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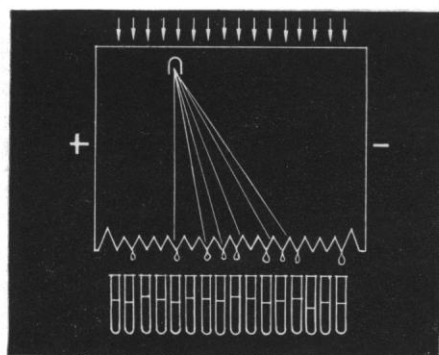
22 April 1960

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

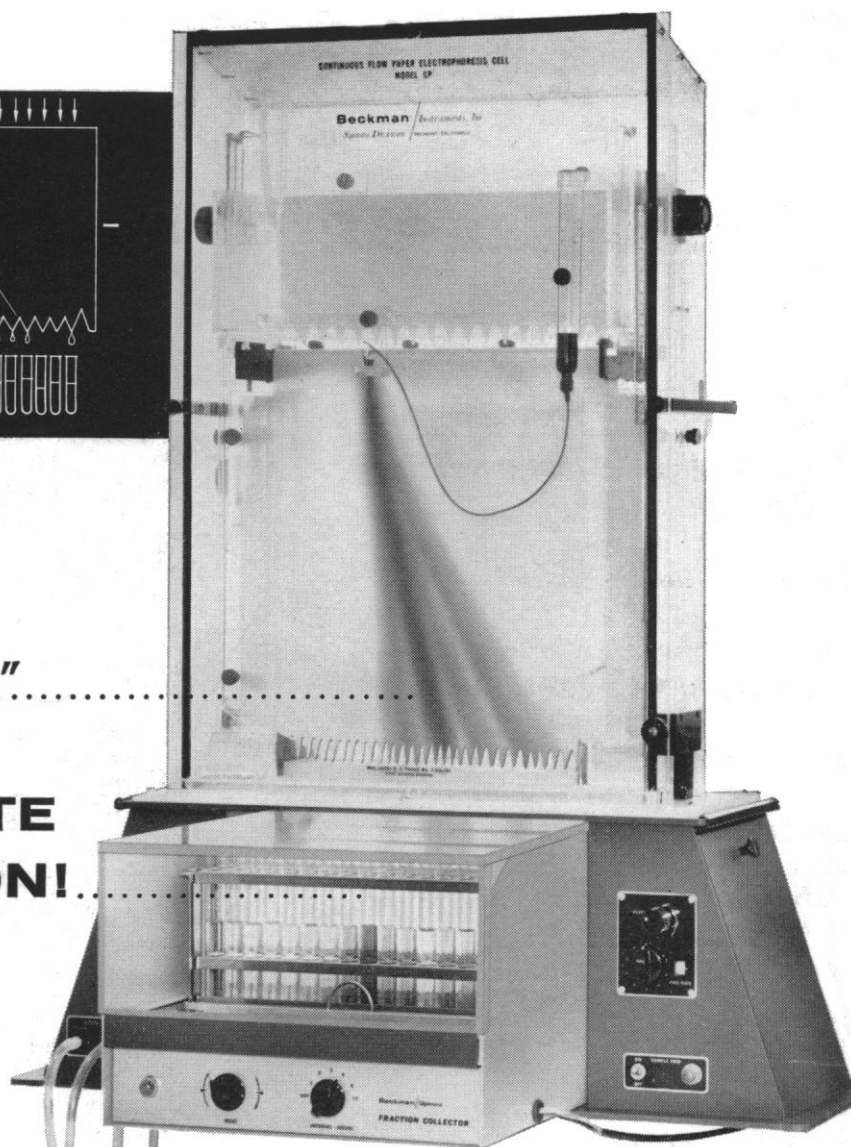


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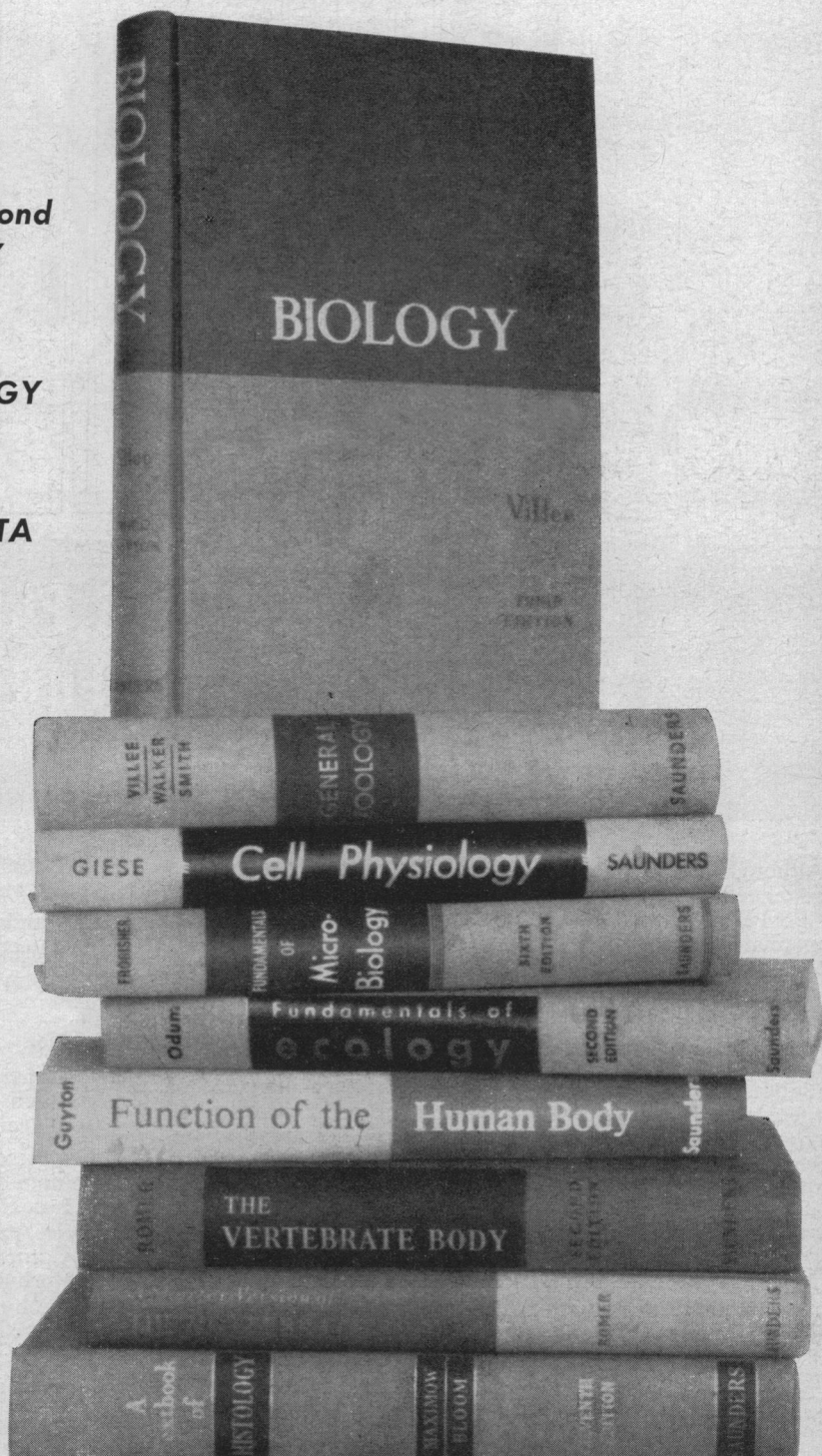
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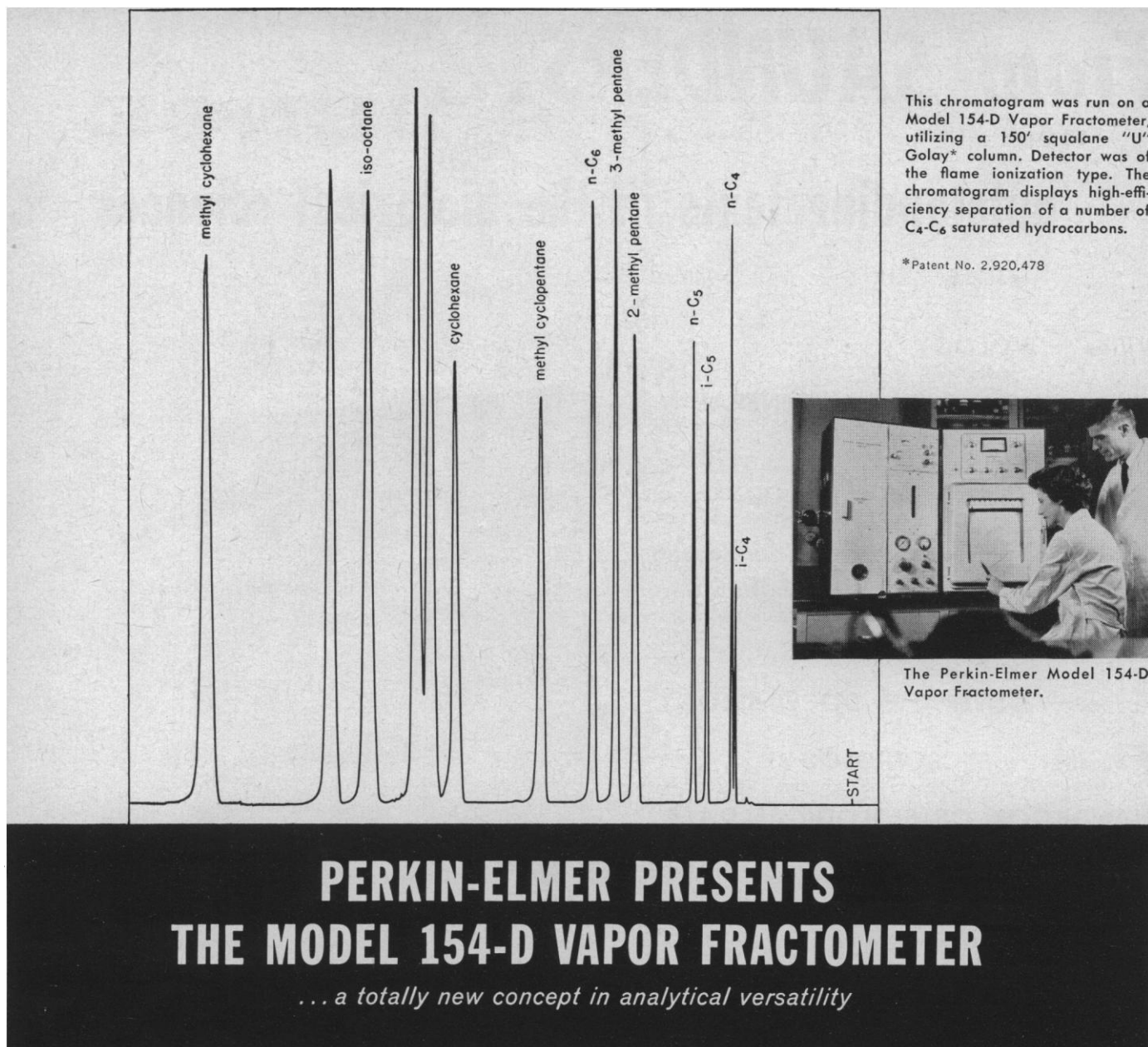
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Volume XI

