SCIENCE

13 April 1962

Vol. 136, No. 3511

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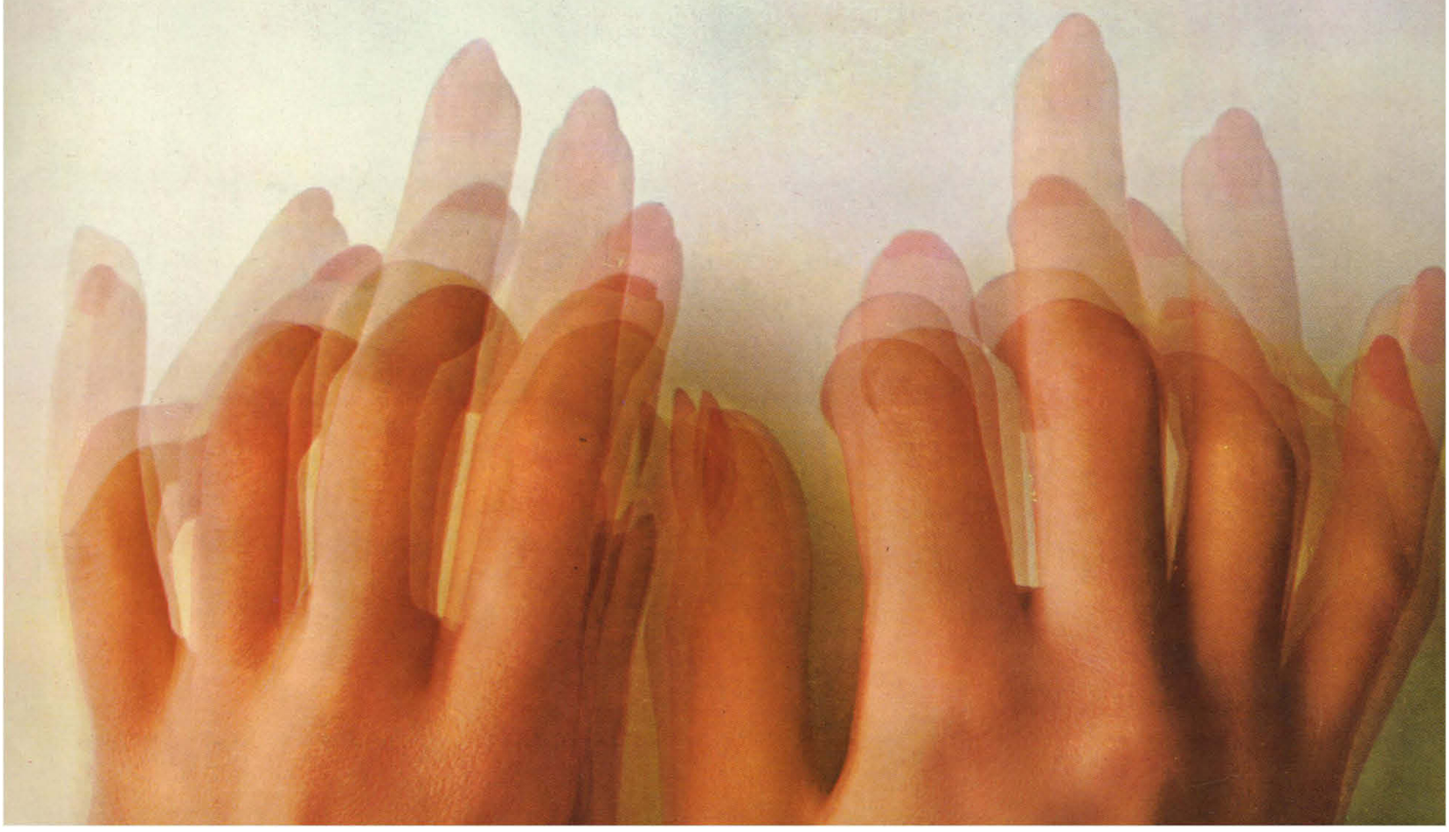

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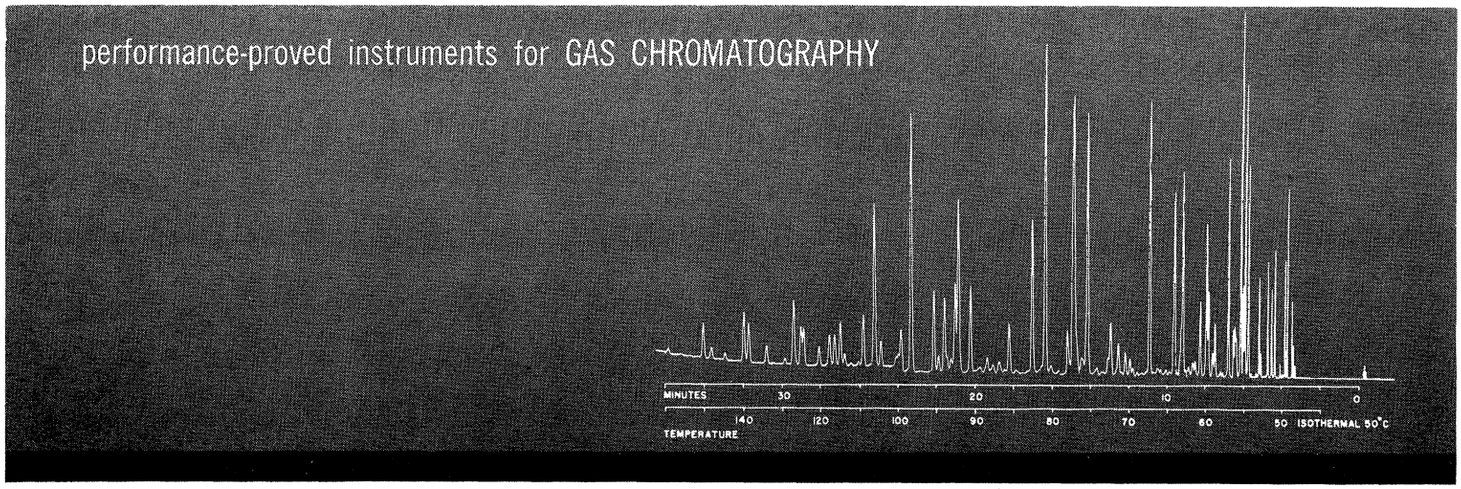

