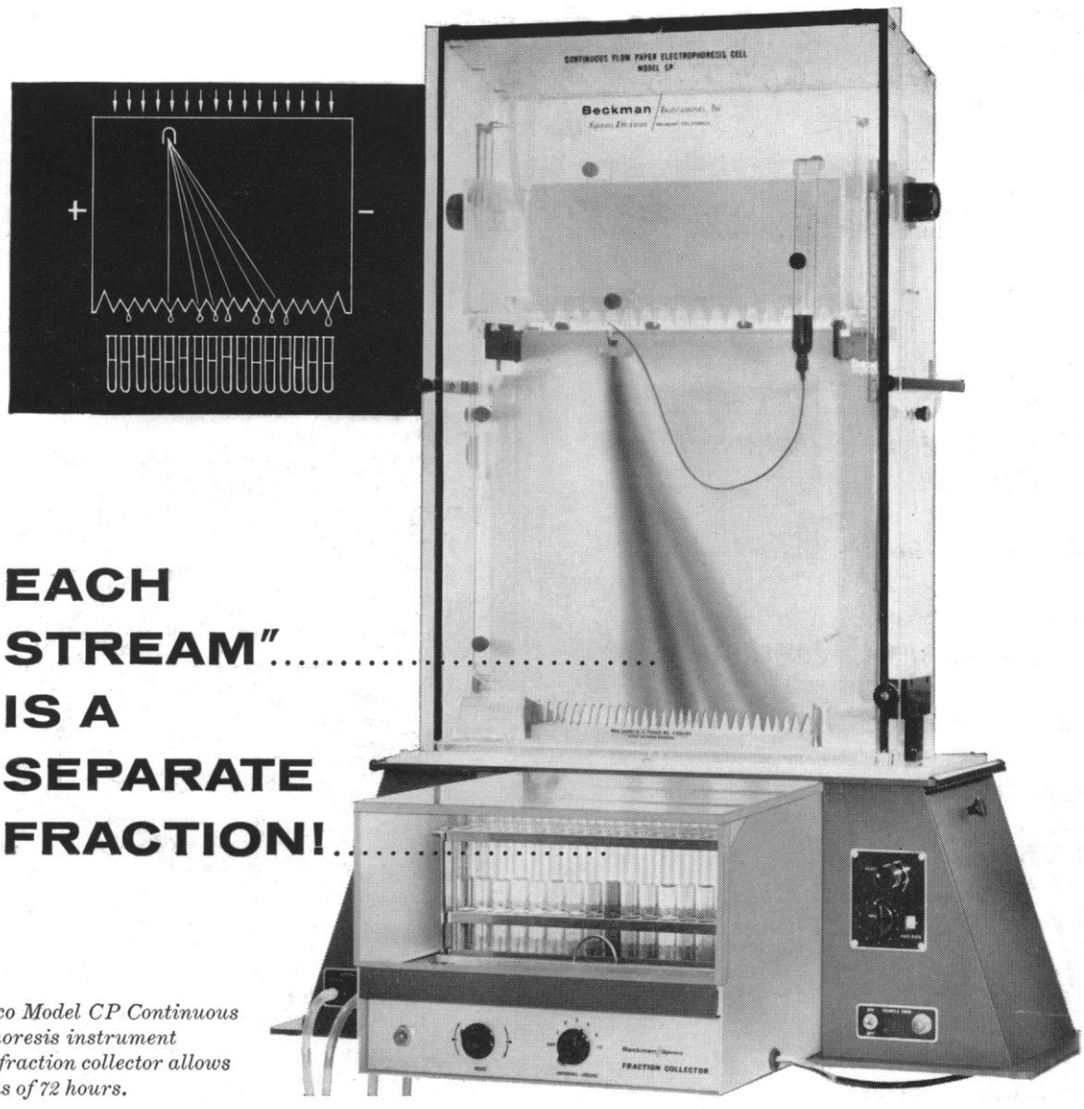
SCIENCE

22 April 1960

Vol. 131, No. 3408

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Annual Book Issue



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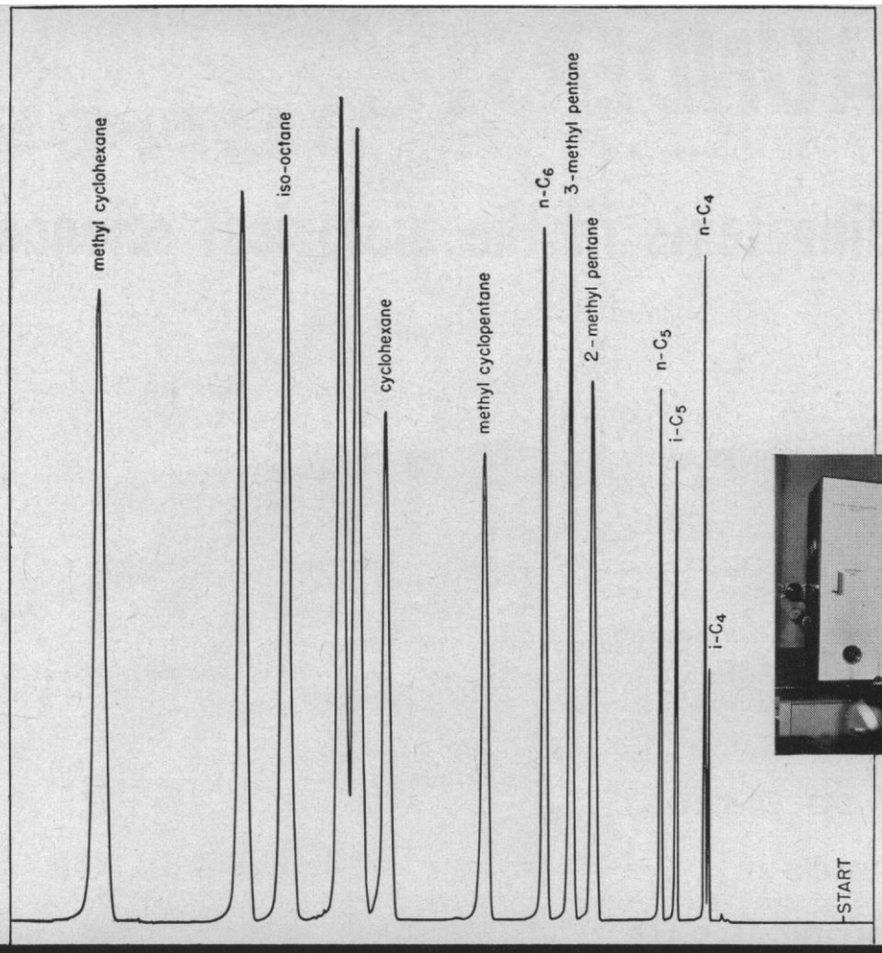

This chromatogram was run on a Model 154-D Vapor Fractometer, utilizing a 150′ squalane "U" Golay* column. Detector was of the flame ionization type. The chromatogram displays high-efficiency separation of a number of C_4-C_6 saturated hydrocarbons.

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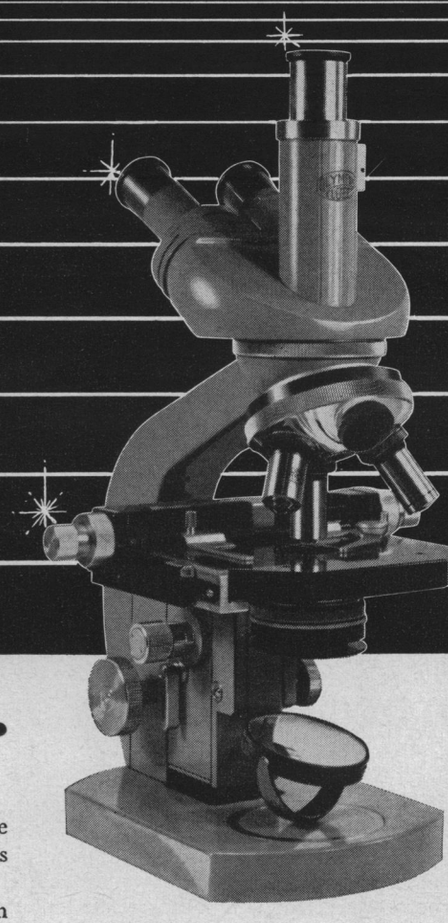

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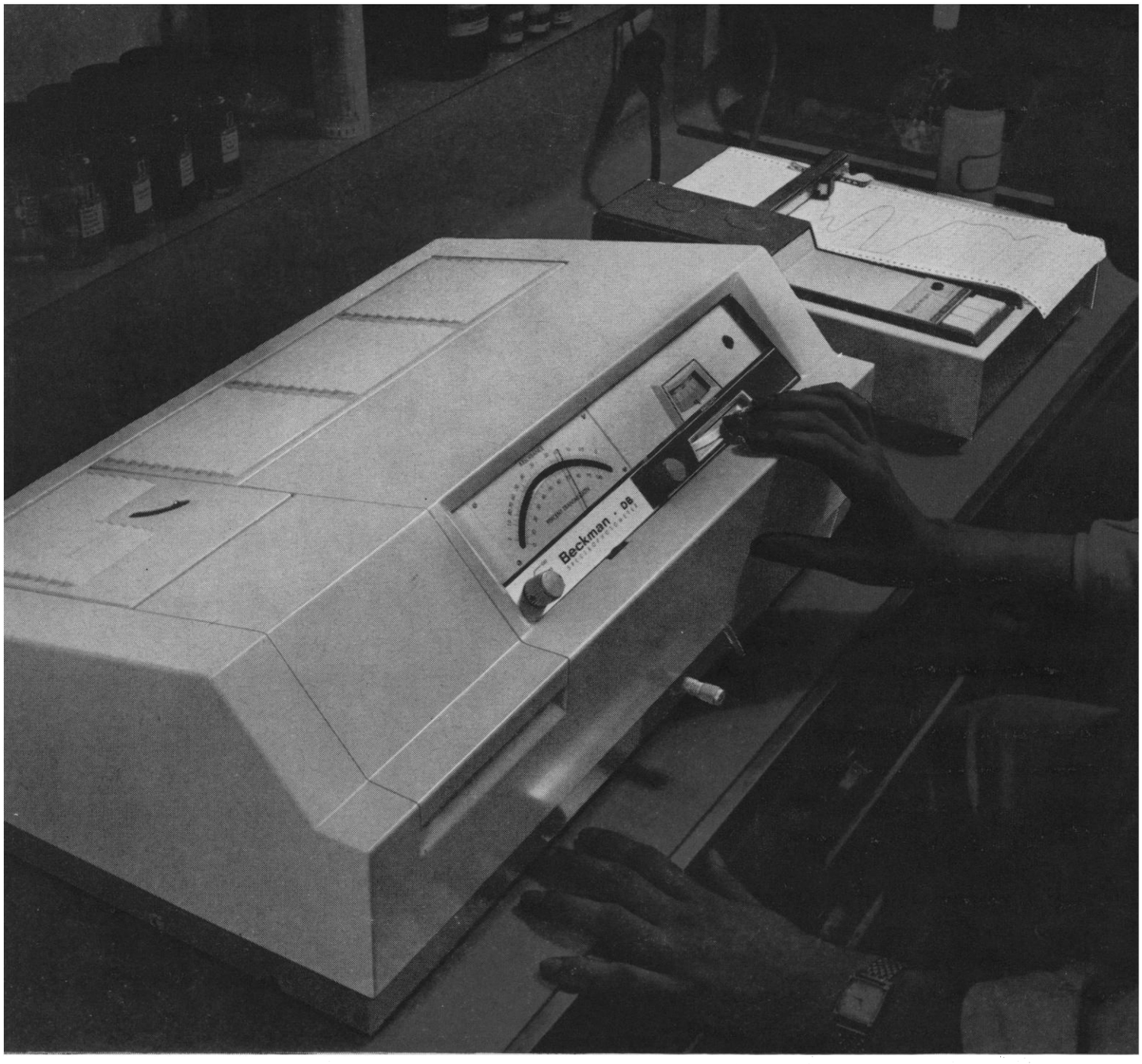

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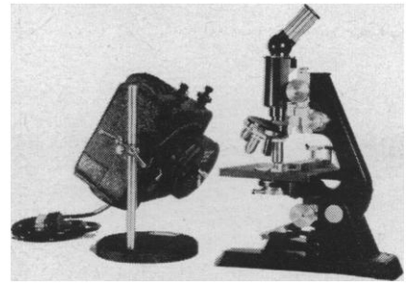

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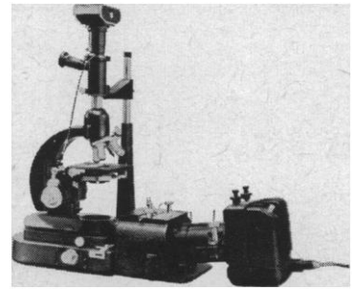

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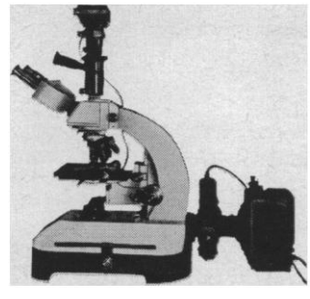

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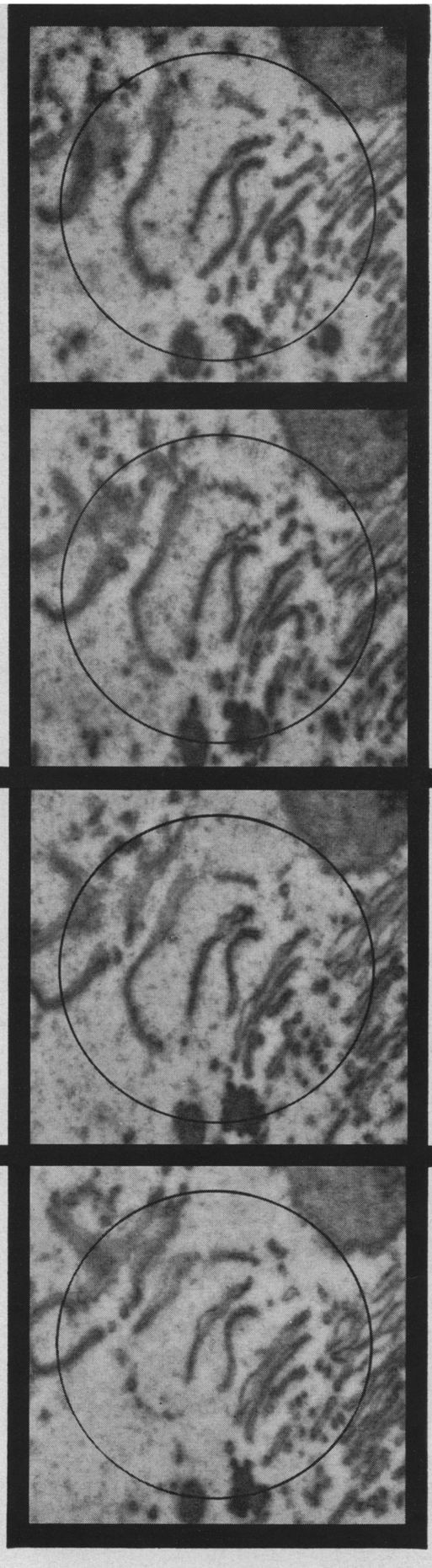