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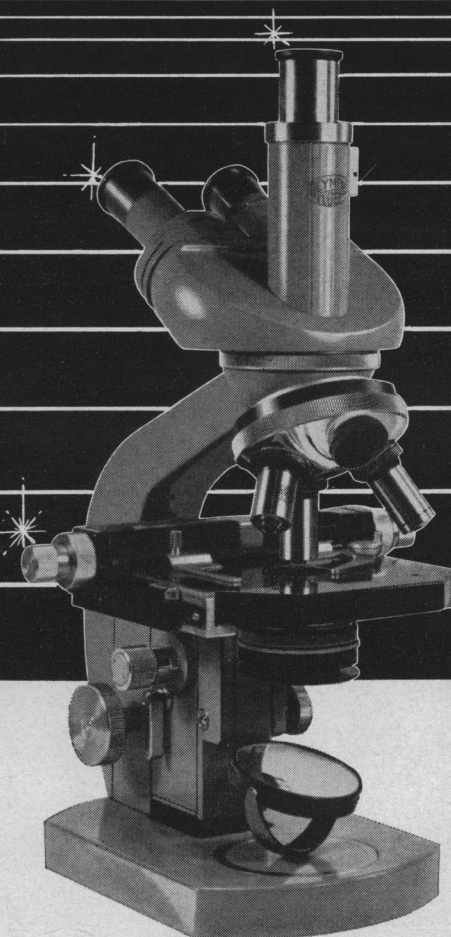
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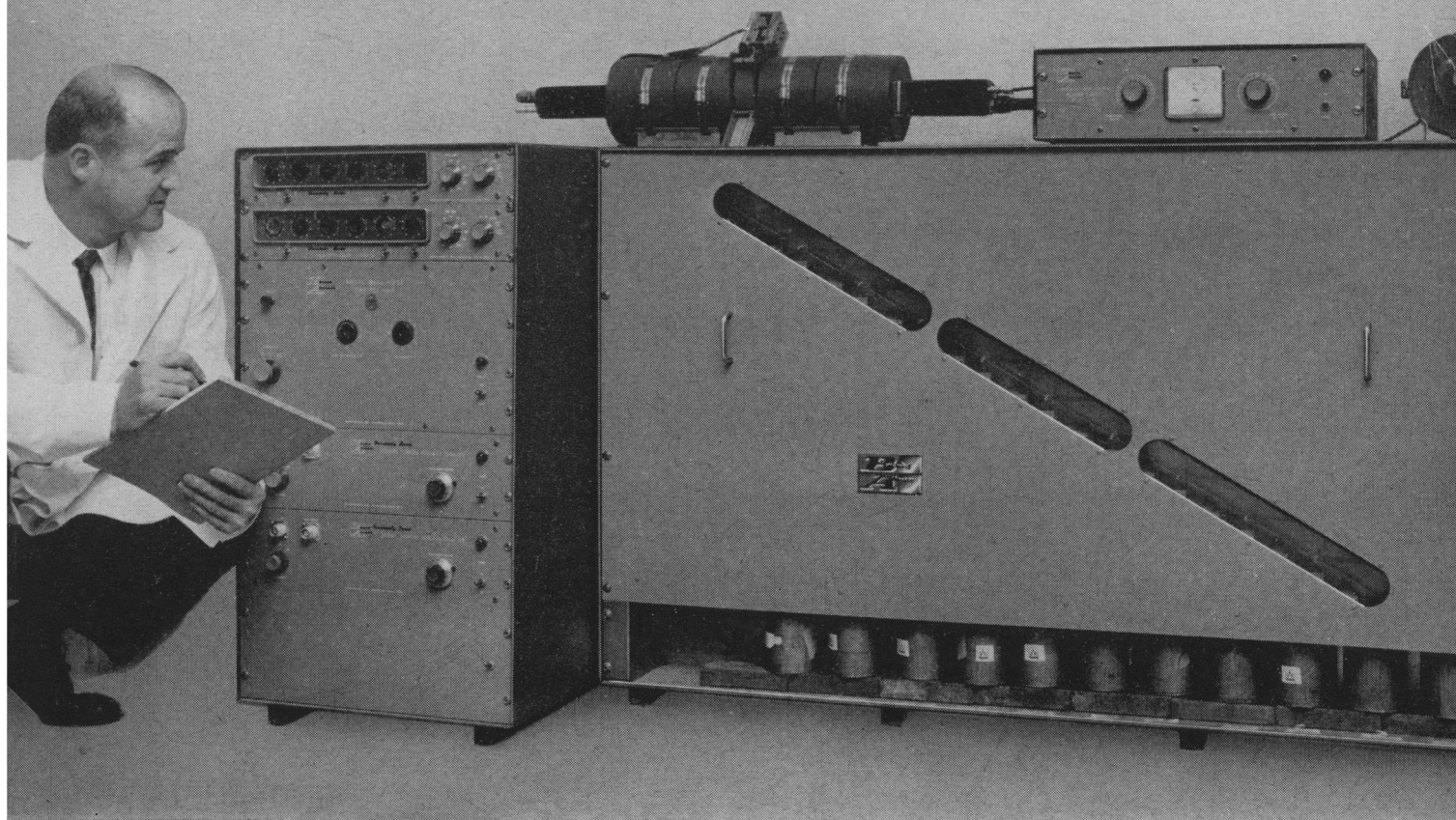
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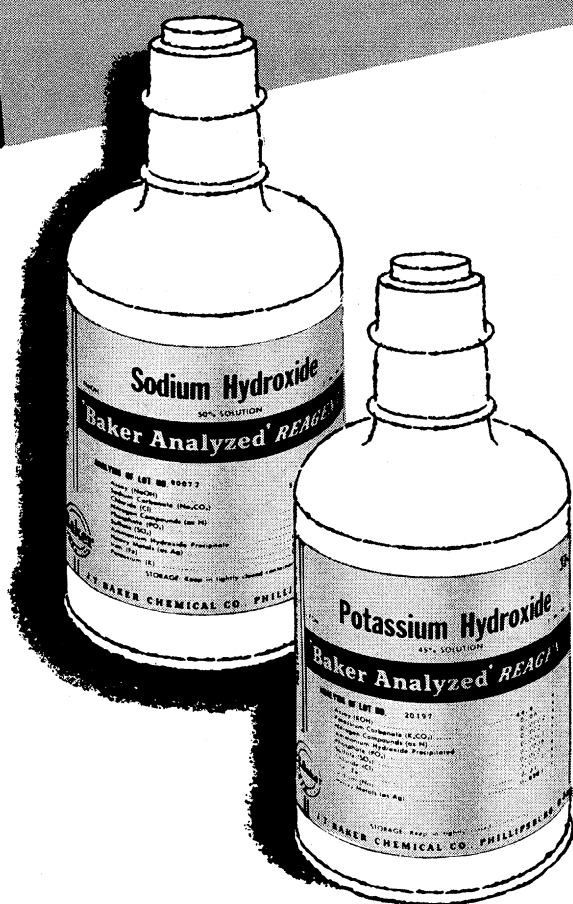
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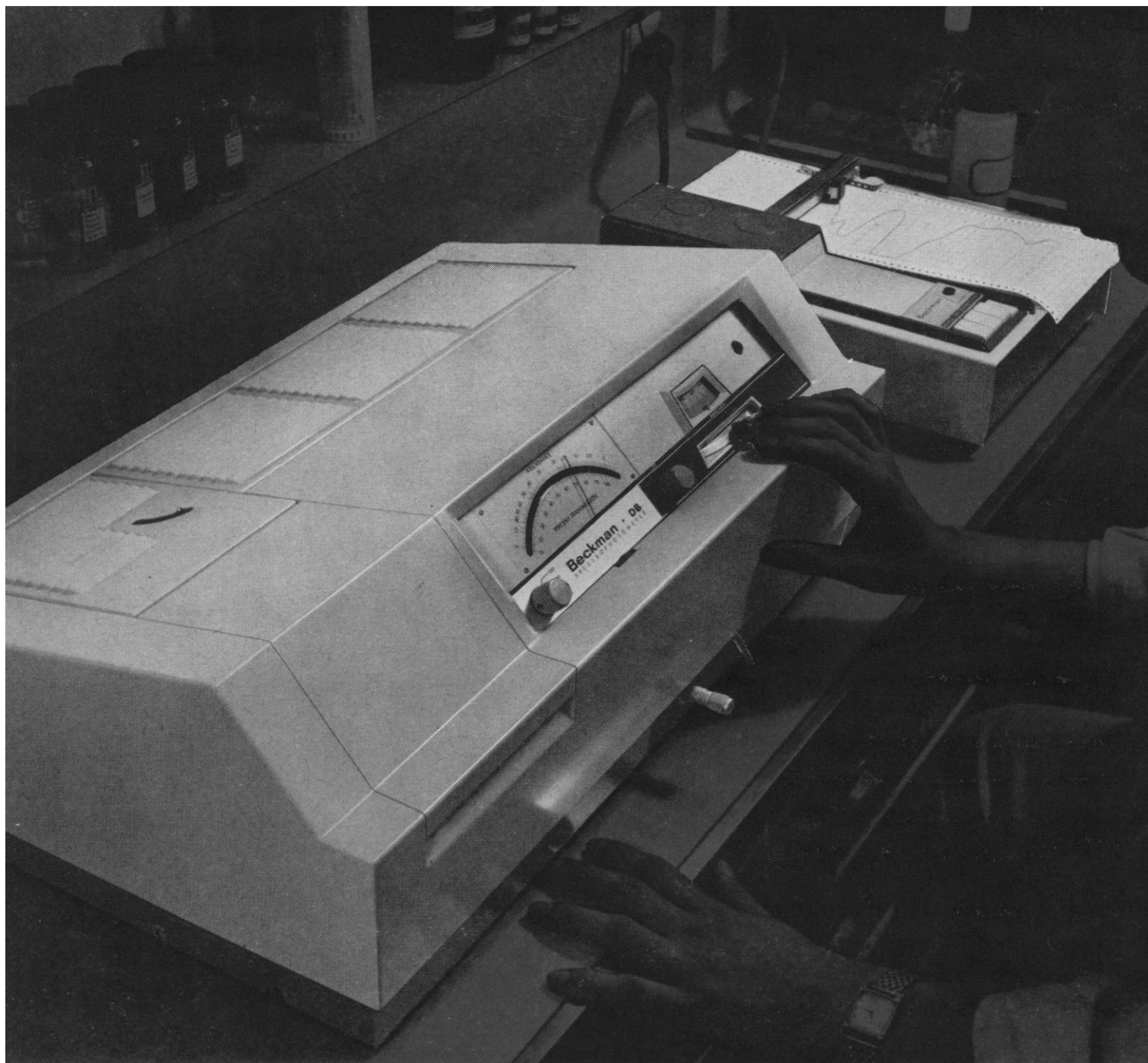
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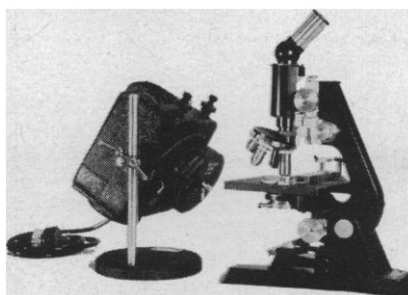
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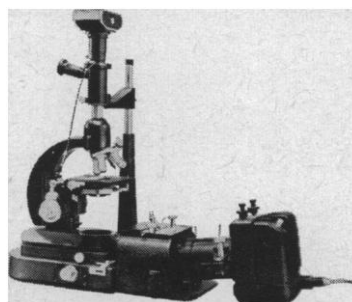
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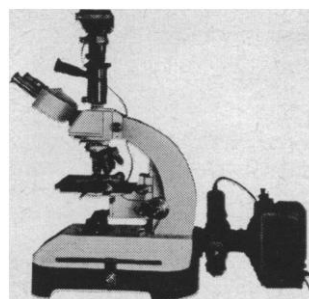
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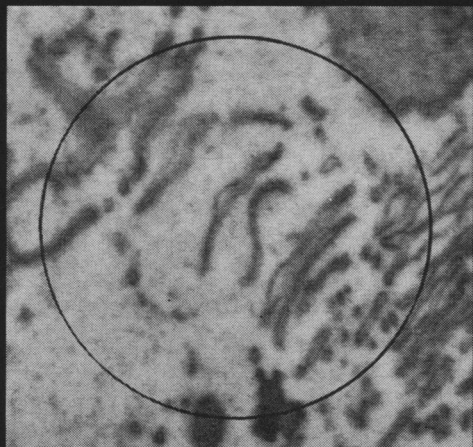
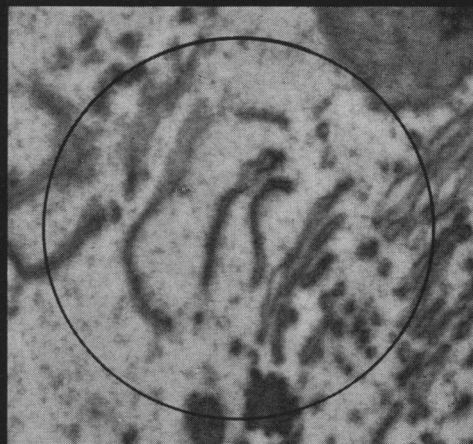
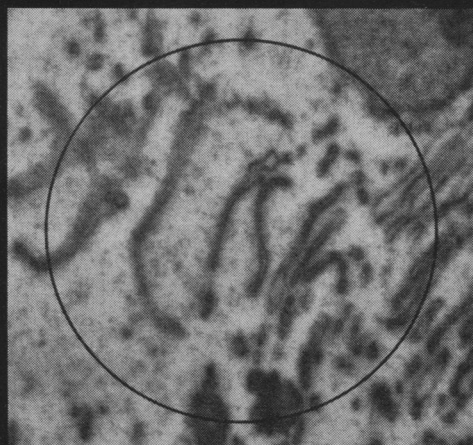
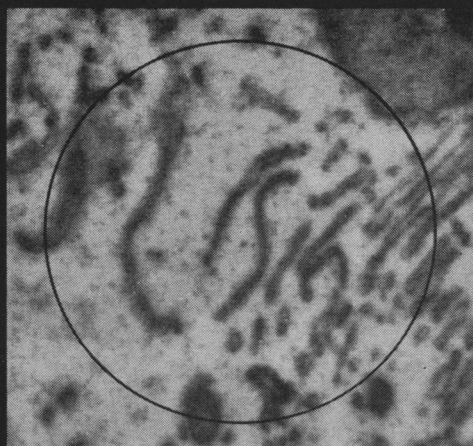
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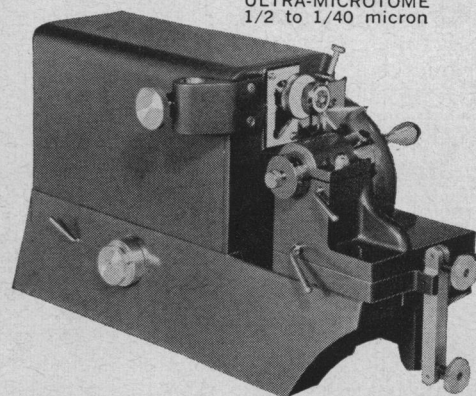
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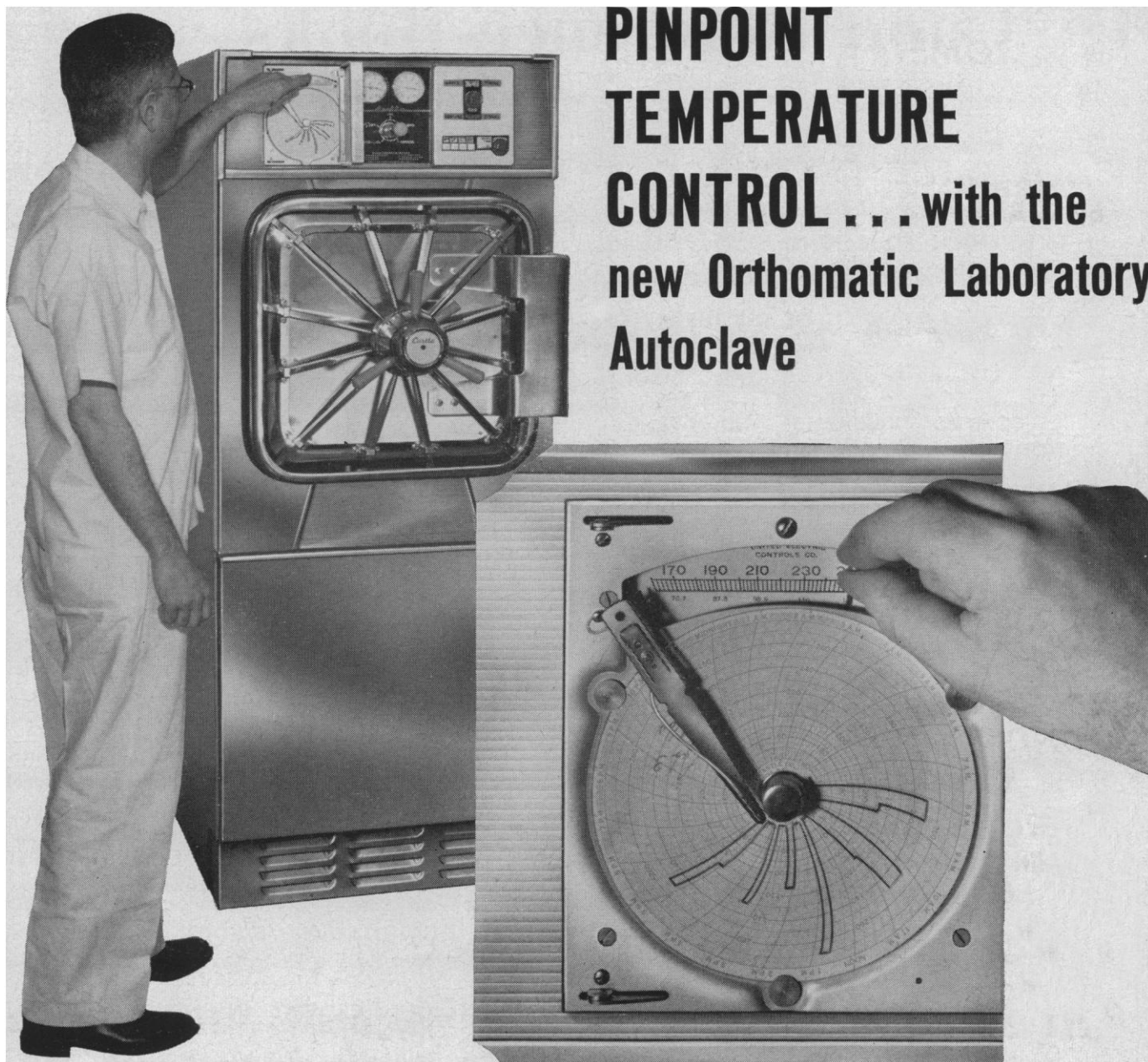
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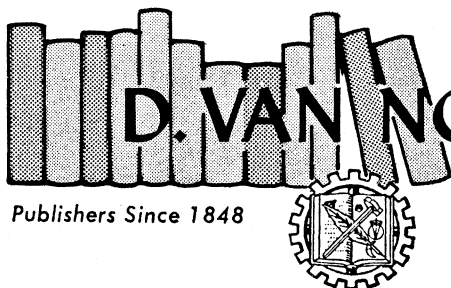
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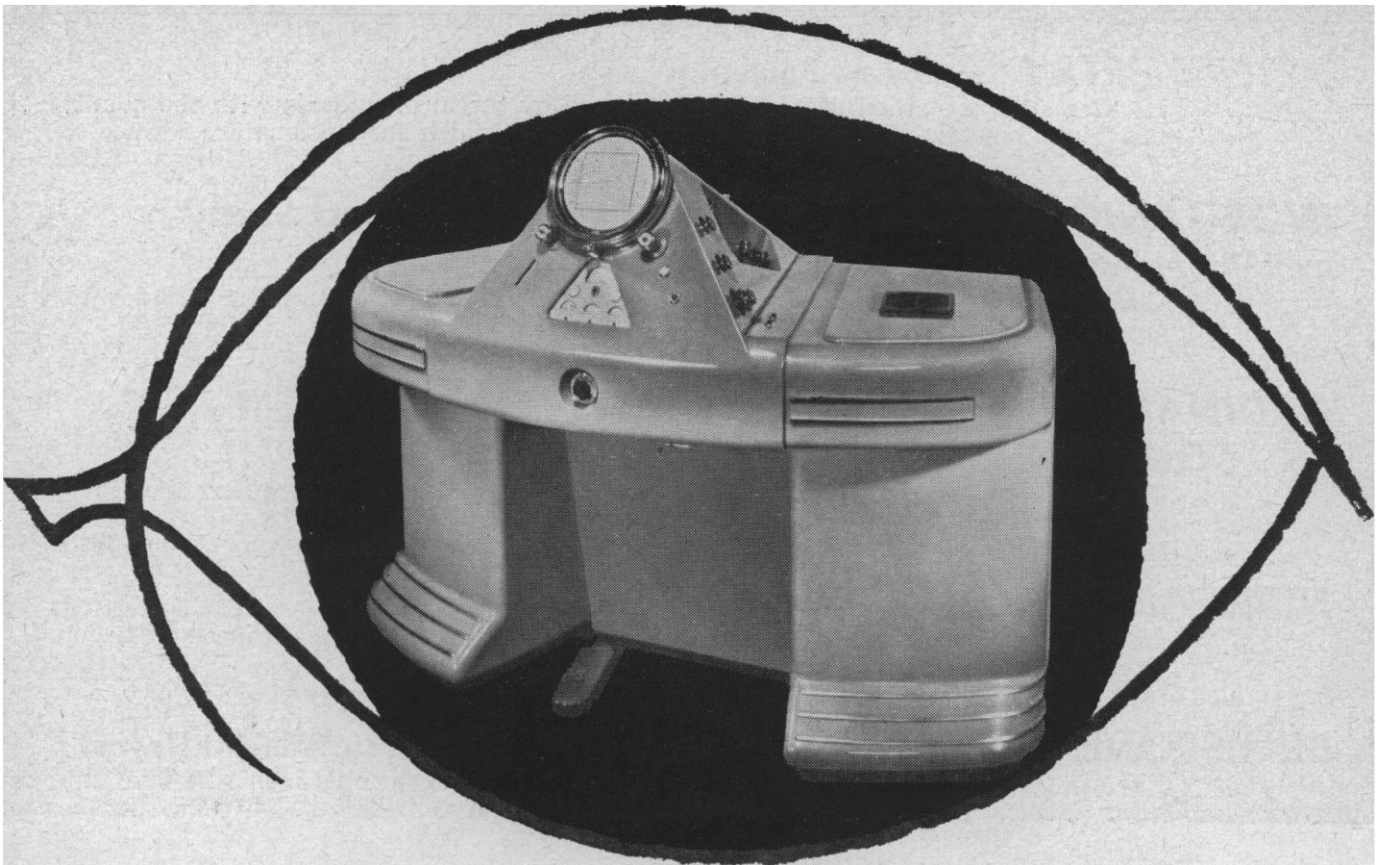
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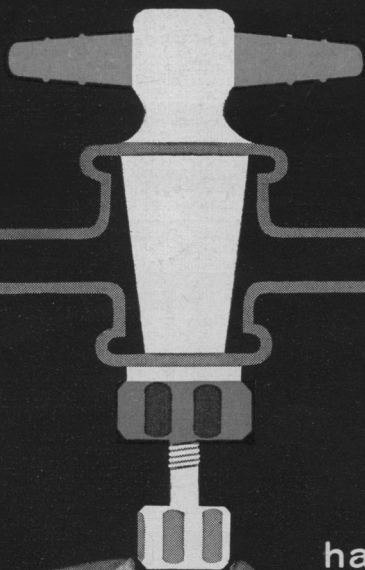
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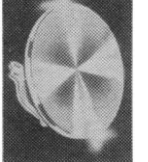
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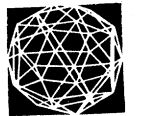


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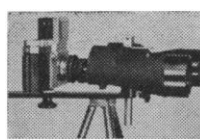
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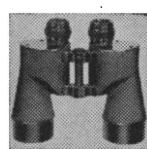
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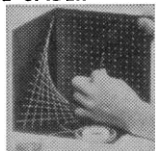
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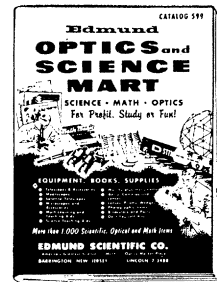
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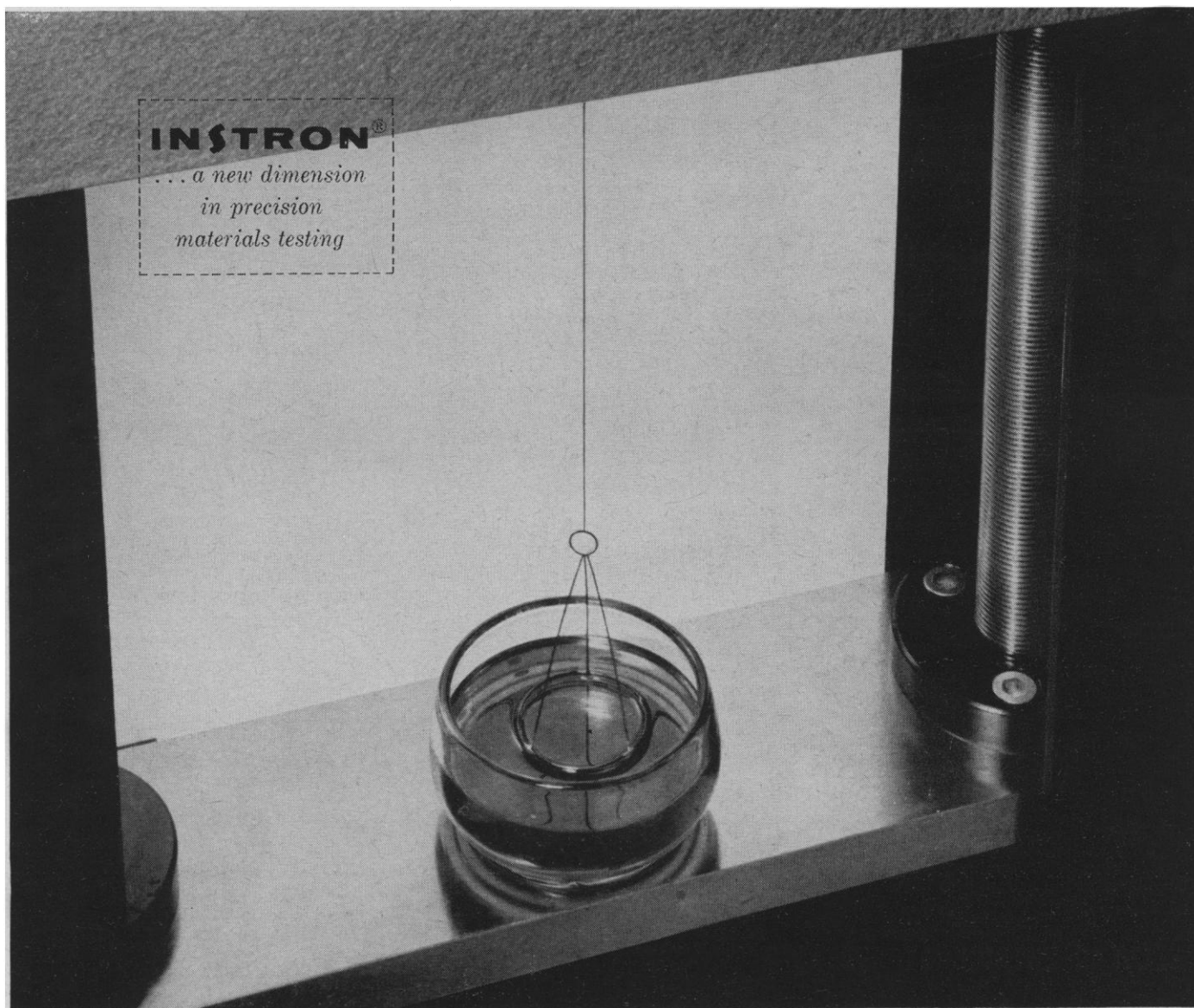
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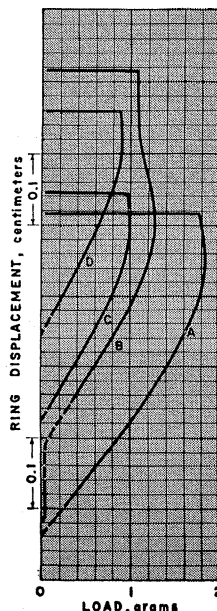


