536.7 + 538.3

TWO LECTURE DEMONSTRATIONS

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1. A wheel with rubber spokes operated as a cyclic heat engine. Utilizing the characteristic increase of tension that accompanies the heating of stretched rubber, an ingenious demonstration of a heat engine becomes possible.[1]

A light wheel (weighing about 60 g) consists of a central disk 5 cm in diameter, a rim of 22 cm o.d. and 20 cm i.d., and four rubber spokes 3–4 cm wide. The rim and central disk each consist of two layers of Duralumin 0.3 mm thick. The spokes, made of surgical-glove rubber, are fastened between these layers by means of cement and light clamps that press the layers together (Fig. 1). The wheel can be rotated about its horizontal axis with very little friction. The center

FIG. 1.

FIG. 2.

of gravity of the wheel should be on, or extremely close to, the axis; centering is performed with the aid of several light sleeves mounted along the rim.

An intense beam of infrared radiation is directed at the left-hand (or right-hand) half of the wheel, heating and thus shortening the spokes in this half. The center of gravity of the wheel is shifted off the axis; the resultant torque causes turning of the wheel. Other spokes are now heated by the radiation, while the previously heated spokes cool off. The wheel continues to rotate with slowing-down periods or brief stops.

The radiation source is a helix, wound around a conical ceramic core, that is heated by alternating current. This 600-watt radiator is mounted near the focus of a school-type concave metal reflector in order to produce a slightly converging beam. In our experiment the reflector was placed 60—80 cm from the plane of the wheel. The heating of the coil is regulated conveniently by means of an autotransformer. Prior to almost each demonstration new spokes must be inserted, since they become unsuitable, especially when heated. This demonstration illustrates the principle of a cyclic heat engine and also teaches something about the thermal characteristics of polymers.

2. Diffraction of 3-cm electromagnetic waves by a circular screen and observation of the Poisson spot. It is difficult in a lecture to demonstrate the diffraction of light waves by a single circular screen. This effect, like diffraction by an aperture,[2] is demonstrated clearly with centimer microwaves. The demonstration is even simpler than that for an aperture, since a huge screen is not required. In addition, the central bright spot in the shadow can be observed.

The source is a 3-cm klystron oscillator (type 51-I, for example) with a horn antenna (radiator). A round screen of 43-cm diameter, made of plywood covered with cemented-on tinfoil, is set up 115 cm from the antenna. The klystron signal modulated by a low frequency is received by a horn antenna located 65—75 cm behind the screen on the axis of the system. The signal is then fed to a detector, is amplified (by a 28-I amplifier, for example), and is displayed on an oscilloscope screen. When the receiving antenna is displaced parallel to the diameter of the screen, we can observe the central maximum and the maxima in the region of the screen's edge (with reduced amplification). When the antenna leaves the shadow of the screen the signal is increased strongly. The set of school apparatus described by Shakhmaev[3] contains equipment for this experiment.

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[1] H. Melville, Big Molecules, Macmillan, New York, 1958, Russ. transl., Moscow, 1960.

[2] V. A. Zoré, N. S. Kuzikova, N. N. Malov, and L. N. Nikulina, Some New Lecture Demonstrations, UFN 77, 197 (1962), Soviet Phys. Uspekhi 5, 460 (1962).

[3] N. M. Shakhmaev, A Set of Apparatus for Studying Electromagnetic Waves, Fizika v shkole (School Physics) No. 4, 67 (1960).