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Baby lemur (*Lemur fulvus rufus*), aged 3 weeks, born in the laboratory of the department of anthropology at Yale University in the spring of 1961. It is thought to be the first lemur born and reared in the United States. [John Buettner-Janusch, Yale University]

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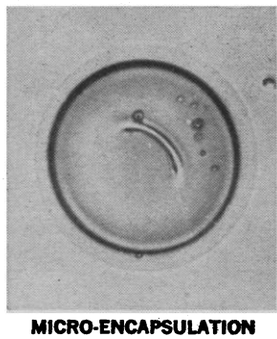

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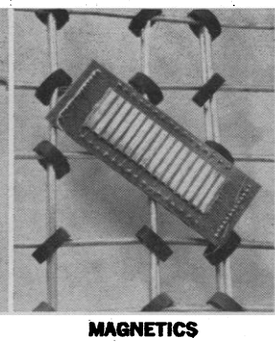

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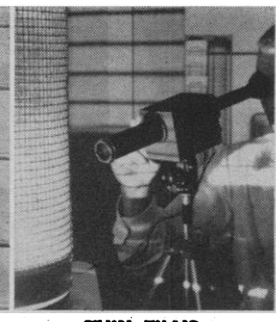

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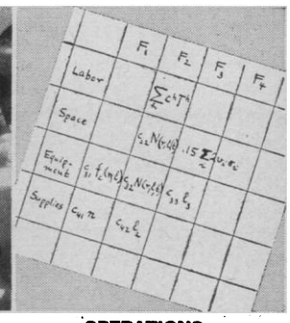

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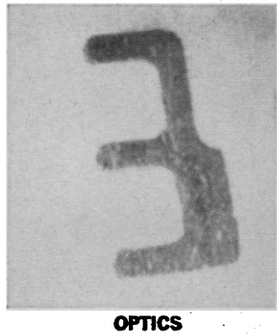

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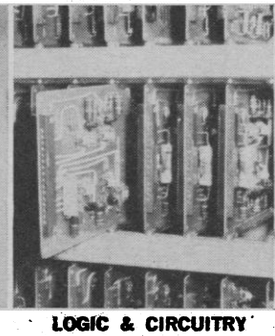

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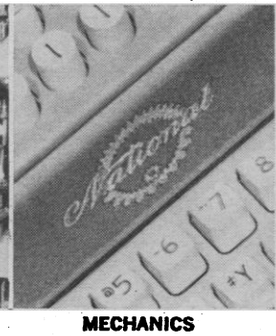

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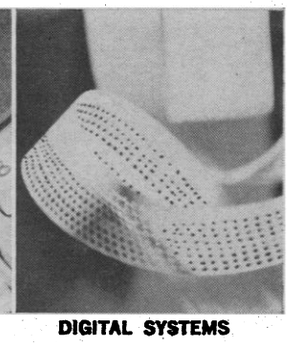

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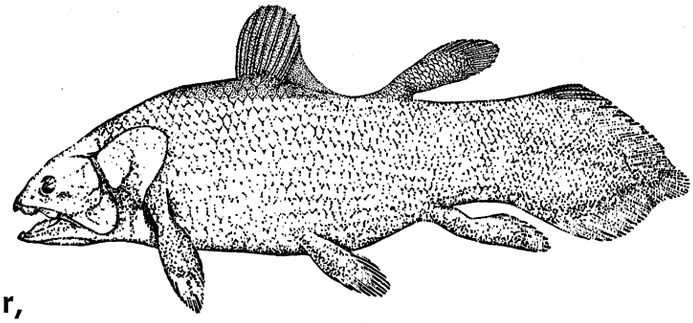

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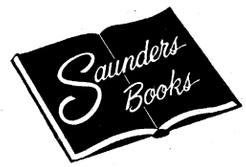