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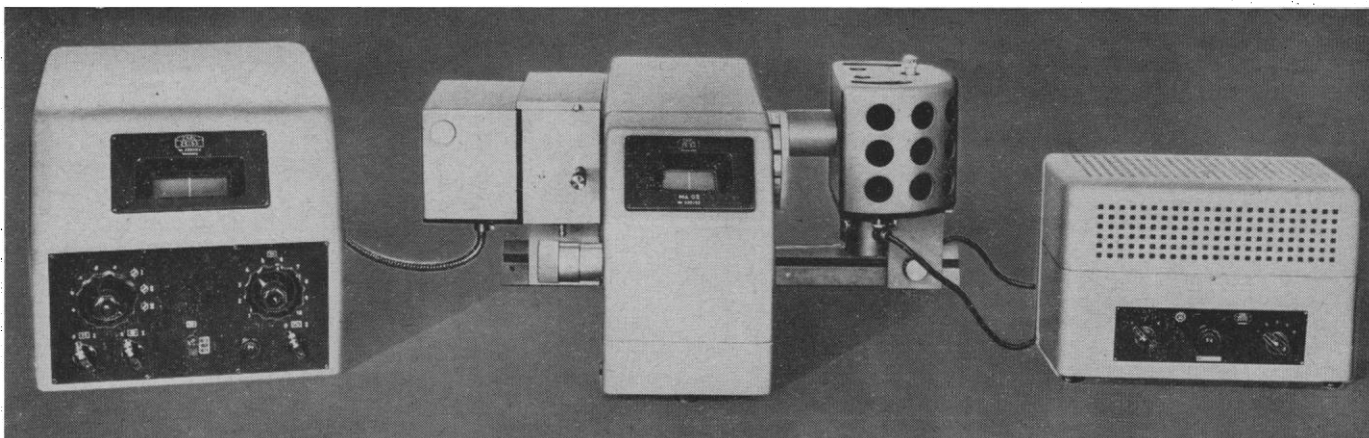
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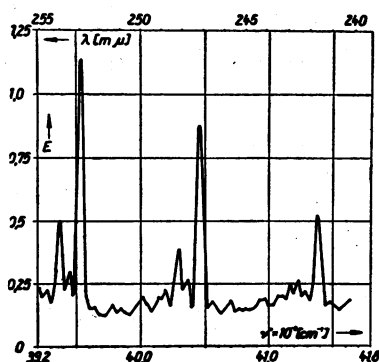
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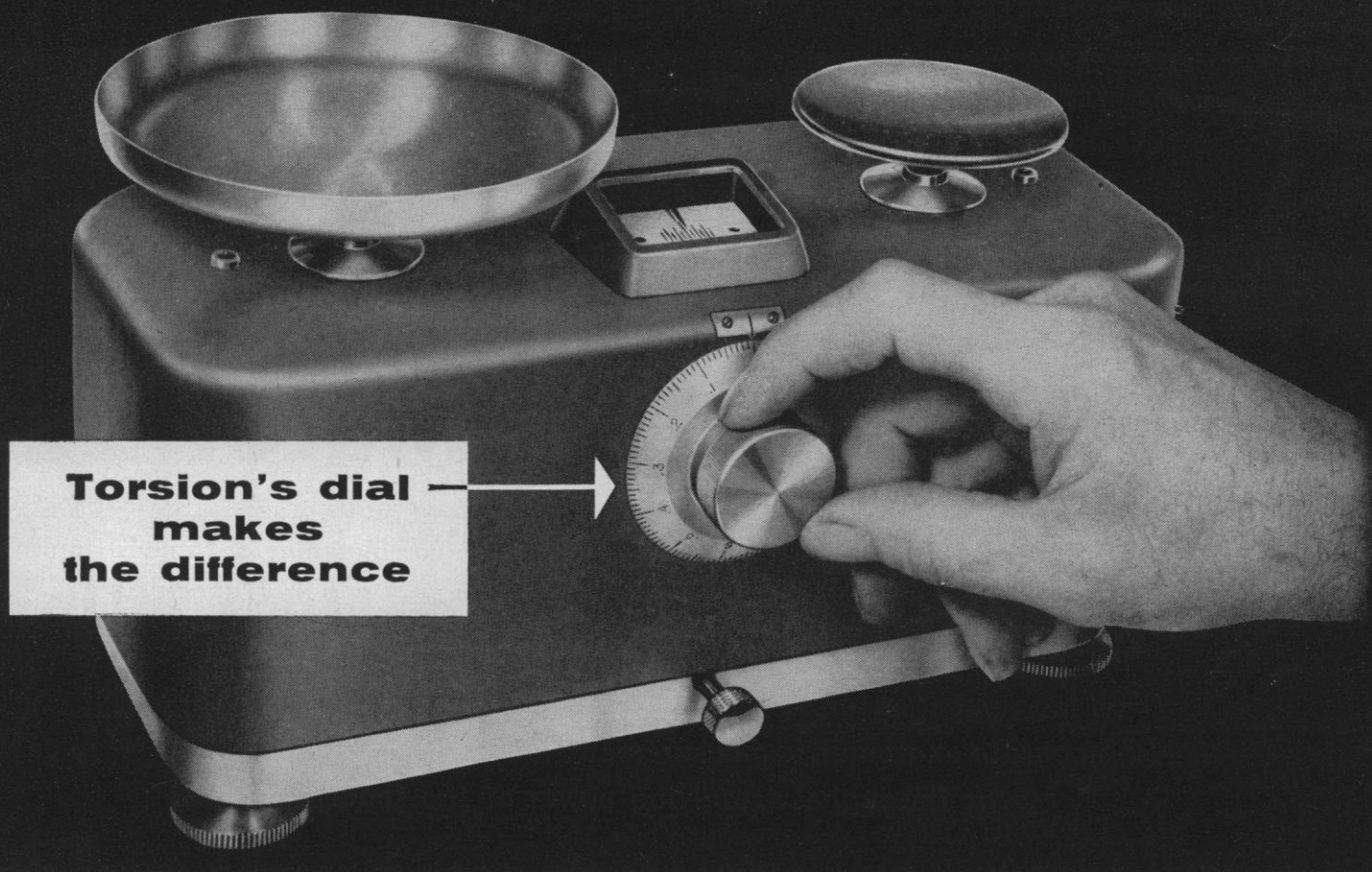
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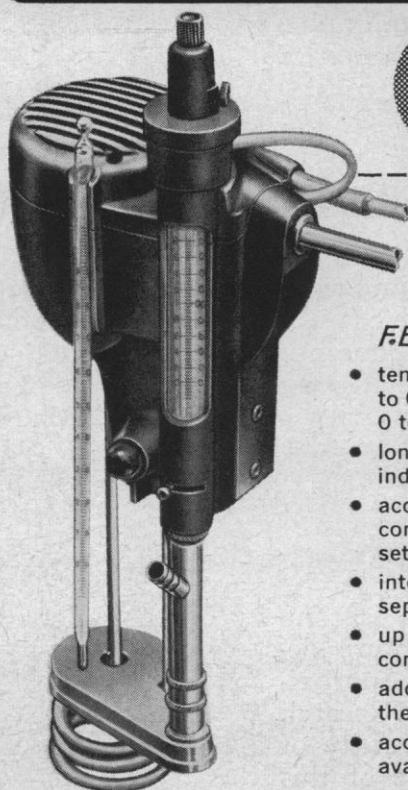
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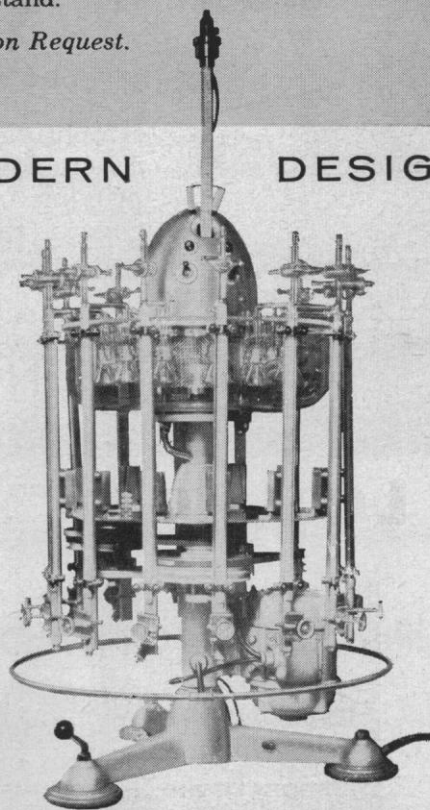
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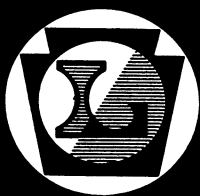
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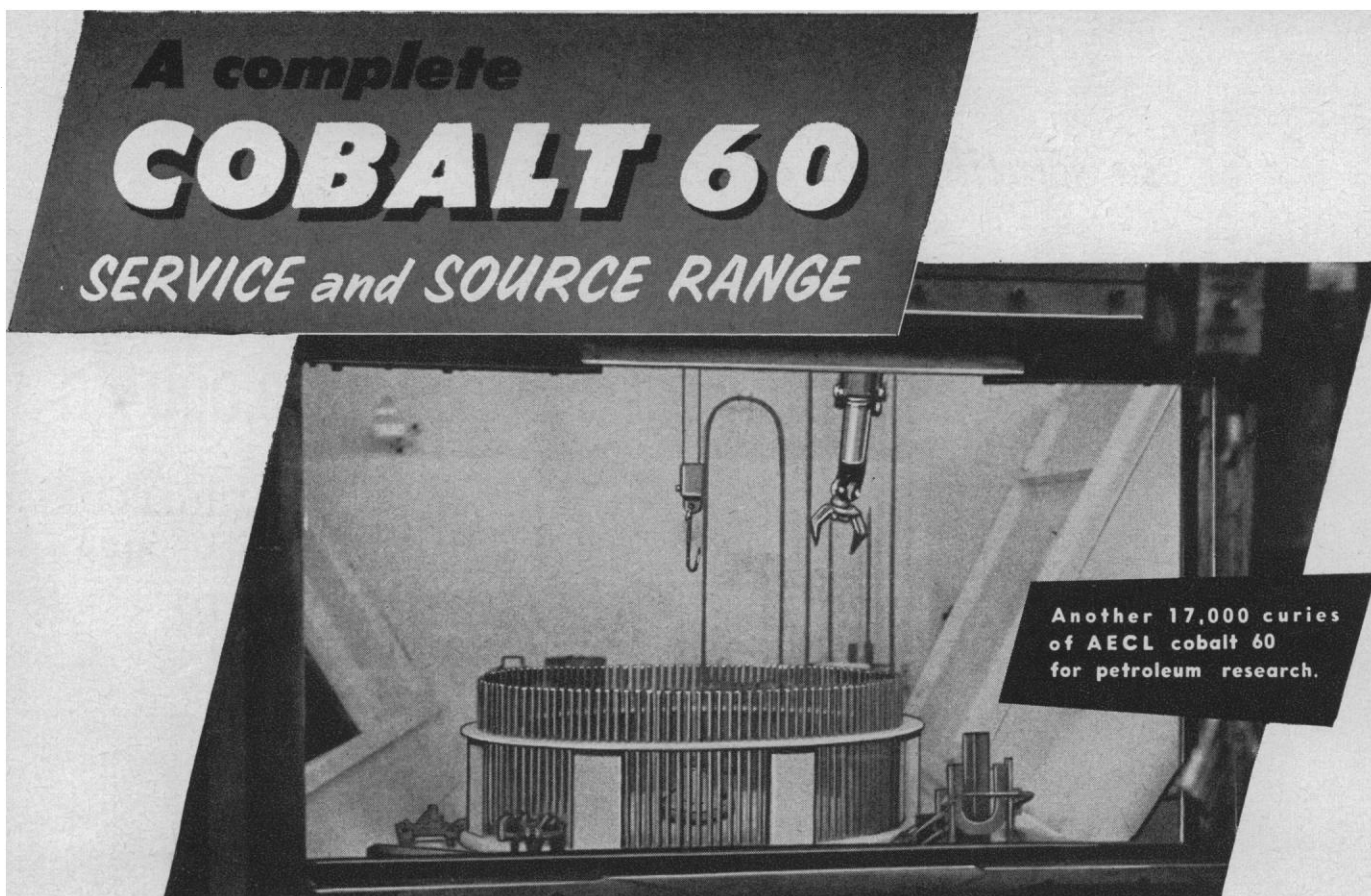
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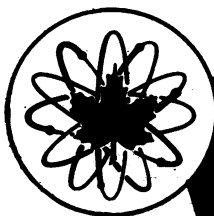
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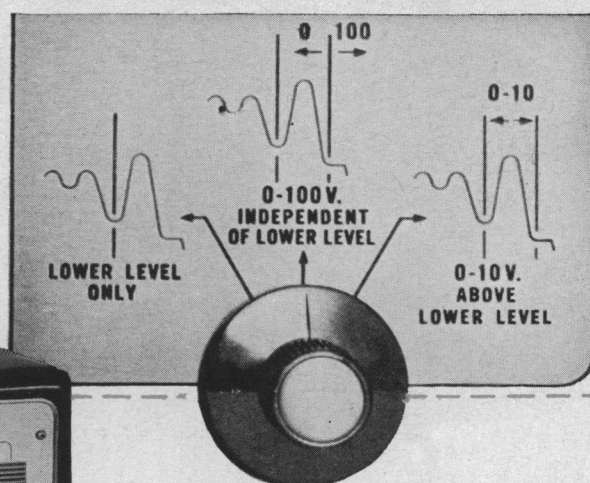
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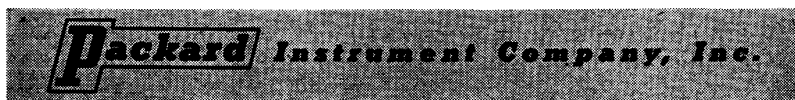
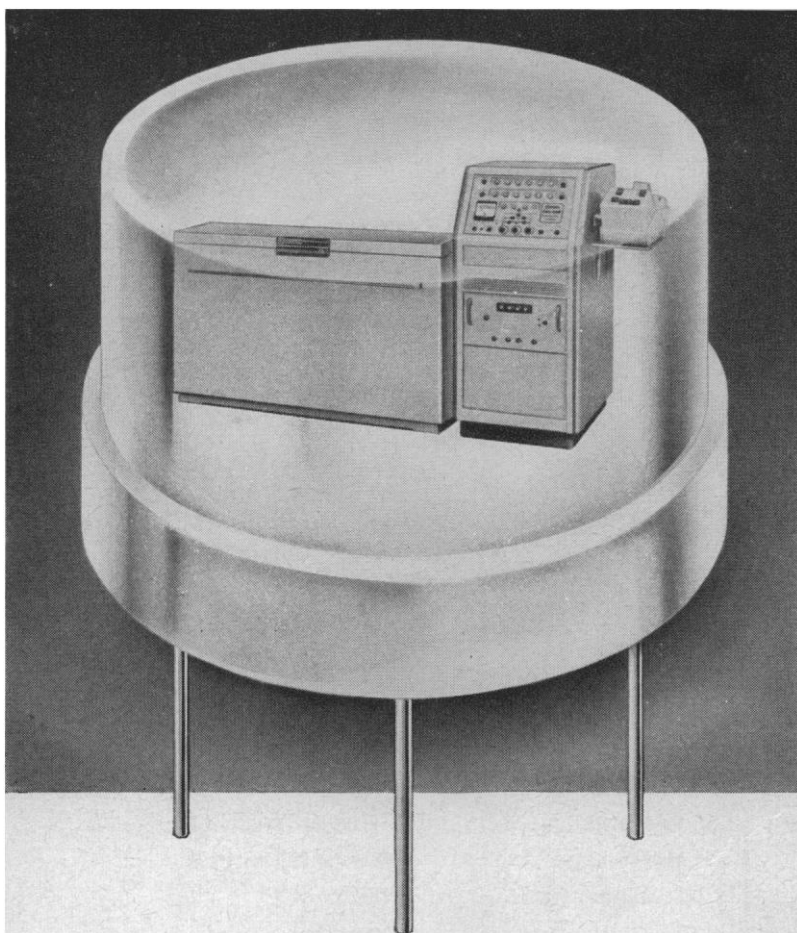
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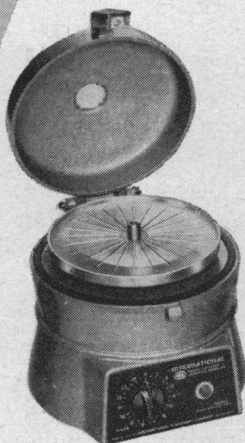
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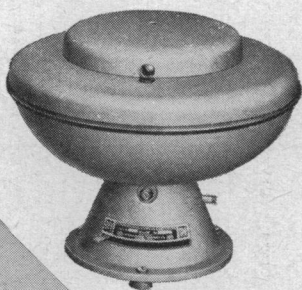
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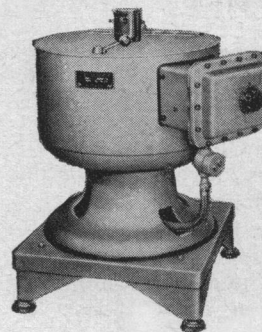
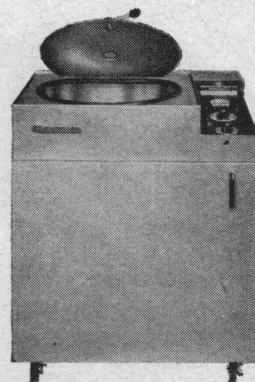


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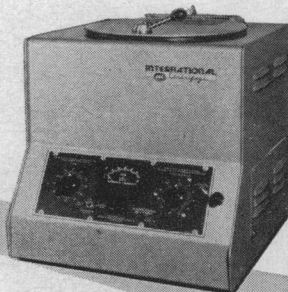
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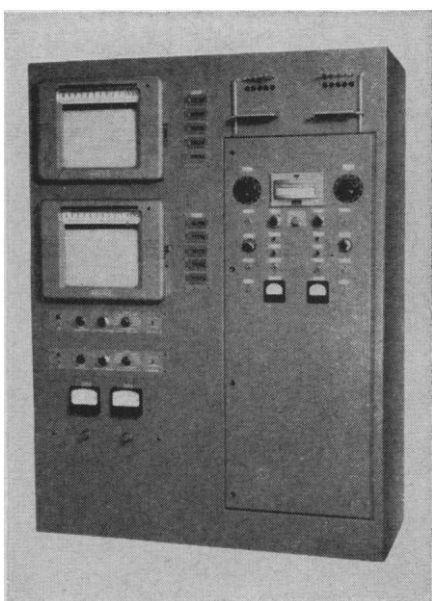
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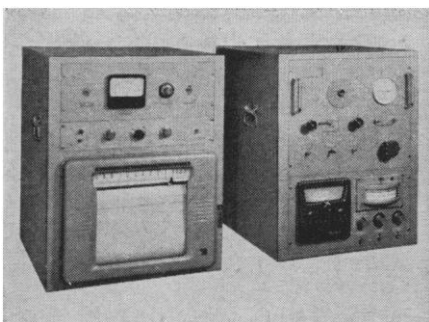
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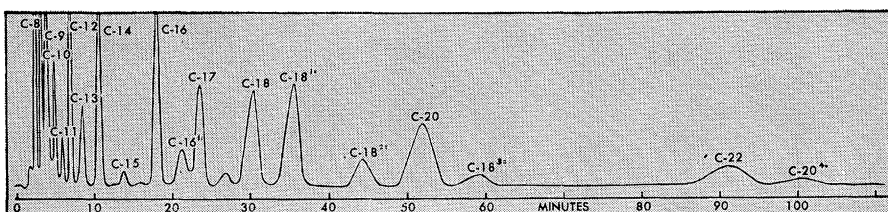
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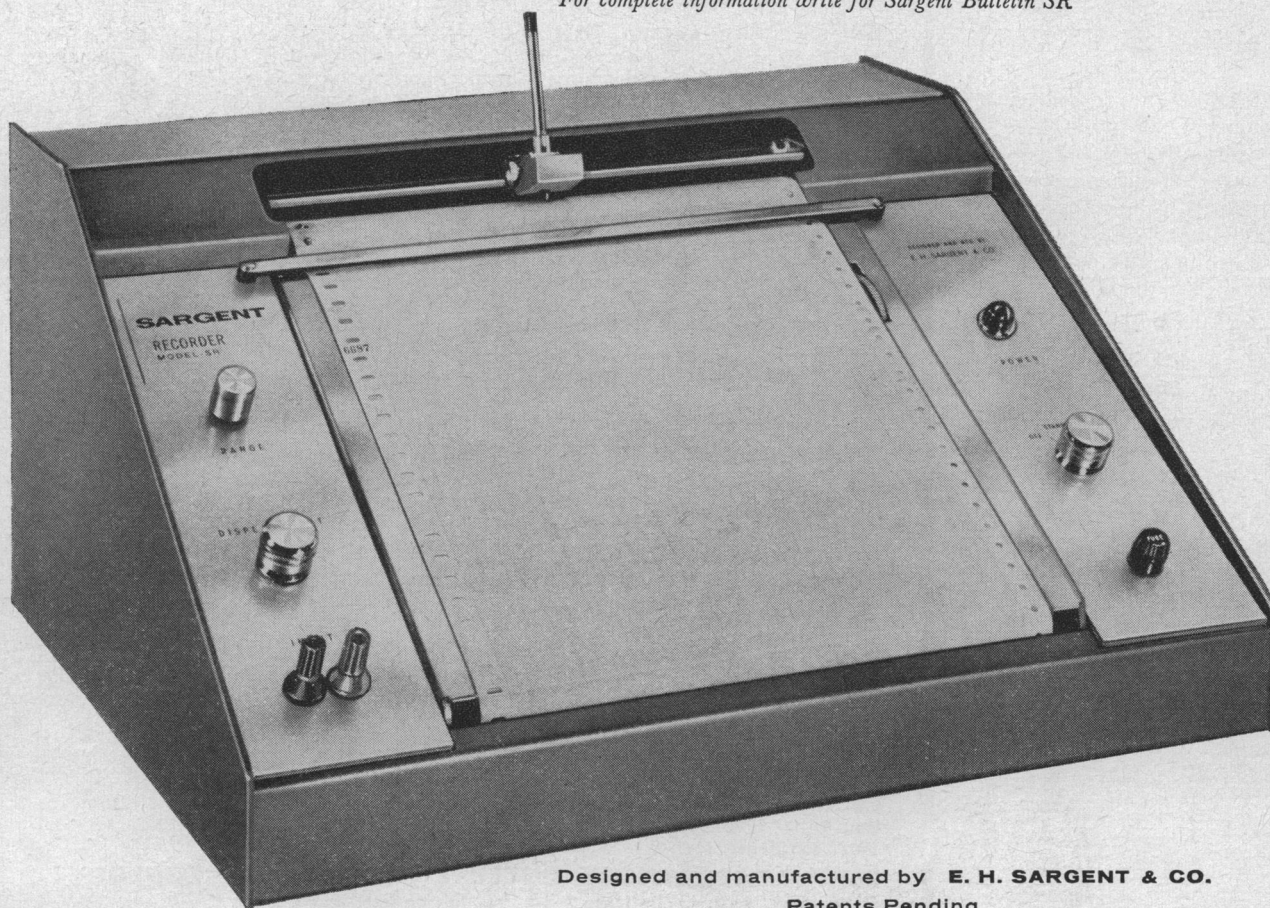
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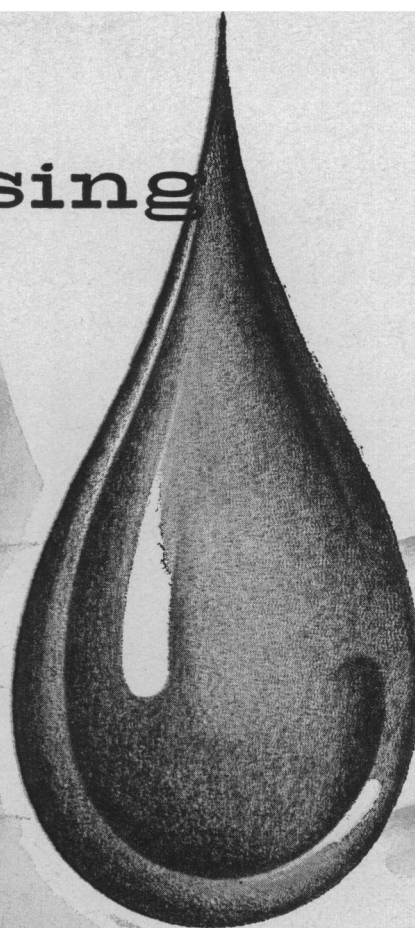
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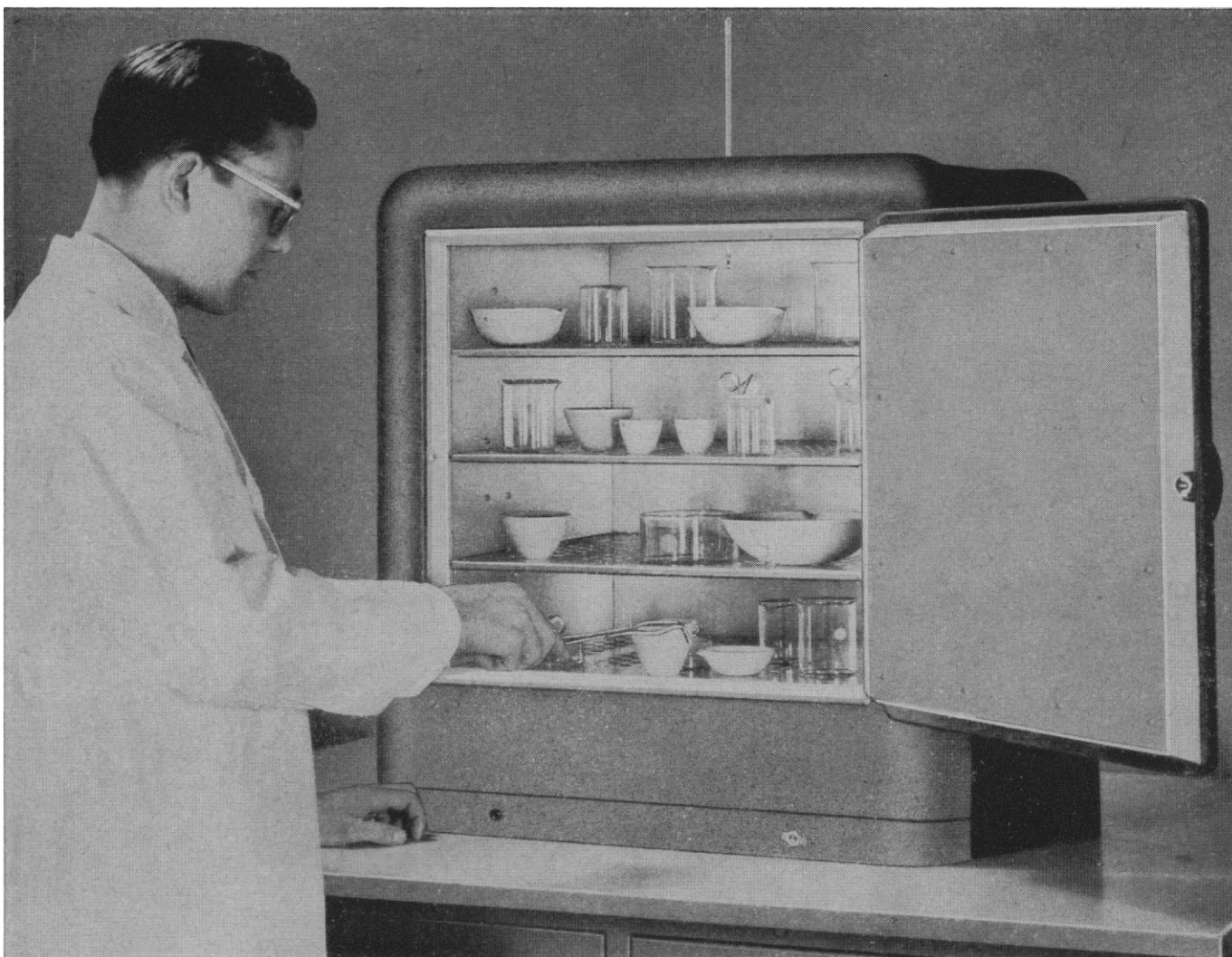
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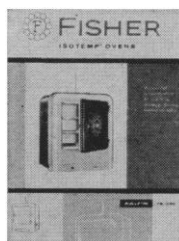
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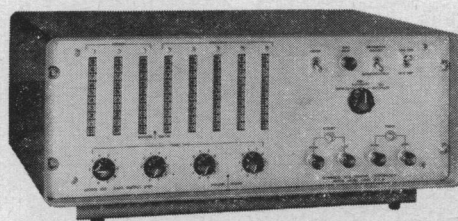
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Rebutting the Preposterous

At one point in the 18-century Chinese novel, *Dream of the Red Chamber*, as translated by Chi-Chen Wang and published by Doubleday Anchor Books, the physician Chang Yu-shih examines Chin-shih, taking her pulse first with his forefinger and then with his second finger. After considering the problem over a cup of tea, Chang Yu-shih reports that the pulse under the second finger is "vague" and that "the vague second finger pulse bespeaks a wood element in the liver too strong for the earth element in the spleen." The doctor goes on to deduce that the symptoms of this disturbance must include "lack of appetite, general fatigue, and a soreness of limbs." A maidservant who has been attending the patient confirms this deduction, and the doctor writes his prescription.

