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METHODOLOGICAL NOTES

OBSERVATION OF SOMMERFELD DIFFRACTION FROM A SPECULARLY REFLECTING HALF-PLANE

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IN 1895, A. Sommerfeld[1], using the theory of functions of complex variable and the theory of Riemann spaces, obtained a rigorous solution of the problem of diffraction of electromagnetic waves from the edge of a mirror. A feature of this solution is the presence of two diffraction patterns (Fig. 1). One is produced as a result of interference of waves traveling directly from the pointlike light source, near the boundary of the geometrical shadow. This picture is observed behind the mirror. The second picture, the presence of which was first pointed out by Sommerfeld, is due to interference of waves reflected by the mirror. Naturally, this picture is observed in front of the mirror, as if the radiation source were to be the virtual image S′ of the real source S. The role of the opaque screen for these reflected waves is played by the second half of the plane in which the mirror is located.

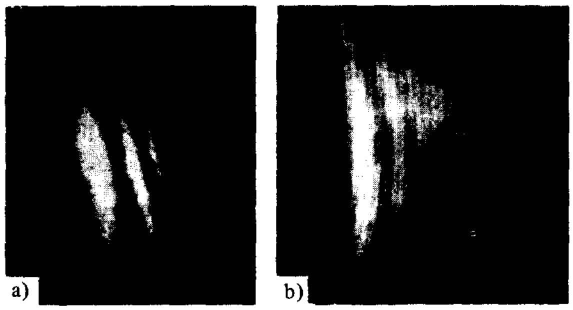

FIG. 3.

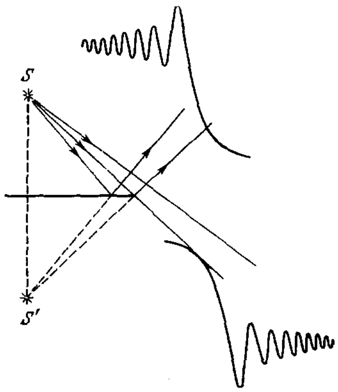

FIG. 1.

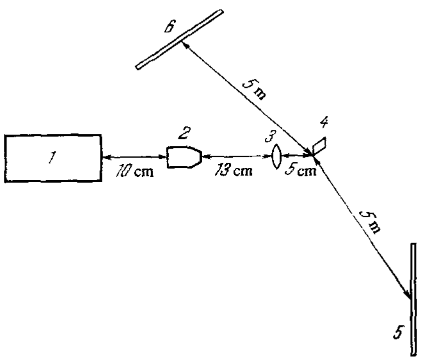

FIG. 2. 1–laser; 2–microscope objective; 3–lens; 4–mirror; 5–screen for observation of the diffraction pattern from the real light source; 6–screen for the observation of the diffraction pattern from the virtual light source.

In those text books on optics[2-4] in which this study by Sommerfeld is described, there are no indications whether the theory has been experimentally verified, and all the more whether the double diffraction picture can be demonstrated in lectures.

The development of modern quantum generators makes it possible to demonstrate with exceeding simplicity the described effect in a large lecture hall. To this end we assembled the setup shown in Fig. 2. The beam of a neon-helium laser (type OKG-11) was broadened with the aid of a microscopic objective (F = 1.5 cm) and a lens (F = 12 cm) to a section of 10–15 cm diameter. The diffraction patterns were observed on screens located 5–6 m from the edge of the mirror. These patterns are shown in a 5 : 1 scale in Figs. 3a and 3b. Careful examination of the latter photograph shows besides the main diffraction effect also interference fringes of equal slope. These fringes were the result of the fact that the mirror coating was not very dense and the beams were reflected also from the rear surface of the glass plate on which the mirror was coated.

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[1] A. Sommerfeld, Optics, Academic Press, 1954.

[2] K. Scheffer, Theoretical Physics, v. III, p. 2, Optics (Russ. Transl.) ONTI, 1938.

[3] R. W. Wood, Physical Optics, Dover.