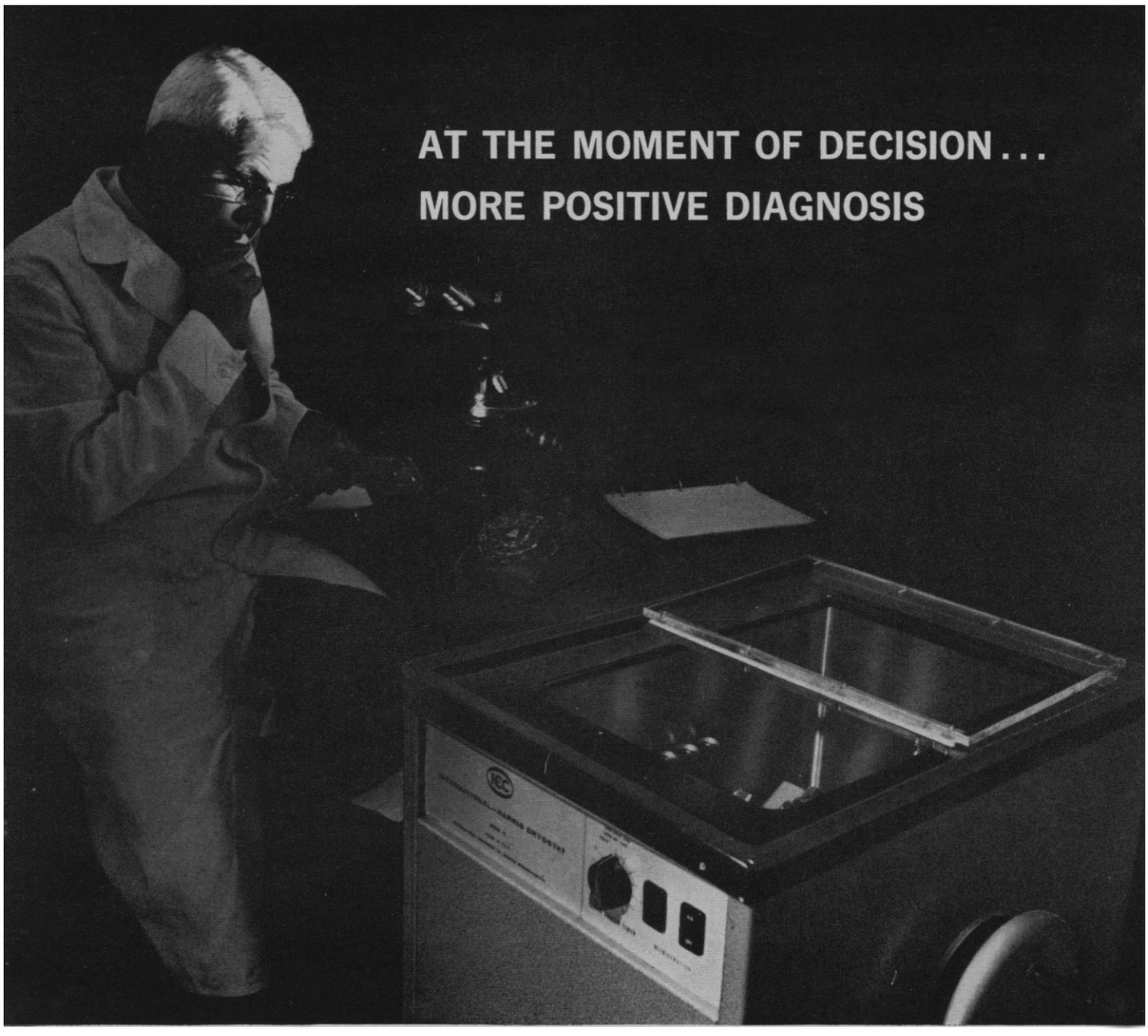

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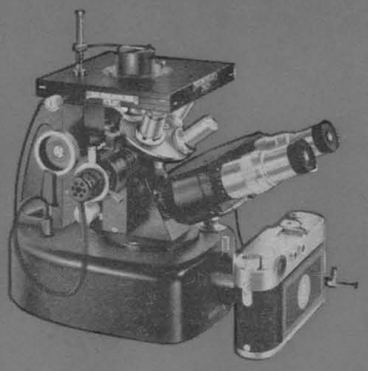

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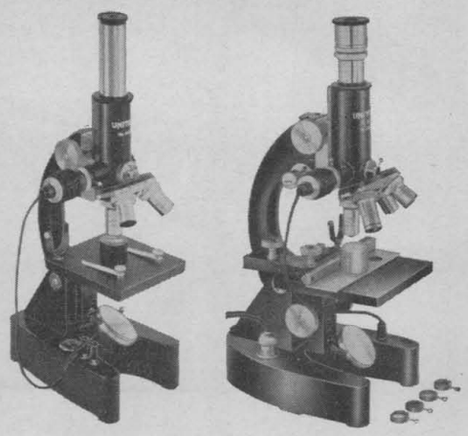

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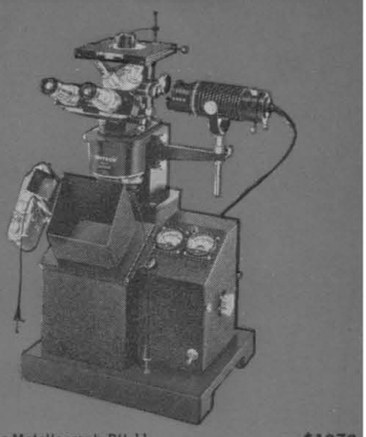

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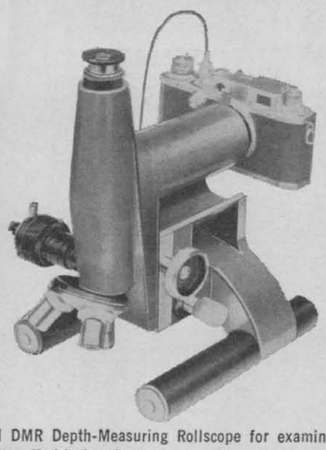

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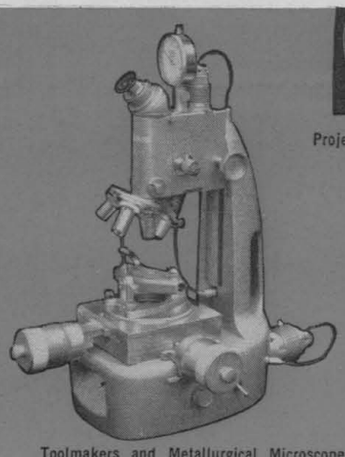

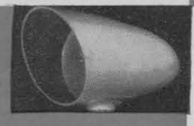

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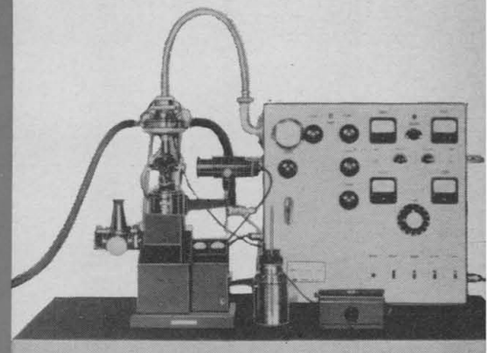

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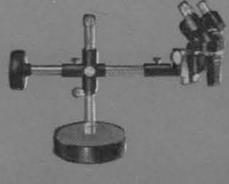