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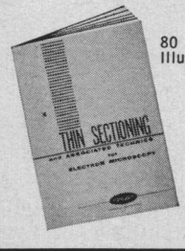

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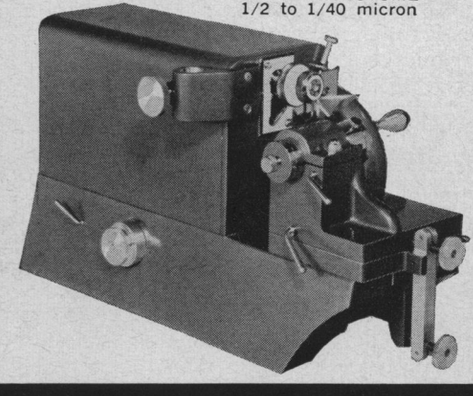

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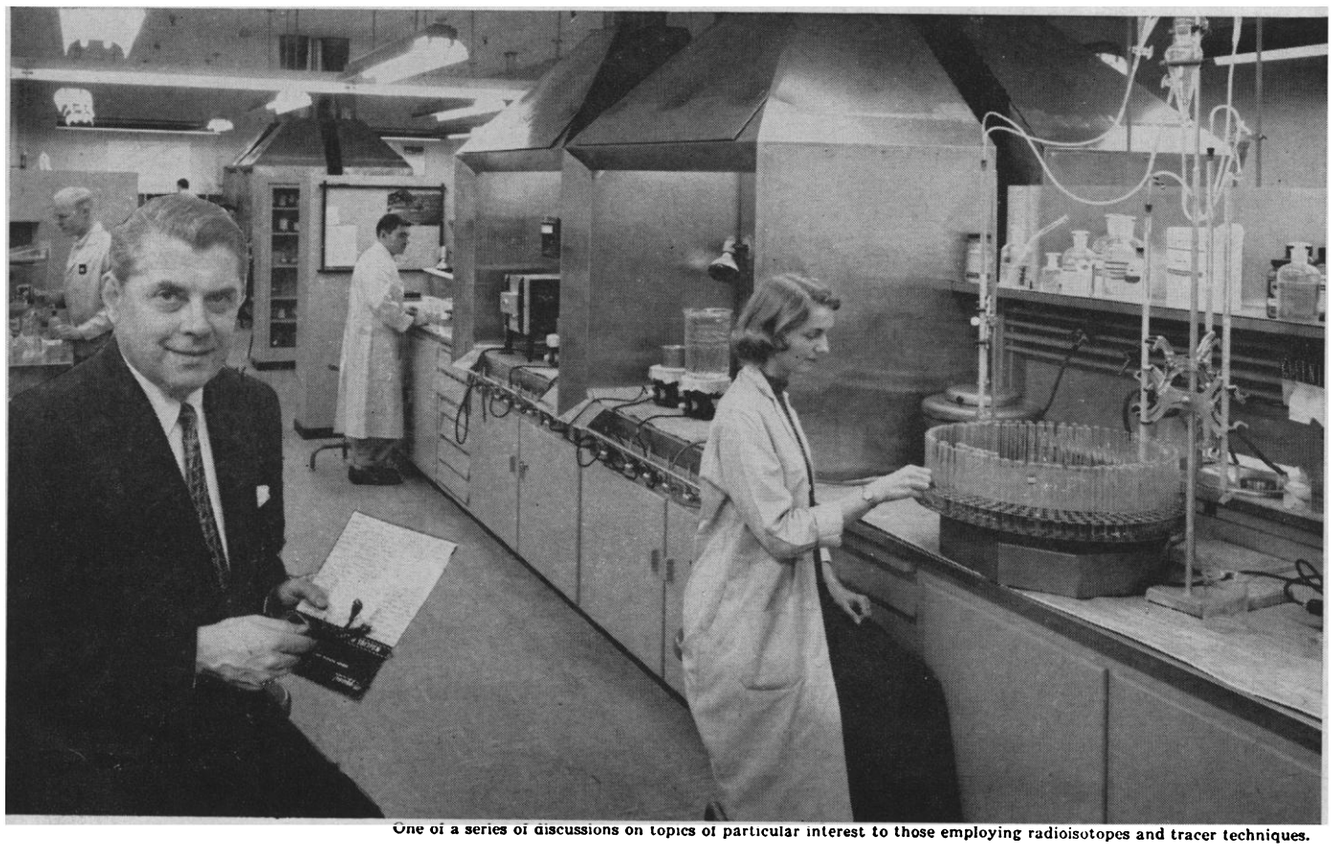

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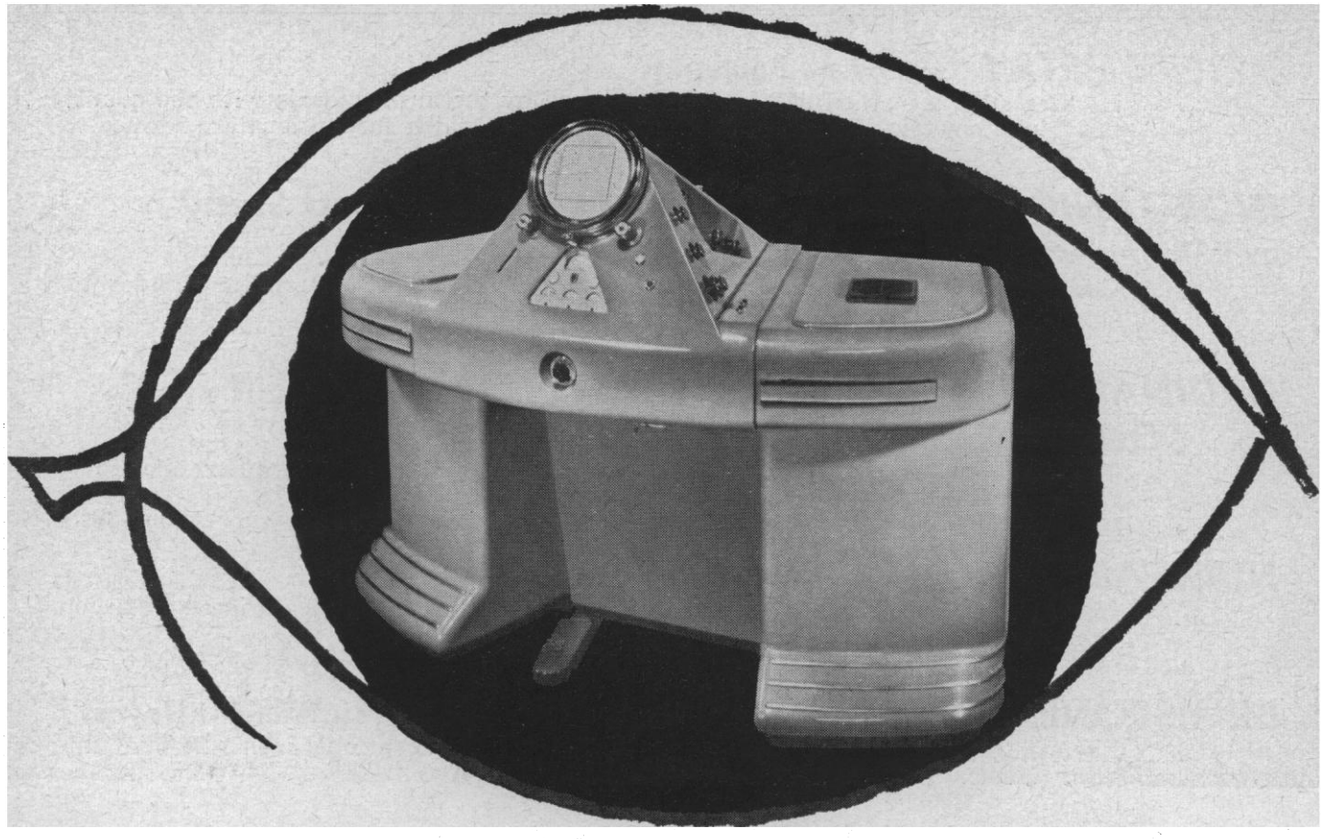

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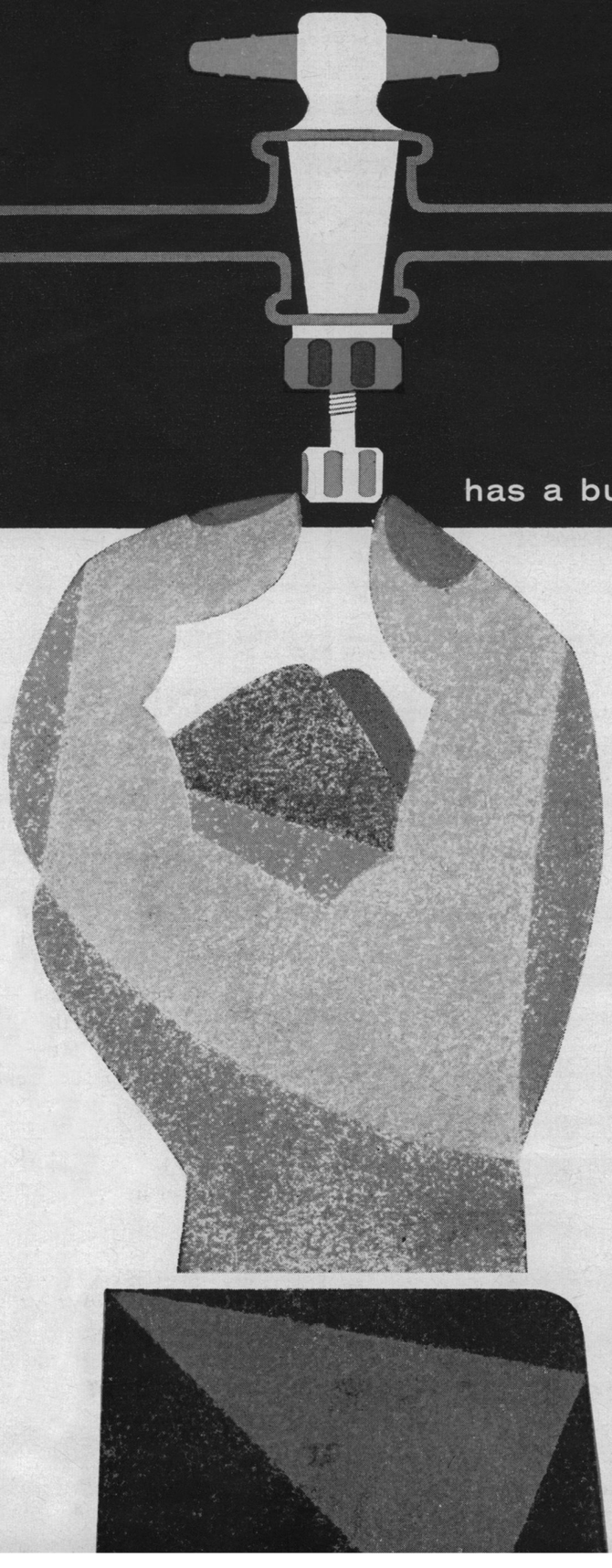

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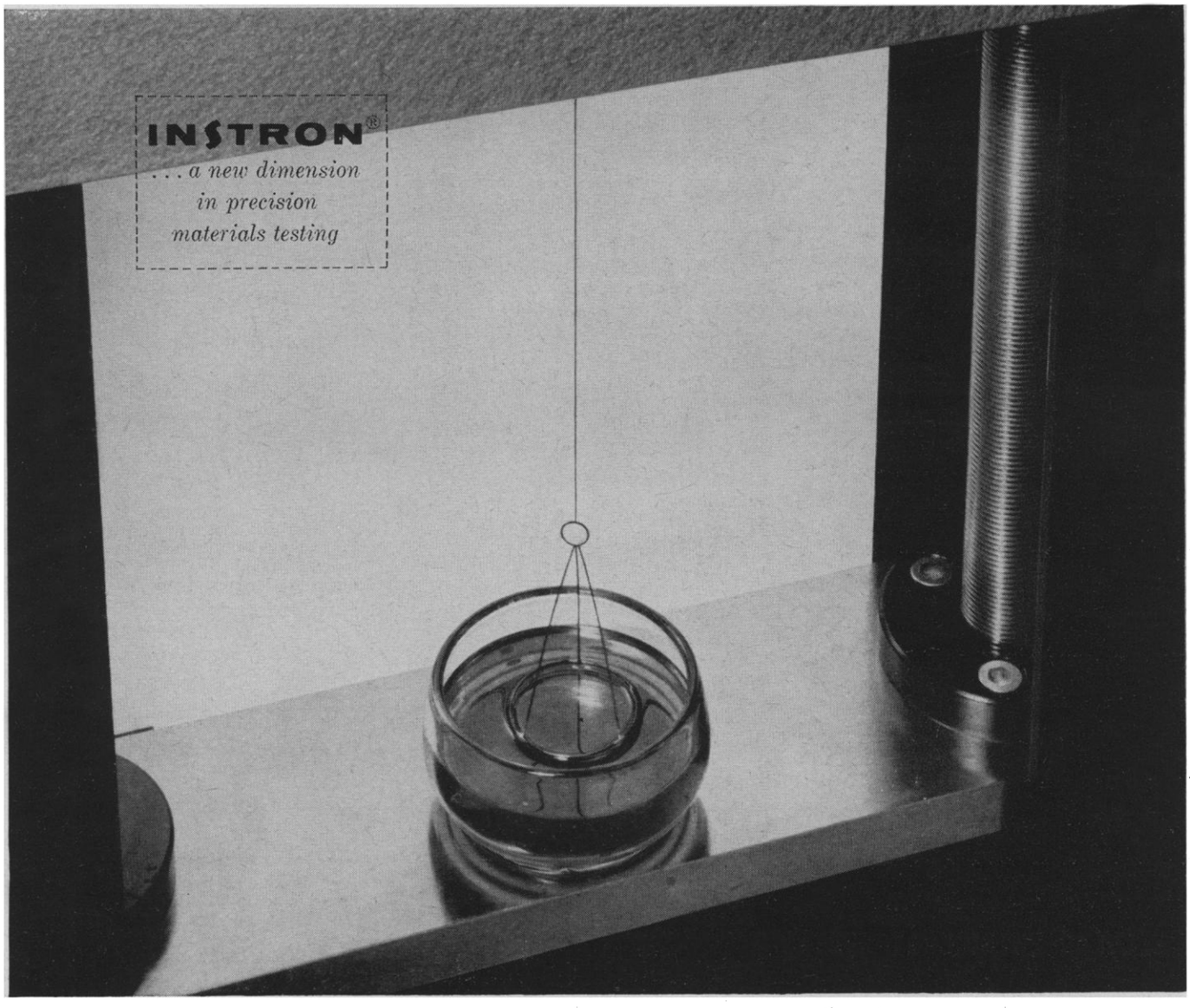