[4] M. Born, Optics (Russ. Transl.), ONTI, 1937

531.232

DEMONSTRATION OF THE LAW OF CONSERVATION OF ANGULAR MOMENTUM (*"TUMBLING CAT"*)

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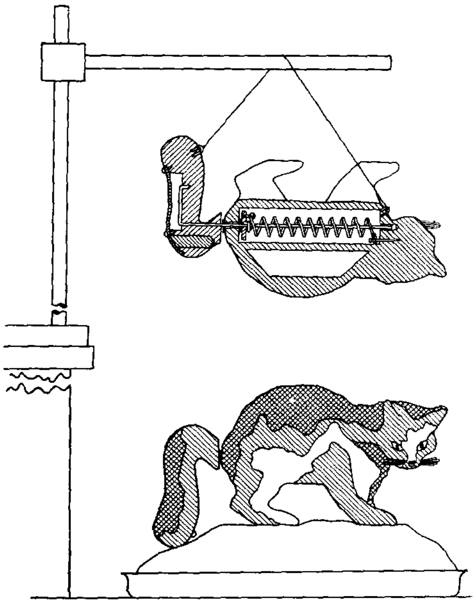
THE law of conservation of angular momentum is one of the most important laws studied in the mechanics section of a course of general physics. However, students frequently do not have a complete understanding of this law, and as a rule they can only cite the "Zhukovskii bench" as an example of its application. It is therefore necessary to perform at the appropriate lecture a convincing demonstration and to present numerous examples of applications of this law.



At the Physics Department of the Moscow State University, we devised a demonstration which has been firmly established as part of the lectures on general physics, namely the "tumbling cat." The cat's instinct of always falling on all four feet, righting itself by rotating its tail, is mentioned in many textbooks on mechanics. But it is impossible to use a live cat in a lecture.

The construction of our "cat" is illustrated in the figure. Its body is made of wood or foamed plastic and consists of two halves. Inside the body there is a cavity for a soft spring, which is wound by rotating the "cat's" tail. After such a winding, the "cat" is suspended from a stand with a string that keeps the tail from unwinding. The string is then burned, and the "cat" falls down to a pan with a sufficiently thick layer of sand. The number of revolutions of the tail during its winding, and the height from which the "cat" falls are so chosen that the "cat" turns through 180° and lands on its feet. The rotation of the tail is stopped by the sand. The body of the "cat" is best balanced with respect to the axis of the spring. The tail is also balanced with respect to this axis by means of an insert made of lead, as can be seen from the figure.

532.9.07

SIMPLE PLASMATRON FOR LECTURE DEMONSTRATIONS

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CONSIDERABLE attention is paid in physics lecture courses to the production and properties of low-temperature plasma. Recently, in particular, arc-discharge plasmas have been successfully used in plasmatrons. In these devices, the plasma jet has a temperature ranging from several thousands to several tens of thousands degrees. Plasmatrons are now used in various branches of engineering. For example, they are used to cut and weld metals, to melt and sputter high-temperature and anti-corrosion coatings, and to produce acetylene.

We constructed a simple plasmatron suitable for demonstration purposes. Its scheme is shown in Fig. 1. The outlet opening of the copper nozzle has a diameter $d = 0.8$ mm, the diameter of the central electrode (8) is 4 mm. The plasmatron is fed from a DG-2 arc generator operating in the spark mode. Air cooling is used in the plasmatron. The vortex stabilization is with the aid of a stream of inert gas or a stream of nitrogen, if the central electrode is made of thoriated tungsten. The use of a copper rod with a pressed end piece of zirconium

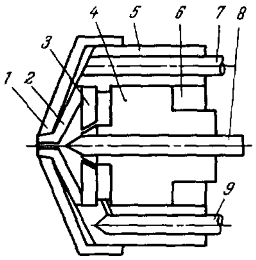

FIG. 1. Diagram of plasmatron. 1–Cover with channels for passage of the focusing stream; 2–copper nozzle serving as a second electrode; 3–asbestos-cement washer with apertures through which the stabilizing gas stream passes; 4–insert of bakelite; 5–plasmatron head; 6–elastic nut; 7–fitting through which the air is fed to cool the copper nozzle and to focus the plasma beam; 8–central electrode; 9–fitting for supply of inert gas.

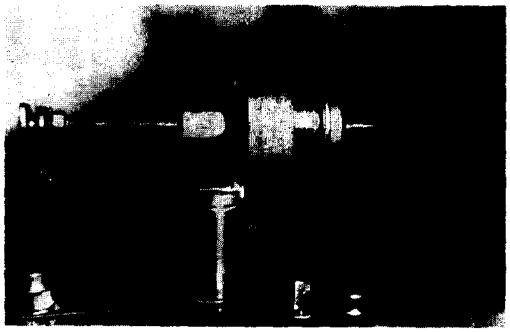

FIG. 2. Plasmatron at the instant of operation.

is the central electrode may obviate the need for using inert gases. In the latter case, the plasmatron operates well with air vortex stabilization.

Figure 2 shows the plasmatron at the instant of operation. The plasma jet of this plasmatron can be used to cut sheet steel up to 0.2 mm thick, and copper and aluminum foil with maximum thickness on the order of 0.1 mm.

Translated by J. G. Adashko