production records were kept, the heat treatment that was used did not affect the viability of potato tuber worm eggs or lower the production of breeding stocks of this host insect.

This method for controlling *Nosema* disease lends itself well to the mass-production routine, and with little additional work it insures the production of parasites that are comparatively free of the disease.

Reference

1. MARVIN, P. H. *J. econ. Entomol.*, 1944, **37**, 560.

A Single Flashlight Source for Ultracentrifuge Research

LIONEL L. LIPSCHULTZ and KURT G. STERN[1]

Polytechnic Institute, Brooklyn, New York

Most of the optical ultracentrifuge observations reported in the literature have been made with the aid of continuous light sources which yield sweep images (*8*). While these are, as a rule, satisfactory for the analysis of sedimenting boundaries and the computation of sedimentation constants and molecular weights, such records give no information on the actual appearance of the sedimenting material. All events occurring at the same latitude of the ultracentrifuge cell are integrated into a continuous streak or sweep across the field of observation. The application of refractive index gradient or schlieren methods to ultracentrifugal problems in conjunction with continuous light sources cannot be expected to reveal local disturbances, e.g. convection or streaming phenomena, existing conceivably in some regions of the sedimenting system.

Bjoernstahl (*2*) has synchronized a light source with the rotation of the rotor of the oil turbine ultracentrifuge to prevent stray light from reaching the photographic plate. Harvey and Loomis (*5*), in their centrifuge microscope, have employed first a stroboscopic and, later on, a semistroboscopic method of illumination for the study of small objects during rotation. A similar device has been suggested by Pickels (*6*) for use with a spinning top. In the course of development of a simple high-speed centrifuge with a plastic rotor (*7*), one of us (K. G. S.) employed a mechanical switch and a General Radio Strobotak light source with promising result. However, the flashing time of the Strobotak lamp amounts to about 1/30,000 second—long enough to cause blurring of the microscopic images even at moderate centrifugal speeds. A preliminary discussion of the problem with Prof. H. Edgerton, of Massachusetts Institute of Technology, led to the conclusion that the recording of images, free of noticeable blurring, would require an illumination time of the order of 1/1,000,000 second when making peripheral observations at ultracentrifugal speeds.

The problem, then, resolves itself into the need for a suitable flash source of high intensity and a synchronizing arrangement which will "trigger" the flash at the instant when the centrifuge cell is aligned with the camera or microscope.

[1] The kind advice of Prof. W. MacLean, of this Institute, and Dr. F. N. Barnes, of General Electric Company, is gratefully acknowledged.

The ultracentrifuge[2] used in the present experiments has a vertical lucite rotor, 6 inches in diameter. It is powered by a special electric motor, rated at 35,000 r.p.m. without load, which imparts to the plastic rotor a maximum speed of 21,000 r.p.m. through a flexible shaft, provided the rotor chamber is partially evacuated to reduce air friction.

For general information on flash photography, reference is made to the monograph of Edgerton and Killian (*4*). Whereas Edgerton, *et al.* (*3*) employed a special gaseous discharge tube with three electrodes, a General Electric mercury burner of the H-6 type was used in the present experiments. This light source has previously been employed by Barnes and Bellinger (*1*) in their studies of air-flow phenomena. The basic flash circuit, developed by these authors, was kindly placed at our disposal by N. F. Barnes. A transformer and a rectifier supply about 2,000 volts direct current to a 2-microfarad capacitor which, in turn, discharges through the H-6 lamp. Instead of a manual switch, a thyratron tube was used in the discharge circuit for the control of flashing rate. For triggering and timing the discharge, the light of an automobile headlight lamp is conducted through a plastic strip to the periphery of the porthole in the centrifuge casing. On the

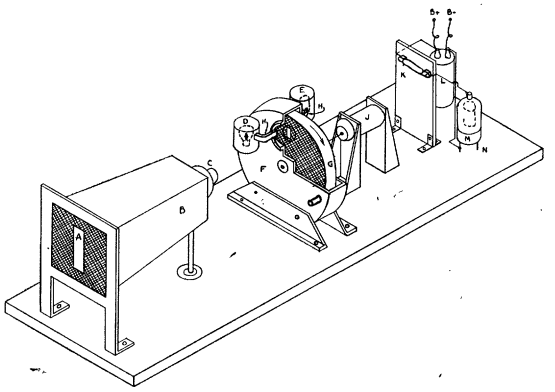

FIG. 1. Experimental arrangement: A, photographic image; B, camera; C, lens; D, synchronizing light source; E, photoelectric cell; F, centrifuge housing; G, plastic rotor with fluid cell; H, transparent plastic strips; J, electric motor; K, B-H-6 mercury lamp; L, 2-microfarad condenser; M, thyratron; N, control grid.

opposite side of the rotor a similar plastic strip conducts the light signal to a vacuum photocell. As the transparent sector of the analytical fluid cell passes through the region of the porthole, the light from the source strikes the photocell cathode. The resulting impulse is amplified, squared, and further differentiated by a RC network arrangement. It was found convenient to employ the trailing rather than the leading edge of the cell sector for the initiation of the flash. The amplified impulse is applied to the thyratron tube in the flash tube circuit, which is so arranged that the discharge through the H-6 source occurs precisely at the instant when the cell is in the center of the porthole and thus aligned with the axis of the photographic system. The camera is equipped with a 5-inch focal length lens. For observation by the schlieren method this system is augmented by a schlieren lens and a horizontal knife edge in front of the camera lens, which is adjustable in the vertical direction. The experimental arrangement is shown schematically in Fig. 1.

[2] This was built by the Development Division of the Fisher Scientific Company, Pittsburgh, in cooperation with one of the authors.