To the best of our knowledge, no one in the United States is presently espousing this particular approach to medicine, but scientists in all fields are occasionally challenged by pseudo scientists who advance theories that are quite as preposterous. To reply to such challenges, however, can prove exasperatingly laborious; the more preposterous the theory, the more laborious the rebuttal.

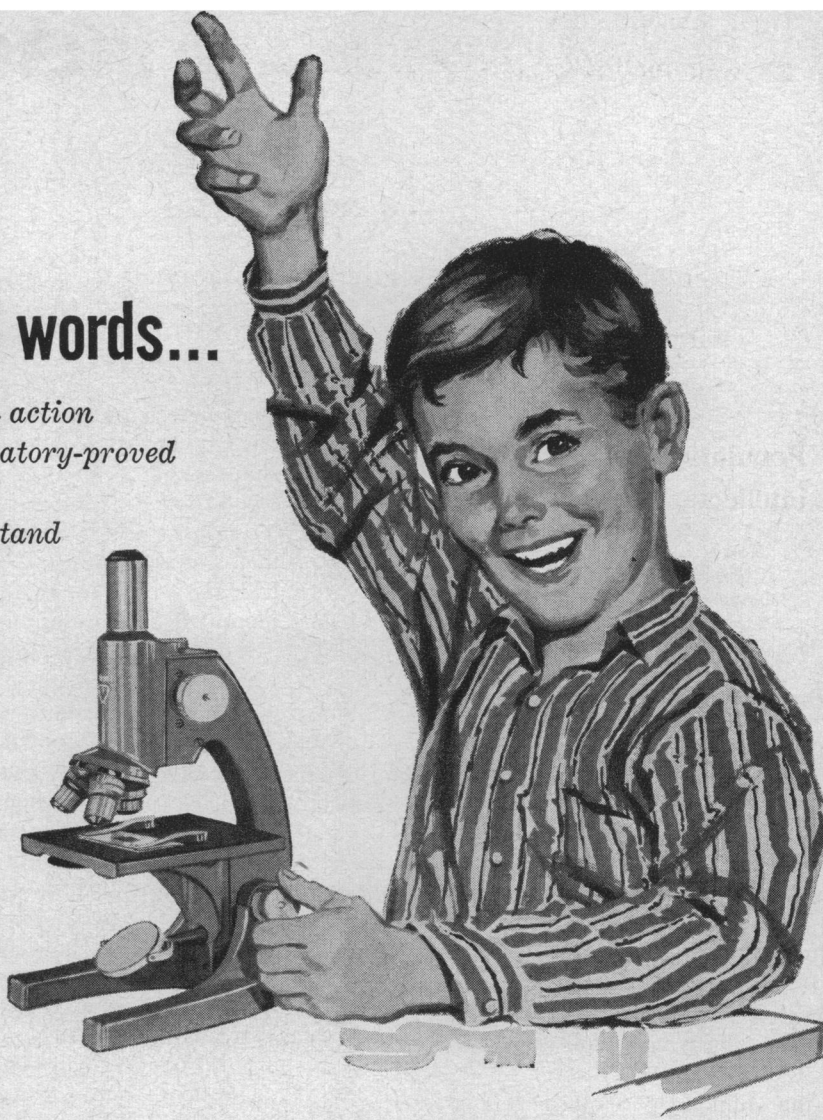
As in the case of the doctor in the story, the difficulty is not that pseudo scientists hold views that are experimentally false, but that they make generous use of concepts that have no experimental meaning at all. We may know what it means to speak of wood, earth, the liver, and the spleen, but we are stymied when it comes to investigating the relation between a surfeit of wood element in the liver and the patient's pulse. If the proponent of such a causal relation cannot prove it true to our satisfaction, we cannot begin to prove it false—for example, the maidservant's confirmation of the doctor's deduction actually confirms nothing—until we have cleared away many misconceptions and replaced them with some solidly based information.

To rebut preposterous theories may be exasperating, but it is sometimes necessary. Usually the pseudo scientist remains well insulated from scientific opinion, but occasionally he gains a considerable public following, with his views appearing in the columns of prominent popular magazines or in hard covers under the imprint of major publishing houses. When a pseudo scientist succeeds in fooling others besides himself, scientists should discuss publicly the merits of his work, both to maintain the prestige of science and to prevent unsound views from gaining further adherents. But the hope of public debate is not to cure a madman of his delusions but to persuade the audience that his views are without foundation.

Ultimately, however, the reply a scientist must accord a pseudo scientist is not so different from the reply he must give his own colleagues when he finds himself in complete disagreement with them. And, indeed, although pseudo science is as different from science as night from day, the two activities shade into each other through the grey of dawn and dusk. The final answer to one's critics is to stop arguing and go back to the laboratory. A scientist may conclude in all justice that it is more profitable for him to spend his time seeking answers from nature than from his opponent's pen.—J.T.

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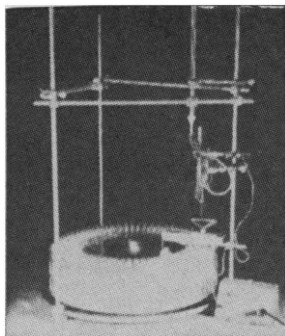
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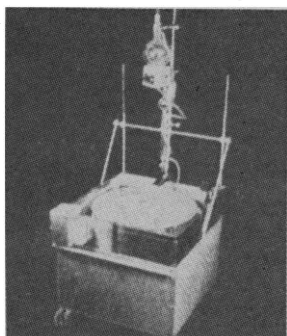
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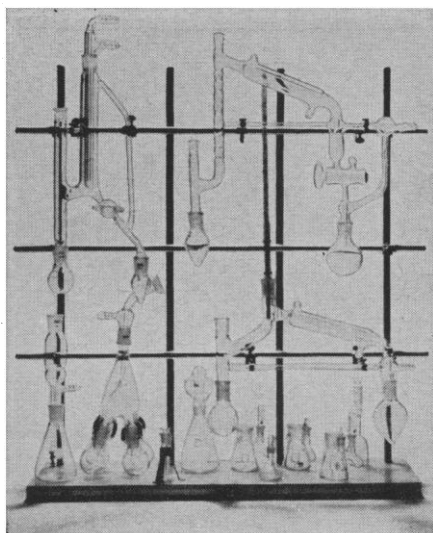
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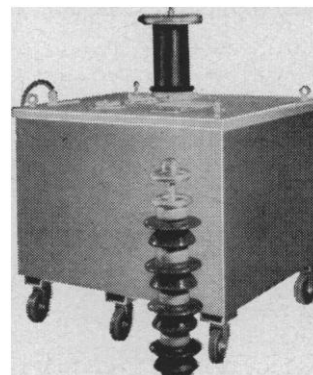
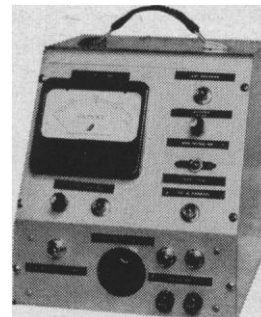
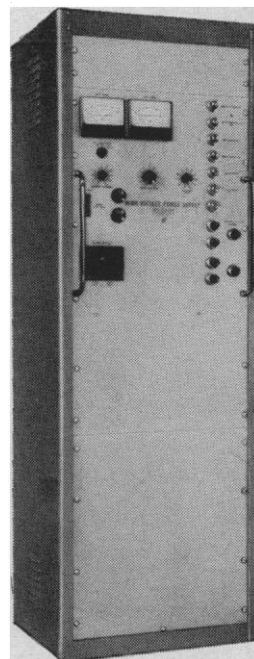
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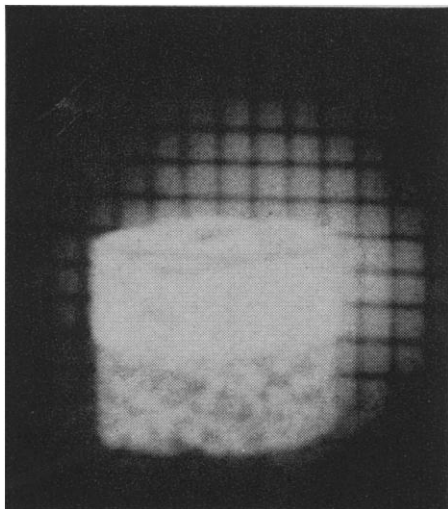
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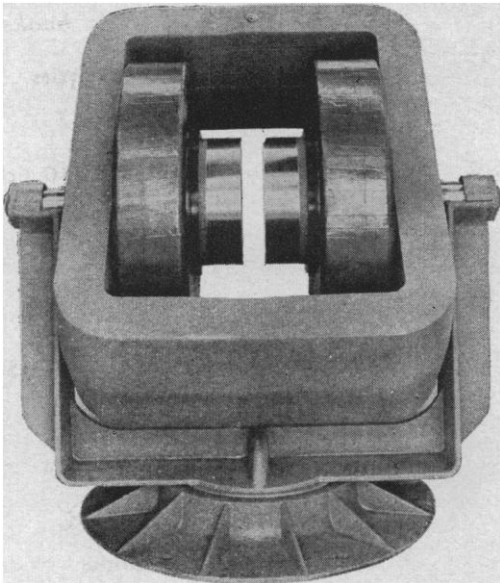
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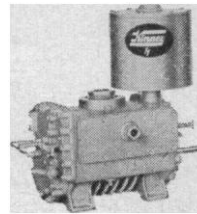
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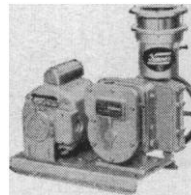


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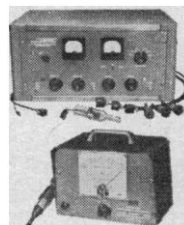


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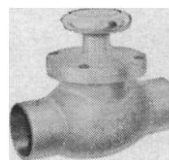


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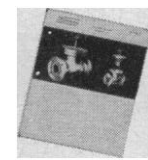


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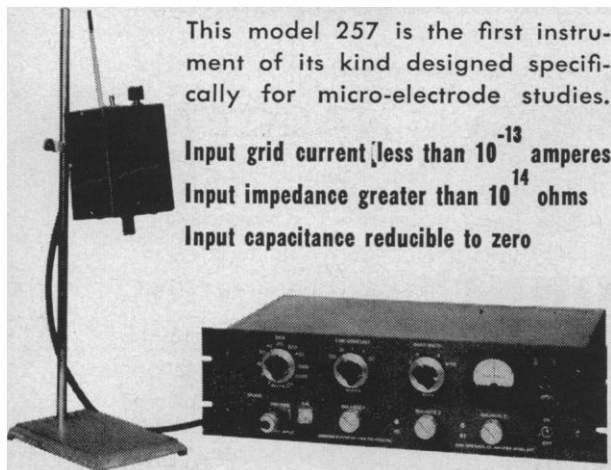
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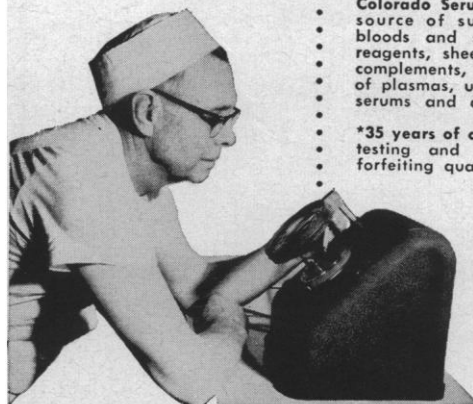
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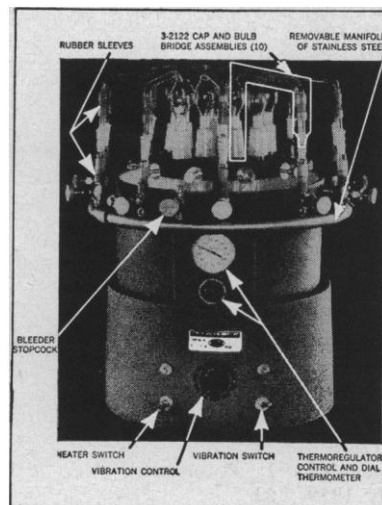
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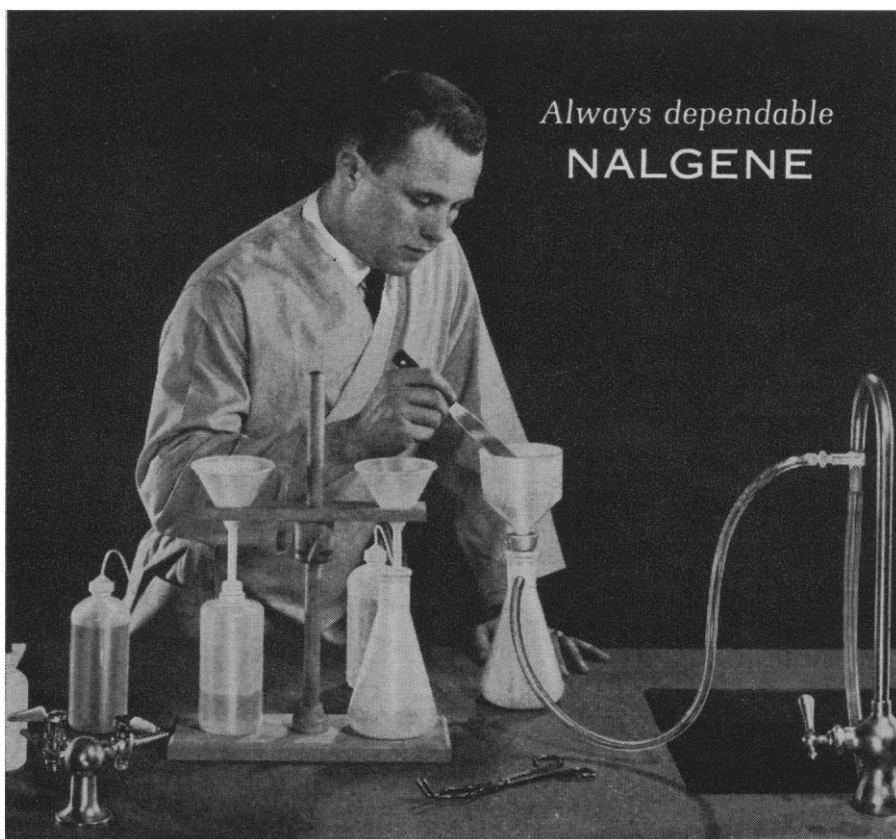
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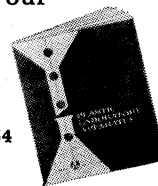
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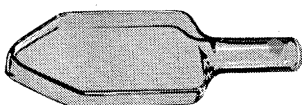


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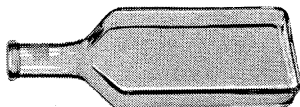
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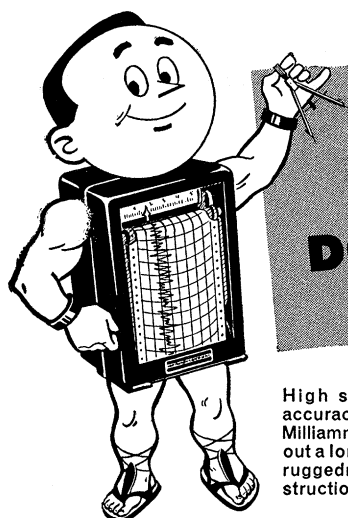
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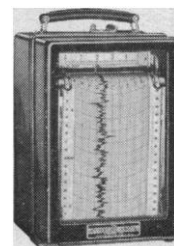
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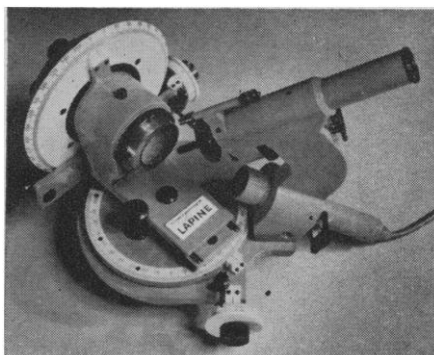
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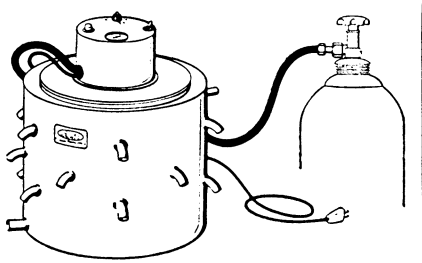
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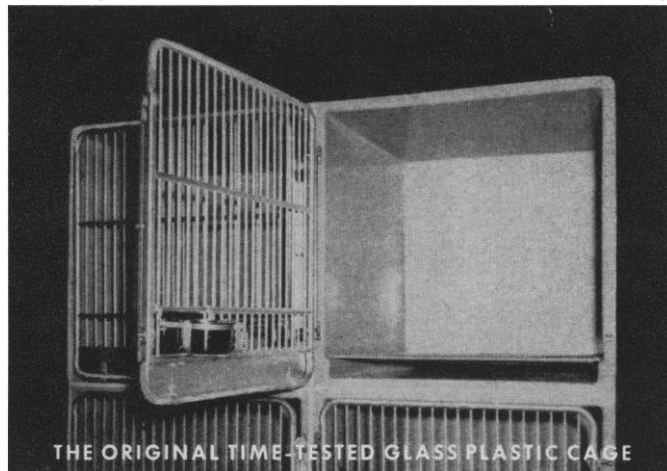


