

Methodological Notes

DEMONSTRATION OF THE PHENOMENON OF WEIGHTLESSNESS

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As is well known, a state of weightlessness occurs in particular when in the free fall of bodies there is no static action of the force of gravity.

Weightlessness is readily demonstrated on a portable device shown schematically on Fig. 1. Four steel wires a (1.5 mm in diameter and 1950 mm long) are stretched between the horizontal metal plates A and B. The wires are at some angle to the vertical. The mechanical system M is mounted on them.

The mechanical system (Fig. 2) includes a bulky metal plate C (the diameter of the holes for the wire is 5 mm), a bracket D, a small steel ball E (23 mm in diameter), and two elastic contact plates K and J. The latter are connected to an electric circuit including a voltage source and small bulb.

The mechanical system can descend along the wires. On the section L (Fig. 1) it falls freely because the friction is sufficiently small. Breaking occurs along the section *l* where there is considerable friction, since the wires make some angle with the vertical and the plate holes are pressed against the wires. The stability of the initial state of the mechanical system M is ensured with the aid of the electromagnet (EM) of a K3 type relay (15-mm core diameter, 32,000

turns, diameter of the wire 0.09 mm).

The small ball E is stationary initially (Fig. 2) and finally (see Fig. 1) it exerts a pressure on the pin N, deflecting the plate J downwards. The electric circuit is open.

The details of the device can be explained by the lecturer using its shadow projection.

The weightlessness demonstration is now carried out. Lifting the small ball, one shows the audience the state in which there is no pressure on the pin, the circuit is open, the small bulb lights up. The ball is placed in its initial position. The bulb goes off.

During free fall the ball experiences an acceleration *g* due to the gravitational force. During the free fall the ball does not exert a pressure on the pin. The ball is in a state of weightlessness. The lower plate moves closer to the upper one. The contacts of the plates close the circuit. The bulb is on, a fact noted by the audience.

After traversing the path L (see Fig. 1), as has been said previously, considerable frictional forces act along *l*. The ball exerts a pressure on the pin. The circuit is opened and the bulb goes off.

The demonstration of weightlessness on the described portable setup is very graphic. After switching off the electromagnet the mechanical system immediately falls. During the entire period of free fall the lamp is on, attesting to the weightless state of the ball.

As is well known, weightlessness can be demonstrated on Professor Lyubimov's device. However, a considerable difficulty of carrying it out is its unwieldiness—it requires a two-story auditorium.

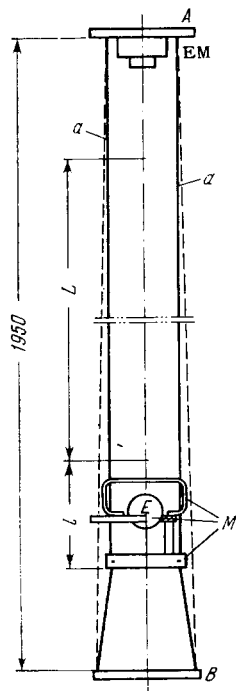


FIG. 1.

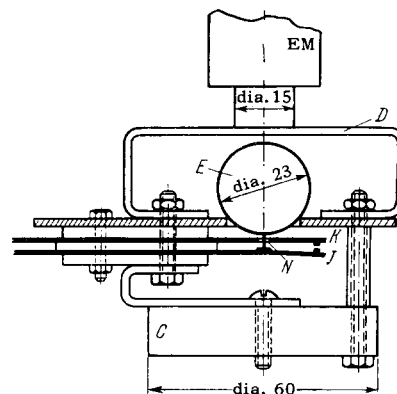


FIG. 2.

¹M. A. Grabovskii, A. B. Mlodzeevskii, R. V. Telesnin, M. P. Shaskol'skaya, and I. A. Yakovlev, *Lektsionnye demonstratsii po fizike (Physics Lecture Demonstrations)*, edited by V. I. Iveronova, Nauka, 1965, pp. 73–74.

²S. É. Khaikin, *Mekhanika (Mechanics)*, Gostekhizdat, 1947, pp. 108–109.

³G. K. Isakov and R. A. Stasevich, *Skorosti, uskoreniya, nevesomost' (Velocities, Accelerations, and Weightlessness)*, Voenizdat, 1962.

⁴*Fizika v shkole (School Physics)*, No. 4, 77–83 (1961).

Translated by Z. Barnea