The results obtainable with this arrangement are illustrated in Fig. 2a, which represents the photograph of a stationary ultracentrifuge cell filled with water so as to leave a small air space, and in Fig. 2b, a flash image of the same cell, recorded by a single discharge at approximately 10,000 r.p.m. The air-water meniscus, which is curved in the stationary

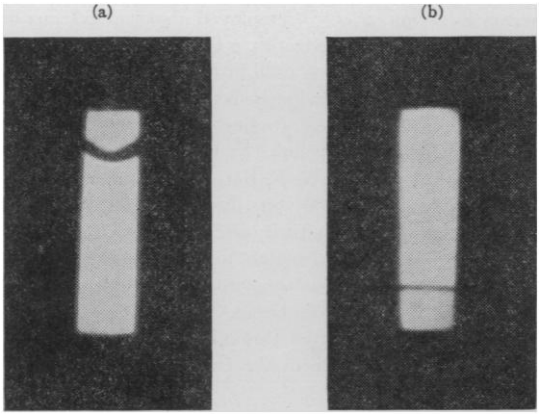

FIG. 2. Flash photographs of centrifuge fluid cell at rest (a) and in motion (b).

picture, becomes practically a straight line. The slight blur at the trailing edge of the cell sector image is probably due to an afterglow phenomenon in the discharge tube.

Images of macroscopic objects during flight may be recorded without appreciable distortion. Fig. 3a is the picture of a stationary, star-shaped object which was attached to the outside of a clear plastic plug inserted in the opaque rotor.

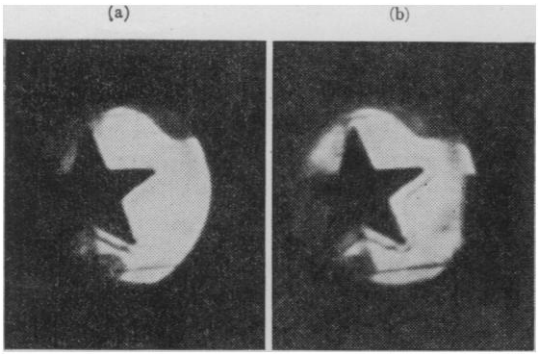

FIG. 3. Flash photographs of star-shaped object at rest (a), and in flight (b).

Fig. 3b represents the image of the same object, photographed with a single flash during rotation at about 4,000 r.p.m. The sedimenting boundary of tobacco mosaic virus protein has been photographed by the schlieren method with the aid of single light flashes.

It is evident that the arrangement here outlined lends itself, in principle, to other applications, e.g. the photomicrography of small objects, such as individual cells, and to studies of photoelastic stress patterns in polarized light. A full report of this work will be published elsewhere.

References

1. BARNES, N. F., and BELLINGER, S. L. *Gen. Elect. Rev.*, December, 1944, p. 1.
2. BJOERNSTAHL, Y. *J. sci. Instr.*, 1939, **16**, 254.
3. EDGERTON, H. E., GERMESHAUSEN, K. J., and GRIER, H. E. *J. appl. Phys.*, 1937, **8**, 2.
4. EDGERTON, H. E., and KILLIAN, J. R. *Flash.* Boston: Hale, Cushman, and Flint, 1939.
5. HARVEY, E. N., and LOOMIS, A. L. *Science*, 1930, 72, 42; 1933, 77, 430.
6. PICKELS, E. G. *Science*, 1936, **83**, 471.
7. STERN, K. G. *Science*, 1942, **95**, 561.
8. SVEDBERG, T., and PEDERSEN, K. O. *The ultracentrifuge.* Oxford: Univ. Press, 1940.

An Apparatus for the Determination of the Tensile Strength of Healing Wounds

JESSE CHARNEY, MARTIN B. WILLIAMSON, and FINN W. BERNHART[1]

Wyeth Institute of Applied Biochemistry, Philadelphia

The role of nutrition in wound healing has been the subject of few quantitative studies. Harvey and Howes, in their studies on the effect of nutritional state on the rate of healing of wounds, used tensile strength as a measure of repair (*1*, *2*).

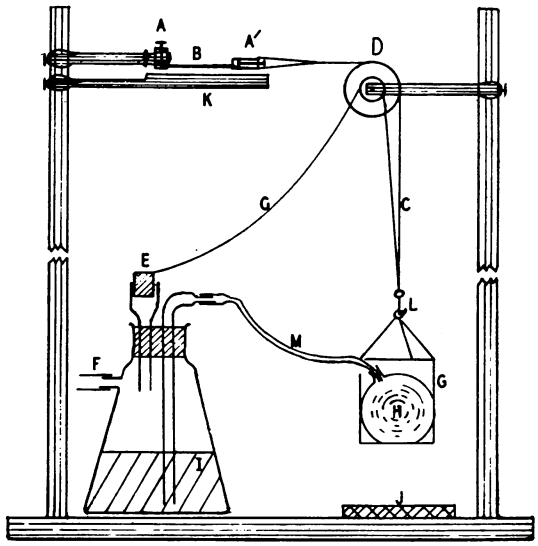

FIG. 1. Arrangement of apparatus: A-A', screw clamps; B, strip of skin to be tested; C, braided nylon cord; D, pulley; E, rubber stopper; F, compressed air line; G, cardboard container; H, rubber balloon; I, mercury; J, cushion; K, support plate; L, hook; M, rubber tubing.

In the course of our work on the role of protein nutrition in wound healing, a simple, semiautomatic apparatus for measuring the breaking strength of skin wounds was devised.

[1] The authors wish to thank Miss Lois H. Henneberger and Miss Mary A. Lord for their technical assistance.