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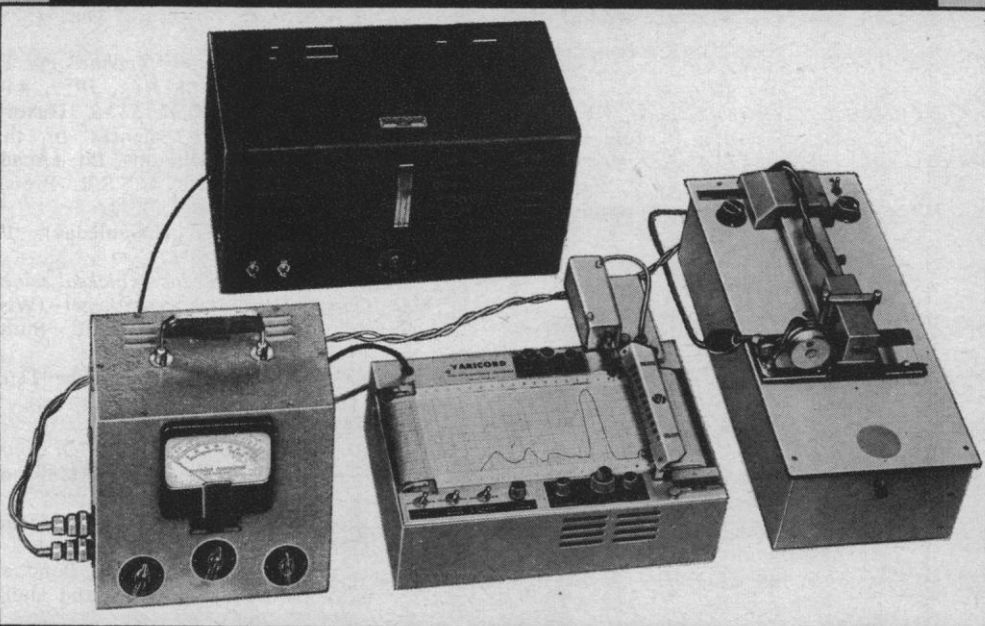
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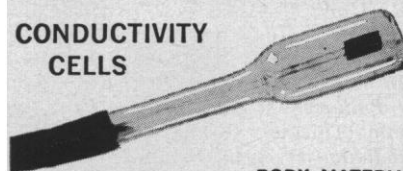
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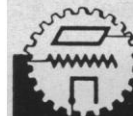
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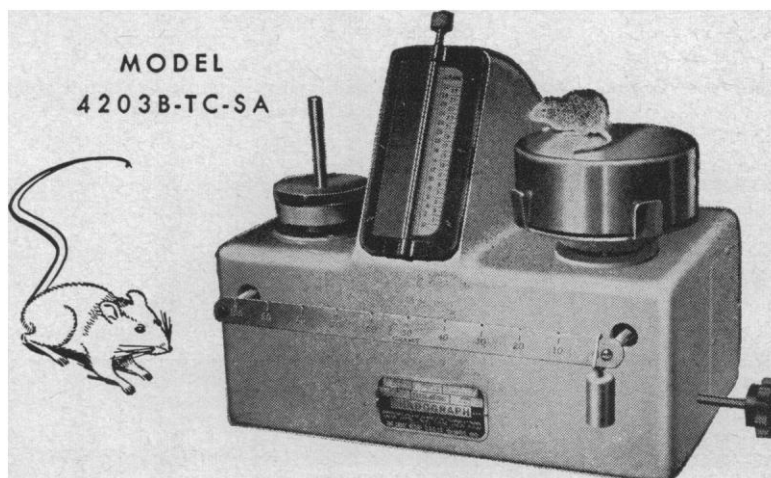
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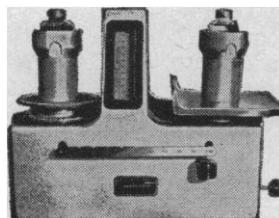
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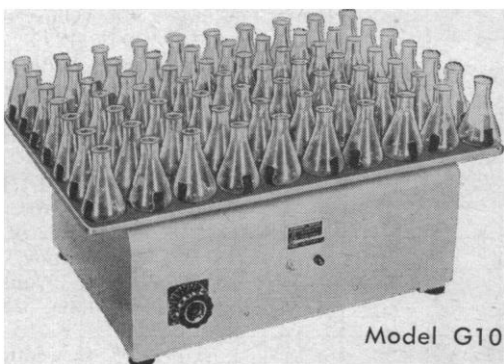
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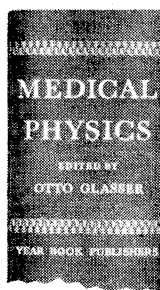
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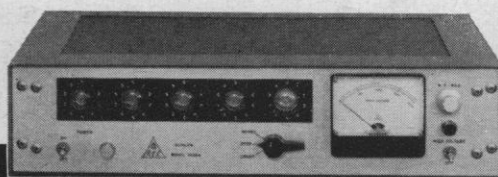
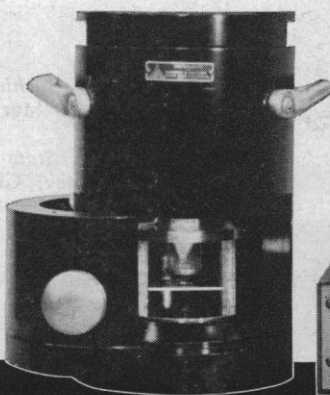
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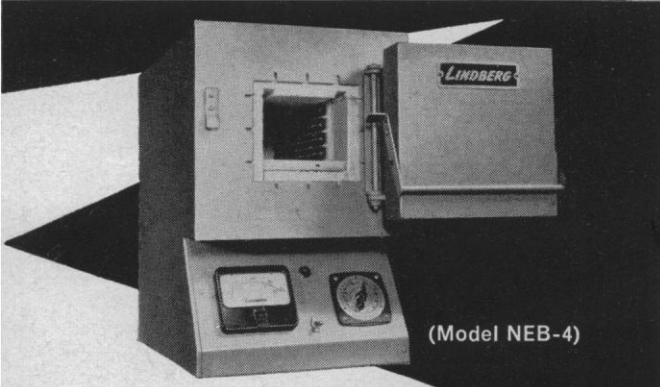


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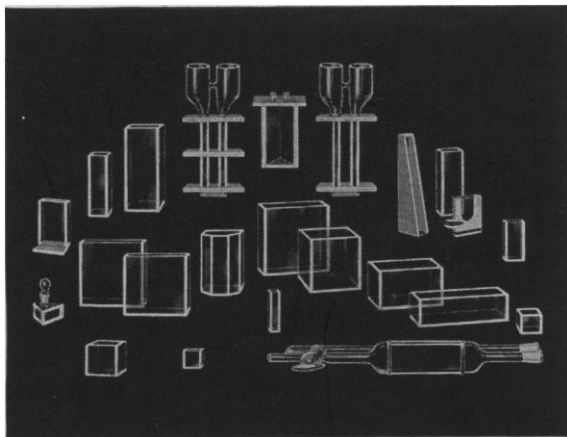
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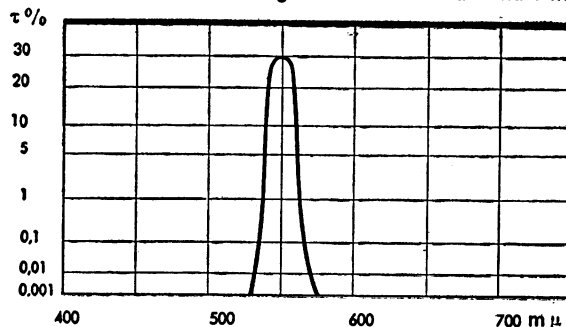
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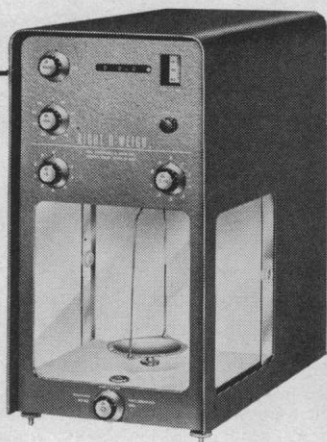
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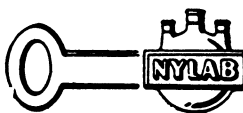


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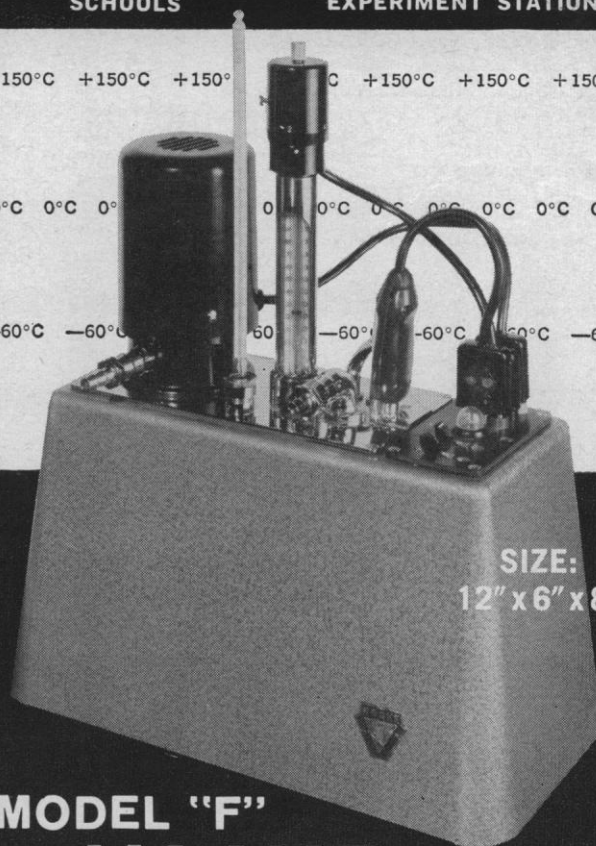
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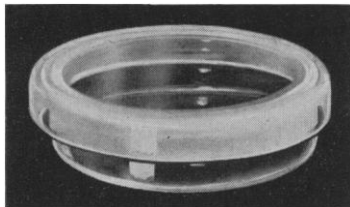
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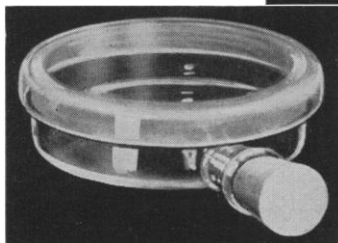
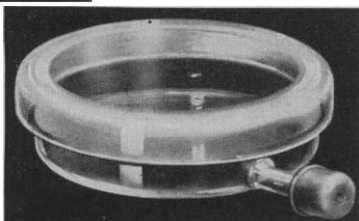
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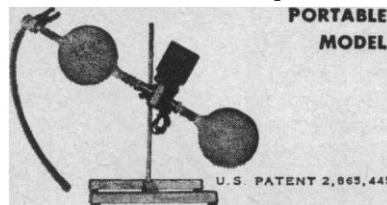
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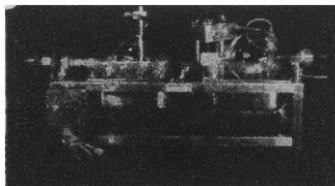
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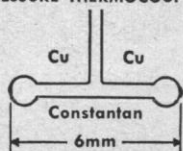
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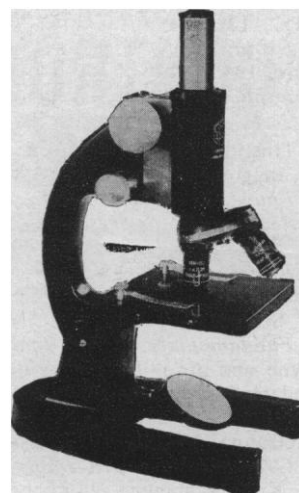
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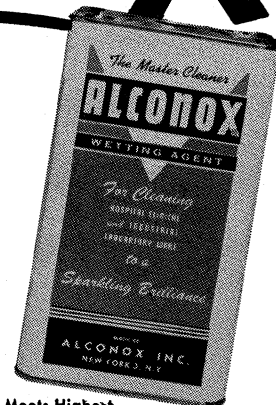
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Technology and Culture, the international quarterly of the society, made its first appearance in January 1960. It contains articles by Roger Burlingame, Peter F. Drucker, Howard Mumford Jones, and Francis R. Allen, dealing, respectively, with the literature of the history of technology, economic problems in the study of technology, the position of technological history in general intellectual history, and the relations between technology and social change. Of particular interest to the readers of *Science* are Robert P. Multhauf's article on the scientist and the "improver" of technology, Cyril S. Smith's metallographic study on methods of making chain mail, John Geise's inquiry into what a railway is, and Carl W. Condit's treatment of Louis Sullivan's skyscrapers as expressions of 19th-century technology. The spring 1960 issue of *Technology and Culture* will contain A. P. Usher's investigation of the industrialization of modern Britain, M. N. Boyer's remarks about the notion that the pivoted axle, known to antiquity, disappeared during the Middle Ages and had to be reinvented, and John Rae's discussion of the "know-how" tradition in American technology, as well as research notes by Nathan Reingold on the U.S. Patent Office records as sources for the history of invention and P. Federico's essay on the records of Eli Whitney's cotton-gin patent. In addition there are book reviews by Leonard Carmichael, Dorothea Waley Singer, Trevor I. Williams, and others.

The interdisciplinary nature of the society and its publication will be shown further in the third issue of *Technology and Culture*, which will contain a "con-

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trover" section wherein I. Jordan Kunik (patent attorney) and Jacob Schmookler (economist) argue against the attempt of S. Colum Gilfillan (sociologist) to measure the rate of American invention and the decline of patenting. That issue will also contain Robert S. Woodbury's "Eli Whitney and the legend of interchangeable parts." Also planned is an issue devoted exclusively to a critique of the monumental five-volume *History of Technology*, edited by Charles Singer and others; this issue will contain articles by Lewis Mumford, Lynn White, and others.

Programs of the society reflect the same interdisciplinary approach. To date the society has met jointly with the American Society for Engineering Education, the American Historical Association, and the American Association for the Advancement of Science. Its programs normally consist of three sessions, one devoted to the general social and cultural relations of technology, a second devoted to the substantive history of technology, and a third dealing with interpretive discussions of technological developments in the past and present.

William Fielding Ogburn, the famed sociologist, served as president of the society until his untimely death early in 1959. He was succeeded as president by David B. Steinman, civil engineer and master bridge-builder, who is responsible for the construction of over 400 bridges on five continents, among them the recently completed Mackinac Bridge, and who has received many awards for his numerous research papers on the aerodynamics of bridge structure and the application of metallurgical developments to bridge construction. First vice president is Lynn White, Jr., professor of medieval history at the University of California (Los Angeles) and former president of Mills College. Mervin J. Kelly, recently retired as president of the Bell Telephone Laboratories and one of the nation's leaders in the field of industrial research, is second vice president. The secretary of the society and editor-in-chief of *Technology and Culture* is Melvin Kranzberg of Case Institute of Technology, and the treasurer is Robert S. Woodbury of Massachusetts Institute of Technology. Among the members of the society's executive and advisory councils are John E. Burchard, Leonard Carmichael, Ralph E. Flanders, Philippe Le Corbeiller, David Riesman, Cyril S. Smith, Richard H. Shryock, Herbert Hoover, I. Bernard Cohen, and Charles W. Cole.

Information regarding membership in the society, which includes subscription to the journal, may be obtained from the secretary, Dr. Melvin Kranzberg, Room 311, Main Building, Case Institute of Technology, Cleveland 6.

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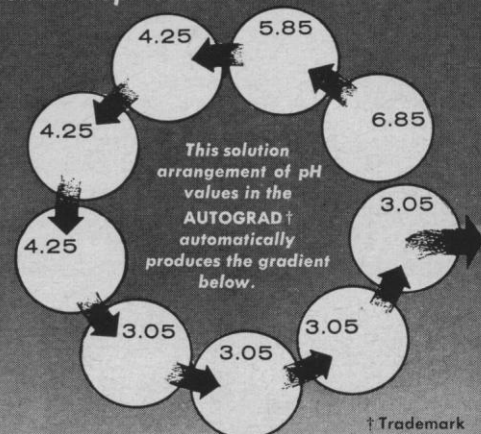
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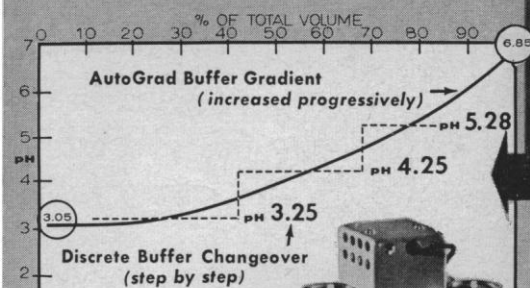
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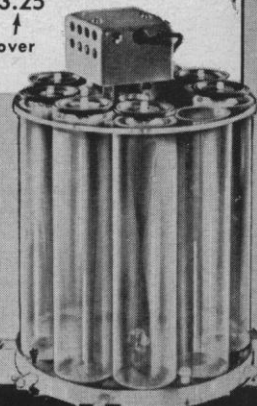
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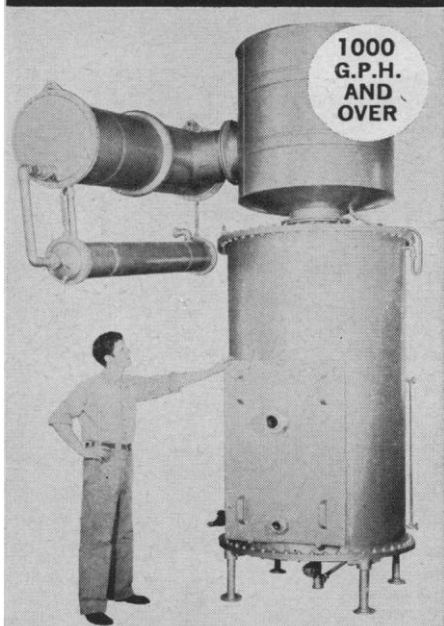
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15-18. International College of Surgeons, 12th biennial conf., Rome, Italy. (ICS, 1516 Lake Shore Drive, Chicago, Ill.)

15-19. Institute of Food Technologists, 20th annual, San Francisco, Calif. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3)

15-20. American Water Works Assoc., annual conv., Miami Beach, Fla. (H. E. Jordan, AWWA, 2 Park Ave., New York 16)

15-20. National Tuberculosis Assoc., Los Angeles, Calif. (J. C. Stone, 1790 Broadway, New York 19)

16-17. Society of American Military Engineers, natl. conv., Washington, D.C. (D. A. Sullivan, SAME, 140 S. Dearborn St., Chicago, Ill.)

16-18. American Ophthalmological Soc., Colorado Springs, Colo. (M. C. Wheeler, 30 W. 59 St., New York 19)

16-18. American Trudeau Soc., Los Angeles, Calif. (F. W. Webster, 1790 Broadway, New York 19)

16-19. American Urological Assoc., Chicago, Ill. (W. P. Didusch, 1120 N. Charles St., Baltimore 1, Md.)

16-20. Medical Library Assoc., Kansas City, Mo. (Miss N. A. Mehne, Upjohn Co. Library, 301 Henrietta St., Kalamazoo, Mich.)

16-21. American Assoc. on Mental Deficiency, annual, Baltimore, Md. (N. A. Dayton, P.O. Box 51, Mansfield Depot, Conn.)

17-18. Superconductive Technique for Computing Systems, symp., Washington, D.C. (Miss J. Leno, Code 430A, Office of Naval Research, Washington 25)

17-20. American Assoc. of Plastic Surgeons, Milwaukee, Wis. (T. D. Cronin, 6615 Travis St., Houston 25, Tex.)

18-19. Agricultural Meteorology, 3rd conf., Kansas City, Mo. (K. C. Spengler, American Meteorological Soc., 45 Beacon St., Boston, Mass.)

18-20. Society for Experimental Stress Analysis, spring, Indianapolis, Ind. (W. M. Murray, SESA, P.O. Box 168, Central Square Station, Cambridge 39, Mass.)

18-27. Wool Conf., intern., Harrogate, Yorkshire, England. (A. W. Bennett, Textile Inst., 10 Blackfriars St., Manchester 3, England)

21-22. Society for Economic Botany, 1st annual, Lafayette, Ind. (Q. Jones, New Crops Research Branch, Beltsville, Md.)

22. Maryland Acad. of Sciences, Baltimore. (J. W. Easter, Owings Mills, Md.)

22-26. Air Pollution Control Assoc., 53rd annual, Cincinnati, Ohio. (C. W. Gruber, 2400 Beekman St., Cincinnati 14)

22-26. Oil and Gas Power Conf., Kansas City, Mo. (D. B. MacDougall, ASME, 29 W. 39 St., New York 18)

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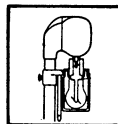


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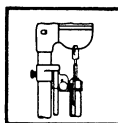
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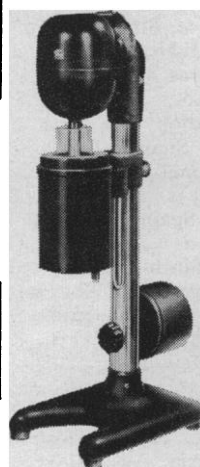
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American Rocket Soc., 925 Book Bldg., Detroit 26, Mich.)

23-25. Technical Assoc. of the Paper and Pulp Industry, Chicago, Ill. (J. Winchester, TAPPI, 155 E. 44 St., New York 17)

23-26. Design Engineering Conf., New York, N.Y. (D. B. MacDougall, ASME, 29 W. 39 St., New York 18)

23-28. American College of Cardiology, 9th annual conv., Indianapolis, Ind. (G. F. Greco, ACC, 114-08 Linden Blvd., Ozone Park 16, N.Y.)

23-28. Instruments, Electronics, and Automation Exhibition, Olympia, London, England. (Industrial Exhibitions Ltd., 9 Argyll St., London, W.1, England)

23-28. International Ceramic Cong., 7th, Great Britain. (G. N. Hodson, Organizing Council, c/o Hathernware Ltd., Loughborough, England)

23-28. International War—Prophylaxis Cong. for Physicians, Noordwijk aan Zee, Netherlands. (M. Knap, 46 Schubertstraat, Amsterdam, Netherlands)

24-29. International Council for Bird Preservation, 12th cong., Tokyo, Japan. (Miss P. Barclay-Smith, British Museum (Natural History), Cromwell Rd., London, S.W.7, England)

25-26. Refractory Metals and Alloys, symp., Detroit, Mich. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

25-5. International Federation for Housing and Town Planning, cong., Puerto Rico. (IFHTP, Park Hotel, Molenstraat 53, The Hague, Netherlands)

26-27. Psychophysiological Aspects of Space Flight (School of Aviation Medicine, USAF Aerospace Medical Center), symp., San Antonio, Tex. (J. Harmon, Southwest Research Inst., 8500 Culebra Rd., San Antonio 6)

26-28. Society of Naval Architects and Marine Engineers, spring, Washington, D.C. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

29-2. Chemical Inst. of Canada, 43rd annual conf., Montreal, Quebec, Canada. (CIC, 18 Rideau St., Ottawa, Ontario, Canada)

29-4. American Soc. for Horticultural Science, 8th annual of Caribbean Region, San Juan, Puerto Rico. (E. H. Cásseres, Londres 40, O.E.E., Mexico 6, D.F.)