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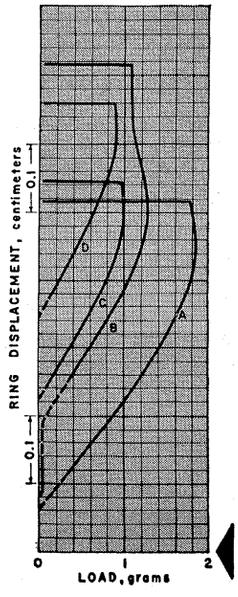

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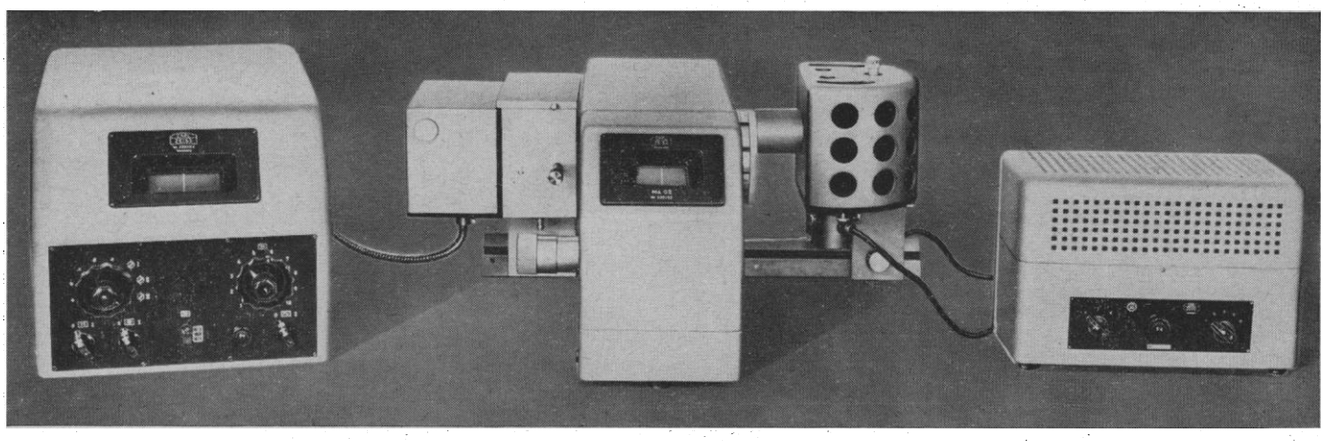

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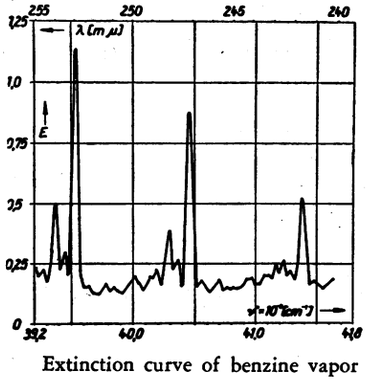

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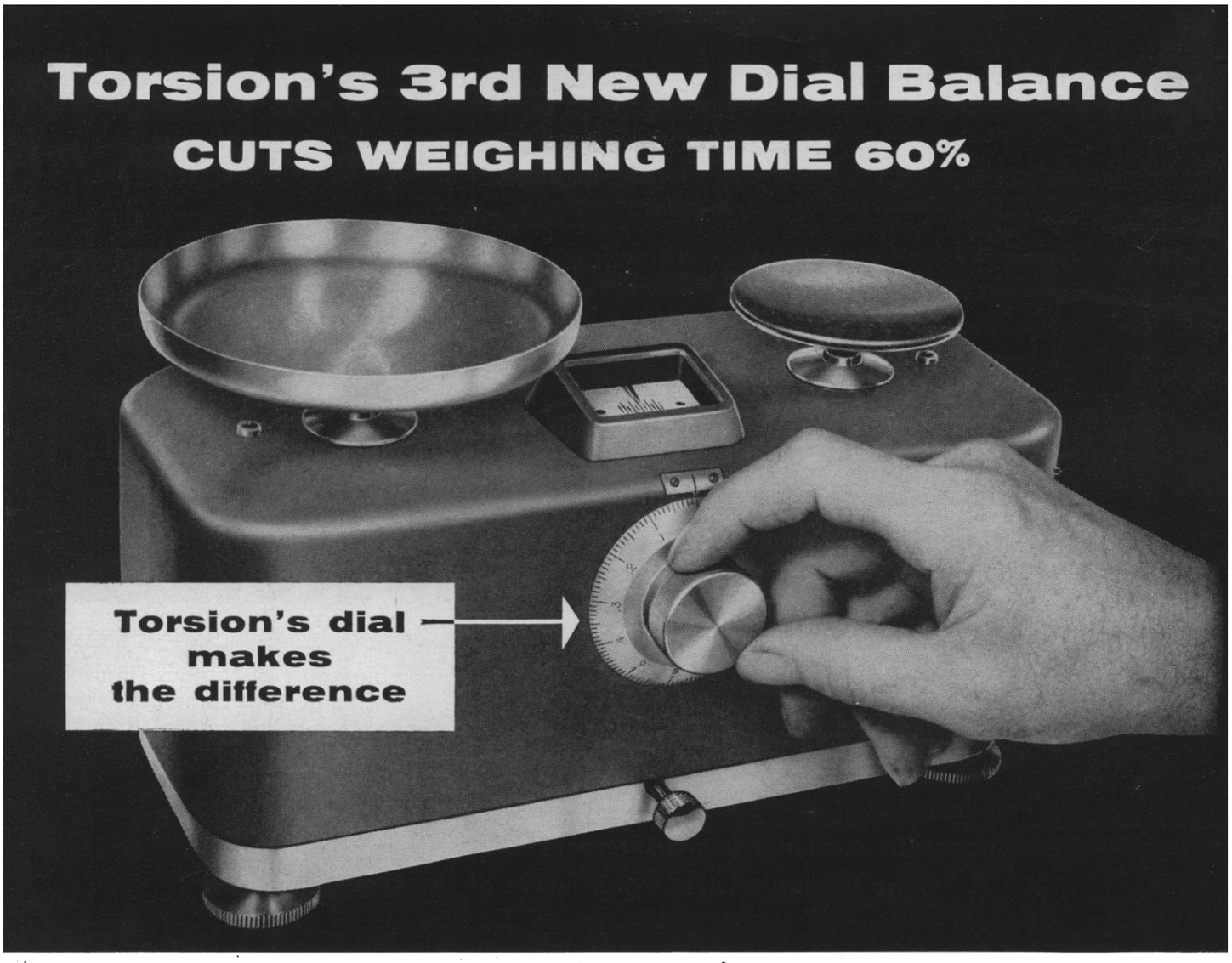

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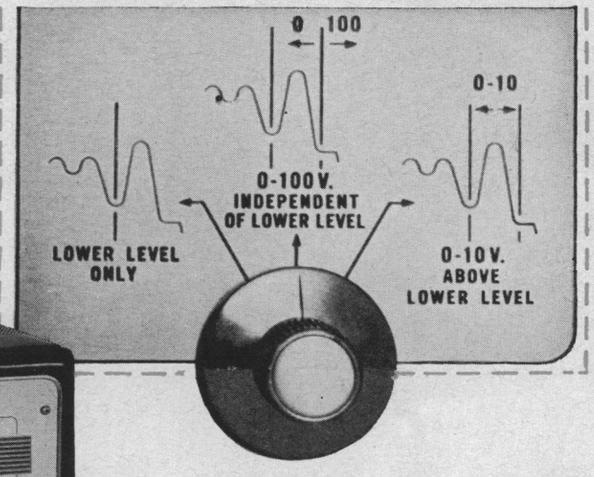

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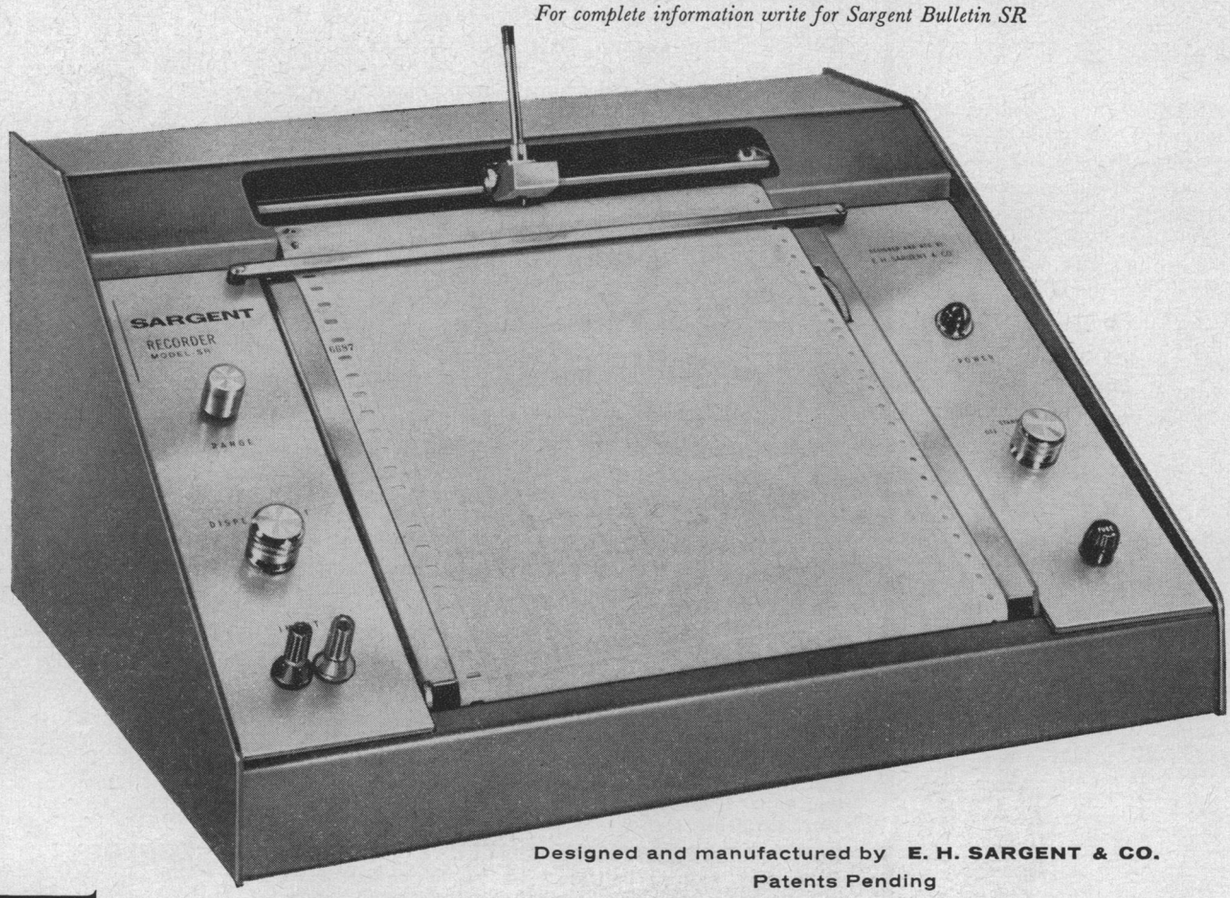

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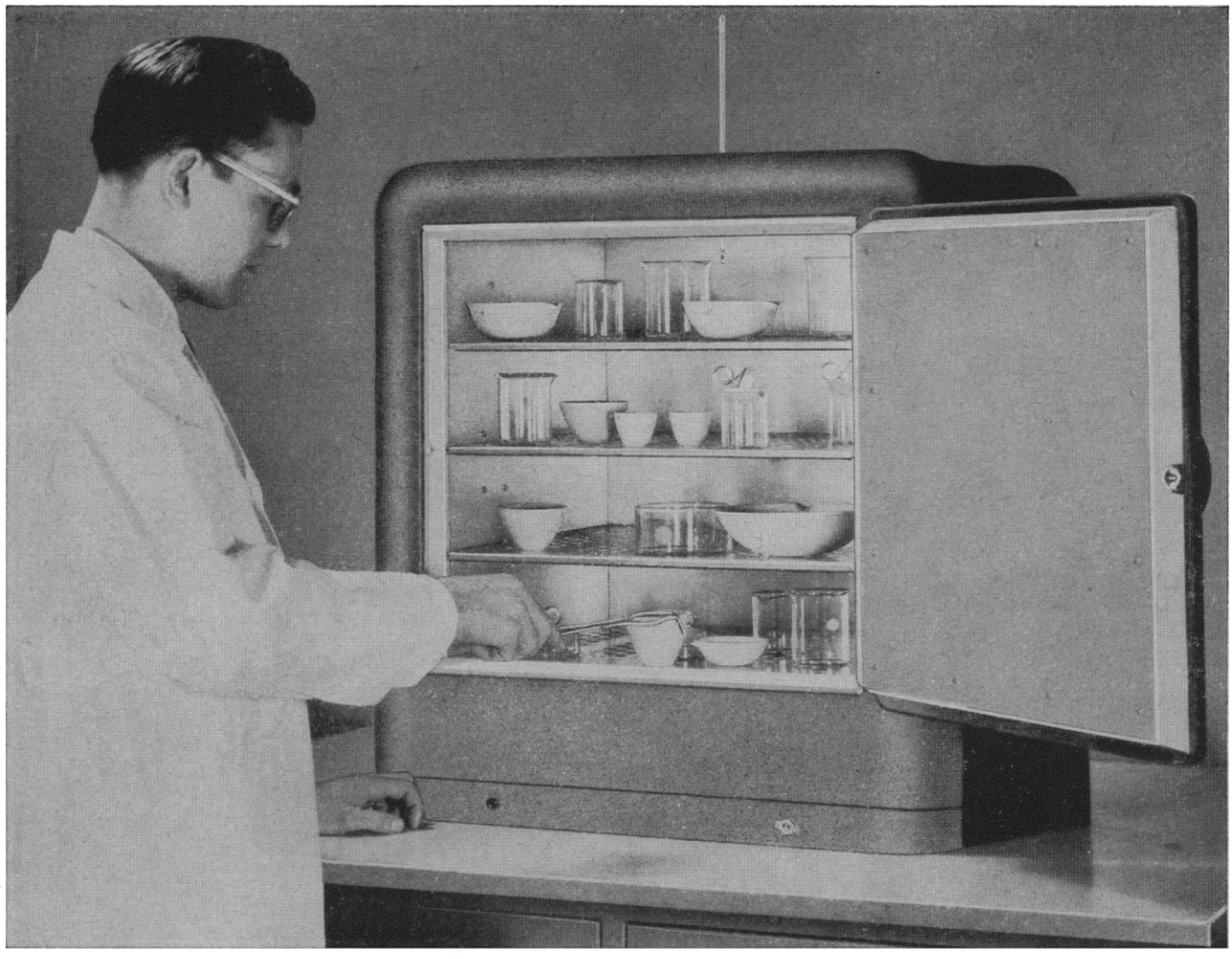

