XI. STROBOSCOPIC RESEARCH

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RESEARCH OBJECTIVES

Intermittent light is an essential component of a very highly specialized type of instrumentation that involves precise flash timing and uses photography for recording. The main object of this work is usually to aid the eye to observe fast actions and to make accurate measurements.

For example, the experimental information about elementary particles and interactions which is now so eagerly sought by nuclear physicists is recorded by electronic flash lamps during the brief moment in the cloud chamber after expansion. Then begins the tedious work of reducing the data from the photographs. Our laboratory has helped many physicists with the illumination problem for the cloud chamber.

In addition to the application work on direct instrumentation, the Stroboscopic Light laboratory is vitally concerned with the development of flash sources of many types and for many uses. Each year brings advancement, usually through theses of students in the Departments of Electrical Engineering and of Physics.

H. E. Edgerton

A. DESIGN AND CONSTRUCTION OF A LUMINESCENCE CAMERA*

An instrument was designed for photographing the sea animals that cause underwater luminescence. These light flashes had been observed by members of the Woods Hole Oceanographic Institution (W.H.O.I.) while using the bathyphotometer (1). Their observations indicated that a luminescence detector could be triggered by flashes with an irradiance of 10^{-5} microwatts/cm^2 or more.

As an extension of his thesis, L. R. Breslau, who is now at M.I.T. as a staff member of W.H.O.I., designed and built the aforementioned instrument. It was constructed at M.I.T. with the cooperation of the Research Laboratory of Electronics, especially in the use of the Laboratory's facilities.

A photomultiplier trigger, which can be actuated by the flash of an underwater animal, was designed to trigger an electronic-flash-and-camera combination. (The photomultiplier device was designed in such a way that it is not injured by direct sunlight or by the light flash emitted by the electronic lamp.) Simultaneously, a sonar pulse is emitted by an attached transducer; this signal indicates that a picture has been taken and, in addition, relays information about the depth of the instrument from the surface.

The instrument, which is self-contained, requires only the mechanical support of a cable. The device can be operated continuously at any depth down to 6000 meters for at least 10 hours before the batteries require recharging. Mercury switches allow loading and storing of the instrument in a prepared state. The camera (2) and the film-advancing circuitry are contained in one cylindrical housing, and the electronic flash

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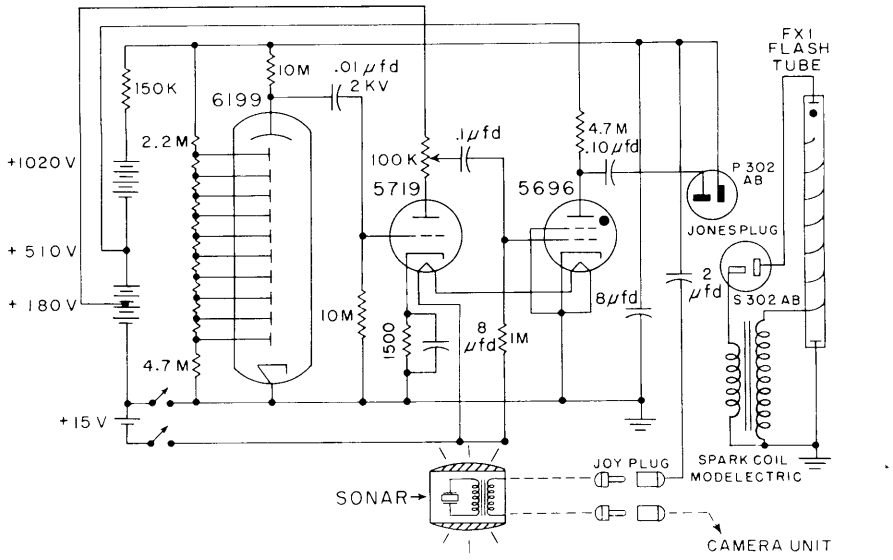

Fig. XI-1. Flash unit of luminescence camera.

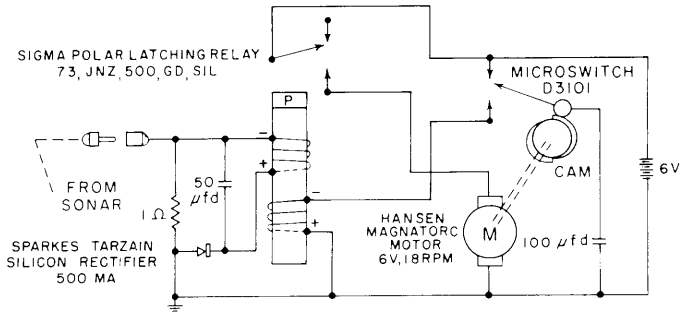

Fig. XI-2. Camera unit of luminescence camera. (The microswitch rides on a cam that is gauged to the film advance motor.)

and photomultiplier trigger (Figs. XI-1 and XI-2) are contained in another. These housings fit into a rigid cradle. Detailed descriptions of the mechanical design, camera design, and electronics are given in a recent report by Breslau and Edgerton (3).

The entire volume of water observed by the photomultiplier is in the field of view of the camera and is illuminated by the electronic flash. Because many luminescent animals have translucent bodies, side lighting was considered advisable. Of course, a compromise must be made between the size of the field and the magnification of the photographed object. Because most of the luminescent animals that were to be photographed were expected to be less than 3 inches long, an observed volume of 0.1 cu ft was decided upon. A second position of the cylindrical housing tubes in the cradle allowed the camera to photograph only one-half of the volume observed

by the photomultiplier but produced twice the magnification.

The luminescence camera was operated from the Research Vessel Crawford and the Coast Guard Cutter Yamacraw in the waters south of Woods Hole, Massachusetts. The best results were obtained when the instrument was used in conjunction with the bathyphotometer and a graphic recorder for echo sounding. (The bathyphotometer is a wide-range, logarithmic device that is sufficiently sensitive to detect luminescence, but is not injured by a high-intensity electronic flash.) Several small animals took their own pictures successfully by means of the luminescence camera.

L. R. Breslau, H. E. Edgerton

References

1. G. L. Clarke and C. Hubbard, Quantitative records of the luminescent flashing of oceanic animals at great depths, forthcoming in April 1959 issue of Limnology and Oceanography.
2. H. E. Edgerton and L. D. Hoadley, Cameras and lights for underwater use, SMPTE J. 64, 345-350 (1955).
3. L. R. Breslau and H. E. Edgerton, The luminescence camera, Technical Report, Reference No. 58-14, Woods Hole Oceanographic Institution, April 1958 (unpublished manuscript).