A SIMPLE DEMONSTRATION OF THE ADDITION OF HARMONIC OSCILLATIONS

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Usp. Fiz. Nauk **79**, 743 (April, 1963)

FOR a simple and cheap method of showing the addition of harmonic oscillations one can utilize for the oscillator a piezoelement from a sound recorder (1×3.5 cm^2 in dimensions). The piezoelement is attached to a board of dimensions $5 \times 5 \times 1$ cm^3. In the side of this board there is cut a depression into which a piece of rubber is inserted and the piezoelement P is set on it. It is pressed against the rubber by a thin strip of wood held by two wood screws. The leads from the piezoelement are connected to two sockets. A double collar C made of sheet iron (consisting of two collars soldered together) is placed on the piezoelement. A steel strip V of length ~ 10 cm cut from a watch spring (of width ~ 5 mm) is inserted in the collar. A small mirror M is affixed near the top of this strip in a soldered holder (or the mirror is simply glued to the strip) (Fig. 1).

About 100 V are applied to the piezoelement from an audio oscillator or from the ac power line. If an audio oscillator is used, then its frequency is varied until the resonance frequency is obtained at which the amplitude of oscillation of the strip will be maximum. If the voltage is obtained from the ac line, then resonance is obtained by varying the length of the strip protruding from the collar. In order to reduce the frequency of natural oscillations one can attach to the

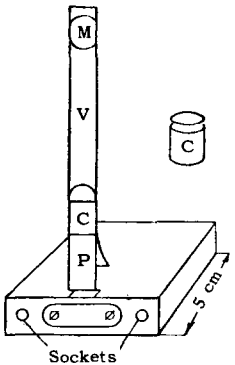

FIG. 1

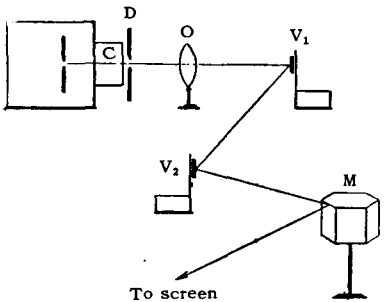

FIG. 2

strip a piece of plasticene etc. A second vibrator is prepared in a similar manner.

The experiment itself is conducted in the following manner: the bases of the vibrators are clamped in holders with the strips held vertically. The apparatus is assembled in accordance with Fig. 2. A narrow light beam from the light source (arc lamp) is directed by means of the condensing lens C, diaphragm D and objective lens O onto the mirror of the first vibrator. The reflected beam must hit the mirror of the second strip and then a rotating mirror M. From the rotating mirror the beam is reflected to a screen. The voltage is now applied to the first vibrator. With the rotating mirror M at rest a vertical bright line must be visible on the screen, and it is focussed by moving the objective lens O. If the mirror is set in rotation, a sinusoidal curve appears. If a voltage is now applied to the second vibrator a picture of beats appears on the screen as a result of a certain difference in the characteristic frequencies of the two vibrators.

If the strip of the second vibrator is placed horizontally and the rotating mirror is replaced by a stationary plane mirror, then we shall obtain on the screen the result of adding two mutually perpendicular harmonic oscillations—the simplest Lissajous figure. In order to obtain Lissajous figures corresponding to a frequency ratio different from unity it is convenient to utilize the fact that the same vibrator will execute strong oscillations with the exciting frequency being twice, etc., higher than the fundamental resonance frequency.

Translated by G. Volkoff