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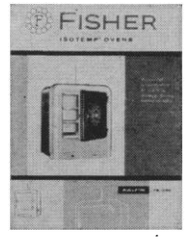

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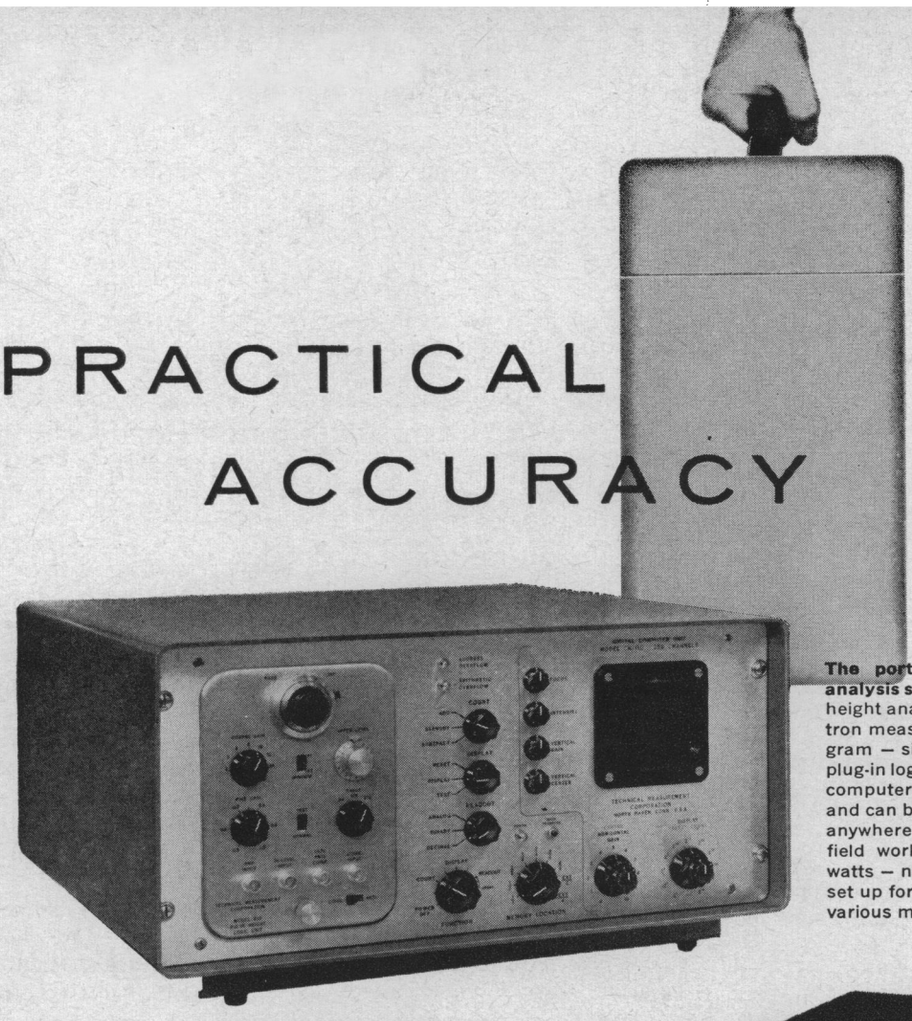

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Rebutting the Preposterous

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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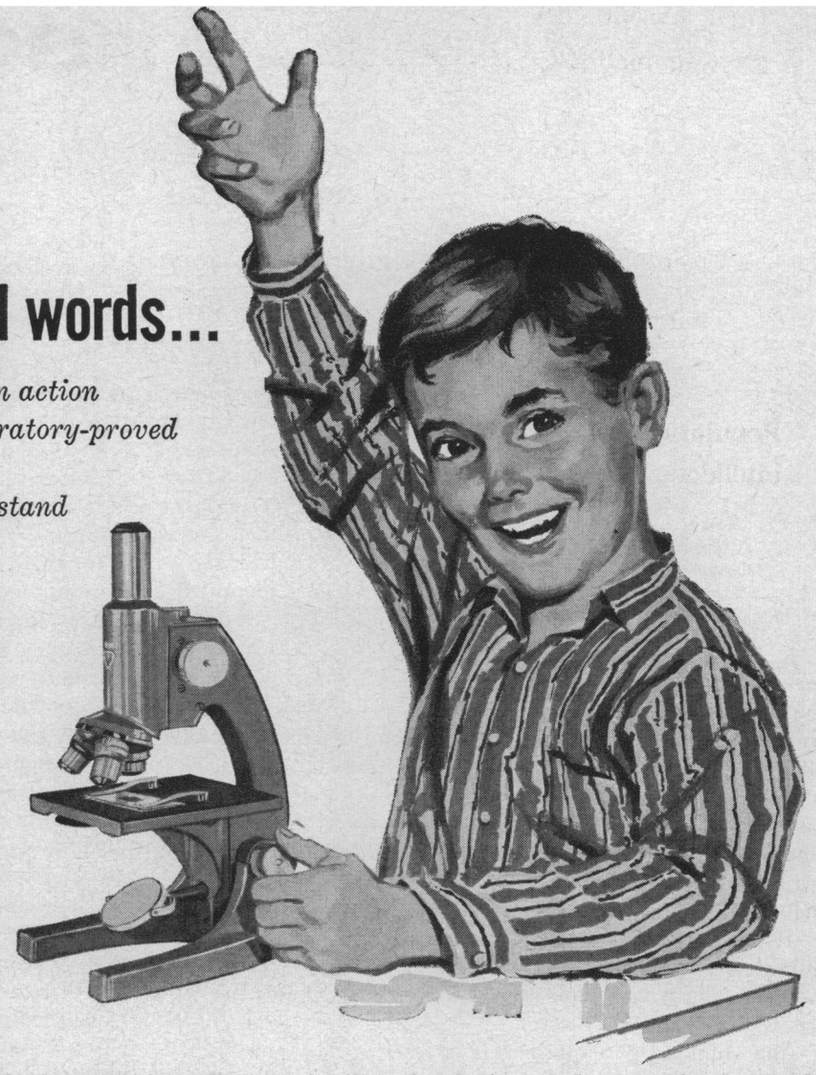

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Belknap, Eds. *Work and the Heart.* Hoeber-Harper, New York, 1959. 559 pp. $12. Transactions of the first Wisconsin conference on work and the heart, sponsored by the American Heart Association, the National Health Institute, and the Industrial Council of the American Medical Association.

Smith, Alice Lorraine. *Carter's Microbiology and Pathology.* Mosby, St. Louis, ed. 7, 1960. 742 pp. $7.50.

Society for Experimental Biology. *Utilization of Nitrogen and Its Compounds by Plants.* Symposia No. 13. Academic Press, New York, 1959. 392 pp. $9.50.

Mathematics, Physical Sciences, and Engineering

Adams, Roger, Ed. *Organic Reactions.* vol. 10. Wiley, New York; Chapman and Hall, London, 1959. 570 pp. $12.

Agnew, Ralph P. *Differential Equations.* McGraw-Hill, ed. 2, 1960. 494 pp. $7.50.

Ahlfors, Lars V. and Leo Sario. *Riemann Surfaces.* Princeton Univ. Press, Princeton, N.J., 1960. 393 pp. $10.

Ball, W. W. R., *et al. String Figures and Other Monographs.* Chelsea, New York, 1960. 495 pp. $3.95.

Batchelor, G. K., Ed. *The Scientific Papers of Sir Geoffrey Ingram Taylor.* vol. 2, *Meteorology, Oceanography and Turbulent Flow.* Cambridge Univ. Press, New York, 1960. 525 pp. $14.50.

Beerbower, James R. *Search for the Past.* An introduction to paleontology. Prentice-Hall, Englewood Cliffs, N.J., 1960. 575 pp. $7.50.

Bell, R. P. *The Proton in Chemistry.* Cornell Univ. Press, Ithaca, N.Y., 1959. 230 pp. $4.75.

Birkhoff, Garrett, and R. E. Langer, Eds. *Orbit Theory.* Proceedings of Symposia in Applied Mathematics, vol. 9. American Mathematical Soc., Providence, R.I., 1959. 200 pp.

Blackburn, John F., Gerhard Reethof, J. Lowen Shearer, Eds. *Fluid Power Control.* Technology Press, Massachusetts Inst. of Technology, and Wiley, New York, 1960. 730 pp. $17.50.

Bockris, J. O'M., J. L. White, J. D. Mackenzie, Eds. *Physicochemical Measurements at High Temperatures.* Academic Press, New York; Butterworths, London, 1959. 402 pp. $13.50.

Carroll, Robert L. *The Aerodynamics of Powered Flight.* Wiley, New York, 1960. 284 pp. $8.50.

Charlot, G., J. Badoz-Lambling, B. Tremillon. *Les Reactions electrochimiques.* Les methodes electrochimiques d'analyse. Masson, Paris, 1959. 401 pp. Paper, F. 6000; cloth, F. 6800.

Churchill, Ruel V. *Complex Variables and Applications.* McGraw-Hill, New York, ed. 2, 1960. 306 pp. $6.75.

Cremer, Herbert W., Ed. *Chemical Engineering Practice.* vol. 11. Academic Press, New York; Butterworths, London, 1959. 507 pp. $19.50.

Cullwick, E. G. *Electromagnetism and Relativity.* With particular reference to moving media and electromagnetic induction. Longmans, Green, New York, 1960. 314 pp. $12.50.

D'Azzo, John J., and Constantine H. Houpis. *Feedback Control System Anal-*

ysis and Synthesis. McGraw-Hill, New York, 1960. 592 pp. $13.50.

Daudel, R., R. Lefebvre, C. Moser. *Quantum Chemistry.* Methods and applications. Interscience, New York, 1959. 585 pp. $14.50.

Dumont, J., Ed. *Les Sciences.* Exposition Universelle et Internationale de Bruxelles, Brussels, Belgium, 1960. 128 pp. F. 110. A survey of the international science exhibits at the 1958 fair.

Fano, Robert M., Lan Jen Chu, Richard B. Adler. *Electromagnetic Fields, Energy and Forces.* Wiley, New York, 1960. 535 pp. $12.

Feather, Norman. *An Introduction to the Physics of Mass, Length, and Time.* Edinburgh Univ. Press, Edinburgh; Quadrangle Books, Chicago, Ill., 1960, 368 pp. $5.

Fowler, John M., Ed. *Fallout.* A study of superbombs, strontium-90, and survival. Basic Books, New York, 1960. 247 pp. $5.

Francis, Gordon. *Ionization Phenomena in Gases.* Academic Press, New York; Butterworths, London, 1960. 308 pp. $10.50.

Friedman, Walter F., and Jerome J. Kipnees. *Industrial Packaging.* Wiley, New York, 1960. 551 pp. $11.50.

Frost, B. R. T., and M. B. Waldron, *Nuclear Reactor Materials.* Simmons-Broadman, New York, 1959. 77 pp. $2.75.

Ginsburg, David, Ed. *Non-Benzenoid Aromatic Compounds.* Interscience, New York, 1959. 555 pp. $18.

Griggs, David, and John Handin, Eds. *Rock Deformation.* Memoir 79. Geological Soc. of America, New York, 1960. 392 pp.

Hamilton, Leicester F., and Stephen G. Simpson. *Calculations of Analytical Chemistry.* McGraw-Hill, New York, ed. 6, 1960. 346 pp. $5.95.

Hartshorne, N. H., and A. Stuart. *Crystals and the Polarising Microscope.* A handbook for chemists and others. Arnold, London; St. Martin's Press, New York, ed. 3, 1960. 572 pp. $17.50.

International Atomic Energy Agency. *International Directory of Radioisotopes.* vol. 2, *Compounds of Carbon 14, Hydrogen 3, Iodine 131, Phosphorus 32, and Sulphur 35.* 213 pp. Paper, $3. *Nuclear Electronics II* (sessions 6–9). Proceedings of the international symposium organized by the French Society of Radioelectricians, 1958. 389 pp. Paper, $4. International Publications, New York 22, 1959.

King, Ronald W. P., and Tai Tsun Wu. *The Scattering and Diffraction of Waves.* Harvard Univ. Press, Cambridge, Mass., 1959. 235 pp. $6.

Kit, Boris, and Douglas S. Evered. *Rocket Propellant Handbook.* Macmillan, New York, 1960. 366 pp. $12.50.

Landes, Kenneth K. *Petroleum Geology.* Wiley, New York; Chapman and Hall, London, ed. 2, 1959. 454 pp. $9.50.

Langer, Rudolph E., Ed. *Boundary Problems in Differential Equations.* Proceedings of a symposium (1959). Univ. of Wisconsin Press, Madison, 1960. 334 pp. $4.

Leontovich, M. A., Ed. *Plasma Physics and the Problem of Controlled Thermonuclear Reactions.* vol. 3. Translated by J. B. Sykes. Pergamon, New York, 1959. 421 pp. $24.

Lewis, J., and R. G. Wilkins, Eds. *Modern Coordination Chemistry*. Interscience, New York, 1960. 503 pp. $12.50.

Mack, Sidney F. *Elementary Statistics*. Holt, New York, 1960. 207 pp. $4.50.

Marion, J. B., and J. L. Fowler, Eds. *Fast Neutron Physics*. Interscience, New York, 1960. 997 pp. $29.

Middleton, David. *An Introduction to Statistical Communication Theory*. McGraw-Hill, New York, 1960. 1159 pp. $25.

Olmsted, John M. H. *Real Variables*. An introduction to the theory of functions. Appleton-Century-Crofts, New York, 1959. 637 pp. $9.

Palmer, W. G. *Valency*. Classical and modern. Cambridge Univ. Press, New York, ed. 2, 1959. 254 pp. $5.50.

Parker, William Vann, and James Clifton Eaves. *Matrices*. Ronald, New York, 1960. 203 pp. $7.50.

Pauling, Linus. *The Nature of the Chemical Bond*. And the structure of molecules and crystals, an introduction to modern structural chemistry. Cornell Univ. Press, Ithaca, N.Y., ed. 3, 1960. 664 pp. $8.85.

Raphael, Ralph A., Edward C. Taylor, Hans Wynberg, Eds. *Advances in Organic Chemistry*. vol. 1, *Methods and Results*. Interscience, New York, 1960. 396 pp. $12.

Reiner, Markus. *Deformation, Strain and Flow*. Revised and enlarged edition of *Deformation and Flow*, 1949. Interscience, New York, 1960. 363 pp. $9.75.

Resnick, Robert, and David Halliday. *Physics*. For students of science and engineering. pt. 1. Wiley, New York, 1960. 608 pp.