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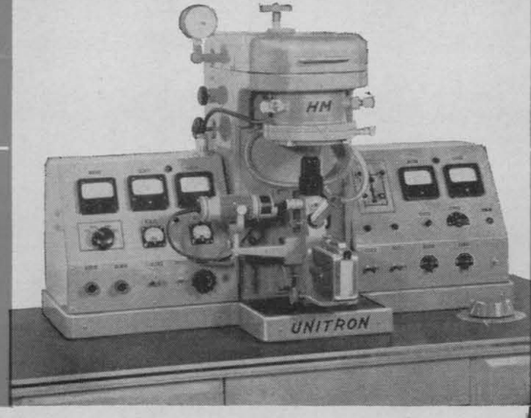

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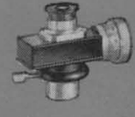

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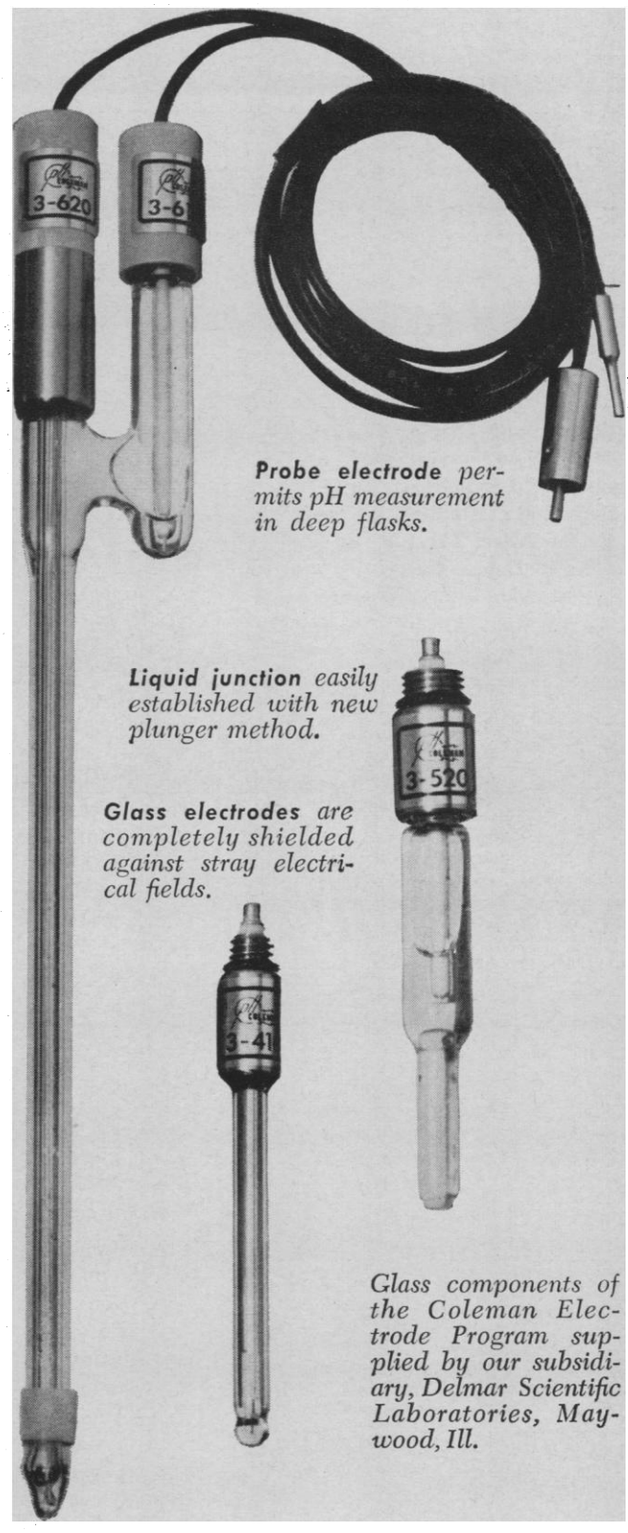

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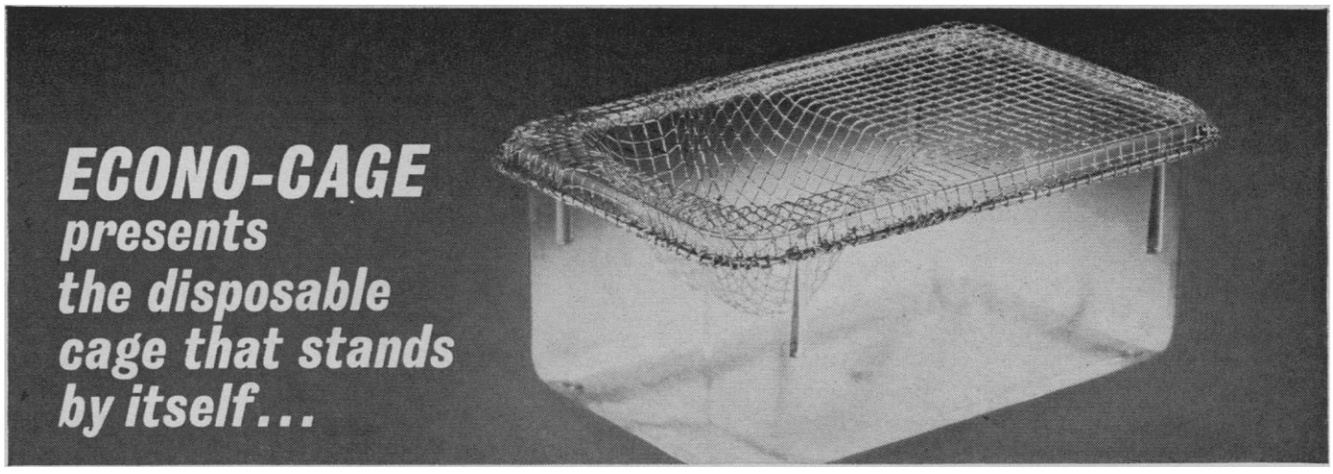

