

Notes on Techniques

*NEW DEMONSTRATION APPARATUS*

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Uspekhi Fiz. Nauk 66, 519-521 (November, 1958)

**C**IRCUIT and construction details are given for the demonstration of wave phenomena on a screen. The design is based on the apparatus developed by P. N. Lebedev and I. F. Usagin.\*

The apparatus described permits the display of a whole series of wave phenomena on the surface of a liquid to be displayed on a screen in a darkened auditorium. The experiments include: (a) launching and propagation of plane and spherical waves (b) the phenomenon of refraction at the interface between two media (c) reflection of waves from plane and spherical surfaces (d) Huygens' principle (e) interference of waves (f) diffraction of waves.

The general form of the apparatus is shown in Fig. 1. The principal parts of the apparatus are the tank, the electro-magnetic vibrator, and the projection system.

The tank is provided with a transparent glass

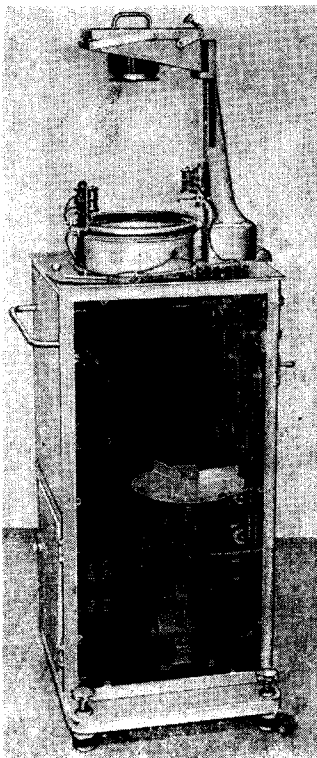


FIG. 1. General view of the apparatus.

bottom. Various obstacles are placed on the bottom to secure different effects. Capillary waves produced on the surface of the liquid (acetone) in the tank are projected onto a screen. The path of the rays of the projection system is shown in Fig. 2. A K-22 motion-picture projector bulb serves as the light source. The light rays from the source travel through the first condenser and, upon reflection from mirror 2, travel upward to lens 3 which focuses the rays on the aperture in disk 4. The shutter disk 4 has three equidistant apertures (at 120°) on a circle. Upon rotation of this disk, the tank is illuminated by the portion of the light passing through the shutter. The illumination of the tank is synchronized with the operation of electromagnetic vibrators; the commutator is set on the same axis with the shutter; in this way, the tank is illuminated stroboscopically, so that a stationary picture of the waves is portrayed on the screen. To obtain "traveling" waves, the apparatus is provided with a special mechanism

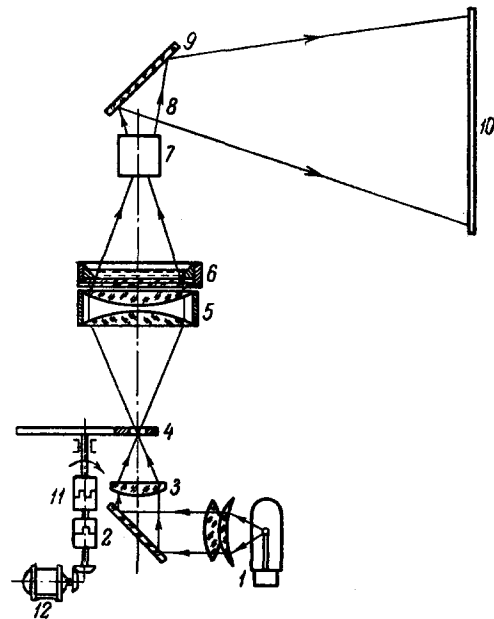


FIG. 2. Diagram of the projection apparatus: 1—K-22 lamp with condenser; 2—mirror with silvered surface; 3—focusing lens; 4—shutter; 5—condenser; 6—tank; 7—objective I-13; 8—small screen for obtaining picture in a darkened field; 9—mirror with variable slope; 10—screen; 11—commutator; 12—electric motor.

\*P. N. Lebedev and I. F. Usagin, "Apparatus for demonstrating Huyghens' principle," Uspekhi Fiz. Nauk 49, 469 (1953).

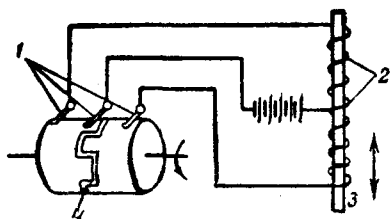


FIG. 3. Diagram of the commutator:  
1 - brushes;  
2 - coil of vibrator;  
3 - core; 4 - insulator.

which destroys the synchronism between the disk and the vibrators. This is achieved by shifting the brushes of the commutator about the axis of the commutator in one direction or another.

The vibrator consists of a coil with two windings, with a core placed inside. A cap of appropriate shape is attached to the end of the core. The vibrator is fed by direct current which flows alternately first in one coil and then in the other; as a result, vibrations take place. The apparatus has two commutators for switching the current. The commutator circuit is shown in Fig. 3. One of the commutators is double, for the purpose of coherent operation of two vibrators.

Rotation of the commutators is produced by electric motors. The speed of the latter is regulated by rheostats ( $R_1 = 400$  ohms). In this way for the frequency of commutation can be altered, and with it the frequency of the vibrators, which can be made as high as 2000 vibrations per minute. The vibra-

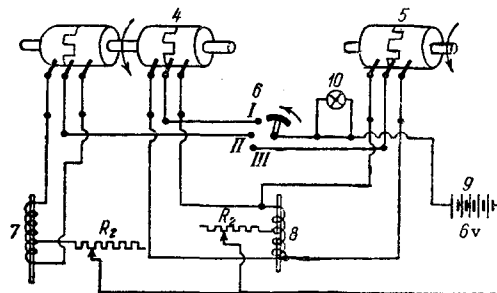
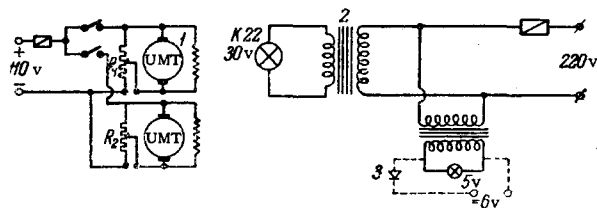


FIG. 4. Electrical circuits: 1 - UMT-21 motor; 2 - transformer; 3 - copper oxide rectifier; 4 - double commutator; 5 - commutator; 6 - four position switch; 7 - permanently fixed vibrator; 8 - movable vibrator; 9 - battery; 10 - lamp.

tor circuit contains variable resistors ( $R_2 = 50$  ohms) which change the vibration amplitude of the vibrators. The electrical circuit of the apparatus is shown in Fig. 4.

Translated by R. T. Beyer