Schierbeek, A. *Measuring the Invisible World*. The life and works of Antoni van Leeuwenhoek. With a biographical chapter by Maria Rooseboom. Abelard-Schuman, New York, 1960. 223 pp. $5.

Schwartz, Manuel, Simon Green, W. A. Rutledge. *Vector Analysis with Applications to Geometry and Physics*. Harper, New York, 1960. 568 pp. $7.50.

Sedov, L. I. *Similarity and Dimensional Methods in Mechanics*. Translated by Morris Friedman, translation edited by Maurice Holt. Academic Press, New York, ed. 4, 1959. 379 pp. $14.

Slater, L. J. *Confluent Hypergeometric Functions*. Cambridge Univ. Press, New York, 1960. 257 pp. $12.50.

Slater, Noel B. *Theory of Unimolecular Reactions*. Cornell Univ. Press, Ithaca, N.Y., 1959. 241 pp. $4.75.

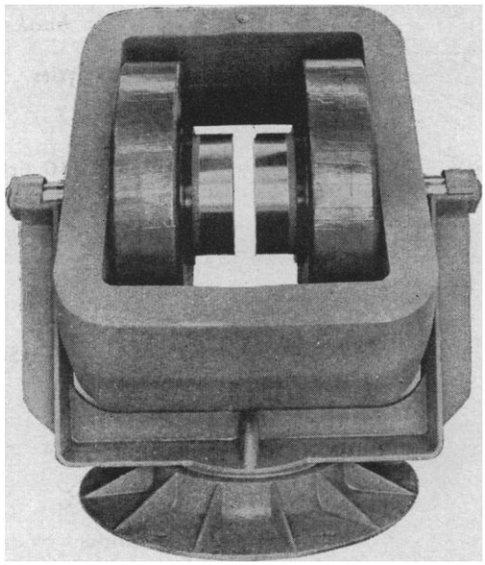
Sloan, Robert W. *An Introduction to Modern Mathematics*. Prentice-Hall, Englewood Cliffs, N.J., 1960. 73 pp. $3.75.

Stanford Research Institute. *High Temperature Technology*, Proceedings of an international symposium (1959). McGraw-Hill, New York, 1960. 354 pp. $15.

Suppes, Patrick. *Axiomatic Set Theory*. Van Nostrand, New York, 1960. 275 pp. $6.

Taylor, Charles F. *The Internal-Combustion Engine in Theory and Practice*. vol. 1, *Thermodynamics, Fluid Flow, Performance*. Technology Press and Wiley, New York, 1960. 584 pp. $16.

Tishler, Max, Ed. *Organic Syntheses*. vol. 39. Wiley, New York; Chapman and Hall, London, 1959. 121 pp. $4.



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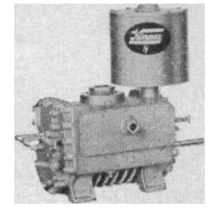

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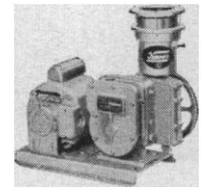

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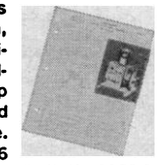

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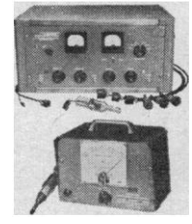

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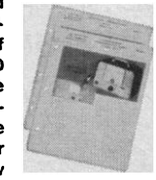

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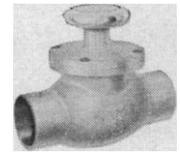

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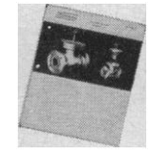

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Astronomy

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Celestial Mechanics, E. Finlay-Freundlich (Pergamon), 3 July 1959, 36

Elementary Astronomy, O. Struve, B. Lynds, H. Pillans (Oxford Univ. Press), 20 Nov. 1959, 1401

From Galaxies to Man, J. Pfeiffer (Random House), 23 Oct. 1959, 1105

The Green Flash and Other Low Sun Phenomena, D. J. K. O'Connell (North-Holland; Interscience), 1 May 1959, 1218

Larousse Encyclopedia of Astronomy, L. Rudaux and G. de Vaucouleurs (Prometheus Press), 18 Dec. 1959, 1704

Biochemistry and Microbiology

Advances in Applied Microbiology, W. W. Umbreit, Ed. (Academic Press), 26 Feb. 1960, 600

The Amphetamines, C. W. Leake (Thomas), 11 Dec. 1959, 1650

Bigger's Handbook of Bacteriology, F. S. Stewart (Williams and Wilkins), 4 Dec. 1959, 1569

The Enzymes, P. D. Boyer, H. Lardy, Karl Myrbäck (Academic Press), 22 May 1959, 1421

Immunity and Virus Infection, V. A. Najjar, Ed. (Wiley; Chapman and Hall), 4 Dec. 1959, 1569

Industrial Microbiology, S. C. Prescott and C. G. Dunn (McGraw-Hill), 26 Feb. 1960, 600

Microbiology, L. P. Gebhardt and D. A. Anderson (Mosby), 5 Feb. 1960, 349

The Molecular Basis of Evolution, C. B. Anfinsen (Wiley; Chapman and Hall), 23 Oct. 1959, 1108

Principles of Microbiology, W. W. Krueger and K. R. Johansson (Saunders), 5 Feb. 1960, 349

Progress in Industrial Microbiology, D. J. D. Hockenhull, Ed. (Interscience), 19 Feb. 1960, 496

The Submicroscopic Organization and Function of Nerve Cells (Academic Press), 24 Apr. 1959, 1125

Textbook of Microbiology, W. Burrows (Saunders), 5 Feb. 1960, 349

Traité de biochimie générale, P. Boulanger and J. Polonovski (Masson), 31 July 1959, 262

Virus, W. Weidel (Univ. of Michigan Press), 22 Jan. 1960, 221

The Viruses, F. M. Burnet and W. M. Stanley, Eds. (Academic Press), vol. 1, *General Virology*, 4 Mar. 1960, 657; vol. 2, *Plant and Bacterial Viruses*, 11 Mar. 1960, 724; vol. 3, *Animal Viruses*, 25 Mar. 1960, 919

Biological Sciences

The Atomic Age and Our Biological Future, H. V. Brøndsted (Philosophical Library), 8 May 1959, 1272

The Biological Way of Thought, M. Beckner (Columbia Univ. Press), 24 Apr. 1959, 1126

Can Man Be Modified? J. Rostand (Basic Books), 12 June 1959, 1606

The Cell, J. Brachet and A. E. Mirsky, Eds. (Academic Press), 16 Oct. 1959, 974

The Cellular Slime Molds, J. T. Bonner (Princeton Univ. Press), 21 Aug. 1959, 446

Comparative Anatomy, W. Montagna (Wiley; Chapman and Hall), 8 Jan. 1960, 96

Comparative Endocrinology, A. Grobman, Ed. (Wiley; Chapman and Hall), 27 Nov. 1959, 1470

Dosimetrie und Strahlenschutz, R. G. Jaeger (Thieme), 25 Mar. 1960, 916

Electronic Apparatus for Biological Research, P. E. K. Donaldson *et al.* (Academic Press), 24 Apr. 1959, 1122

The Evolution of Living Things, H. G.

Cannon (Thomas), 26 Sept. 1959, 785

Fresh-Water Biology, H. B. Ward and G. C. Whipple; W. T. Edmonson, Ed. (Wiley; Chapman and Hall), 29 Jan. 1960, 296

Fundamentals of Ecology, E. P. Odum (Saunders), 15 May 1959, 1354

Handbook of Circulation, P. L. Altman (Saunders), 18 Mar. 1960, 823

Inside the Living Cell, J. A. V. Butler (Basic Books), 29 May 1959, 1481

Mineral Nutrition and the Balance of Life, F. A. Gilbert (Univ. of Oklahoma Press), 24 Apr. 1959, 1126

Physiology of Fungi, V. W. Cochrane (Wiley; Chapman and Hall), 5 June 1959, 1542

Polarography, M. Brezina and P. Zuman (Interscience), 1 May 1959, 1217

Progress in Biophysics and Biophysical Chemistry, J. A. V. Butler and B. Katz, Eds. (Pergamon), 17 July 1959, 155

Radiation, Genes, and Man, B. Wallace and Th. Dobzhansky (Holt), 29 Jan. 1960, 293

The Relation of Fungi to Human Affairs, W. D. Gray (Holt), 16 Oct. 1959, 973

Botanical Sciences

Circumpolar Arctic Flora, N. Polunin (Oxford Univ. Press), 31 July 1959, 263

Complete Field Guide to American Wildlife, H. H. Collins, Jr. (Harper), 13 Nov. 1959, 1334

Excursion Flora of the British Isles, A. R. Clapham, T. G. Tutin, E. F. Warburg (Cambridge Univ. Press), 28 Aug. 1959, 497

Index of American Palms, B. E. Dahlgren (Chicago Natural History Museum), 11 Dec. 1959, 1650

Index Kewensis Plantarum Phanerogamarum, G. Taylor, Ed. (Oxford Univ. Press), 7 Aug. 1959, 328

The Orchids, C. L. Withner, Ed. (Ronald), 8 Jan. 1960, 98

Plant Nematodes, J. R. Christie (Agricultural Experiment Stations, Univ. of Florida), 10 July 1959, 94

Records of the American-Australian Scientific Expedition to Arnhem Land, vol. 3, *Botany and Plant Ecology*, R. L. Specht and C. P. Mountford, Eds. (Melbourne Univ. Press), 24 Apr. 1959, 1125

Taschenbuch der Botanik, W. Mevius (Thieme), 4 Sept. 1959, 561

Taxonomy of Flowering Plants, C. L. Porter (Freeman), 18 Mar. 1960, 821

Tree Maintenance, P. P. Pirone (Oxford Univ. Press), 30 Oct. 1959, 1183

Vascular Plants of the Pacific Northwest, C. L. Hitchock, A. Cronquist, M. Ownbey (Univ. of Washington Press), 25 Sept. 1959, 786

Vegetation of the Outer Banks of North Carolina, C. A. Brown (Louisiana State Univ. Press), 18 Sept. 1959, 703

Chemistry

Chromatographic Reviews, M. Lederer, Ed. (Elsevier), 11 Sept. 1959, 618

Colorimetric Determination of Traces of Metals, E. B. Sandell (Interscience), 5 June 1959, 1542

Colorimetric Methods of Analysis, F.

D. Snell and C. T. Snell (Van Nostrand), 26 June 1959, 1735

Comprehensive Analytical Chemistry, C. L. Wilson and D. W. Wilson, Eds. (Elsevier), 9 Oct. 1959, 913

Crystal Chemistry of Simple Compounds of Uranium, Thorium, Plutonium, and Neptunium, E. S. Makarov, (Consultants Bureau; Chapman and Hall), 11 Mar. 1960, 723

Elementary Practical Organic Chemistry, A. I. Vogel (Longmans, Green), 19 June 1959, 1668

Free Radicals, A. F. Trotman-Dickenson (Methuen; Wiley), 4 Dec. 1959, 1570

Gmelins Handbuch der Anorganischen Chemie, System No. 5, supplement, *Fluorine*; System No. 15, *Silicon*, pt. C; System No. 59, supplement 2, *Iron, Magnetic Materials, Magnetic and Electrical Properties*, pt. D (Verlag Chemie), 25 Sept. 1959, 788

Nouveau traité de chimie minérale, vol. 11, group V, *Arsenic, antimoine, bismuth*; vol. 14, group VI, *Chrome, complexes du chrome, molybdène, tungstène, hétéropolyacides*. P. Pascal, Ed. (Masson), 15 May 1959, 1355

The Physico-Chemical Constants of Binary Systems in Concentrated Solutions, J. Timmermans (Interscience), 8 Jan. 1960, 97

Progress in the Chemistry of Organic Natural Products, L. Zechmeister, Ed. (Springer), vol. 15, 28 Aug. 1959, 498; vol. 16, 18 Sept. 1959, 704

Some Problems in Chemical Kinetics and Reactivity, vol. 1, N. N. Semenov, translated by M. Boudart (Princeton Univ. Press), 22 May 1959, 1419

Some Problems of Chemical Kinetics and Reactivity, vol. 1, N. N. Semenov, translated by J. E. S. Bradley (Pergamon), 22 May 1959, 1419

Soviet Research in Crystallography, 1956 (Consultants Bureau), 19 Feb. 1960, 495

Steroids, L. F. Fieser and M. Fieser (Reinhold; Chapman and Hall), 13 Nov. 1959, 1336

Earth Sciences

Arctic Bibliography, vols. 6 and 7, M. Tremaine, Ed. (Dept. of Defense, Washington, D.C.), 1 May 1959, 1218

Between Earth and Space, C. Orr, Jr. (Macmillan), 29 May 1959, 1480

The Chemistry and Physics of Clays and Other Ceramic Materials, A. B. Searle and R. W. Grimshaw (Interscience), 10 July 1959, 95

Climatology and Microclimatology, UNESCO, Paris (Columbia Univ. Press), 24 Apr. 1959, 1135

Covered Wagon Geologist, C. N. Gould (Univ. of Oklahoma Press), 12 Feb. 1960, 407

Dana's Manual of Mineralogy, revised by C. S. Hurlbut, Jr. (Wiley; Chapman and Hall), 15 Jan. 1960, 154

The Earth beneath the Sea, F. P. Shepard (Johns Hopkins Press), 18 Sept. 1959, 702

Elements of Physical Metallurgy, A. G. Guy (Addison-Wesley), 21 Aug. 1959, 447

Environmental Conservation, R. F. Dasmann (Wiley), 8 May 1959, 1274

The Evolution of North America, P. B. King (Princeton Univ. Press), 17 July 1959, 154

Features and Formation of the Great Kawir and Masileh, H. Bobek (Arid Zone Research Centre, Univ. of Teheran, Teheran, Iran), 18 Dec. 1959, 1705

Geochemical Methods of Prospecting and Exploration for Petroleum and Natural Gas, A. A. Kartsev, Z. A. Tabasaranskii, M. I. Subbota, G. A. Mogilevskii (Univ. of California Press), 11 Dec. 1959, 1650

Géologie de l'uranium, M. Roubault (Masson), 24 Apr. 1959, 1133

Geology of the Great Lakes, J. L. Hough (Univ. of Illinois Press), 24 Apr. 1959, 1134

Grasslands, H. B. Sprague, Ed. (AAAS), 8 Jan. 1960, 96

The Gulf Stream, H. Stommel (Univ. of California Press), 5 June 1959, 1544

Historical Geography of the North Carolina Outer Banks, G. S. Dunbar (Louisiana State Univ. Press), 29 May 1959, 1481

How Old Is the Earth?, P. M. Hurley (Doubleday), 11 Sept. 1959, 616

Hydrogéologie, P. Fourmarier (Masson; Vaillant-Carmanne), 12 June 1959, 1607.

