Maritime University of Szczecin

Faculty of Marine Engineering

Department of Physics and Chemistry

Physics Laboratory

Laboratory Description

Study of string vibration by resonance method

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Objectives:

- Knowledge of the wave interference phenomenon presented on the example of standing wave formation.
- Observation of the standing wave.
- Calculation of density of a steel wire.

Questions and problems to solve:

- Density, weight, specific weight and mass and the relationship between these quantities.
- Equation of plane harmonic wave and definition of its basic parameters:
    - wavelength, amplitude, period, frequency and angular frequency.
- What is a wave interference?
- How are standing waves formed? The equation of a standing wave. What are antinodes and nodes?
- Illustrate the standing wave for parameters $k = 1$, $k = 2$ and $k = 5$, formed on the string with rigidly fixed ends.
- What string load should be used in the experiment to generate a standing wave of a value $k = 1$?
- What parameters connected with guitar strings determine the sound pitch?

Short description:

The examined steel string is permanently fixed at a point A. The pan S of mass m_S is attached to the other end of the string connected through a block B. Under the string there is an electromagnet E powered by the alternating current of frequency 50 Hz. This electromagnet stimulates strings to vibrate at a frequency $\nu = 100$ Hz as in one period of voltage changes, the magnetic field produced by the electromagnet reaches the maximum value twice.

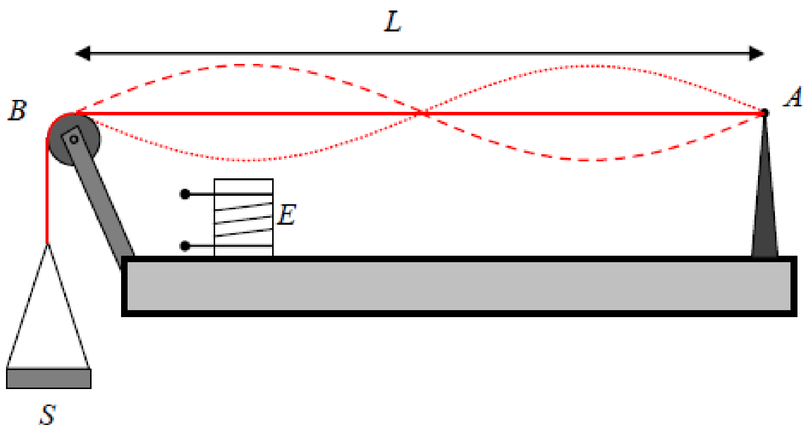

Fig. 1. Diagram of a system for studying the vibration of a string

The diameter d of the string and its length L measured from the point A to the support point on the block B have to be determined at the beginning of the experiment. The electromagnet is set to ¼ length of the string. We put heavy weights on the slab of a mass m, so that a standing wave of a wavelength equal to the length L of the string is formed. By changing the place of the solenoid (bearing in mind that it should always be placed under the antinode) and by loading the pan appropriately, we can find standing waves of smaller lengths. Knowing length L and diameter d of the string, row of vibrations k, tension $F = (m + m_s)g$ and the vibration frequency ν, we can calculate the string density ρ:

$$\rho = \left(\frac{k}{dL\nu}\right)^2 \frac{F}{\pi} \tag{1}$$

Literature:

1. Resnick R., Halliday D., Walker J., *Fundamentals of Physics*, John Wiley & Sons, INC (available editions).