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Methodological Notes

THE NEW PHYSICS DEMONSTRATIONS

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1. ILLUSTRATION OF BREWSTER'S LAW WITH THE AID OF THREE-CENTIMETER ELECTROMAGNETIC WAVES

As is well known the physical meaning of Brewster's law consists of the fact that if the electric vector of a wave incident on a dielectric lies in the plane of incidence then for a certain angle of incidence (the Brewster angle) the direction of oscillation of the molecular dipoles of the dielectric may coincide with the direction of the reflected wave, and then there is no radiation in this direction. In the case when the electric vector of the incident wave is perpendicular to the plane of incidence reflection occurs for any angle of incidence.

In the demonstration illustrating Brewster's law the role of elementary radiators is played by a system of wire dipoles whose length is chosen to be an integral multiple of the incident wavelength. The elementary dipoles are mounted on dielectric rods which can be rotated about a vertical axis, and this enables the dipoles to be oriented in space. The rods carrying the dipoles are fixed in a wooden frame. Thus a lattice of horizontal and vertical dipoles is obtained which enables one to study the reflected wave for any orientation of the electric vector of the incident wave in the plane of incidence or perpendicular to it. The lattice utilized for the demonstration is made of four rods of 0.35 m. in height. The distance between the rods is 0.08 m. To each rod are attached 25 horizontal and four vertical dipoles of length 0.07 m made of copper wire of 2mm diameter. The lattice is schematically shown in Fig. 1.

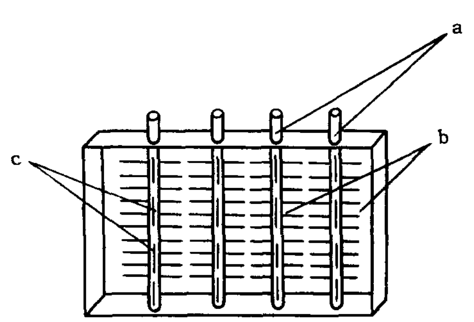


FIG. 1. a–dielectric rods; b–horizontal elementary dipoles; c–vertical elementary dipoles.

The source of a linearly polarized electromagnetic wave is a generator of three-centimeter waves with a waveguide terminated by a horn emitter; the wave is modulated at a frequency of 400 Hz. The receiver is in the form of a second horn waveguide with a detector section. The received signal is fed through an amplifier (U2-4) to the vertical input of an oscilloscope (ÉO-7). The intensity of the reflected wave is inferred from the magnitude of the signal on the oscilloscope screen.

The electric vector of the emitted wave is, as is well known, parallel to the short side of the rectangular waveguide. The emitting and the receiving horn antennas are situated at an angle of 45° with respect to the lattice.

In the case when the electric vector of the emitted wave lies in the plane of incidence the reflected wave exists for an arbitrary orientation of the elementary dipoles, and this is monitored by the presence of the signal on the oscilloscope screen.

But if the elementary dipoles are placed strictly in the direction of propagation of the reflected wave (the angle of incidence is equal to the Brewster angle) there is no reflection. The amplitude of the signal on the oscillograph screen is equal to zero.

By a rotation of the horn antennas one can orient the electric vector of the incident wave perpendicular to the plane of incidence. The reflected wave due to the vertical dipoles is present for any angle of orientation of the rods, and the signal does not disappear from the oscilloscope screen.

2. THE ACOUSTIC OHM'S LAW

Ohm's law in acoustics asserts that the perception of sound obtained from a sum of sounds is deter-

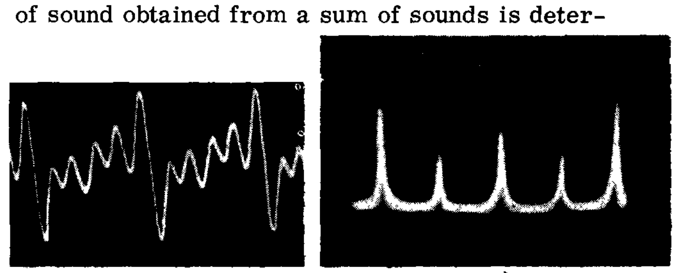


FIG. 2. a–temporal and B–spectral characteristics of the signal at the output of the generator prior to alteration of the phases of the harmonics.

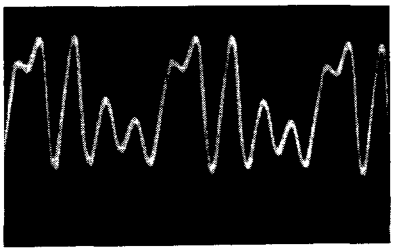
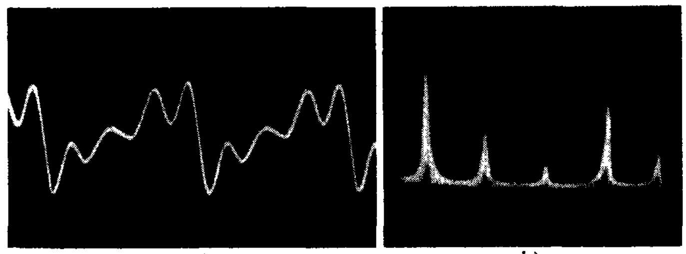


FIG. 3. The temporal characteristic of the signal at the output of the generator after a change in the phases of the harmonics. The spectral characteristic remains unchanged (cf. Fig. 2b).



a) b)

FIG. 4. a–temporal and b–spectral characteristics of the signal at the output of the generator after a change in the amplitudes of the harmonics.

mined only by the frequencies and the amplitudes but not by the phases of the sounds being added.

The validity of this law can be demonstrated by using a harmonics generator of the type G6-1.

The low frequency spectrum analyzer ASChKh-1, the cathode-ray oscilloscope ÉO-7 and the loudspeaker of type 1GD-5 utilized for the demonstration to which is applied the signal from the output of the generator enable one simultaneously to observe visually the time characteristic of the signal and its frequency spectrum and also to perceive the signal by ear.

The generator G6-1 can produce in addition to the fundamental frequency also its harmonics up to the sixth inclusive. At the output of each harmonic there is a phase shifter and an attenuator which enable one to vary the phases and the amplitudes of the harmonics.

Figs. 2 and 3 show the temporal and the spectral characteristics of the signal at the output of the generator for two different phase relationships between the harmonics. A change of phase leads to a sharp change in the temporal form of the signal. The frequency characteristic is not altered by this. The perception by ear in both cases is the same.

Figure 4 shows the temporal and the spectral characteristics of the signal at the output of the generator which differs from the signal corresponding to Fig. 2 only by the amplitudes of the component sounds, and this is accompanied by a change both of the temporal characteristic and of the perception by ear.

The demonstration shows sufficiently conclusively the validity of Ohm's law for a wide range of medium sound frequencies.

Translated by: G. Volkoff