Landscape from the Air, F. J. Monkhouse (Cambridge Univ. Press), 3 July 1959, 36

Landslides in Clays, A. Collin (Univ. of Toronto Press), 31 July 1959, 261

Living Resources of the Sea, L. A. Walford (Ronald), 24 Apr. 1959, 1122

Mineralogy, E. H. Kraus, W. F. Hunt, L. S. Ramsdell (McGraw-Hill), 31 July 1949, 264

Mineralogy and Geology of Radioactive Raw Materials, E. W. Heinrich (McGraw-Hill), 15 May 1959, 1355

Minerals of New Mexico, S. A. Northrop (Univ. of New Mexico Press), 11 Mar. 1960, 724

Oceanography and Marine Biology, H. Barnes (Macmillan), 9 Oct. 1959, 913

The Open Sea: Its Natural History, part 2, A. Hardy (Houghton Mifflin), 6 Nov. 1959, 1247

Our Atmosphere, T. Loebsack (Pantheon), 31 July 1959, 262

Ozeane Salzlagerstätten, H. Borchert (Borntraeger, Berlin), 17 July 1959, 156

The Perpetual Forest, W. B. Collins (Lippincott), 19 June 1959, 1668

Phosphorus and Its Compounds, J. R. Van Wazer (Interscience), 8 May 1959, 1271

Researches in Geochemistry, P. H. Abelson, Ed. (Wiley; Chapman and Hall), 4 Sept. 1959, 562

This Sculptured Earth: The Landscape of America, J. A. Shimer (Columbia Univ. Press), 29 Jan. 1960, 294

The Stratigraphy of Western Australia, J. R. H. McWhae, P. E. Playford, A. W. Lindner, B. F. Glenister, B. E. Balme (Melbourne Univ. Press), 26 June 1959, 1736

The Study of Rocks in Thin Section, W. W. Moorhouse (Harper), 20 Nov. 1959, 1400

Survey of Raw Material Resources, vol. 2 of *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy* (United Nations, Geneva), 22 May 1959, 1421

History and Philosophy of Science

Adventures with the Missing Link, R. A. Dart, with D. Craig (Harper), 26 Feb. 1960, 603

The Age of Improvement, A. Briggs (Longmans, Green), 26 June 1959, 1735

The Ancient Mariners, L. Casson (Macmillan), 8 May 1959, 1271

The Autobiography of Charles Darwin 1809–1882, N. Barlow, Ed. (Harcourt, Brace), 24 Apr. 1959, 1121

Nicholas Biddle, T. P. Govan (Univ. of Chicago Press), 19 Feb. 1960, 495

The Canal Builders, R. Payne (Macmillan), 14 Aug. 1959, 383

George Catlin, Episodes from Life among the Indians and Last Rambles, M. C. Ross, Ed. (Univ. of Oklahoma Press), 4 Mar. 1960, 656

George Catlin and the Old Frontier, H. McCracken (Dial Press), 4 Mar. 1960, 656

J. M. Charcot, 1825–1893, His Life—His Work, G. Guillain, P. Bailey, Ed. (Hoeber), 30 Oct. 1959, 1184

Critical Problems in the History of Science, M. Clagett, Ed. (Univ. of Wisconsin Press), 25 Mar. 1960, 918

A Diderot Pictorial Encyclopedia of Trades and Industry, C. C. Gillispie, Ed. (Dover), 17 July 1959, 154

Asa Gray, A. H. Dupree (Belknap Press of Harvard Univ. Press), 2 Oct. 1959, 855

The Great Decision, M. Amrine (Putnam's), 3 July 1959, 32

The Great Pulse, M. W. Standlee (Tuttle, Rutland, Vt.), 11 Sept. 1959, 619

Histoire générale des sciences, vol. 2, *La Science moderne (de 1450 à 1800)*, R. Taton, Ed. (Presses Universitaries de France), 14 Aug. 1959, 382

A History of Technology, vol. 4, *The Industrial Revolution, c 1750 to c 1850;* vol. 5, *The Late Nineteenth Century, c 1850 to c 1900*. C. Singer, E. J. Holmyard, A. R. Hall, T. I. Williams, Eds. (Oxford Univ. Press), 28 Aug. 1959, 496

A History of Western Morals, C. Brinton (Harcourt, Brace), 18 Dec. 1959, 1702

A History of Western Technology, F. Klemm (Scribner's), 21 Aug. 1959, 448

Istoriia Akademii Nauk SSSR [History of the Academy of Sciences of the U.S.S.R.], K. V. Ostrovitianov, Ed. (Academy of Sciences of the U.S.S.R. Press), 15 Jan. 1960, 151

Magnets, F. Bitter (Doubleday), 11 Sept. 1959, 616

Gregor Mendel und das Schicksal seiner Vererbungsgesetze, I. Krumbiegel (Wissenschaftliche Verlagsgesellschaft, Stuttgart), 5 Feb. 1960, 347

Antonio Meucci, Inventor of the Telephone, G. E. Schiavo (Vigo Press), 9 Oct. 1959, 914

Lewis Henry Morgan: the Indian Journals, 1859–62, L. A. White, Ed. (Univ. of Michigan Press), 12 Feb. 1960, 404

90° South, P. Siple (Putnam's), 11 Mar. 1960, 724

Notes of a Soviet Doctor, G. S. Pondoev (Consultants Bureau; Chapman and Hall), 31 July 1959, 263

Patterns of Discovery, N. R. Hanson (Cambridge Univ. Press), 19 June 1959, 1666

A Philosopher Looks at Science, J. G.

Kemeny (Van Nostrand), 14 Aug. 1959, 383

The Pulse of Radar: The Autobiography of Sir Robert Watson-Watt (Dial Press), 24 Apr. 1959, 1135

The Rainbow, C. Boyer (Yoseloff), 1 Jan. 1960, 29

A Record of History and Evolution of Early American Bridges, L. N. Edwards (University Press, Orono, Maine), 21 Aug. 1959, 445

Roman Construction in Italy from Tiberius through the Flavians, M. E. Blake (Carnegie Institution of Washington), 20 Nov. 1959, 1401

Science and Civilisation in China, vol. 3, *Mathematics and the Sciences of the Heavens and the Earth*, J. Needham and W. Ling (Cambridge Univ. Press), 4 Mar. 1960, 658

The Science of Mechanics in the Middle Ages, M. Clagett (Univ. of Wisconsin Press; Oxford Univ. Press), 4 Dec. 1959, 1571

A Short History of Scientific Ideas to 1900, C. Singer (Oxford Univ. Press), 12 Feb. 1960, 405

The Sleepwalkers, A. Koestler (Macmillan), 7 Aug. 1959, 326

The Social History of Lighting, W. T. O'Dea (Macmillan), 27 Nov. 1959, 1468

The Study of Man, M. Polanyi (Univ. of Chicago Press), 9 Oct. 1959, 912

The Transits of Venus, H. Woolf (Princeton Univ. Press), 11 Mar. 1960, 723

A Treasury of Science, H. Shapley, S. Rapport, H. Wright, Eds. (Harper), 2 Oct. 1959, 858

Voice across the Sea, A. C. Clarke (Harper), 22 May 1959, 1420

The Way Things Are, P. W. Bridgman (Harvard Univ. Press), 3 July 1959, 31

Mathematics

Applications of Finite Groups, J. S. Lomont (Academic Press), 18 Sept. 1959, 705

Applications of the Theory of Matrices, F. R. Gantmacher (Interscience), 12 Feb. 1960, 405

A Course of Pure Mathematics, G. H. Hardy (Cambridge Univ. Press), 17 July 1959, 157

Fallacies and Mathematics, E. A. Maxwell (Cambridge Univ. Press), 4 Dec. 1959, 1570

The Gentle Art of Mathematics, D. Pedoe (Macmillan), 29 Jan. 1960, 295

Information Theory and Statistics, S. Kullback, (Wiley; Chapman and Hall), 25 Mar. 1960, 917

Introduction à l'étude des variétés kählériennes, A. Weil (Hermann, Paris), 24 Apr. 1959, 1136

Méthodes numériques, interpolation, dérivées, J. Kuntzmann (Dunod), 1 Jan. 1960, 29

Les problèmes aux limites de la physique mathématique, H. G. Harnir (Birkhauser, Basel), 24 Apr. 1959, 1136

Program for College Preparatory Mathematics, Commission on Mathematics (College Entrance Examination Board, Princeton), 28 Aug. 1959, 497

Programming for an Automatic Digital Calculator, K. H. V. Booth (Academic

Press; Butterworths), 19 June 1959, 1669

Readings in Linear Programming, S. Vajda (Wiley), 25 Mar. 1960, 916

Studies in Mathematical Learning Theory, R. R. Bush and W. K. Estes, Eds. (Stanford Univ. Press), 22 Jan. 1960, 221

Trigonometric Series, A. Zygmund (Cambridge Univ. Press), 11 Sept. 1959, 618

Medicine

Anatomy of the Human Body, H. Gray, C. M. Goss, Ed. (Lea and Febiger), 25 Dec. 1959, 1757

Anatomy of the Human Body, R. D. Lockhart, G. F. Hamilton, F. W. Fyfe (Lippincott), 18 Sept. 1959, 705

British Pharmaceutical Codex, 1959 (Pharmaceutical Press), 25 Mar. 1960, 917

Conference on the Chemistry of Muscular Contraction (Igaku Shoin Ltd., Tokyo), 12 June 1959, 1608

The Ecology of Human Disease, J. M. May (MD Publications), 15 May 1959, 1356

Experimental Surgery, J. Markowitz, J. Archibald, H. G. Downie (Williams and Wilkins), 25 Mar. 1960, 918

Handbook of Physiology, J. Field, Ed. (American Physiological Soc.), 1 Jan. 1960, 27

Human Nutrition and Dietetics, S. Davidson, A. P. Meiklejohn, R. Passmore (Williams and Wilkins), 12 Feb. 1960, 407

Introduction to Human Anatomy, C. C. Francis (Mosby), 4 Sept. 1959, 563

Manuale di micologia medica, R. Ciferri (Cortina, Pavia, Italy), 8 May 1959, 1272

Measurement of Subjective Responses: Quantitative Effects of Drugs, H. K. Beecher (Oxford Univ. Press), 12 Feb. 1960, 406

A Method of Anatomy, J. C. B. Grant (Williams and Wilkins), 10 July 1959, 95

Mirage of Health, R. Dubos (Harper), 10 July 1959, 93

The Onset of Stuttering, W. Johnson *et al.* (Univ. of Minnesota Press), 17 July 1959, 157

Die pränatalen Infektionen des Menschen unter besonderer Berücksichtigung von Pathogenese und Immunologie, H. Flamm (Thieme), 23 Oct. 1959, 1107

Radiation Hygiene Handbook, H. Blatz, Ed. (McGraw-Hill), 30 Oct. 1959, 1184

Radiographic Atlas of Skeletal Development of the Hand and Wrist, W. W. Greulich and S. I. Pyle (Stanford Univ. Press; Oxford Univ. Press), 24 July 1959, 215

Safe Handling of Radio-isotopes (International Atomic Energy Agency, Vienna), 10 July 1959, 92

Speech and Brain-Mechanisms, W. Penfield and L. Roberts (Princeton Univ. Press), 26 June 1959, 1731

Physics

The ABC of Relativity, B. Russell (Allen and Unwin; Essential Books), 18 Mar. 1960, 822

Advances in Chemical Physics, vol. 2, I. Prigogine, Ed. (Interscience), 27 Nov. 1959, 1468

Atomic Energy in the Communist Bloc, G. A. Modelski (Melbourne Univ. Press;

Cambridge Univ. Press), 8 Jan. 1960, 94

Atomic Energy in the Soviet Union, A. Kramish (Stanford Univ. Press), 8 Jan. 1960, 94

The Birth of a New Physics, I. B. Cohen (Dcubleday), 22 Jan. 1960, 219

Cerenkov Radiation and Its Applications, J. V. Jelley (Pergamon), 8 May 1959, 1273

Classical Mechanics, J. W. Leech (Methuen; Wiley), 5 Feb. 1960, 347

Crystals and Crystal Growing, A. Holden and P. Singer (Doubleday), 22 Jan. 1960, 219

The Determination of Molecular Structure, P. J. Wheatly (Oxford Univ. Press), 20 Nov. 1959, 1402

Echoes of Bats and Men, D. R. Griffin (Doubleday), 11 Sept. 1959, 616

Elements of Solid State Theory, G. H. Wannier (Cambridge Univ. Press), 30 Oct. 1959, 1185

Free Radicals as Studied by Electron Spin Resonance, D. J. F. Ingram (Academic Press), 5 June 1959, 1544

Glossary of Meteorology, R. E. Huschke, Ed. (American Meteorological Soc.), 22 Jan. 1960, 222

Group Theory, E. P. Wigner (Academic Press), 23 Oct. 1959, 1106

Handbook of Physics, E. U. Condon and H. Odishaw, Eds. (McGraw-Hill), 3 July 1959, 31

Handbuch der Physik, S. Flugge, Ed. (Springer), vol. 41, pt. 1, *Nuclear Reactions—Theory*, 12 Feb. 1960, 408; vol. 44, pt. 1, *Nuclear Instrumentation*, 29 Jan. 1960, 295; vol. 51, *Astrophysics: Stellar Structure*, 26 June 1959, 1734; vol. 53, *Astrophysics: Stellar Systems*, 20 Nov. 1959, 1400

Low Temperature Physics and Chemistry, J. R. Dillinger, Ed. (Univ. of Wisconsin Press), 8 May 1959, 1273

Methods of Experimental Physics, K. Lark-Horovitz and V. A. Johnston, Eds. (Academic Press), 19 Feb. 1960, 493

The Neutrino, J. S. Allen (Princeton Univ. Press), 24 Apr. 1959, 1133

The Neutron Story, D. J. Hughes (Doubleday), 11 Sept. 1959, 616

A New Method in the Theory of Superconductivity, N. N. Bogoliubov, V. V. Tolmachev, D. V. Shirkov (Consultants Bureau; Chapman and Hall), 28 Aug. 1959, 498

Nuclear Scattering, K. B. Mather and P. Swan (Cambridge Univ. Press), 24 Apr. 1959, 1137

The Physical Theory of Neutron Chain Reactors, A. M. Weinberg and E. P. Wigner (Univ. of Chicago Press), 24 Apr. 1959, 1135

Physics of Meteor Flight in the Atmosphere, E. J. Opik (Interscience), 15 May 1959, 1354

The Physics of Television, D. Fink and D. M. Lutyens (Doubleday), 22 Jan. 1960, 219

Principles of Optics, M. Born *et al.* (Pergamon), 19 Feb. 1960, 495

Polar Atmosphere Symposium, pt. 2, *Ionospheric Section*, K. Weeks, Ed. (Pergamon), 5 June 1959, 1543

Relativity for the Layman, J. A. Coleman (Macmillan), 18 Mar. 1960, 822

Semiconductors, N. B. Hannay, Ed. (Reinhold; Chapman and Hall), 3 July 1959, 34

Semiconductors and Phosphors, M. Schön and H. Welker, Eds. (Interscience; Vieweg and Sohn), 1 May 1959, 1218