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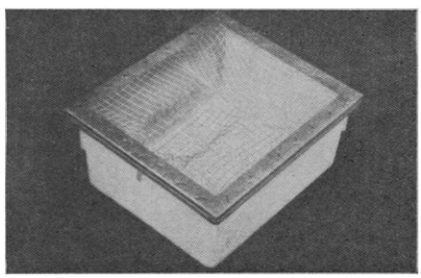

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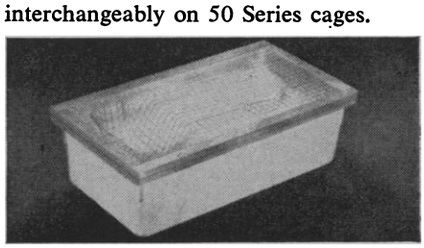

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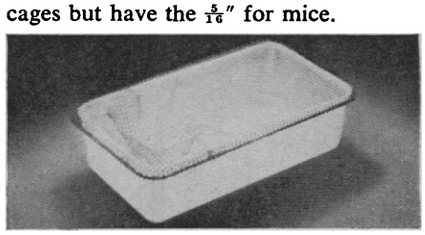

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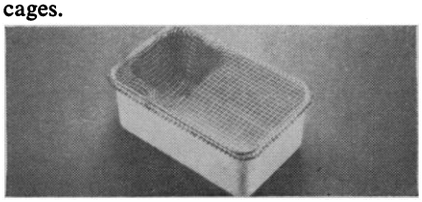

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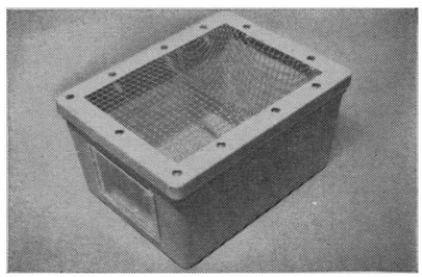
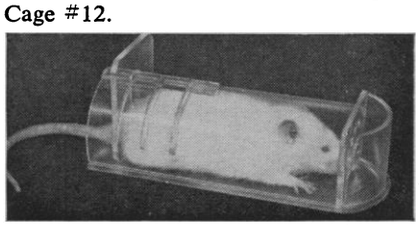
Econo-Cages in the 20 Series are designed primarily for mice. Over-all dimensions of the cages are 11½" X 7½" X 5". This cage is used for housing animals during experimentation and also as a one-to-one and two-to-one breeding cage. The cages are available in Polystyrene – new disposable Econo-Cage #21, Fiberglass, reinforced plastic – Econo-Cage #22, clear Styrene-Acrylonitrile Copolymer – Econo-Cage #23, transculent Linear Polyethylene—Econo-Cage #24, autoclavable Polypropylene—Econo-Cage #25 and Polycarbonate Resin—Econo-Cage #27. All 20 Series lids are interchangeable on 20 Series cages.



GENERAL PURPOSE ECONO-CAGE #12

Over-all dimensions of the Econo-Cage general purpose unit are 11½" X 8" X 6" deep. This cage is designed especially for laboratories with changing animal use requirements. It can be used to house mice, Hamsters, rats and guinea pigs. Because of its versatility, it is ideal in teaching situations. The cage is available with or without windows. It is made of fiberglass reinforced polyester plastic. All #12 lids can be used on General Purpose Cage #12.



ECONO-RESTRAINING CAGES #90 SERIES

The small Restraining Cage #88 can be varied from 2" to 3½" in length and is 1¼" wide. Econo-Cage #90 can be varied from 4½" to 6" in length and is 2½" wide. Econo-Cage #91 can be varied from 5" to 7" in length and is 3" wide. All these units can be cleaned chemically or with hot water. They are not autoclavable.

FOR MORE INFORMATION ABOUT THE LINE THAT STANDS BY ITSELF, write:

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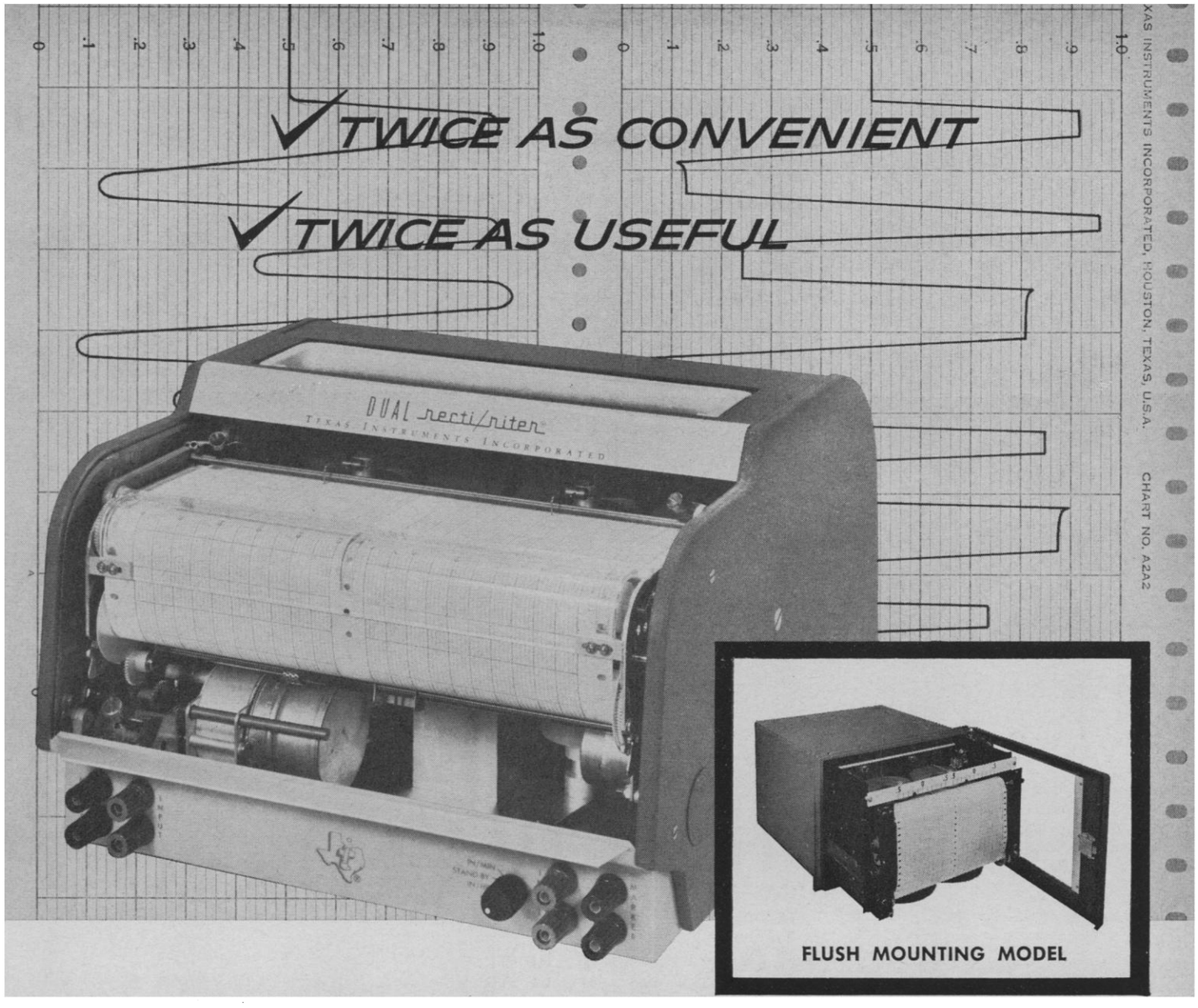

