LECTURE DEMONSTRATIONS WITH CENTIMETER WAVES

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THE use of centimeter electromagnetic waves makes it possible to demonstrate a number of derivations of wave theory much more graphically than is possible in optics. Thus, a zone plate is described in [1] for 12-cm waves. A zone plate was prepared at the Tomsk University for 3-cm waves from a klystron oscillator (Fig. 1). A zone plate with phase reversal was also prepared (Fig. 2), in the following way. Rings of paraffin were placed on a thick sheet of multilayered plywood. These rings covered the odd Fresnel zones of a spherical wave, with a source and receiver separated from the front by a distance of 1 m. The thickness of the rings was so chosen that passage through them added a path difference of one half wavelength. Therefore,

$$d(n-1)=\frac{\lambda}{2},$$

and since $n = 1.5$ for a frequency of 10^{10} cps, $d = \lambda$

FIG. 1

FIG. 2

= 3.2 cm. To pour the paraffin, the zone was surrounded by two rings of cardboard, and a thin layer initially poured; then, after it solidified, more paraffin was gradually added.

The demonstration is performed in the following way: the horn of the oscillator is covered by a diaphragm, which is opened for several centimeters to obtain a wavefront that is close to spherical. The horn of the receiver is placed at a distance of 2 m from it. The signal modulated by the sound generator is detected and is fed, after amplification (28IM amplifier) to the oscilloscope. If a zone plate is placed in the center, the amplitude of the signal increases. By putting the plate in this same place and reversing the phase of the oscillations of the odd zones, we get another twofold increase in amplitude.

The following experiment is carried out with a sheet of plywood with foil attached so that there remains an aperture with the dimension of four zones.

Rings covering zones 1, 2 and 3 are cut from the metal and slipped over small bolts. Initially, the effect is observed with a completely open front. Then a sheet of plywood with an open central zone is inserted. The received amplitude is then increased. Upon removal of the ring which covers the first zone, the reception vanishes. Upon removal of the next ring, it is again restored, etc.

With the same klystron generator, we demonstrate the important effect of the penetration of waves into the second medium in the case of total reflection. For this purpose, a paraffin prism was used with an edge 30 cm long and cross section in the form of a right isosceles triangle with side equal to 12 cm. The waves radiated from a horn farther than one meter away are incident normally on the hypotenuse face and strike the side faces at 45°, which exceeds the critical angle. A DK-I-1 probe detector placed vertically serves as the receiver. The generating voltage is amplified by a 28IM and is fed to an ÉO-7 oscilloscope. If the probe is placed exactly on the center of the side face and moved along the normal, then a wave field that falls off rapidly with distance is clearly detected. If the probe is moved still further, the reception amplitude increases significantly and successive maxima and minima are observed in the intensity as the result of interference of the direct wave with waves from secondary sources.

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[1]T. Brown, Am. J. Phys. **30**, 71 (1962).

Translated by R. T. Beyer