Soap Bubbles, C. V. Boys (Doubleday), 11 Sept. 1959, 616

Soviet Reviews of Nuclear Science (Pergamon), 16 Oct. 1959, 974

Theory of Relativity, W. Pauli (Pergamon), 12 June 1959, 1606

Waves and the Ear, W. A. van Bergeijk, J. R. Pierce, E. E. David, Jr. (Doubleday), 22 Jan. 1960, 219

Psychology

American Handbook of Psychiatry, S. Arieti, Ed. (Basic Books), 4 Mar. 1960, 656

Automatic Teaching: the State of the Art, E. Galanter, Ed. (Wiley; Chapman and Hall), 1 Jan. 1960, 29

Behaviour and Physique, R. W. Parnell (Arnold), 25 Sept. 1959, 788

Biological and Biochemical Bases of Behavior, H. F. Harlow and C. N. Woolsey, Eds. (Univ. of Wisconsin Press), 15 May 1959, 1355

Cumulative Record, B. F. Skinner (Appleton-Century-Crofts), 3 July 1959, 34

The Fifth Mental Measurements Yearbook, O. K. Buros, Ed. (Gryphon Press), 8 Jan. 1960, 95

Free Associations, E. Jones (Basic Books), 29 Jan. 1960, 295

The Ineffective Soldier, vol. 1, *The Lost Divisions*, E. Ginzberg, J. K. Anderson, S. W. Ginsburg, J. L. Herma; vol. 2, *Breakdown and Recovery*, E. Ginzberg, J. B. Miner, J. K. Anderson, S. W. Ginsburg, J. L. Herma; vol. 3, *Patterns of Performance*, E. Ginzberg, J. K. Anderson, S. W. Ginsburg, J. L. Herma, D. W. Bray, W. Jordan, F. J. Ryan (Columbia Univ. Press), 24 July 1959, 213

Levels of Knowing and Existence, H. L. Weinberg (Harper), 25 Mar. 1960, 916

The Measurement of Values, L. L. Thurstone (Univ. of Chicago Press), 29 May 1959, 1481

Motivation, D. Bindra (Ronald), 24 Apr. 1959, 1128

Prediction and Outcome, S. Escalona and G. M. Heider (Basic Books), 12 Feb. 1960, 404

A Psychiatrist's World, B. H. Hall, Ed. (Viking), 26 Feb. 1960, 603

Rehabilitation of the Mentally Ill, M. Greenblatt and B. Simons, Eds. (AAAS), 1 Jan. 1960, 30

Scoring Human Motives: A Manual, J. Dollard and F. Auld, Jr. (Yale Univ. Press), 18 Mar. 1960, 822

Theory of Psychoanalytic Technique, K. Menninger (Basic Books), 26 June 1959, 1732

Public Affairs

Administration and Policy-Making in Education, J. Walton (Johns Hopkins Press), 4 Mar. 1960, 655

The Afro-Asian States and Their Problems, K. M. Panikkar (Day), 18 Mar. 1960, 820

Air Pollution Control, W. L. Faith (Wiley; Chapman and Hall), 2 Oct. 1959, 858

The American College President, H. W. Stoke (Harper), 5 June 1959, 1542

American Universities and Federal Research, C. V. Kidd (Harvard Univ. Press), 18 Dec. 1959, 1703

Atomic Energy in the United States, A. Kramish (Stanford Univ. Press), 8 Jan. 1960, 94

The Chinese Family in the Communist Revolution, C. K. Yang (Technology Press), 25 Mar. 1960, 915

A Chinese Village in Early Communist Transition, C. K. Yang (Technology Press), 25 Mar. 1960, 915

The College Influence on Student Character, E. D. Eddy, Jr. (American Council on Education, Washington, D.C.), 5 June 1959, 1544

College Testing, Committee on Measurement and Evaluation (American Council on Education, Washington, D.C.), 24 July 1959, 215

Communist Economic Strategy: The Rise of Mainland China, A. D. Barnett (National Planning Assoc.), 11 Dec. 1959, 1649

Communist Economic Strategy: The Role of East-Central Europe, J. Wszelaki (National Planning Assoc.), 29 May 1959, 1482

Communist Economy Strategy: Soviet Growth and Capabilities, A. Nove (National Planning Assoc.), 5 Feb. 1960, 348

Dairy Cattle, Judging and Selection, W. W. Yapp (Wiley; Chapman and Hall), 1 May 1959, 1219

East and West in India's Development, W. Malenbaum (National Planning Assoc.), 28 Aug. 1959, 497

Economics of American Forestry, A. C. Worrell (Wiley; Chapman and Hall), 28 Aug. 1959, 499

Economics and the Policy Maker (Brookings Institution, Washington, D.C.), 26 Feb. 1960, 602

The Far East, N. Peffer (Univ. of Michigan Press), 4 Sept. 1959, 561

The Fearful Choice, P. Toynbee (Wayne State Univ. Press), 26 June 1959, 1734

Federal Budget and Fiscal Policy, 1789–1958, L. H. Kimmel (Brookings Institution, Washington, D.C.), 7 Aug. 1959, 328

Germany Rejoins the Powers, K. W. Deutsch and L. J. Edinger (Stanford Univ. Press), 25 Dec. 1959, 1754

The House of Intellect, J. Barzun (Harper), 17 July 1959, 155

Introduction to Nuclear Power Costs, A. Rochman (Simmons-Boardman), 12 June 1959, 1608

Law and Administration, H. S. Marks, Ed. (Pergamon), 2 Oct. 1959, 855

Libraries and Bibliographic Centers in the Soviet Union, P. L. Horecky (Indiana Univ.), 13 Nov. 1959, 1335

Manual on Rockets and Satellites, L. V. Berkner, Ed. (Pergamon), 24 Apr. 1959, 1134

Men and Atoms, W. L. Laurence (Simon and Schuster), 13 Nov. 1959, 1335

Nationalism in Colonial Africa, T. Hodgkin (New York Univ. Press), 10 July 1959, 94

Organizing Peace in the Nuclear Age, A. N. Holcombe (New York Univ. Press), 4 Dec. 1959, 1568

Perspectives on Government and Science, vol. 327 of *Annals*, N. Wengert, Ed. (American Acadmy of Political and Social Science), 26 Feb. 1960, 601

Plain Talk from a Campus, J. A. Perkins (Univ. of Delaware Press), 19 June 1959, 1667

Planning for Freedom, E. V. Rostow (Yale Univ. Press), 5 Feb. 1960, 346

Political Man, S. M. Lipset (Doubleday), 11 Mar. 1960, 722

Prologue to Teaching, M. B. Smiley and J. S. Diekhoff, Eds. (Oxford Univ. Press), 18 Mar. 1960, 821

Publishing in the U.S.S.R., B. I. Gorokhoff (Indiana Univ.), 4 Mar. 1960, 657

Purchase Guide for Programs in Science, Mathematics, Modern Foreign Languages, Council of Chief State School Officers (Ginn), 6 Nov. 1959, 1246

Report on the State of Machine Translation in the United States, Y. Bar Hillel (Office of Technical Services, U.S. Department of Commerce), 30 Oct. 1959, 1185

Russian Diary, G. P. Harnwell (Univ. of Pennsylvania Press), 18 Mar. 1960, 821

Russian for the Scientist, J. Turkevich and L. B. Turkevich (Van Nostrand), 4 Sept. 1959, 560

Science and Liberal Education, B. Glass (Louisiana State Univ. Press), 11 Mar. 1960, 722

Science and Public Policy, D. Wolfle (Univ. of Nebraska Press), 1 Jan. 1960, 28

Science Students' Guide to the German Language, A. F. Cunningham (Oxford Univ. Press), 15 May 1959, 1354

The Second (1957) University of Utah Research Conference on the Identification of Creative Scientific Talent, C. W. Taylor (Univ. of Utah Press), 24 Apr. 1959, 1132

Soviet Economic Aid, J. S. Berliner (Praeger), 24 Apr. 1959, 1129

The State of Israel, L. F. R. Williams (Macmillan), 4 Sept. 1959, 560

Strategy in the Missile Age, B. Brodie (Princeton Univ. Press), 19 Feb. 1960, 493

The Study of Politics, C. S. Hyneman (Univ. of Illinois Press), 13 Nov. 1959, 1333

Target for Tomorrow, I. M. Levitt (Fleet, New York), 23 Oct. 1959, 1107

The Tempter, N. Wiener (Random House), 4 Mar. 1960, 655

Ten Steps into Space (Franklin Inst., Philadelphia), 2 Oct. 1959, 857

The Thirteen Steps to the Atom, C.-N. Martin (Watts), 4 Dec. 1959, 1570

Translators and Translations, F. E. Kaiser, Ed. (Special Libraries Assoc.), 24 July 1959, 214

Virus Hunters, G. Williams (Knopf), 15 Jan. 1960, 152

On War, R. Aron (Doubleday), 4 Sept. 1959, 559

We Come from the Sea, H. Hass (Doubleday), 15 Jan. 1960, 153

The Western Economy and Its Future as Seen by Soviet Economists, R. G. Stolt, Ed. (International Film and Publications Co., Montreal), 14 Aug. 1959, 384

Social Sciences

Africa, G. P. Murdock (McGraw-Hill), 19 Feb. 1960, 494

Africa, E. Schulthess (Simon and Schuster), 20 Nov. 1959, 1402

Alcohol and the Jews, C. R. Snyder (Yale Center of Alcohol Studies; Free Press) 26 June 1959, 1733

Ancient Landscapes (Bell, London), 25 Sept. 1959, 789

Ancient Mexico, F. A. Peterson (Putnam's; Allen and Unwin), 25 Mar. 1960, 917

Ancient Population of Siberia and Its Cultures, A. P. Okladnikov (Peabody Museum), 27 Nov. 1959, 1467

An Anthropological Reconnaissance in West Pakistan, 1955, H. Field (Peabody Museum), 10 July 1959, 91

The Archeology of Coastal North Carolina, W. G. Haag (Louisiana State Univ. Press), 24 Apr. 1959, 1131

The Aztec: Man and Tribe, V. W. von Hagen (New American Library), 17 July 1959, 157

Birth Control and Catholic Doctrine, A. W. Sulloway (Beacon Press), 4 Sept. 1959, 559

The Child, the Parent, and the State, J. B. Conant (Harvard Univ. Press), 30 Oct. 1959, 1182

Class in American Society, L. Reissman (Free Press), 18 Mar. 1960, 823

The Customs and Religion of the Ch'iang, D. C. Graham (Smithsonian Institution), 13 Nov. 1959, 1336

Digging into History, P. S. Martin (Chicago Natural History Museum Press), 22 May 1959, 1419

Eskimo Prehistory in the Vicinity of Point Barrow, Alaska, J. A. Ford (American Museum of Natural History), 6 Nov. 1959, 1246

The Evolution of Culture, L. A. White (McGraw-Hill), 24 Apr. 1959, 1128

Evolution, Marxian Biology, and the Social Scene, C. Zirkle (Univ. of Pennsylvania Press), 29 May 1959, 1479

Evolution by Natural Selection, C. Darwin and A. R. Wallace (Cambridge Univ. Press), 7 Aug. 1959, 330

Excavations at La Venta Tabasco, 1955, P. Drucker, R. F. Heizer, R. J. Squier (Smithsonian Institution), 7 Aug. 1959, 329

Family Planning, Sterility, and Population Growth, R. Freeman, P. K. Whelpton, A. A. Campbell (McGraw-Hill), 2 Oct. 1959, 856

Forerunners of Darwin, B. Glass, Ed. (Johns Hopkins Press), 24 Apr. 1959, 1121

The Gifted Group at Mid-Life, vol. 5 of *Genetic Studies of Genius*, L. M. Turman and M. H. Oden (Stanford Univ. Press), 7 Aug. 1959, 328

Heredity and Evolution in Human Populations, L. C. Dunn (Harvard Univ. Press), 24 Apr. 1959, 1123

Hunger and Food, J. de Castro, Ed. (World Federation of Scientific Workers, London), 24 July 1959, 214

The Incas of Pedro Cieza de León, V. W. von Hagen, Ed. (Univ. of Oklahoma Press), 16 Oct. 1959, 973

Indians of the High Plains, G. E. Hyde (Univ. of Oklahoma Press), 30 Oct. 1959, 1185

International Bibliography of Social and Cultural Anthropology, G. Balandier and J. F. M. Middleton, Eds. (UNESCO), 8 May 1959, 1273

Investment in Innovation, C. F. Carter and B. R. Williams (Oxford Univ. Press), 24 Apr. 1959, 1130

Just before Darwin: Robert Chambers and "Vestiges," M. Millhauser (Wesleyan Univ. Press), 17 July 1959, 158

Landmarks of Tomorrow, P. F. Drucker (Harper), 24 Apr. 1959, 1130

The Living Races of the Sahara Desert, L. C. Briggs (Harvard Univ.), 1 May 1959, 1216

The Lost Cities of Africa, B. Davidson (Little, Brown), 19 Feb. 1960, 494

Man's Journey through Time, L. S. Palmer (Philosophical Library), 22 Jan. 1960, 220

Mankind in the Making, W. Howells (Doubleday), 20 Nov. 1959, 1399

Mass Leisure, E. Larrabee and R. Meyersohn, Eds. (Free Press), 7 Aug. 1959, 329

Maya, C. Gallenkamp (McKay), 8 Jan. 1960, 97

Medical Biology and Etruscan Origins, G. E. W. Wolstenholme and C. M. O'Connor (Little, Brown), 23 Oct. 1959, 1106

Medicine and Anthropology, I. Galdston, Ed. (International Universities Press), 25 Sept. 1959, 789

Mutilaciones dentarias prehispanicas de México y America en general, J. Romero (Instituto Nacional de Antropología e Historia, Mexico City), 11 Sept. 1959, 619

Native Peoples of South America, J. H. Steward and L. C. Faron (McGraw-Hill), 8 Jan. 1960, 94

Nature and Man's Fate, G. Hardin (Rinehart), 5 Feb. 1960, 347

Navaho Art and Culture, G. Mills (Taylor Museum, Colorado Springs Fine Arts Center), 27 Nov. 1959, 1469

The North Alaskan Eskimo, R. F. Spencer (Smithsonian Institution), 25 Sept. 1959, 788

One Great Society, H. M. Jones (Harcourt, Brace), 24 July 1959, 215

The Origin of Species by Charles Darwin (a variorum text), M. Peckham, Ed. (Univ. of Pennsylvania Press), 24 Apr. 1959, 1121

Population: An International Dilemma, F. Osborn (Population Council, New York), 11 Sept. 1959, 618

The Population Ahead, R. G. Francis, Ed. (Univ. of Minnesota Press), 18 Sept. 1959, 702

Population Growth and Economic Development in Low-Income Countries, J. Coale and E. M. Hoover (Princeton Univ. Press), 24 Apr. 1959, 1127