29-5. International Commission on Irrigation and Drainage, 4th cong., Madrid, Spain. (D. Diaz-Ambrona, Comité Nacional Español, c/o Ministerio de Obras Públicas, Agustín de Bethencourt, 4, Madrid, Spain)

30-1. American Gynecological Soc., Williamsburg, Va. (A. A. Marchetti, Georgetown Univ. Hospital, Washington 7)

30-2. American Orthopaedic Assoc., Hot Springs, Va. (L. R. Straub, 535 E. 70 St., New York 21)

30-3. Asian-Pacific Cong. of Cardiology, 2nd, Melbourne, Australia. (A. E. Doyle, Alfred Hospital, Melbourne, S.1, Victoria, Australia)

30-3. Fibre Science, annual conf., London, England. (A. W. Bennett, Textile Inst., 10 Blackfriars St., Manchester 3, England)

30-4. Reactivity of Solids, 4th intern. symp., Amsterdam, Netherlands. (Ir. G. van Gijn, Secretary, 4th Intern. Symp. on the Reactivity of Solids, Technisch Hogeschool, Eindhoven, Netherlands)

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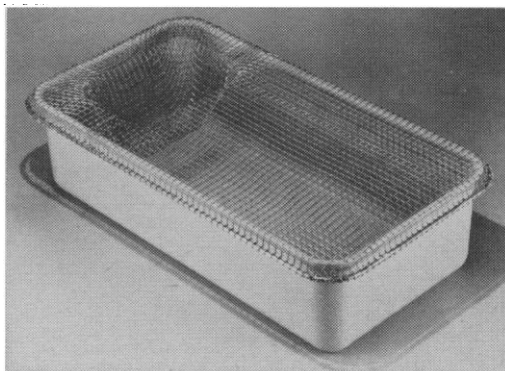
A fourth lid style has been added to the Econo-Cage line. These all metal, single piece lids with built-in, deep-drawn feeders (lid style "D"), make it possible to clean and service cage lids and feeders in one operation—without the extra time and inconvenience required to separate and loosen feeder and lid, clean them separately and re-assemble them. When you clean an Econo-Cage Lid "D", you clean the feeding trough at the same time.

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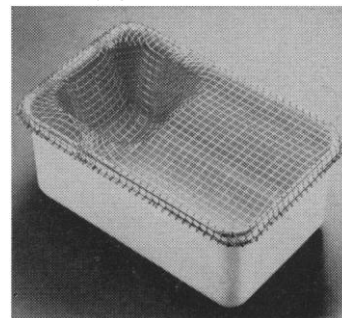
Single piece lid #32D with built-in trough feeder, is shown here with cage #32 (19"x10½"x5½" deep). The cage is Fiberglas and can be autoclaved.

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1-3. Instrumental Methods of Analysis, annual symp., Montreal, Quebec, Canada. (W. H. Kushnick, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22)

1-5. Irrigation and Drainage, 4th intern. cong., Madrid, Spain. (D. Diaz-Ambrona, Comité Nacional Espanol de la Comision Internacional de Riegos y Drenajes, Ministerio De Obras Publicas, Agustin De. Bethencourt 4, Madrid)

2-4. American Assoc. of Bioanalysts and California Assoc. of Clinical Laboratories, annual, San Francisco, Calif. (Mrs. M. K. Higgins, 75 Buena Vista Ave., San Francisco 17, Calif.)

2-4. Drugs Affecting Lipid Metabolism, intern. symp., Milan, Italy. (S. Garattini, c/o Institute of Pharmacology, Via del Sarto 21, Milan, Italy)

3-8. Pan American Medical Women's Alliance, 7th cong., San Juan, Puerto Rico. (Mrs. S. D. Rosekrans, 504 Newett St., Nullsville, Wis.)

5-8. Special Libraries Assoc., 51st annual, Cleveland, Ohio. (B. M. Woods, SLA, 31 E. 10 St., New York 3)

5-9. American Soc. of Mechanical Engineers, summer annual and aviation conf., Dallas, Tex. (L. S. Dennegar, ASME, 29 W. 39 St., New York 18)

5-9. World Power Conf., Madrid, Spain. (D. J. Pérez, Pozualo, Spanish National

Committee, General Pardinias, 55, Madrid, Spain)

5-10. National Conf. on Social Welfare, annual, Atlantic City, N.J. (Natl. Conf. on Social Welfare, 22 West Gay St., Columbus 15, Ohio)

5-14. XXV Cold Spring Harbor Symp. on Quantitative Biology, Cold Spring Harbor, N.Y. (A. Chovnick, Biological Laboratory, Long Island Biological Assoc., Cold Spring Harbor)

6-10. International Conf. on Live Poliovirus Vaccines, Washington, D.C. (Secretariat, Pan American Health Organization/World Health Organization, 1501 New Hampshire Ave., NW, Washington 6, D.C.)

7-11. Microwave Tubes, intern. cong., Munich, Germany. (Nachrichtentechnische Gesellschaft im VDE (NTG), Frankfurt-am-Main, Osthafenplatz 6, Germany)

7-13. Dosimetry in Health Physics, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

7-15. Partial Differential Equations and Continuum Mechanics, intern. conf., Madison, Wis. (R. E. Langer, Mathematics Research Center, U.S. Army, Univ. of Wisconsin, Madison 6)

8-9. Selenium in Nutrition, conf., Ithaca, N.Y. (K. C. Beeson, U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, N.Y.)

8-10. Canadian Federation of Biological Societies (Canadian Physiological Soc., Pharmacological Soc. of Canada, Canadian Assoc. of Anatomists, Canadian Biochemical Soc.), 3rd annual, Winnipeg, Manitoba. (E. H. Bensley, Montreal General Hospital, 1650 Cedar Ave., Montreal 25, P.Q.)

8-11. National Soc. of Professional Engineers, annual, Boston, Mass. (P. H. Robbins, NSPE, 2029 K St., NW, Washington 6)

8-12. American College of Chest Physicians, Miami Beach, Fla. (M. Kornfeld, 112 E. Chestnut St., Chicago 11, Ill.)

9-10. American Geriatrics Soc., Miami Beach, Fla. (R. J. Kraemer, 2907 Post Rd., Warwick, R.I.)

9-11. Acoustical Soc. of America, Providence, R.I. (W. Waterfall, ASA, 335 E. 45 St., New York 17)

9-11. Endocrine Soc., Miami Beach, Fla. (H. H. Turner, 1200 N. Walker, Oklahoma City 3, Okla.)

9-11. National Speleological Soc., annual, Carlsbad, N.M. (G. W. Moore, U.S. Geological Survey, Menlo Park, Calif.)

9-12. American Medical Women's Assoc., Miami Beach, Fla. (Mrs. L. T. Majally, 1790 Broadway, New York 19, N.Y.)

9-12. American Rheumatism Assoc., annual, Hollywood-by-the-Sea, Fla. (F. E. Demartini, Presbyterian Hospital, 622 W. 168 St., New York 32)

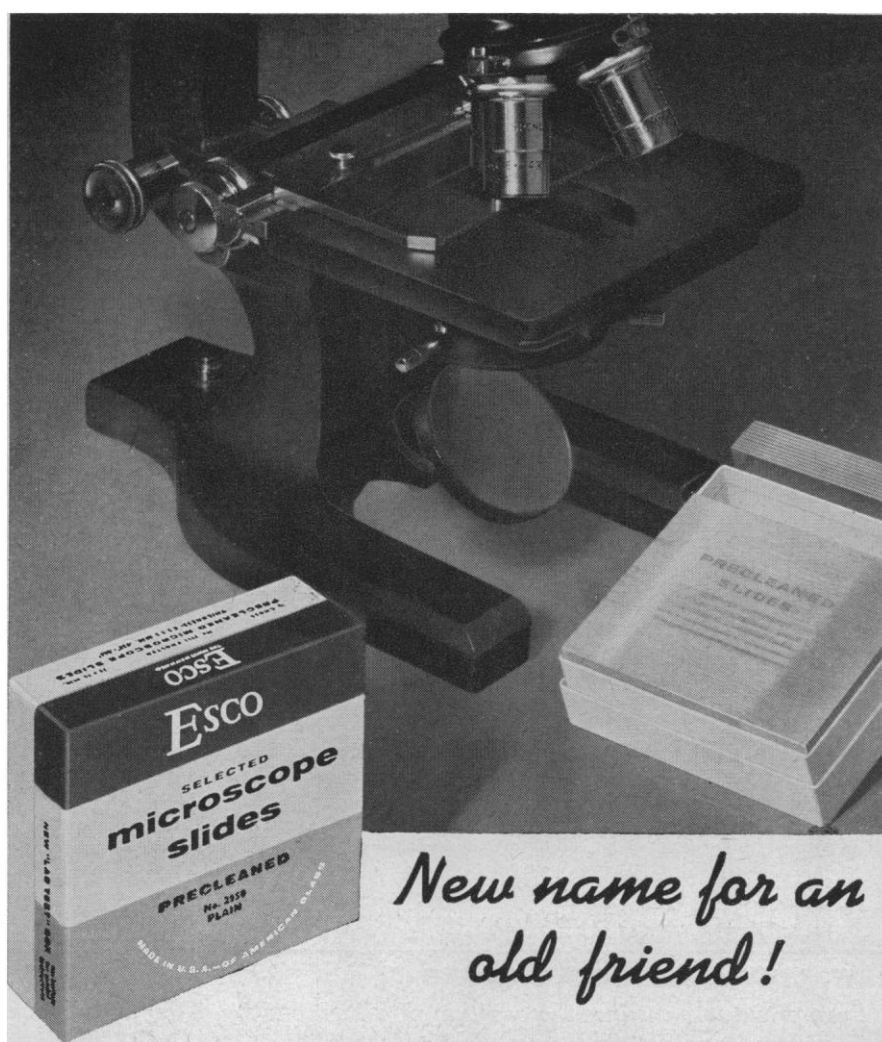
9-12. American Therapeutic Soc., Miami Beach, Fla. (O. B. Hunter, Jr., 915 19 St., NW, Washington 6)

10-12. American College of Angiology, Miami Beach, Fla. (A. Halpern, 11 Hampton Court, Great Neck, N.Y.)

10-12. American Electroencephalographic Soc., Boston, Mass. (G. A. Ulett, 1420 Gratten St., St. Louis 4, Mo.)

10-12. Society for Biological Psychiatry, Miami Beach, Fla. (G. N. Thompson, 2010 Wilshire Blvd., Los Angeles 57, Calif.)

11. American Acad. of Tuberculosis



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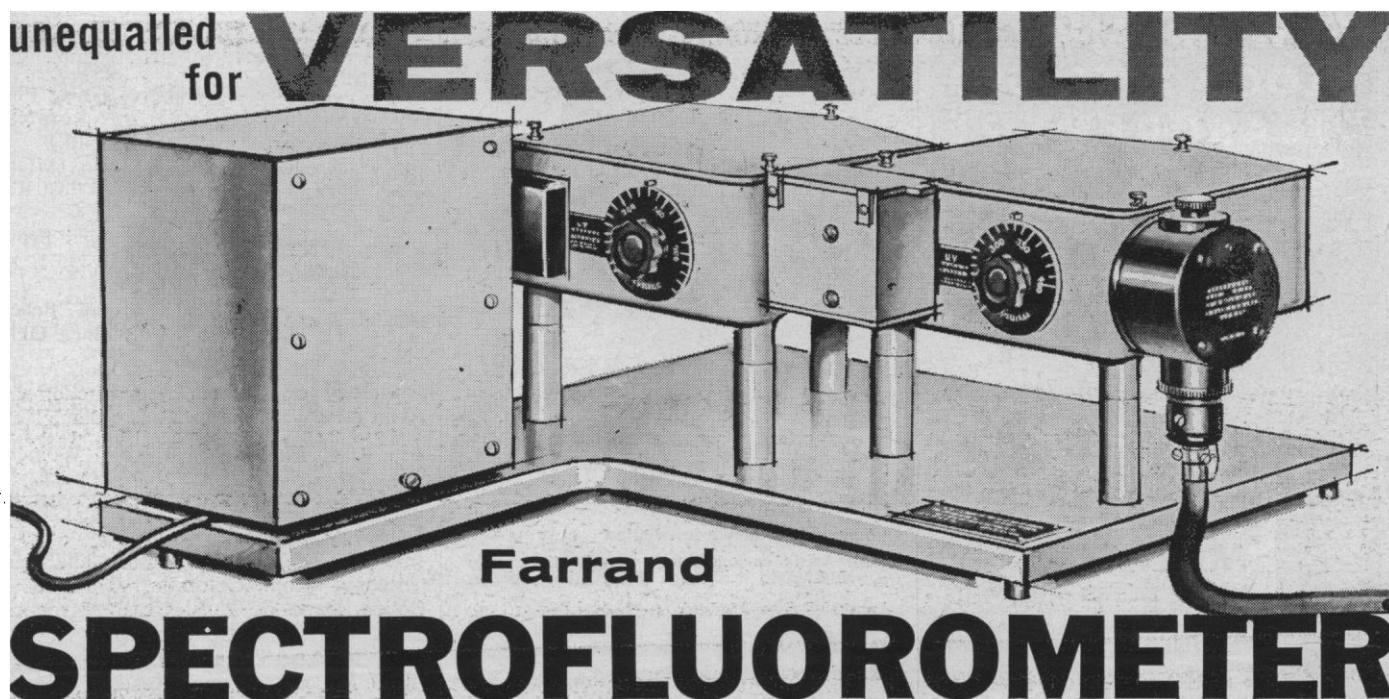
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Physicians, Miami Beach, Fla. (G. P. Bailey, P.O. Box 7011, Denver 6, Colo.)

11-12. American Diabetes Assoc., Miami Beach, Fla. (J. R. Connelly, 1 E. 45 St., New York 17)

11-16. American Soc. of X-ray Technicians, Cincinnati, Ohio. (G. J. Eilert, 16 Fourteenth St., Fond du Lac, Wis.)

12. Society for Vascular Surgery, Miami Beach, Fla. (G. H. Yeager, 314 Medical Arts Bldg., Baltimore 1, Md.)

12-15. American Soc. of Agricultural Engineers, Columbus, Ohio. (J. L. Butt, P.O. Box 229, St. Joseph, Mich.)

12-16. American Nuclear Soc., 6th annual, Chicago, Ill. (O. Du Temple, ANS, c/o John Crerar Library, 86 E. Randolph St., Chicago 1)

12-16. Cancer Research, 4th Canadian conf., Honey Harbour Ontario, Canada. (R. L. Noble, Collip Research Laboratory, Univ. of Western Ontario, London, Ontario, Canada)

12-17. Association for Research in Ophthalmology, Miami Beach, Fla. (L. V. Johnson, 10515 Carnegie Ave., Cleveland)

13-14. Technical Writing Improvement Soc., 5th Southern Calif. Industrial Writing Inst., Los Angeles, Calif. (J. L. Kent, TWIS, P.O. Box 5453, Pasadena, Calif.)

13-15. American Neurological Assoc., Boston, Mass. (M. D. Yohr, 710 W. 168 St., New York 32)

13-15. American Soc. of Heating, Refrigerating and Air-Conditioning Engineers, 67th annual, Vancouver, B.C. (E. R. Searles, ASHRAE Journal, 234 Fifth Ave., New York 1)

13-15. International Powder Metallurgy Conf., New York, N.Y. (K. H. Roll, Metal Powder Industries Federation, 60 E. 42 St., New York 17)

13-15. Microscopy, natl. symp., Chicago, Ill. (Walter C. McCrone Associates, 501 E. 32 St., Chicago 16)

13-15. Society for Investigative Dermatology, 21st annual, Miami Beach, Fla. (H. Beerman, SID, 255 S. 17 St., Philadelphia 3, Pa.)

13-17. American Medical Assoc., Miami Beach, Fla. (F. J. L. Blasingame, 535 N. Dearborn St., Chicago 10, Ill.)

13-17. Canadian Medical Assoc., 93rd annual, Banff, Alberta. (CMA, 244 George St., Toronto, Canada)

13-17. International Conf. of Physio-Pathology of Animal Reproduction and Artificial Insemination, Amsterdam, Netherlands. (J. Edward, Milk Marketing Board, Thames, Surrey, England)

13-17. International Cong. of Clinical Pathology, Madrid, Spain. (J. A. Garrido, Sandoval 7, Madrid)

13-17. Molecular Structure and Spectroscopy, symp., Columbus, Ohio. (R. A. Oetjen, Dept. of Physics and Astronomy, Ohio State Univ., Columbus 10)

13-18. AAAS Pacific Div., Eugene, Ore. (R. C. Miller, California Acad. of Sciences, Golden Gate Park, San Francisco 18)

13-2 Sept. Gordon Research Confs., Meriden and New London, N.H. (W. G. Parks, Univ. of Rhode Island, Kingston)

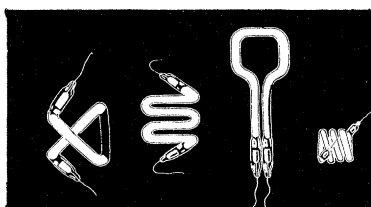
14-16. American Meteorological Soc., Eugene, Ore. (K. C. Spengler, AMS, 45 Beacon St., Boston 8, Mass.)

15-17. American Physical Soc., Montreal, Quebec, Canada. (K. Darrow, APS, Columbia Univ., 116 St. and Broadway, New York, N.Y.)

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15-17. Mechanisms of Peroxide Reactions, conf., Providence, R.I. (J. O. Edwards, Metcalf Research Laboratory, Brown Univ., Providence 12)

15-24. International Union for Conservation of Nature and Natural Resources, Warsaw and Cracow, Poland. (H. J. Coolidge, National Research Council, Washington 25, D.C.)

15-25. Large Electric Systems, intern. conf., Paris, France. (British National Committee, Thorncroft Manor, Dorking Rd., Leatherhead, Surrey, England)

15-29. Nuclear Congress and Exhibition on Electronics and Atomic Energy, 7th intern., Rome, Italy. (Secretariat, Rassegna Eletttronica, Nucleare e della Cinematografia, Via della Scrofa 14, Rome, Italy)

16-18. American Scientific Glassblowers Soc., 5th annual conf., Pittsburgh, Pa. (W. E. Barr, Gulf Research & Development Co., P.O. Box 2038, Pittsburgh 30)

16-18. Growth; Molecule, Cell, and Organism, intern. symp., Lafayette, Ind. (M. X. Zarrow, Dept. of Biological Sciences, Purdue Univ., Lafayette, Ind.)

17-19. American Soc. of Ichthyologists and Herpetologists, Chicago, Ill. (R. Conant, Philadelphia Zoological Garden, 34 St. and Girard Ave., Philadelphia 4)

19-22. American Inst. of Chemical Engineers, Mexico City, Mexico. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36)

19-22. American Soc. of Mammalogists, annual, Tacoma, Wash. (B. P. Glass, Dept. of Zoology, Oklahoma State Univ., Stillwater)

19-24. American Soc. of Medical Technologists, Atlantic City, N.J. (Miss M. C. Wethington, 4221 Ann St., Saginaw 3, Mich.)

19-25. American Library Assoc., Montreal, Canada. (D. H. Clift, ALA, 50 E. Huron St., Chicago 11, Ill.)

19-25. American Soc. of Civil Engineers, Reno, Nevada. (W. H. Wisely, 33 W. 39 St., New York 18)

20-22. Society for the Study of Development and Growth, 19th symp., Waltham, Mass. (L. Jaffe, Biology Dept., Brandeis Univ., Waltham 54)

20-23. Society for Applied Spectroscopy, 11th annual symp., Chicago, Ill. (H. Wilson, Continental Can Co., Inc., 7622 So. Racine Ave., Chicago 20)

20-24. American Soc. for Engineering Education, Lafayette, Ind. (W. L. Collins, Univ. of Illinois, Urbana, Ill.)

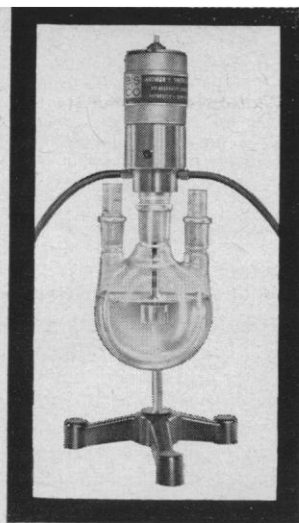
20-24. International Acad. of Pathology, London, England. (G. J. Cunningham, Royal College of Surgeons of England, London, W.C.2, England)

20-24. National Inventions Exhibition and Creativity Conf. (Cleveland Engineering Soc.), Cleveland, Ohio. (Cleveland Engineering Soc., 3100 Chester Ave., Cleveland 14)

20-26. Congress on Nuclear Energy, Rome, Italy, (Comitato Nazionale per le Ricerche Nucleari, Via Belisario 15, Rome, Italy)

20-1. Air Force Missile Development Center and Univ. of New Mexico, series of seminars, Cloudcroft, N.M. (J. R. Foote, P.O. Box 1053, Holloman AFB, N.M.)

22-24. Standards and Electronic Measurements, conf., Boulder, Colo. (J. F. Brockman, National Bureau of Standards, Boulder)



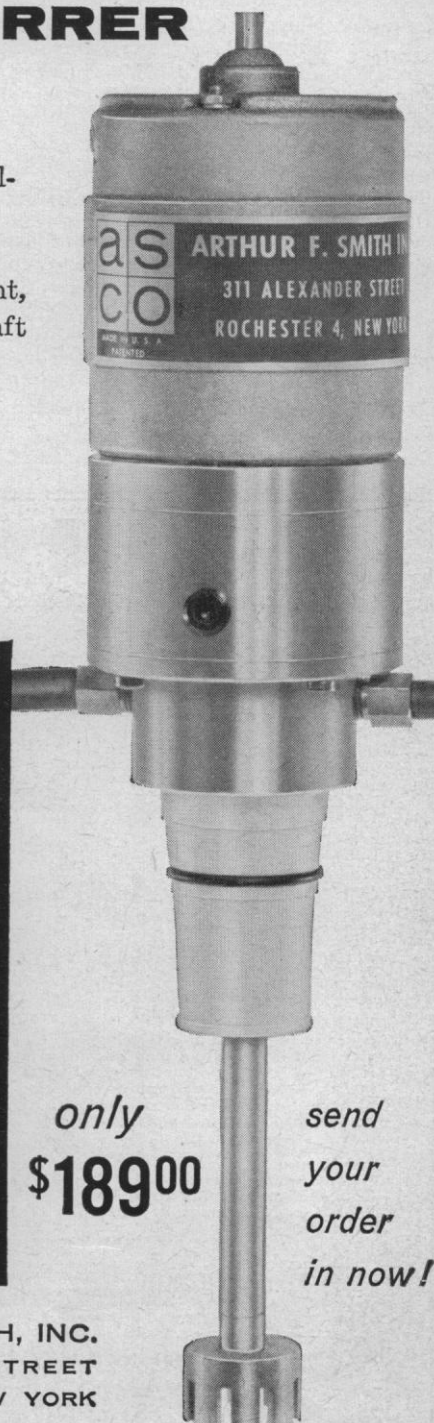
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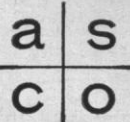
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22-25. Society of Nuclear Medicine, Estes Park, Colo. (T. P. Sears, V.A. Hospital, Denver 20, Colo.)

