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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
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Letter Circular
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SELENIUM CELLS; PHOTOELECTRIC CELLS; THERMOPILES

1. SELENIUM CELLS: These function through a change in their electrical conductivity when exposed to light. The electrical properties of a selenium cell depend so much upon heat treatment, that specific statements cannot be made. Its sensitivity is a function of many factors; for example, temperature, also the intensity and color of the light.

2. In the dark, the resistance of a selenium cell increases with decrease in temperature. Records show that a cell having a dark resistance of 1,000,000 ohms at 20°C, (68°F) increased to three times that value (3,000,000 ohms) at 0°C, (32°F).

3. When exposed to light, the resistance of a good cell drops as low as 1/10 to 1/50 of its value in the dark; but this change in resistance is a function of the spectral quality (the color) and the intensity of the light; also the temperature of the cell. At low temperatures (0°C) the intrinsic photoelectric sensitivity is far greater than at 20°C.

4. Selenium cells usually have a dark resistance of 100,000 to 500,000 ohms. When exposed to full daylight, the resistance may be reduced to between 3,000 and 10,000 ohms. The resistance change of the selenium cell on exposure to light, and its recovery after exposure is not instantaneous, especially when exposed to light of long wave lengths.

5. In Bureau of Standards Scientific Paper No. 319, p. 527 (obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 10 cents per copy, prepaid) references are cited showing that the spectral light sensitivity curve of a selenium cell depends upon heat treatment. A cell that has been annealed at 200°C, has its maximum sensitivity in the red part of the spectrum, while a cell which has been annealed at 150°C has its maximum sensitivity in the blue-green part of the spectrum.

6. Since the magnitude and the position of the maximum of the spectral sensitivity of a selenium cell depends so largely upon heat treatment (as well as upon temperature and perhaps humidity) we do not regard it a suitable device for standardization.

7. Information on the design, construction and characteristics of selenium cells may be found in the following publications:
"Selenium Cells, (How Made)", by Thomas W. Benson, (published by Spon and Chamberlain, 120 Liberty Street, New York, N. Y.);
"Selenium Cells and How They are Made" by Samuel Wein (Spon and Chamberlain, New York);
"The Moon Element", by E. E. Fournier d'Albe (D. van Nostrand Company, New York);
"The Selenium Cell", by G. P. Barnard, Journ. Institution of Electrical Engineers, vol. 67, p. 97, December, 1928;
Bureau of Standards Scientific Paper No. 319;
See also summary on Selenium Cells in a book on "Primary Batteries", by W. R. Cooper (published by D. van Nostrand Company, New York, N. Y.).

8. The element, Selenium, may be purchased from dealers in chemical supplies, e.g., Eimer and Amend, New York, N. Y.; or J. A. Samuel and Company, 220 Broadway, New York, N. Y.

9. Selenium Cells may be purchased from the following dealers:
James Biddle, Philadelphia, Pennsylvania;
The Braun Corporation, Los Angeles, California;
John J. Griffin and Sons, Ltd., London, England;
L. E. Knott Apparatus Company, Cambridge, Massachusetts;
The Photoelectric Bean-Grader Products Co., Inc., Ithaca, Michigan;
Radiovision Corporation, 62 West 39th street, New York, N. Y.

10. PHOTOELECTRIC CELLS: The photoelectric cell functions as a result of electron emission from the cathode (consisting of a relatively large surface of some metal, for example, potassium, barium, etc.) which is exposed to light.

11. The photoelectric cell is practically instantaneous in its action and is not greatly affected by temperature. Some of the highly evacuated types (also some cells filled with inert gas) have a fairly close linear relationship between the current and the intensity of the illumination. When subjected to continuous usage, they are likely to become fatigued and the sensitive surface may be destroyed. Further data are given in Bureau of Standards Scientific Paper No. 319.

12. For the most recent developments, see papers in G. E. Review, vol. 31, pp. 85, 373 and 476; Journ. O.S.A., vol. 19, pp. 81, and 135; Phys. Rev., vol. 32, pp. 44 and 57; Phil. Mag. 7, ser., vol. 7, pp. 792 and 812; Journ. Phys. Chem., vol. 31, p. 1537; Sibley Journ., vol. 41, p. 176; Proc. Nat. Acad. Sci., vol. 14, p. 272; Bell System Tech. Journ., vol. 5, p. 320; Zeit. Tech. Phys., vol. 7, p. 133; Bull. Soc. Franc. Elec., vol. 6, p. 1167; Zeit. für Phys., vol. 55, p. 701.

13. Photoelectric cells are finding numerous technical and industrial applications. For the use of photoelectric cells in photometry, see papers in Trans. Ill. Eng. Soc., vol. 21, p. 117; vol. 23, pp. 391, 419, 428; vol. 24, p. 674; Trans. Opt. Soc. (London), vol. 28, p. 195; Ill. Eng. (London), vol. 19, p. 132; Licht und Lampe, vol. 15, p. 203; Phys. Zeit., vol. 29, p. 693.

14. For various industrial uses, see papers in trans. A.I.E.E., vol. 48, p. 283; Journ. A.I.E.E., vol. 49, p. 113; Amer. Mech., vol. 71, p. 819; Journ. Soc. Dyers and Col., vol. 46, p. 12; Elec. Journ., vol. 23, p. 135, and vol. 27, p. 31; Amer. Dyestuff Reporter, vol. 16, p. 715; Zeit. Tech. Phys., vol. 10, p. 52.

15. Photoelectric cells may be purchased from the following dealers:
Argco Laboratories, Inc., 150 West 22 Street, New York, N. Y.;
The Case Research Laboratory, Auburn, New York (the photoelectric properties of the Case "Thalofide Cell" are described in Bureau of Standards Scientific Paper No. 380, obtainable from the Superintendent of Documents at a price of 5 cents per copy, prepaid);
Robert C. Burt, Scientific Instruments, Pasadena, California;
The General Electric Company, Schenectady, New York;
The G-M Scientific Instrument Co., 1208 Grace St., Chicago, Ill.;
Luckenbach and Hallberg, Inc., New York, N. Y. (Cadmium Cells);
National Carbon Company, New York, N. Y. (Raytheon Fotocells);
The Photion Electric Corporation, 247 Park Avenue, New York, N. Y.;
Watson and Sons, Parker Street, London, England;
Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.

16. THERMOPILES: These are sources of e.m.f. which are maintained by temperature differences in the electric circuit. The method of construction, and properties of thermopiles are given in Bureau of Standards Scientific Paper No. 229, (obtainable from the Superintendent of Documents, at a price of 20 cents per copy, prepaid). Thermopiles of this type are obtainable from the Eppley Laboratory, Newport, Rhode Island. Western Electric Vacuum thermocouples (for measuring feeble alternating currents) are obtainable from Graybar Electric Company, 420 Lexington Avenue, New York, N. Y.

17. New types and new designs of the above described types of photoelectric and radiometric instruments are frequently to be found in the literature and in the advertisements published in "The Physical Review", the "Journal of the Optical Society of America", "The Review of Scientific Instruments", "Science", and the "Journal of Scientific Instruments" (London).

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