378.147:535.4

DEMONSTRATION EXPERIMENT WITH A ZONE PLATE

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Usp. Fiz. Nauk 82, 166-167 (January, 1964)

THE method of Fresnel zones is the basis of analysis of wave phenomena. An analytical exposition of this method without supporting demonstration experiments creates some doubt among students. We have prepared and used demonstration experiment using a zone plate. The use of zone plates for light waves under lecture-demonstration conditions encounters many difficulties. A zone plate was therefore prepared for acoustic wavelengths.

The zone plate was made of a wire framework. The even zones were filled with an acoustically opaque material. The choice of the covering of the zones was made with account of the fact that the experiment will be most convincing if the central zone is covered (see the drawing). Calculation of the radii of the zones was made by the formula

$$r_n = \sqrt{F(n+1)\lambda + \left(\frac{n+1}{2}\right)^2 \lambda^2} \qquad (n=0, 1, 2, 3, \ldots),$$

where r_n is the radius of the n-th Fresnel zone, F is the principal focal length, and λ is the wavelength.

Our zone plate possessed several Fresnel zones, and had a principal focal length $F = 100$ cm. The sound waves used in the experiment had a frequency $\nu = 9 \times 10^3$ cps. An electrodynamic loudspeaker, fed by a GZ-34 sound generator, served as the sound source. The electrodynamic speaker was placed in an internally soundproofed wooden box with dimensions $20 \times 20 \times 10$ cm. The output aperture had a diameter of 1.5 cm. A crystal earphone served as the sound detector. The signal from the earphone was applied to an ÉO-7 oscilloscope. Insertion of the zone plate between the source and receiver of the sound increased the amplitude of sinusoidal oscillations by a factor of 2—3.

It can be shown that the given zone plate corresponds to a definite frequency. It was sufficient to change the frequency by ± 20% to make the effects disappear.

Translated by R. T. Beyer