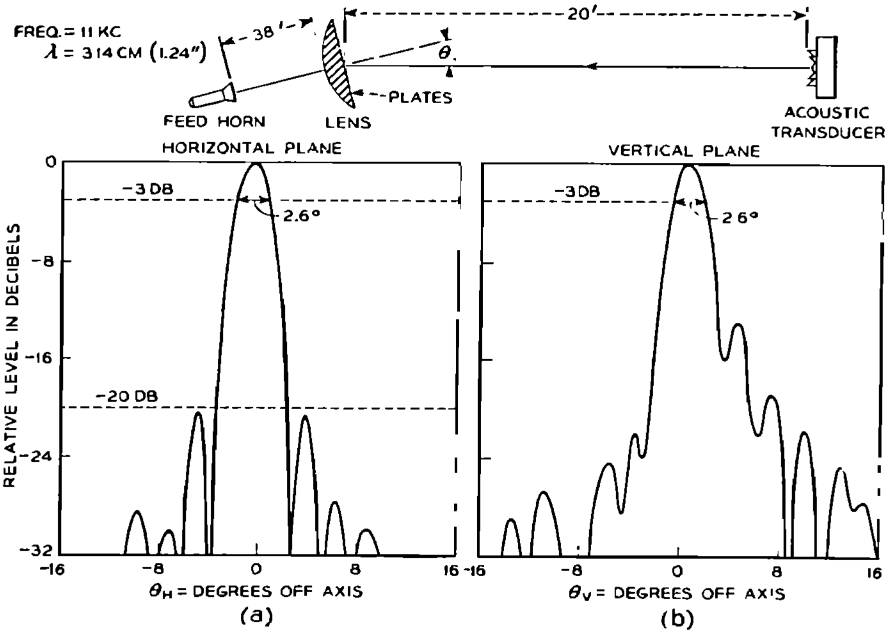

FIG. 15. Directional patterns of the slant plate lens of Fig. 14 using a 3-in. diameter feed horn: (a) Horizontal Plane. (b) Vertical Plane.

Fourier spectrum of a complex sound wave,[10] so a prism of the type described can be used as a spectrum analyzer. Very rapid analyses can be taken since all portions of the wave and all frequency components require approximately equal times to pass through the prism and arrive at the receiving points. This is in contrast to a grating where there is a time delay between the ray arriving from the grating element nearest the receiver and the ray arriving from the most distant element. Even the small prism of Fig. 9 could resolve four or five frequency components located between 4 kc and 10 kc as seen in Fig. 11. Much higher resolution could be obtained with larger prisms.

The index of refraction, as obtained from the measured angle of deviation and the angular width of the prism, was 1.23 at 4 kc but rose gradually to 1.64 at 10 kc. The value of n as obtained from the formula involving the obstacle dimensions (without frequency correction) is 1.24 which corresponds very well with the measured value at 4 kc where the index is still fairly constant.

This prism was originally constructed for 3 cm micro-

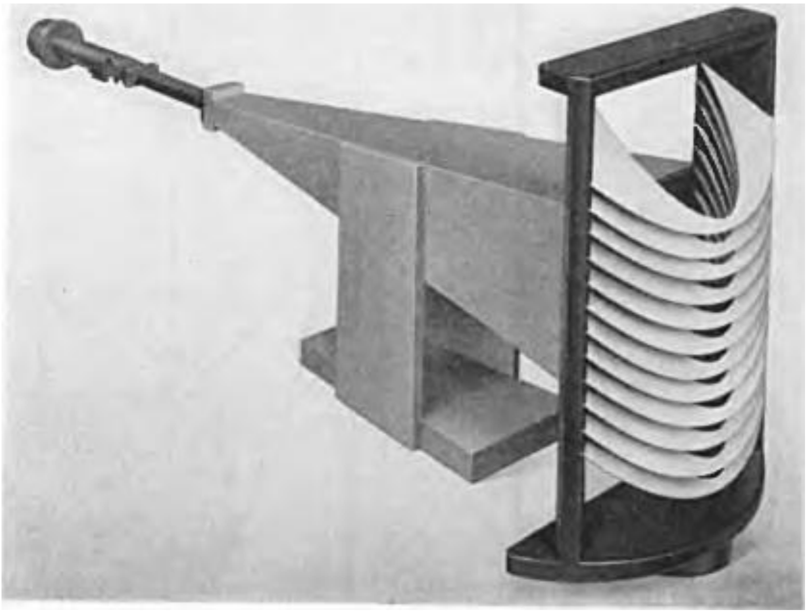

FIG. 16. A divergent slant plate cylindrical lens placed in front of a horn having a 6-in. square aperture.