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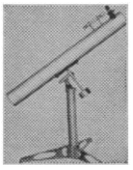

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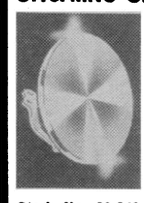

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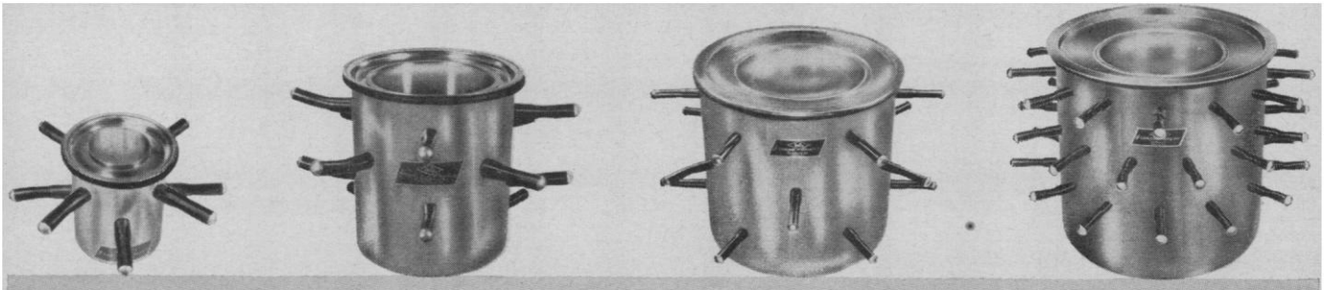

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For the research laboratory, VirTis dry ice refrigerated manifold style freeze-dryers offer the greatest flexibility. Samples can be introduced or withdrawn from the vacuum system without interference to other samples — ampoules can be heat sealed under the original vacuum — drying rates are visually observed. Fabrication is entirely in 18-8 stainless steel. The center well in each instrument serves the double function of convenient cold bath for pre-freezing samples as well as water vapor condenser during freeze-drying. Center wells are removable for maximum ease in de-icing and cleaning.

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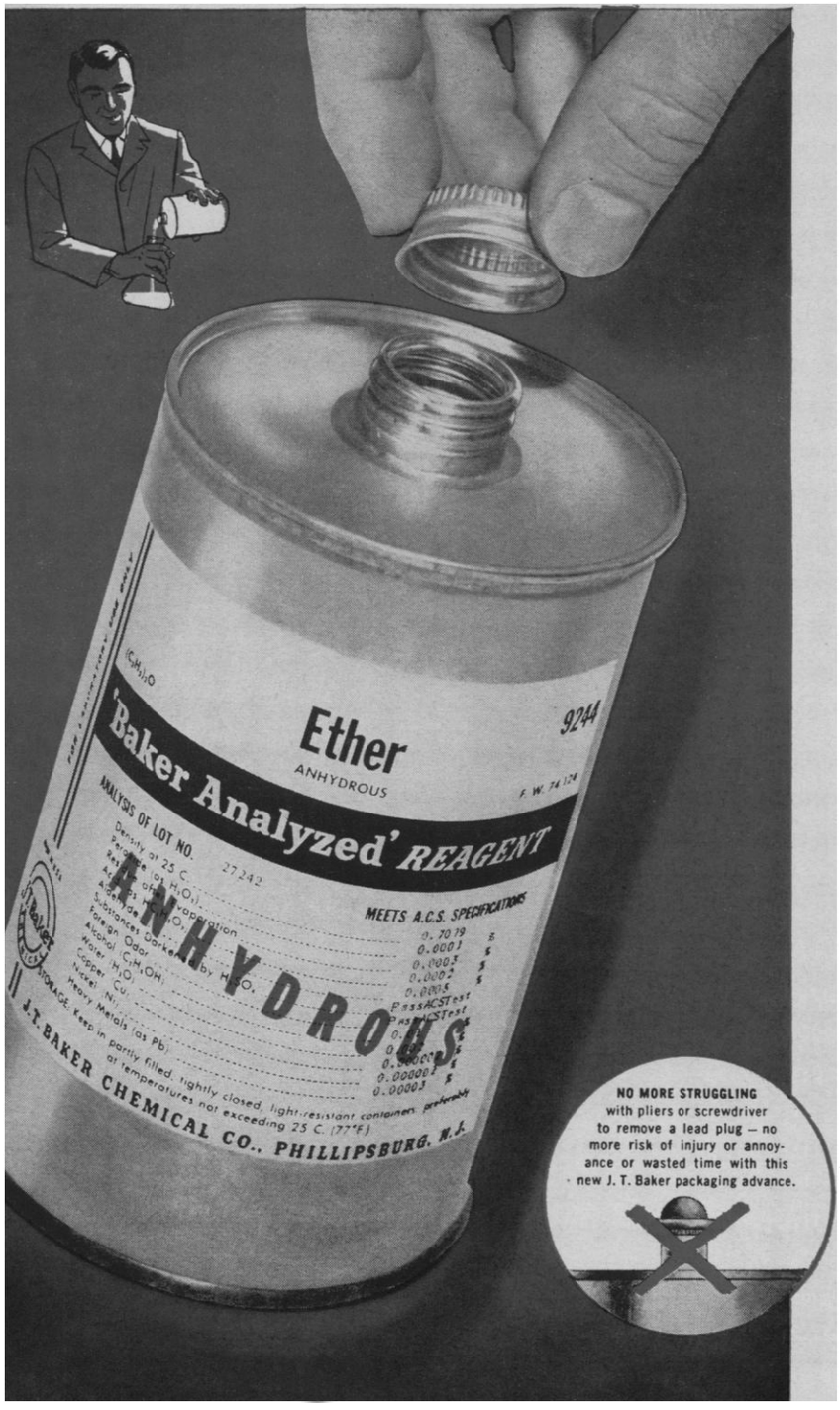