25-5. First Intern. Cong. on Automatic Control, Moscow, U.S.S.R. (R. Oldenburger, Mechanical Engineering Dept., Purdue Univ., Lafayette, Ind.)

26-1. American Physical Therapy Assoc., Pittsburgh, Pa. (Miss J. Bailey, 157 N. 79 St., Milwaukee 13, Wis.)

26-1. American Soc. for Testing Materials, Atlantic City, N.J. (R. J. Painter, 1916 Race St., Philadelphia 3, Pa.)

26-1. Mass Spectrometry, 8th annual, Atlantic City, N.J. (V. H. Dibeler, National Bureau of Standards, Washington 25)

26-1. National Education Assoc., Los Angeles, Calif. (W. G. Carr, 1201 16 St., NW, Washington 6)

26-2. American Physical Therapy Assoc., Pittsburgh, Pa. (Miss L. Blair, 1790 Broadway, New York 19)

27-29. Military Electronics, 4th natl. conv., Washington, D.C. (C. M. Crenshaw, Dept. of Army, Office of the Chief Signal Officer, R. & D. Division, SIGRD-2, Washington 25)

27-30. Institute of the Aeronautical Sciences, Los Angeles, Calif. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

27-30. National Assoc. of Power Engineers, annual conv., San Francisco, Calif. (E. J. Schuetz, NAPE, 176 W. Adams St., Chicago 3, Ill.)

27-1. International Assoc. for Bridge and Structural Engineering, 6th cong., Stockholm, Sweden. (P. Lardy, IABSE, Ecole Polytechnique Fédérale, Zurich, Switzerland)

New Products

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■ **TEMPERATURE CONTROLLER** is a multichannel instrument available in models for proportioning and on-off control with up to five control points on a single power supply chassis. Sensing elements of the resistance-wire or thermistor type are used. With addition of an anticipating section, control capability is said to be $\pm 0.25^\circ\text{F}$ with the proportional instruments and $\pm 0.5^\circ\text{F}$ with the on-off unit. (Electronic Processes Corporation of California, Dept. Sci485, 436 Bryant St., San Francisco 7, Calif.)

■ **PAPER-TAPE-TO-MAGNETIC-TAPE CONVERTER** makes possible direct conversion of paper tape to IBM 650 and 704 magnetic tape at 300 characters per second. The converter automatically generates the required magnetic tape format structure—longitudinal parity bits, record and file spaces, and end of file marks—without special tape codes. Facilities are included for paper-tape parity checks and format checking. (Gilliland-NRI, Dept. Sci478, 3124 E. 14 St., Oakland 1, Calif.)

■ **RECORDING SYSTEM** reads computer magnetic tapes and displays the corresponding characters on the face of a cathode-ray tube. A special camera continuously photographs the face of the tube to record a complete page on microfilm. Recording speed is 16,500 characters per second. Two frames per second are photographed with as many as 66 lines of 130 characters appearing as a page. A roll of 1000 ft of 16-mm film is said to be capable of recording the decoded information from more than 35 reels of 2400 ft of magnetic tape. (Recordak Corp., Dept. Sci474, 343 State St., Rochester, N.Y.)

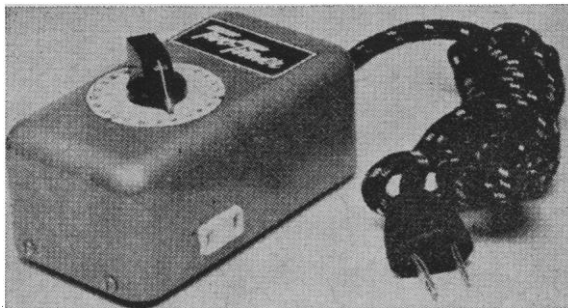
■ **OPTICAL DENTAL MONITOR** is a closed-circuit television system that projects an image of the patient's teeth on a television screen. The probe used in the mouth is attached to a flexible optical fiber bundle of $\frac{5}{8}$ in. outside diameter. Length of the cable is 3 ft, and percentage transmission is 20. The over-all magnification provided by the system is 32. Incident light intensity in the mouth is approximately 15 ft-ca. (Avco Corporation, Dept. Sci479, 201 Lowell St., Wilmington, Mass.)

■ **DIGITAL RECORDING SYSTEM** may be used for recording of data represented by electrical signals in the 0- to 10-mv range. The system will select sequentially up to 200 inputs and record each variable with three-digit point identification via a tape punch. Data are recorded in eight-channel codes suitable for conversion to punched cards. Cycle time per data point is 1 sec; maximum recording-cycle time is 15 min. System accuracy is said to be ± 0.5 percent

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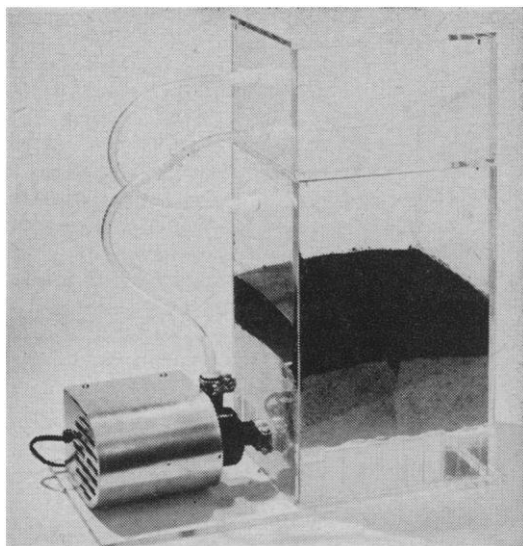
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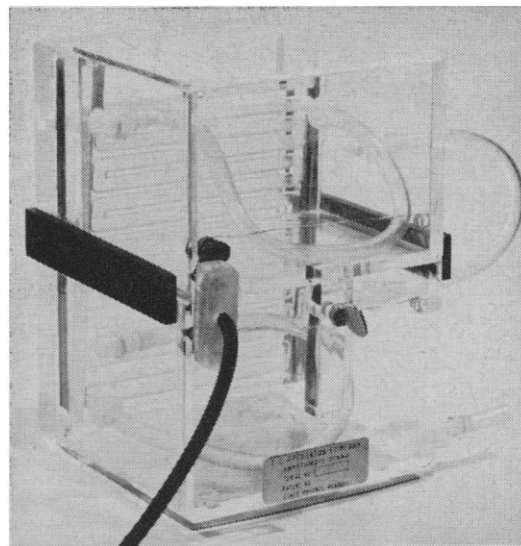
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of full scale. Data are also displayed digitally and recorded on a strip chart. (Dalex Corp., Dept. Sci466, 1307 So. Myrtle Ave., Monrovia, Calif.)

■ **RECORDER** carries a paper chart 30 by 20 cm on a flat bed that is driven past the pen carriage. Linear or logarithmic recording can be selected by switch; linear range is 0 to 10 mv, logarithmic range 0 to 200 mv. Full-scale response time is normally 0.7 sec. The chart is driven by a synchronous motor. (Unicam Instruments, Ltd., Dept. Sci502, Cambridge, England)

■ **ELECTROMICROMETER** is designed to measure displacement in the microinch range in extreme temperature and radiation environments. A variable-permeance transducer forming half of an inductive bridge is located at the measurement point. Inductive balance is varied by translation of a radiation-resistant slug attached to the test specimen. An identical transducer located externally, the other half of the bridge, is driven to null balance by a servo-system. The mechanical motion of the balancing slug is coupled to a digital indicator. Transducer temperature sen-

sitivity is 0.003 percent per degree at 1000°F. Accuracy of the system is said to be ± 0.1 percent. (Technical Industries Corp., Dept. Sci467, 389 N. Fair Oaks Ave., Pasadena, Calif.)

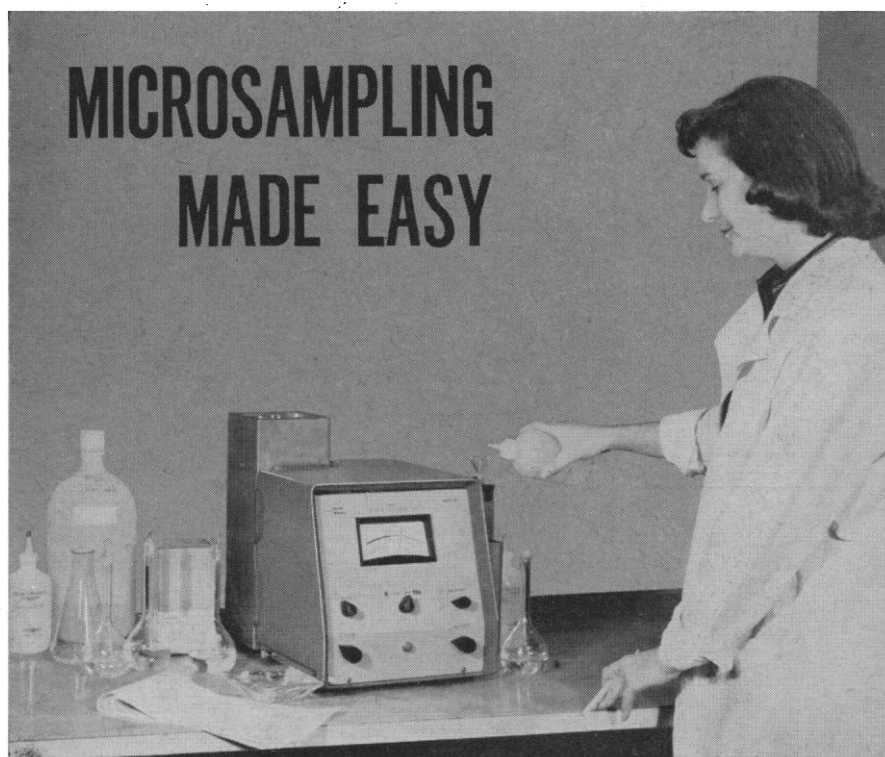
■ **NEUTRON DETECTOR MULTIPLIER PHOTOTUBE** is a 2-in. diameter, high-gain, ten-stage, end-window tube that can be used with standard multiplier-phototube circuitry. The neutron-sensitive coating, especially sensitive to thermal neutrons, is deposited on the inside surface of the tube window. A standard S-11 cathode is deposited, in turn, over the neutron-sensitive coating. Alpha particles and negative ions ejected upon neutron capture cause secondary electron emission from the cathode. (Allen B. DuMont Laboratories, Inc., Dept. Sci465, 750 Bloomfield Ave., Clifton, N.J.)

■ **VISCOSIMETER** is a recording, paddle-type instrument said to be completely linear. The instrument is available with 15 paddle designs for a variety of fluids. Paddles and sample containers are disposable. A stepless, variable-speed drive provides rotation rates from 20 to 200 rev/min. Tension-spring cartridges from 125 to 2000 cm gm are interchangeable. (C. W. Brabender Instruments Inc., Dept. Sci472, South Hackensack, N.J.)

■ **ELECTRON-BEAM MACHINING** permits holes and figures to be cut into such materials as tungsten, diamond, and Carboloy, as well as more common materials. Width of cut may be as small as 40 μ , with tolerance $\pm 5 \mu$. Dimensions of holes are programmed into the machine. Machining is accomplished by a beam of electrons accelerated by 25,000 to 110,000 volts. Heat-affected zone is said to extend only a few microns. (L. R. Industries Inc., Dept. Sci481, 50 MacQuesten Parkway South, Mount Vernon, N.Y.)

■ **GLASS CAPILLARY COILS** up to 300 ft long are being produced for use in gas chromatography. The coils are treated to resist abrasion and are heavily walled for mechanical strength. The outside diameter of the tubing is 1/16 in., the inside diameter can be either 0.01 or 0.02 in. Inside diameter of the coils is either 2 or 3 in. Lengths are 100, 200, or 300 ft. According to the manufacturer, the tubing will not deteriorate at temperatures up to 510°C. (Corning Glass Works, Dept. Sci514, Corning, N.Y.)

■ **AUTOMATIC SAMPLER** transfers samples automatically to and from the measurement cell of a spectrophotometer, polarimeter, refractometer, or other analytical instrument, or collects samples from a source such as a sample line or fractionator. Up to 144 samples



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may be collected in test tubes held on three removable racks. The samples are protected by ball caps that are removed and replaced when samples are withdrawn or collected. Samples are transferred in sequence from test tubes to an instrument cell and each sample is returned to its original test tube after measurement. (Applied Physics Corp., Dept. Sci491, 2724 S. Peck Rd., Monrovia, Calif.)

■ **FOUR-PI COUNTER** uses two hemispherical chambers with loop center-wire assemblies. Separate transistorized amplifier discriminators are provided for each hemisphere. An input selector permits choice of signal from either hemisphere, from both hemispheres simultaneously, or from a coincidence circuit counting simultaneous pulses only. Gas-flow control and leakproof, shatterproof bubbler are built in. Three inches of iron shielding are provided. Accuracy of ± 0.1 percent is claimed. (Nuclear Measurements Corp., Dept. Sci489, 2460 N. Arlington Ave., Indianapolis 18, Ind.)

■ **TEMPERATURE PROGRAMER** is designed to provide linearly increasing temperature of heating equipment to maintain constant temperature. Thirteen linear heating rates range from 0.8° to $44.3^\circ\text{C}/\text{min}$ over the temperature range 0° to 500°C . A limit mechanism can be preset to any upper temperature desired. The unit is adaptable to other temperature ranges to 1600°C . (F & M Scientific Corp., Dept. Sci486, 1202 Arnold Ave., New Castle, Del.)

■ **X-Y RECORDER** operates directly from a transducer, eliminating the need for an extra a-c converter. Accuracy is said to be better than ± 0.2 percent on d-c ranges. Input range is 7.5 mv to 150 volts on the x-axis and 5 mv to 100 volts on the y-axis. A built-in x-axis time base provides five steps from 7.5 to 750 sec. Pen speed is 20 in./sec for each axis. Accessories include a pull-through, tear-off, roll-chart transport. (F. L. Moseley Co., Dept. Sci488, 409 N. Fair Oaks Ave., Pasadena, Calif.)

■ **PULSE-HEIGHT ANALYZER** provides 256 analyzer channels with choice of 128- or 256-point analysis. The ferrite-core memory of the instrument stores up to 100,000 counts per channel. Integral linearity is said to be better than 0.5 percent of full scale and differential linearity better than 2 percent over the top 97 percent of range. Dead time includes 16 μsec storage time and addressing time of 0.5 μsec per channel. The analyzer accepts pulses with rise times from 0.2 to 2.0 μsec , directly from the multiplier-phototube anode. Analysis is terminated automatically



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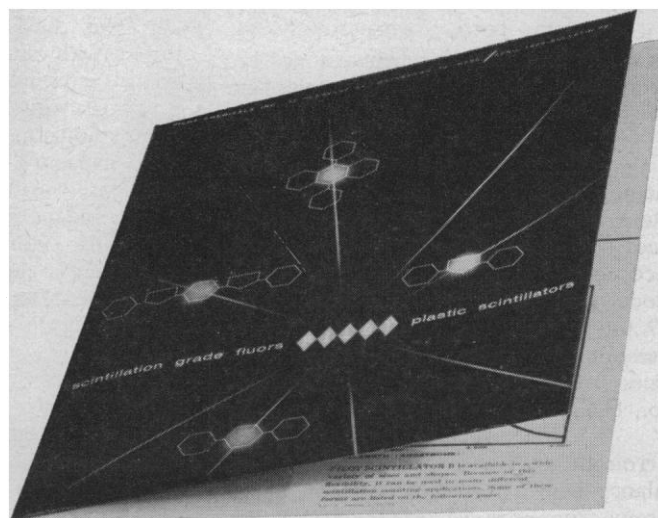
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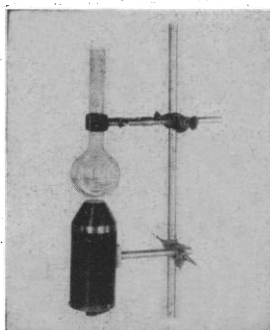
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after 1, 2, 4, 10, 20, 40, 100, 200, or 400 min, corrected automatically for dead-time effects. (Nuclear Data Inc., Dept. Sci506, 145 N. Washington St., Wheaton, Ill.)

■ **AIR PUMP** is capable of producing vacuum or clean dry air. Parts of the pump are assembled with ground surfaces so that seals and gaskets are unnecessary. No lubrication is used. Models are available in capacities from 3.9 to 32.3 ft³/min. Intake filters and pressure relief valves are available as accessories. (Conde Milking Machine Co., Dept. Sci487, Sherrill, N.Y.)

■ **TORQUE TESTER** is a dead-weight beam balance device for calibration of static torque from 3 in.-oz to 150 ft.-lb. The 24-in. beam, notched at 1-in. intervals, is pivoted on ball bearings. The device is designed for bench mounting. (Apco Mossberg Co., Dept. Sci490, 1008 Lamb St., Attleboro, Mass.)

■ **RADIATION-PYROMETER SYSTEM** measures temperature in ranges from 0° to 200°F up to 1100°F. In use, the pyrometer is sighted on the surface to be measured, and the output of its thermocouple is transferred to a recording instrument. The latter corrects for ambient temperature and records the corrected measurement. Adjustment is provided for emissivity of the surface being measured. (Bristol Co., Dept. Sci494, Waterbury 20, Conn.)

■ **ENVIRONMENTAL CHAMBERS** are designed to mount up to five units in a 19-in. rack providing preselected, individually controlled environments from -100° to +500°F. Test drawers are interchangeable, permitting rapid withdrawal of devices under test from one temperature extreme and insertion into another for thermal-shock test. Test volumes are 10 by 7 by 7 in. Temperature control accuracies of ±2°F and ±0.2°F are available. (Delta Design, Inc., Dept. Sci510, 3163 Adams Ave., San Diego 16, Calif.)

■ **METERING PUMP** for liquids or gases combines a vertically disposed hypodermic syringe with an electromagnetic linear stepping motor. The motor advances one step for each contact closure. Step size is adjustable from 0.0033 to 0.050 in. Reset is accomplished by manual relocation of the motor. The motor will respond at rates up to 60 steps per second for the smaller step sizes. An internal power source furnishes half-wave 60 cy/sec sine wave to advance the motor rapidly. A contactor provides an output signal suitable for counting. (Davis Scientific Instruments, Dept. Sci511, 12137 Cantura St., Studio City, Calif.)

■ **FRAMING CAMERA** is a portable instrument that uses image-converter-tube shutters with speed range 0.1 to 10 μ sec. A separate shutter tube and objective lens with independent form and aperture adjustment are used for each of four exposure channels. Four 50-mm f/1.4 lenses are used. Each channel has an independent delay adjustable from 1 to 1000 μ sec. Other shutter speed ranges can be supplied. (Abtronics, Inc., Dept. Sci498, 64 South P St., Livermore, Calif.)

■ **COLOR METER** permits control of color of regular or irregular patterns applied to a background of uniform color and only slight curvature. The sample, ranging from 5 to 11 in. in diameter, is placed inside a dark chamber and strongly illuminated. Reflected light is passed through a selectable green, amber, or blue filter, and through an aperture with an adjustable stop, to a photocell. The amplified photometric signal is compared with reference signals from comparison photocells. (Gardner Laboratory, Inc., Dept. Sci496, P.O. Box 5728, Bethesda 14, Md.)

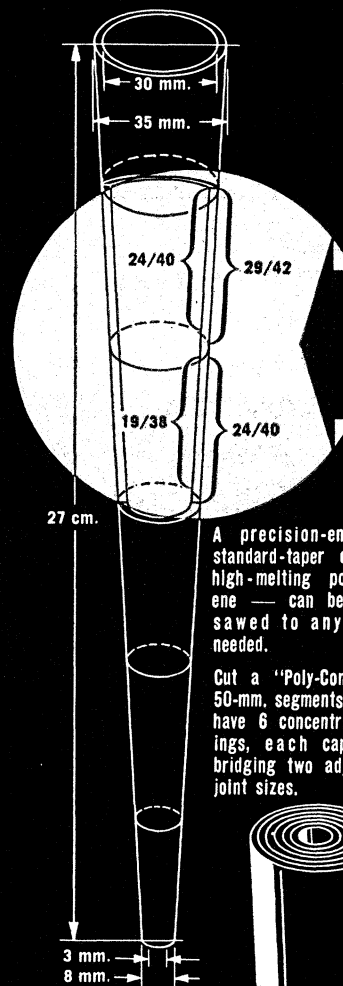
■ **pH ELECTROMETER** uses a vibrating capacitor followed by a four-stage amplifier, the gain of which is stabilized by feedback. Full-scale, direct-reading ranges of 0.1, 0.3, or 1.0 pH units can be applied anywhere over a standard calibrated range from 3 to 10 pH units that can be extended to 0 to 14. Accuracy is said to be ±0.002 pH when the buffer solution used to standardize the instrument is within 1 pH unit of the test solution and at the same temperature. Temperature compensation is manually adjustable in steps of 0.5°C from 15° to 40°C. (Milton Roy Co., Dept. Sci515, 1300 E. Mermaid Lane, Philadelphia 18, Pa.)