[10] E. Meyer, *Electro-Acoustics* (G. Bell and Sons, London, 1939), p. 24.

wave experiments but failed to exhibit the expected properties at 3.2 or 3.3 cm. It was then tested acoustically and the reason for its behavior immediately became evident. The size and spacing of the strips were such as to effect resonance at 3.45 cm, and the 3.3-cm wave-lengths were reflected. It was re-examined at microwaves at 3.7 cm and found to operate as expected and to possess the same refractive index for acoustic and microwaves, as predicted from theory. This incident suggests that pertinent information about the electromagnetic behavior of periodic structures can be obtained from the simpler acoustic measurements.

The Strip Array as a Convergent Lens

A 10-in. diameter double convex lens similar to the strip prism just described was constructed for acoustical purposes (see Fig. 12). This lens operates on centimeter microwaves and is a model of the type projected for the New York–Chicago microwave relay circuit of the American Telephone and Telegraph Company. At 9 kc this lens had a focal length of approximately nine inches. As in the prism, transmission cuts off sharply in the neighborhood of 10 kc.

A Modified Strip Lens Using Perforated Metal

A perforated metal plate can be looked upon as a modified strip array with the strips running in two perpendicular directions and having round holes instead of square. Accordingly, perforated metal plates were spaced and stacked to form the 10-in. diameter planoconvex lens shown in Fig. 13. The holes were 0.125 in. in diameter and placed on 0.200-in. centers in a 0.025-in. brass sheet, the sheets spaced 0.375 in. apart. Satisfactory focusing action was observed at a focal length of 18 in. at 11 kc. This lens is, of course, effective only for acoustic waves.

The Slant Plate Array as a Convergent Lens

Tests were made on a 30-in. path length lens composed of an array of slanted plates (see Fig. 14). Its aluminum plates are spaced $\frac{1}{2}$ in. apart and slanted at an angle of 48.3° ($n=1.5$). It was designed to have a focal length of 30 in. for plane waves. However, in order that waves received from a distant point source be flat to within $\frac{1}{16}$ of a wave-length over the 30-in. aperture, the source would have to be 120 ft distant. This was not possible in our test room; therefore, with the source 20 ft distant, a longer focal length (38 in.) was employed to obtain proper focusing. The horizontal directional pattern of this lens at 11 kc is shown in Fig. 15a. The vertical pattern is shown in Fig. 15b. In this plane the slant plates cause an unsymmetrical distribution of energy across the lens face and cause some dissymmetry in the minor lobe structure. The measured beam width of 2.6° checks fairly well with the expected $65\lambda/d$ value of 2.69°. The lens can be rotated almost ±15° about a diametral axis (with the feed fixed) before the gain is reduced by 2 db.

From 10 to 13 kc the measured gain of the lens was found to be approximately 2.5 db down from that calculated for uniform illumination ($G=4\pi A/\lambda^2$). This corresponds closely to results on most microwave lenses and paraboloids. This 56 percent "effective area" was maintained to within 2 db of this value over the band from 7.5 kc to 15 kc, falling off at the low end because

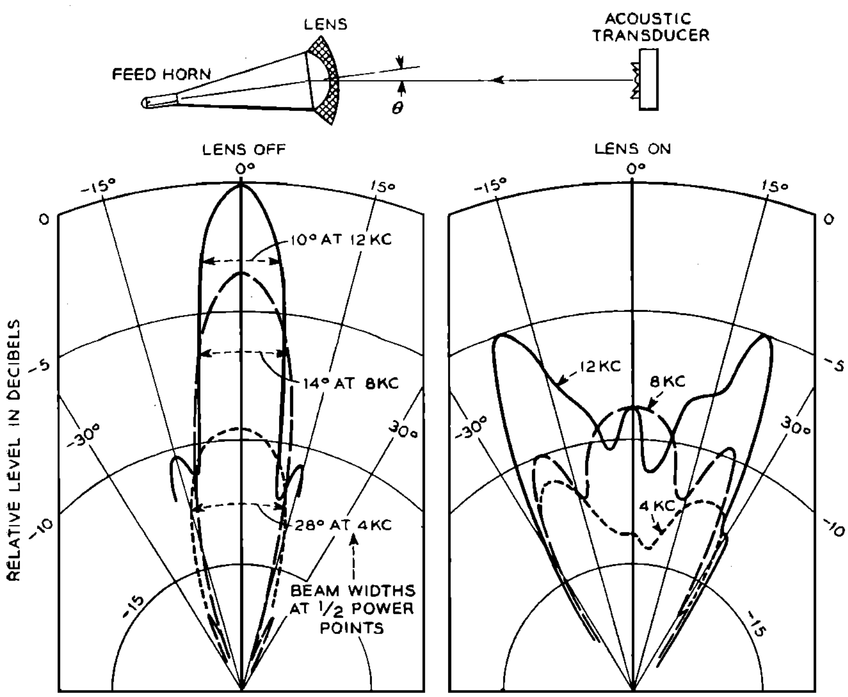

FIG. 17. Horizontal plane directional patterns of the horn of Fig. 16: left, the horn alone, and right, the combination of horn and diffusing lens.