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- **Exclusive leak-proof, vapor-proof, cap-liner.**
- **No ether loss on lab shelf, no contamination.**
- **Easy pouring from the large, smooth-edged opening.**
- **Safe, easy to open. No sharp-edged tool needed, no risk of injury.**

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Ether 'Baker Analyzed' Reagent
Ether 'Baker Analyzed' Reagent Anhydrous
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* Patent applied for

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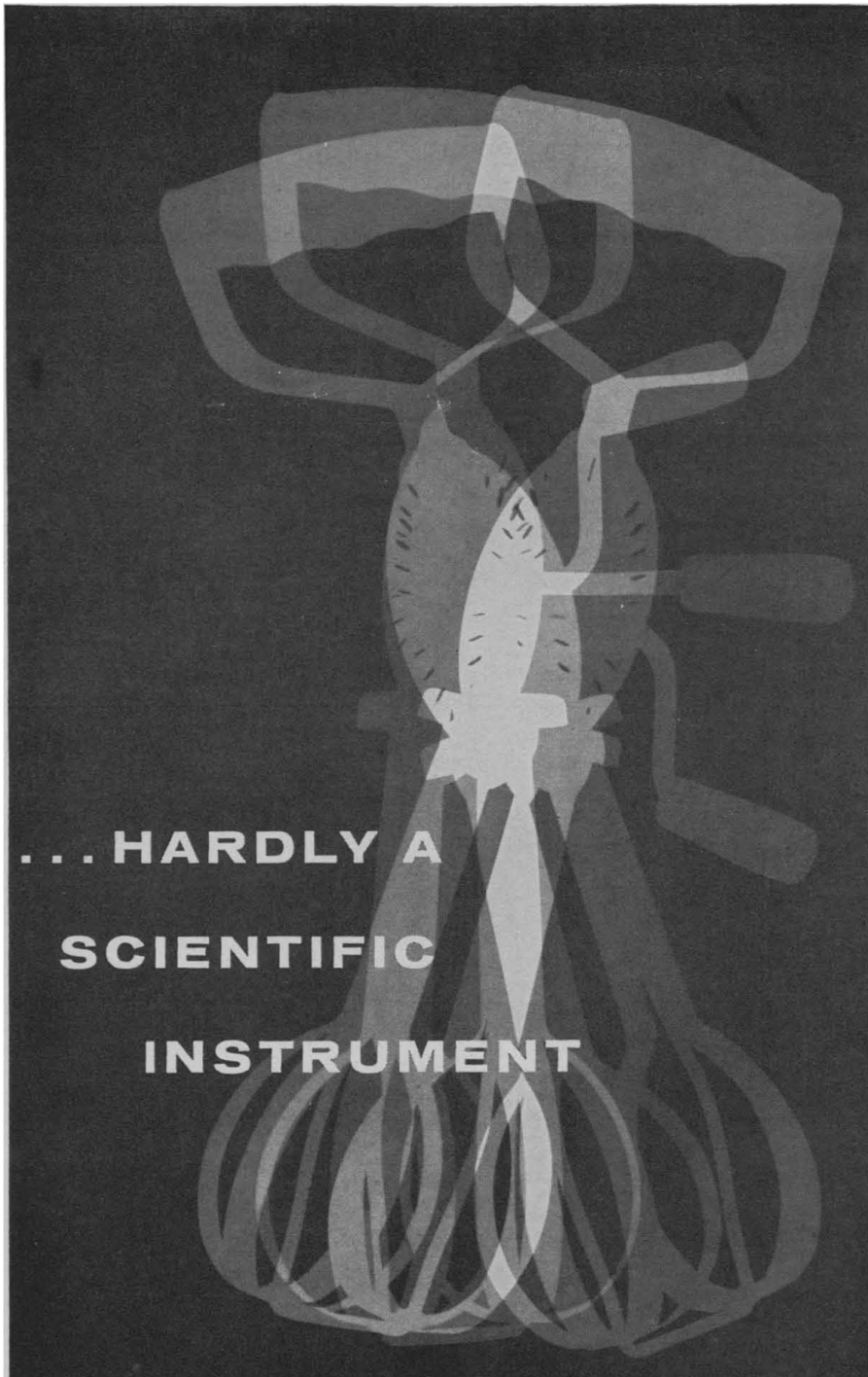

