the 3-in. receiving horn failed to intercept the optimum size focal spot and at the high end because the plate spacing reached, at 13.6 kc, the ½-wave-length value where the 2nd order mode can be propagated between the plates. It is interesting to note that at 13 kc the combination of the lens and feed horn is 4500 times more directive than an isotropic radiator.

The Slant Plate Array as a Cylindrical Divergent Lens

The lenses thus far described were mostly focusing devices designed to increase the directivity of acoustic transducers. Divergent or diffusing lenses, however, are also of interest in certain applications. For example, long exponential horns are often used as loud speakers to provide an acoustic impedance match between the narrow aperture of the driver unit and the mouth of the horn. For a satisfactory match to free air, the horn aperture must be of the order of a half-wave-length for the lowest frequency transmitted, and the horn length is also dictated by this lowest frequency since the rate of taper determines the low frequency cut-off. Horns required to handle frequencies from 1 or 2 kc upwards therefore have apertures 6 in. or so in width and may be 2 or 3 ft long. This gradual flare means that the emerging phase fronts are approximately plane and because, at the high frequencies, the 6-in. aperture is quite directive, the energy at these frequencies is sharply beamed along the horn axis. Multiple horns are thus required to distribute adequately spatially these higher frequencies. A diverging lens in front of a single horn could accomplish the same result with an appreciable space saving (see Fig. 16).

Here a slant plate array in the form of a cylindrical convexo-concave lens is employed in conjunction with a 6-in. square feed horn 30 in. long. The plates were spaced ½ in. apart and slanted at an angle of 48.3°. Characteristic directional patterns of the lens and feed horn were taken at representative frequencies throughout the operating range from 4 to 14 kc (see Fig. 17). With the lens on the horn, the beam width appeared fairly constant at around 50° to 60°. With the lens off, the beam width was considerably narrower and decreased as the frequency was raised. Also noticeable was a better equalization of response for equal energy signals. It is apparent that the lens tends to produce the desired circular wave front.

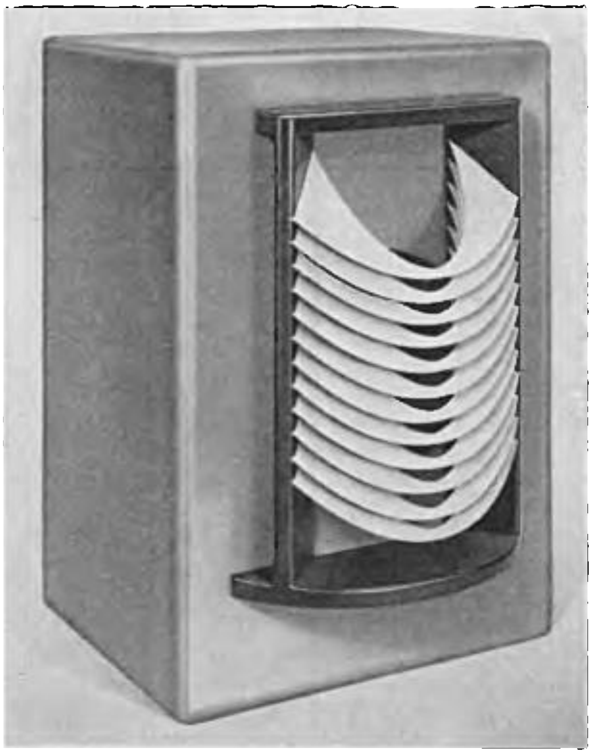

Fig. 18. The divergent lens of Fig. 16 employed in conjunction with a conventional cone type loud speaker.

Listening tests were made using a hiss tone containing frequencies from 5.6 to 11.2 kc sent out from the feed horn with and without the lens. All observers preferred the broader pattern obtained with the lens for high fidelity radio receiver use, since most loud speakers project the higher frequency sounds in a narrow beam directly in front of the receiver. Figure 18 shows a photograph of a cone loud speaker equipped with the cylindrical diffusing lens.

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