The Population of Japan, I. B. Taeuber (Princeton Univ. Press), 24 Apr. 1959, 1131

Population and Progress in the Far East, W. S. Thompson (Univ. of Chicago Press), 21 Aug. 1959, 445

The Population of the United States, D. J. Bogue (Free Press), 15 Jan. 1960, 153

Primitive Peoples Today, E. Weyer, Jr. (Doubleday), 18 Sept. 1959, 703

A Reader's Guide to the Social Sciences, B. F. Hoselitz, Ed. (Free Press), 18 Dec. 1959, 1704

The Sociological Imagination, C. W. Mills (Oxford Univ. Press), 3 July 1959, 33

Sons of the Shaking Earth, E. R. Wolf (Univ. of Chicago Press), 26 Feb. 1960, 602

Southeastern Indians, Life Portraits, E. L. Fundaburk, Ed. (Editor, Luverne, Ala.), 10 July 1959, 93

The Soviet Citizen, A. Inkeles and R. A. Bauer (Harvard Univ. Press), 11 Dec. 1959, 1648

The Study of Population, P. M. Hauser and O. D. Duncan, Eds. (Univ. of Chicago Press), 25 Sept. 1959, 787

Symposium on Sociological Theory, L. Gross, Ed. (Row, Peterson), 24 Apr. 1959, 1132

Techniques of Population Analysis, G. W. Barcley (Wiley; Chapman and Hall), 24 Apr. 1959, 1129

Terms Used in Archaeology, C. Trent (Philosophical Library), 25 Sept. 1959, 785

Trend and Tradition in the Prehistory of the Eastern United States, J. R. Caldwell (Illinois State Museum), 19 June 1959, 1667

Village Japan, R. K. Beardsley, J. W. Hall, R. E. Ward (Univ. of Chicago Press), 23 Oct. 1959, 1104

Women and Work in America, R. W. Smuts (Columbia Univ. Press), 3 July 1959, 35

Technology

Aircraft and Missile Propulsion, M. J. Zucrow (Wiley; Chapman and Hall), 12 June 1959, 1607

Applied Solar Energy Research, J. S. Jensen, Ed. (Assoc. for Applied Solar Energy, Phoenix, Ariz.), 11 Dec. 1959, 1651

Chemical Engineering Practice, vol. 6, *Fluid Systems, II*, H. W. Cremer and T. Davies, Eds. (Academic Press), 9 Oct. 1959, 913

Dairy Handbook and Dictionary, J. H. Frandsen, Ed. (Editor, Amherst, Mass.), 22 May 1959, 1422

Directory of Nuclear Reactors (International Atomic Energy Agency, Vienna), 25 Dec. 1959, 1756

Economics for the Mineral Engineer, E. J. Pryor (Pergamon), 24 Apr. 1959, 1136

The Emergence of the German Dye Industry, J. J. Beer (Univ. of Illinois Press), 2 Oct. 1959, 856

Fundamental Aspects of Reactor Shielding, H. Goldstein (Addison-Wesley), 3 July 1959, 35

International Directory of Radioisotopes (International Atomic Energy Agency, Vienna), 6 Nov. 1959, 1247

Medical Museum Technology, J. J. Edwards and M. J. Edwards (Oxford Univ. Press), 25 Sept. 1959, 786

Modern Materials, H. H. Hausner, Ed. (Academic Press), 24 Apr. 1959, 1137

New Instruments and Methods of Engineering Geology, N. V. Glazov and A. N. Glazov (Consultants Bureau), 22 Jan. 1960, 221

The Nimonic Alloys, W. Betteridge

(Arnold; St. Martin's), 25 Sept. 1959, 785

Nomograms for Chemical Engineers, O. P. Kharbanda (Academic Press), 29 May 1959, 1480

Nuclear Engineering Handbook, H. Etherington, Ed. (McGraw-Hill), 24 Apr. 1959, 1137

Photomicrography, R. M. Allen (Van Nostrand), 29 May 1959, 1480

Tools for Machine Literature Searching, J. W. Perry and A. Kent, Eds. (Interscience), 22 May 1959, 1420

Zoological Sciences

Anatomie de Latimeria Chalumnae, J. Millot and J. Anthony (Éditions du Centre National de la Recherche Scientifique), 24 Apr. 1959, 1124

A Bibliography of Birds, R. M. Strong (Chicago Natural History Museum), 25 Dec. 1959, 1756

Bumblebees, J. B. Free and C. G. Butler (Macmillan), 16 Oct. 1959, 975

Catalogue of the Type Specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 3, *Tortricidae, Olethreutidae, Noctuidae*, J. F. G. Clarke [British Museum (Natural History)], 6 Nov. 1959, 1246

Collecting, Preserving, and Studying Insects, H. Oldroyd (Macmillan), 31 July 1959, 261

Curious Naturalists, N. Tinbergen (Basic Books), 13 Nov. 1959, 1334

Dangerous Marine Animals, B. W. Halstead (Cornell Maritime Press), 19 June 1959, 1668

Ecological Processes, A. Mozley (Lewis), 31 July 1959, 263

Elephants, R. Carrington (Basic Books), 26 June 1959, 1733

Encyclopaedia Zoologica Illustrated in Colours, vol. 2, sections 1 and 2, I. Tomiyama and T. Abe; section 3, T. Tokioka (Hokuryukan, Tokyo), 24 Apr. 1959, 1123

Exotic Zoology, W. Ley (Viking), 27 Nov. 1959, 1469

Exploration hydrobiologique des Lacs Kivu-Édouard et Albert (1952–1954), vol. 3 (Institut Royal des Sciences Naturelles de Belgique, Brussels), 21 Aug. 1959, 447

Faune de France, vol. 3, *Coléoptères Curculionides*, A. Hoffmann (Lechevalier), 11 Sept. 1959, 620

Fishes of the Great Lakes Region, C. L. Hubbs and K. F. Lagler (Cranbrook Inst. of Science), 10 July 1959, 93

Fundamentals of Ornithology, J. Van Tyne and A. J. Berger (Wiley; Chapman and Hall), 31 July 1959, 264

Grassblade Jungle, N. Pain (Coward-McCann), 31 July 1959, 261

Grundriss der Allgemeinen Zoologie, A. Kuhn (Thieme), 26 June 1959, 1736

Die Haustiere Afrikas, C. R. Boettger (Fischer, Jena, Germany), 24 Apr. 1959, 1126

The Hydromedusae of the Atlantic Ocean and Adjacent Waters, P. L. Kramp (Carlsberg Foundation, Copenhagen), 14 Aug. 1959, 384

The Invertebrates, vol. 5, *Smaller Coelomate Groups*, L. H. Hyman (McGraw-Hill), 25 Sept. 1959, 790

The Mammals of North America, E. R. Hall and K. R. Kelson (Ronald), 15 May 1959, 1353

Manual of Insect Morphology, E. M. DuPorte (Reinhold; Chapman and Hall), 18 Sept. 1959, 704

Manuel de paléontologie animale, L. Moret (Masson), 1 May 1959, 1217

On the Pectoral Fin and Shoulder Girdle of the Arthrodires, E. Stensiö (Almquist and Wiksell, Stockholm), 20 Nov. 1959, 1401

The Road to Man, H. Wendt (Doubleday), 25 Sept. 1959, 787

Sea Shells of Tropical West America, A. M. Keen (Stanford Univ. Press), 18 Dec. 1959, 1704

Studies in Invertebrate Morphology (Smithsonian Institution), 14 Aug. 1959, 384

The Tarantula, W. J. Baerg (Univ. of Kansas Press), 24 Apr. 1959, 1125

On the Track of Unknown Animals, B. Heuvelmans (Hill and Wang), 6 Nov. 1959, 1245

The Vertebrate Story, A. S. Romer (Univ. of Chicago Press), 5 June 1959, 1545

The World of Insects, P. Pesson (McGraw-Hill), 31 July 1959, 261

The World of Living Things, P. G. Howes (Duell, Sloan and Pearce), 13 Nov. 1959, 1334

Zulu Journal, R. B. Cowles (Univ. of California Press), 12 Feb. 1960, 406

Meetings

History of Technology

Technology has been one of the dominant factors in shaping civilization, and it seems almost incredible that in the United States—the most technologically minded of all nations in history—there had been no organized group or scholarly periodical specifically devoted to the study of the development of technology and its relations with society and culture prior to the formation in 1958 of the Society for the History of Technology and the publication of its journal. Although the name of the organization (a recent affiliate of the AAAS) might indicate that it is concerned solely with history, the relations of technology with society and culture is such a broad topic that the society is interdisciplinary in scope, bringing together the engineer, the scientist, the industrialist, the social scientist, and the "humanist" to promote the study of developments which have influenced the civilizations of the past and which are creating the world of the future.

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-

troversy" 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.

MELVIN KRANZBERG
Case Institute of Technology, Cleveland, Ohio

Forthcoming Events

May

15–18. American Soc. of Maxillofacial Surgeons, Los Angeles, Calif. (E. C. Hinds, 1508 Medical Towers, Houston 25, Tex.)

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)

23–25. American Soc. for Quality Control, annual conv., San Francisco, Calif. (W. P. Youngclaus, Jr., ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.)

23–25. National Telemetering Conf., Santa Monica, Calif. (A. F. Denham,

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 ann 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, AIIE, 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)

June

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 International 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 Pardinas, 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

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.)

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 Elettronica, 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 Icthyologists 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 Richerche 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)

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

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed is included in the post card insert. Circle the department number of the items in which you are interested on this coupon.*

■ IMPEDANCE TESTER measures impedance, inductance, capacitance, phase shift, and related parameters. Measurements can be made at operating voltage and frequency. Frequency range is 30 to 20,000 cy/sec, and impedance range is 1 to 99,999 ohm. Circuit design permits high current to be imposed on test components, and direct current of 1 amp or higher can be superimposed on the a-c signal. Accuracy is said to be ±1 percent. (Western Electronic Products Co., Dept. Sci470, 655 Colman St., Altadena, Calif.)

■ TAPE-TENSION GAGE is designed to measure magnetic-tape tension on the supply-reel side as well as on the take-up-reel side of the manufacturer's recorder systems. Tape widths up to 1 in. are accommodated. Tension range is 2 to 40 oz and static calibration accuracy is said to be ±0.5 oz. (Consolidated Electrodynamics Corp., Dept. Sci483, 360 Sierra Madre Villa, Pasadena, Calif.)

■ 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 ±0.25°F with the proportional instruments and ±0.5°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 ⅝ 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

of full scale. Data are also displayed digitally and recorded on a strip chart. (Datex 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 sensitivity 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 ±5 μ. Dimensions of holes are programed 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 heavy 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

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°C/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

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 ft^3/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 μsec. 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 μsec. 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.)

■ *p*H 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 *p*H units can be applied anywhere over a standard calibrated range from 3 to 10 *p*H units that can be extended to 0 to 14. Accuracy is said to be ±0.002 *p*H when the buffer solution used to standardize the instrument is within 1 *p*H 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 CO_2 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.

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

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

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 meteorlogical 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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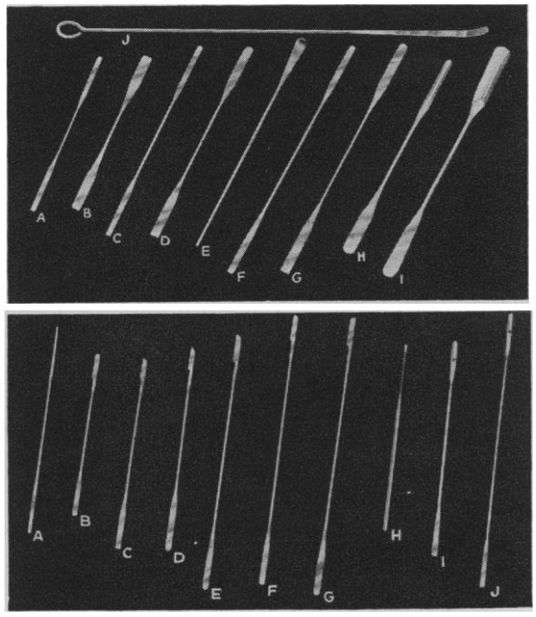

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E	One rounded, bent—One handle	130 x 6
F	One rounded—One square	150 x 3
G	One rounded—One square	150 x 5
H	One shovel type—One rounded	130 x 4(1)
I	One shovel type—One rounded	150 x 8(2)
J	One rounded, bent—One ring handle	240 x 5

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

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C	One square—One knife	150 x 3
D	One rounded, bent—One knife	150 x 4
E	One rounded—One knife	180 x 4
F	One rounded—One knife	200 x 4
G	One rounded—One "chopper"	200 x 4
H	One short, rounded—One round handle	140 x 2
I	One spoon—One square	160 x 3
J	One spoon—One square	210 x 3

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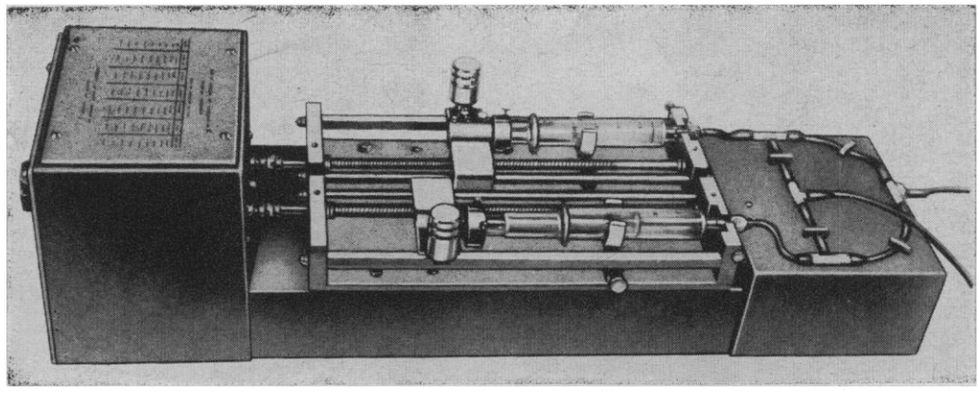

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values based on temperature alone to be of doubtful validity, presumably utilized normal mean period temperatures, which may include below-zero temperatures, when plants are inactive. Plant activity or growth is the same at −5°, −20°, or −40°C, so 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.

Further, the factors of insolation, humidity, and wind, which, if they differ, would be certain to alter the potential evapotranspiration readings for a given type of artificially established vegetation in distinct areas, are canceled out in natural vegetation by the evolved physiognomic changes in such characters as leaf size, leaf texture, and vegetation height. In fact, the physiognomic variations in natural vegetation provide the theoretical basis for the formula.

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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 4½ 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

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!

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Hello Out There (Project Ozma)

Twinkle, twinkle, little star,
  Out in space so very far.
If you're as bright as we think you are,
  Beam us a signal, little star.

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

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

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
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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

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. Postmortem examination of the brains of these birds revealed that the trigeminal