly Spaced Antenna Arrays*

It is the purpose of this communication to present some preliminary results on the properties of nonuniformly spaced antenna arrays which were synthesized with the aim of suppressing the sidelobe levels. Most antenna synthesis work with this type antenna has been concerned with large interelement spacings; here we are concerned with the closely spaced arrays so that attention is on the sidelobe level rather than the grating lobes.

For synthesizing these arrays, a procedure similar to that of Andreasen[1] has been used, in which a digital computer is employed to systematically vary the interelement spacings until a significant decrease in the sidelobe level has been obtained. Using this procedure, it has been possible to develop an empirical method for predicting the approximate element positions for a nonuniform array having greatly decreased sidelobe levels. Furthermore, it has been possible to investigate the effect of current tapering as well as nonuniform spacings for further sidelobe reduction.

Using the technique described above, antennas with reduced sidelobe levels were successfully synthesized for arrays involving 10 to 24 elements; the technique is immediately applicable to larger arrays, but the computation time would become prohibitive for the type of computer used in these investigations. Table I summarizes the results. Shown for comparison purposes is a Chebyshev tapered array with half-wave spacing, which has the same sidelobe level as the corresponding nonuniform array, and an over-all length as close as possible to the nonuniform array length. The results presented in Table I clearly indicate that the attempts to reduce the sidelobe level have been successful. Since the approximate maximum sidelobe level of a linear array is −13 db, reductions ranging from 6 db for a 10-element array to 10 db for a 22-element array have been realized.

In order to present the results of the synthesized arrays in a form suitable for future design work, the spacings were plotted versus the number of elements, and

* Received October 14, 1963.

[1] M. C. Andreasen, "Investigation of Linear Arrays with Variable Spacings," Stanford Research Inst., Menlo Park, Calif., SRI Project No. 3833, p. 19; December, 1961.