■ **CLINICAL GAS CHROMATOGRAPH** determines carbon dioxide, oxygen, and nitrogen in blood, serum, or respiratory gases with ±1 percent reproducibility for CO₂ in serum; ±1.5 percent for blood gases; and ±0.2 percent for respiratory gases. Total time for analysis is said to be 6 min. Sample size is 0.1 ml for blood or serum and 1 ml for respiratory gases. Blood and serum samples are treated in a reaction chamber with reagent chemicals similar to those used for Van Slyke analysis. Gases produced are flushed by helium gas. The reaction chamber holds enough chemicals for six to eight blood or serum samples. (Fisher Scientific Co., Dept. Sci507, 717 Forbes St., Pittsburgh 19, Pa.)

JOSHUA STERN

National Bureau of Standards,
Washington, D.C.

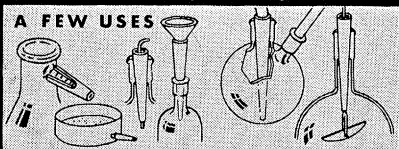
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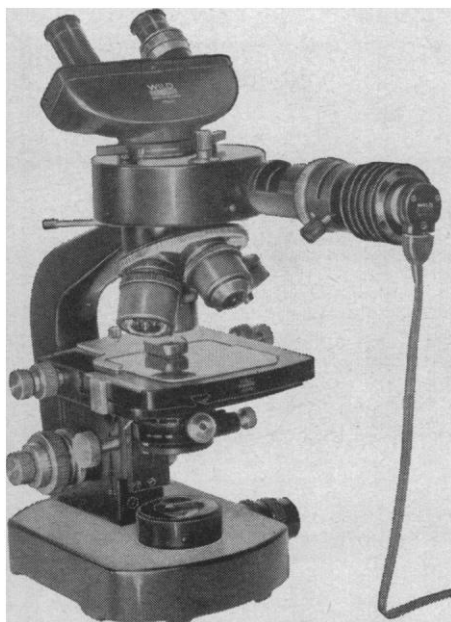
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Letters

Trajectory of Lunik III

Using available tracking data released by Tass, the General Electric Company has computed the trajectory of the Russian automatic interplanetary station (AIS), otherwise known as Lunik III, which obtained the first pictures of the far side of the moon.

The results showed that the 7th perigee passage of the vehicle occurred on 21 January at 12.87 hours (universal time) at a distance of 18,225 kilometers from the earth's center, and predicted entry into the earth's atmosphere on 8 March at 5.19 hours.

The U.S.S.R. had predicted 7th perigee passage on 22 January at 9.03 hours at a distance of 18,486 kilometers, and final entry into the earth's atmosphere late in March. Subsequent corrections to the initial conditions of the General Electric program were made to permit agreement with the 7th perigee time predicted by the U.S.S.R.; computations made on this basis show little change in the value for perigee distance. However, these computations place entry into earth's atmosphere in April or later.

The calculations are obviously very sensitive to initial conditions; this is due primarily to a second close approach to the moon (of about 50,000 kilometers), on 24 January. Additional tracking or sighting data are therefore needed to confirm, or permit corrections to be made in, the trajectory predictions if a meaningful entry watch is to be established. We would be pleased to receive such additional information and would undertake to rerun the computations and to advise both *Science* and others interested in the results.

J. E. MICHAELS

Space Sciences Laboratory,
General Electric Company,
Philadelphia, Pennsylvania

Evapotranspiration

It is surprising that no comments or criticisms have appeared in reference to the report by Holdridge [*Science* 130, 572 (4 Sept. 1959)] concerning a "Simple method for determining potential evapotranspiration from temperature data."

The formula

$$\text{Potential evapotranspiration (in mm)} = \left[58.93 \left(\frac{\text{Unit period of time}}{\text{No. of units of time in 1 yr}} \right) \right] \times \left[\text{Comparative plant growth mean temperature (}^{\circ}\text{C)} \right]$$

is not consistent with Holdridge's statement that "the potential evapotranspiration at a given temperature decreases proportionately along the gradient of increasing precipitation from arid to wet areas. . . ." It is difficult to see a theoretical basis for the formula.

Work by Penman [*Proc. Roy. Soc. (London)* A193, 120 (1948)], Thornthwaite [*Geograph. Rev.* 38, 55 (1948)], and Blaney-Criddle ["Water," *Yearbook Agr. (U.S. Dept. Agr.)* (1955)] indicate that such a formula, based on temperature alone, is of doubtful validity. Ramage [*Pacific Sci.* 13, 1 (1959)] found that both the Penman and Thornthwaite formulas gave values of potential evapotranspiration which were too high during the wet summer months at Hong Kong. Use of the Holdridge formula on the Hong Kong data shows the same tendency. In fact, values for potential evapotranspiration for Hong Kong for 1951-56 computed by the Holdridge formula are intermediate between those computed by the Penman and the Thornthwaite equations, respectively, and are considerably higher than observed values for an evapotranspiration battery.

Potential evapotranspiration is dependent upon a number of meteorological factors which fluctuate from day to day and from season to season, so that a formula based on temperature alone will be valid only under very restricted conditions of insulation, humidity, and wind.

TERRELL L. NOFFSINGER

Land Study Bureau,
University of Hawaii, Honolulu

Regarding the comments of Noffsinger, which I appreciate because they offer me an opportunity to clarify certain points in my report in *Science*, the following discussion is submitted.

Noffsinger's first paragraph looks convincing only because he has misquoted from my report, using in his letter "the potential evapotranspiration at a given temperature decreases. . . ." rather than, as appeared in the article, "the potential evapotranspiration rate at a given temperature decreases. . . ." Naturally, potential evapotranspiration is quite distinct from the potential evapotranspiration rate, which is equal to the mean potential evapotranspiration in millimeters per year divided by the mean precipitation in millimeters per year.

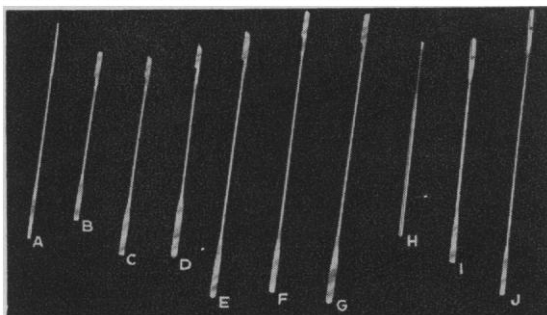
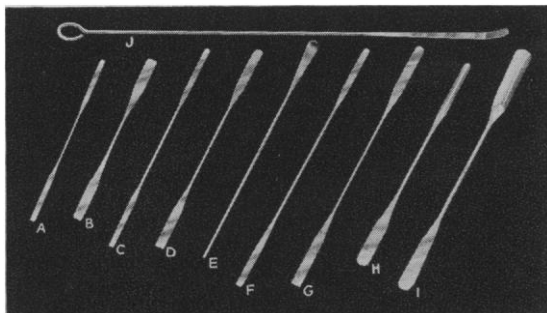
As for his statements on temperature, my formula uses the comparative plant growth mean temperature, preferably called "mean biotemperature," which discards temperatures below 0°C. The mean biotemperature is derived by summing up the positive time-unit means of temperature and dividing this total by the number of time units in the period. The workers cited, who found

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D	One square—One rounded	125	x 5
E	One rounded, bent—One handle	130	x 6
F	One rounded—One square	150	x 3
G	One rounded—One square	150	x 5
H	One shovel type—One rounded	130	x 4(1)
I	One shovel type—One rounded	150	x 8(2)
J	One rounded, bent—One ring handle	240	x 5

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(2) Shovel is 8mm. wide by 4mm. deep—rounded spatula end is 7mm. wide.

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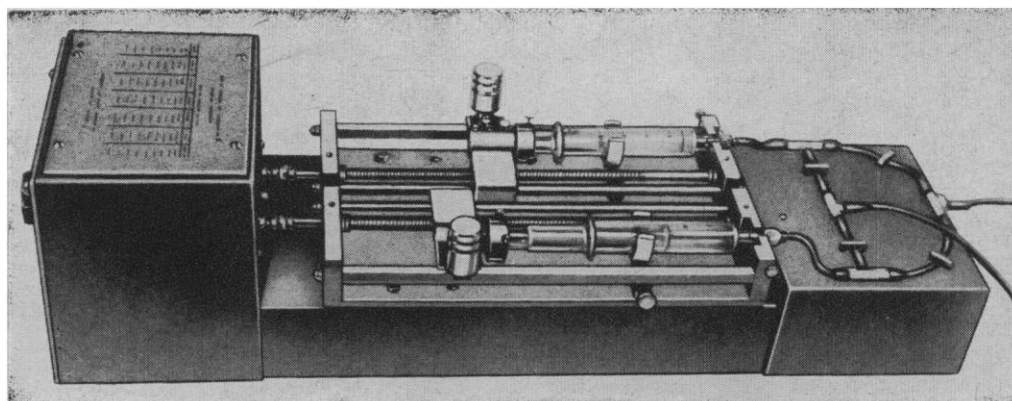
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values based on temperature alone to be of doubtful validity, presumably utilized normal mean period temperatures, which may include below-zero temperatures, when plants are inactive. Plant activity or growth is the same at -5° , -20° , or -40°C , so the inclusion of such data in means obscures the marked differences in plant activity that occur at even less widely separately positive temperatures.

My potential evapotranspiration values should be higher than the observed values for an evapotranspiration battery in moist-to-wet climates, since the former apply to natural, mature vegetation and not to the low, artificially established vegetation of the latter. Contrarily, one would expect my values to be lower than battery values in arid or drier climates, provided the battery is set up with a moist-climate vegetation such as the commonly utilized Kentucky blue grass.

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L. R. HOLDRIDGE

*Technical Cooperation Program,
Organization of American States,
San Jose, Costa Rica*

Intragalactic Communication

The "Next question" proposed in the 25 December editorial [*Science* 130, 1733 (1959)]: "May not other civilizations [on other planets] . . . be waiting in silence [due to restraints imposed by local fiscal authorities] for our signal before they give their response [and are we to await approval from our own fiscal authorities before beaming signals into space, the mutual wait yielding an impasse]?" is indeed thought-provoking.

In addition to financial considerations there may be other factors responsible for man's not having been contacted by other beings. It has taken the earth some $4\frac{1}{2}$ billion years to cool and evolve life to the point where radio astronomy could be developed. For man to suppose that planet X has arrived technologically in the same decade (10 years compared with 4.5×10^9) smacks of egocentricity and lack of perspective. More probably the galaxy contains planets varying widely

LOW-LEVEL IRRADIATION

Editor: Austin M. Brues

A symposium organized by the AAAS Section on Zoological Sciences, cosponsored by the U.S. Atomic Energy Commission and the Division of Biological and Medical Research of the Argonne National Laboratory.

Public debate on global fallout has been acrimonious because scientific facts about radiation and human implications regarding nuclear warfare have become confused. Scientists have consequently been thought guilty of ignorance or of partisanship. The Symposium on Low-Level Irradiation deals in a considered way with the many points of view that have brought this about, and indicates possible solutions.

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in mass and temperature, with a resultant wide distribution of cooling times, onsets of life, and technological advances on the part of the intelligent beings that have evolved. This is to say that many thousands of years may separate the evolution of planets X and Y to the point of intragalactic communication. It follows that with this sort of "arrival spectrum" a given planet cannot afford to send signals throughout the centuries toward planets in a less advanced stage of development.

It may well be that in the older, cooler planets—located, in general, in the outer fringes of the galaxy—intelligent beings "arrived" technologically many thousands of years ago; in that case, the logical thing for them to do would be to wait for developing societies (like that of Earth) to signal *them*, once the new civilizations have "arrived."

In short, the rule for initiating intragalactic communication could well be: Let the innermost (relative to the center of the galaxy), and supposedly youngest, planet, send signals toward the outermost.

Thus it may well be up to Earth to make itself known by beaming signals of high intensity in narrow bands toward the outer stars in the galaxy. The time and cost involved is the price man must pay for being a curious and sociable being!

WILLIAM S. JARNAGIN
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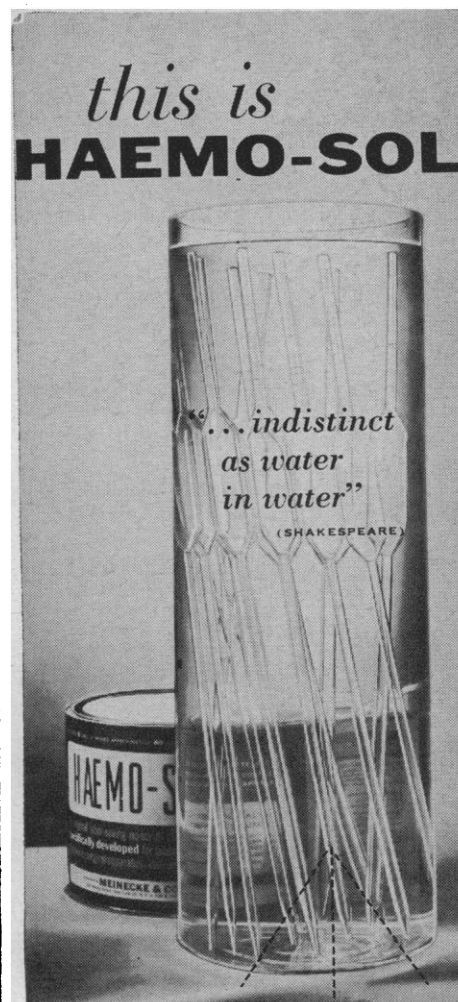
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KATHARINE O'BRIEN
Portland, Maine

Olfactory Discrimination

Michelsen recently reported in *Science* [130, 630 (1959)] some interesting work from the Harvard Psychological Laboratory on olfactory discrimination in the pigeon. The general findings as summarized in the abstract were as follows: "A discrimination, based on olfactory stimuli, was established in two pigeons by an operant conditioning procedure. Results from control sessions demonstrate that the discrimination can be attributed only to the presence or absence of olfactory stimuli." I was pleased to learn of these findings since they made more tenable the hypothesis



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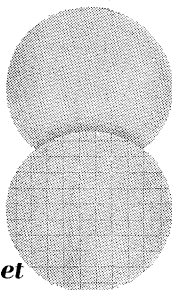
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advanced in a previous publication [A. D. Calvin, C. M. Williams, N. Westmoreland, *Am. J. Physiol.* **188**, 255 (1957)] that olfactory cues could be a supplemental aid in homing.

Michelsen has shown a great deal of ingenuity, working in a very difficult area; however, there are some aspects of the investigation as presented in *Science* which should be brought to the reader's attention.

One apparent weakness in the experimental design is in the control conditions. According to the article, during the control sessions the training schedule was so devised as to destroy the discrimination, and thus make the control sessions meaningless. In a personal communication Michelsen informed me that this implication was due to a clerical error and that actually the key numbers given in the paragraph on control conditions should be altered in such a fashion as to make the control sessions adequate in terms of the previous experimental procedure.

The second disturbing aspect of the study is not so easily remedied. It relates to the way the "olfactory" discrimination was established. Training was begun with sec-butyl acetate, which as Michelsen noted, is a trigeminal nerve irritant. After a discrimination was established, isooctane was substituted—this is an odorant with "minimal irritating effects"—and the discrimination did not break down. Aside from speculation as to what possible physiological changes might have taken place in the organism during the training sessions with sec-butyl acetate, it is apparent that while the study did demonstrate that a discrimination based on a trigeminal nerve irritant such as sec-butyl acetate could be maintained when a "minimally irritating" substance such as isooctane is substituted, this does not answer the more basic question as to whether an "ordinary" bird (one not given discrimination training with a trigeminal nerve irritant) could learn to make an olfactory discrimination.

It should be pointed out that Michelsen did not claim that his data answered this question, but no mention of this restriction is made, and an affirmative answer is certainly implied in the summarizing statement quoted above. In his letter to me, Michelsen acknowledged that he had no data to answer the question of whether an olfactory discrimination could be established in a pigeon without the preliminary use of a trigeminal nerve irritant. Work had been planned to answer this question, but due to technical difficulties and time problems, it was not carried out.

Michelsen in our correspondence noted that some operative work on the subjects had been done which had not

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been reported in the *Science* article. He cut the olfactory nerves of the pigeons and found that the olfactory discrimination disappeared. In addition, tests on one bird were rerun, with sec-butyl acetate as the stimulus, and in this case the discrimination immediately returned to its postoperative level. A number of different implications can be drawn from this finding, but space precludes a discussion of them here. It seems to me, however, that the results point to the likelihood that under the conditions of Michelsen's tests an olfactory discrimination could *not* be established with an "ordinary" bird that had not previously been exposed to a trigeminal nerve irritant. Of course, this question can only be resolved by a direct experimental attack on the problem.

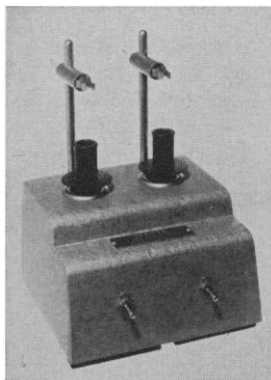
As Michelsen has stressed, much of the earlier work in this area was very poorly conducted, and it is difficult to draw valid conclusions from these studies. To sum up the present state of affairs, there has not been a single laboratory experiment which conclusively demonstrates the existence of precise olfactory discrimination in "ordinary" birds. This obviously does not mean that birds cannot make such a discrimination, and I personally believe they can, but we must have additional laboratory findings before we reject the null hypothesis. Perhaps Michelsen's study will provide the necessary spur for such investigations.

ALLEN CALVIN

Hollins College, Roanoke, Virginia

I would like to thank Calvin for pointing out the serious error that appeared in my earlier paper on olfactory discrimination in the pigeon. However, the remainder of the comment suggests no valid reason for altering the conclusion that pigeons are capable of olfactory discrimination.

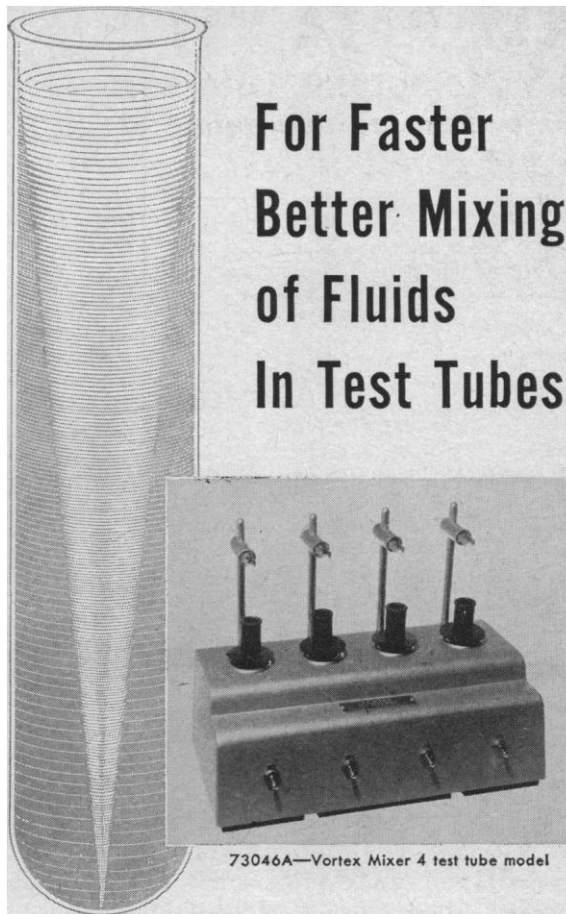
In describing the control procedure (p. 631), the article states, "seven pecks by bird No. 264 on key No. 2 produced the food reward. For bird No. 263, both saturators were filled with isooctane. When air passed through the saturator that formerly contained distilled water, seven pecks on key No. 1 produced the food reward." Due to a clerical error, the key numbers in this paragraph were incorrectly placed. The paragraph should read: "seven pecks by bird No. 264 on key No. 1 produced the food reward. For bird No. 263, both saturators in the delivery system were filled with isooctane. When air was passed through the saturator that formerly contained distilled water, seven pecks on key No. 2 produced the food reward." With this correction, the order of events in the study becomes clear. The birds demonstrated



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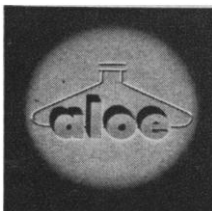
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behavior that was presumably due to the presence or absence of olfactory stimuli. The control procedure provided evidence that the birds were responding differentially *only* to the presence or absence of an odor.

Calvin's only objection to the study is that the birds learned to make a discrimination based on a trigeminal nerve stimulant prior to learning to discriminate an olfactory stimulus. The use of this procedure, Calvin believes, has made these birds different somehow from "ordinary" birds. Two possible implications stem from this belief. The first is that birds are never exposed to vapors that stimulate the trigeminal nerve in their normal environment. This seems a most unreasonable assumption. The second possibility is that the use of sec-butyl acetate, by some unknown mechanism, created in both of these birds the ability to smell. This hypothesis has far-reaching consequences and should be subjected immediately to experimental verification.

Many studies have ended with evidence that birds are not able to smell. One difficulty with many of these studies is that no evidence was presented that the experimental techniques and odor-control systems were adequate for demonstrating a discrimination based on a vaporous substance, even if the birds under investigation could smell.

In the study under examination I first demonstrated that the apparatus and procedure used were adequate for establishing a discrimination based on a vaporous substance. This vapor, sec-butyl acetate, stimulates the trigeminal nerves and therefore could be used without the assumption that any function of the olfactory nerves was involved. After establishing the procedure as a valid one for studying the problem at hand, I began the second part of the experiment, using isooctane. At this point in the experiment it would have been justifiable to state that the pigeons could not smell isooctane, if negative results had been observed. If the initial training had not been carried out, such a conclusion would have been unwarranted.

I have made some additional studies with these two pigeons since the article in question was written (W. J. Michelsen, in preparation). After the conclusion of the last part of the study reported in *Science*, the olfactory nerves of both birds were severed. Neither bird was able to discriminate isooctane postoperatively. Sec-butyl acetate was reintroduced as the stimulus with one bird postoperatively, and this discrimination was readily learned. Post-mortem examination of the brains of these birds revealed that the trigeminal

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