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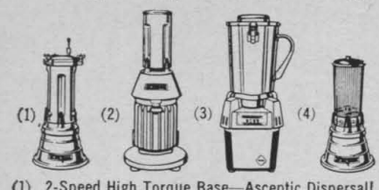

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(2) Explosion Proof Base—Stainless Steel Container
(3) 3-Speed Heavy Duty Base—Stainless Container
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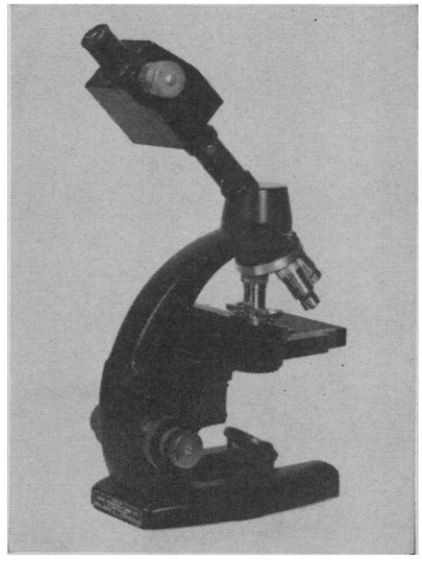
Particle Size Analysis and Precise Measurement

The New Cooke-A.E.I. Image Splitting Microscope (Patent Applied For)



Inaccuracies in measurements made under the microscope are nearly always due to uncertainty as to the precise location of the reference line used (either the wire of a filar micrometer eyepiece or the graduations on a graticule). Location of the reference line at the very edge of an object is inherently difficult, tiresome, time-consuming and rarely is the location precisely the same from operator to operator.

With the new Cooke-A.E.I. Image Splitting Microscope measuring settings of a type to be described can be made easily, with extreme precision and unequalled operator-to-operator repeatability. Here, briefly stated, are some of the characteristics of the instrument:

1. Measuring accuracy is as high as 0.125μ (0.000005″), depending upon the Numerical Aperture of the objective in use.

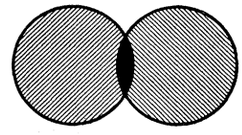
2. Comparative measurements can be made *without actually measuring.* Operator can determine at a glance which particles in a field are larger than, smaller than or equal to a particular dimension.

3. Rigidity of the microscope, or a lack thereof, does not affect accuracy. Measurements can even be made on slowly moving objects.

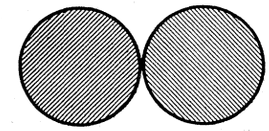
The Image Splitting Microscope consists essentially of a special prism assembly mounted in a conventional compound microscope system. Prisms are linked to a micrometer screw by means of which their angular relation to each other can be varied. When the prism faces are parallel to each other, two images of the object, exactly superimposed and appearing as one, will be visible in the eyepiece. As the micrometer screw is turned the images move (or shear) across each other. Four different relations of the two images are possible:

A 

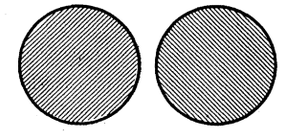
Double images of object, exactly superimposed. Prism faces parallel – zero shear.

B 

Images of object overlapping. Amount of shear less than object dimension.

C 

Images of object just touching. Amount of shear equal to object dimension.

D 

Images of object apart. Amount of shear greater than object dimension.

The edge-to-edge setting (as in C) is made with great precision, since both images are of identical appearance and sharpness and the transition from bright to dark in the area between the images is very distinct. To avoid confusion in a crowded field of view color filters can be introduced, coloring the two images distinctively.

To make an exact measurement, setting is made to the relation C, then to the reversed relation C and the total amount of micrometer run read off. Calibration of this value for the various magnifications produced by the microscope system is routine. With calibration the amount of micrometer screw shear is readily converted into an absolute measurement. Figures B, C and D show how the comparative "measurements", mentioned under 2. above and of such value in particle size analyses, are made.

Table 1. Performance Data

Objective Power (1.5X Magnification Factor in Prism System)	Reading Accuracy		Maximum size object which can be completely sheared (10X eyepiece in use)	
3X (N.A. 0.1)	0.0001″	2.5μ	0.06″	1.5mm
5X (N.A. 0.15)	0.00008″	2.0μ	0.04″	1.0mm
10X (N.A. 0.28)	0.00004″	1.0μ	0.02″	0.5mm
20X (N.A. 0.50)	0.000026″	0.6μ	0.01″	0.25mm
40X (N.A. 0.65)	0.0000128″	0.325μ	0.005″	0.12mm
100X (N.A. 1.30)	0.000005″	0.125μ	0.0025″	0.06mm

Note 1. Under very favorable conditions estimations can be made to twice the above accuracies.

Note 2. It is possible to detect conditions of image overlap indicating values so small that they cannot be measured with the micrometer. (For instance, small variations in diameter of fine wires or rods.)

References

DYSON, J. *Precise Measurement by Image Splitting*, J. Opt. Soc. Amer. **50** 754, 1960

DUFFEY, F. C. H. *Optical Methods of Helix Measurement for the VX4164 Travelling Wave Tube*, A. E. I. Rugby Research Laboratory Report L4758

BARER, R. *A New Micrometer Microscope*, Nature, **188** No. 4748 29 Oct. 1960

DYSON, J. *The Precise Measurement of Small Objects*, A. E. I. Engineering **1** No. 1 January 1961

Headline is seen through this untouched photograph of 500 ml bottle of pooled calf serum.

Quality-conscious investigators have praised the exceptional clarity of Flow Laboratories' pooled calf serum. The serum is collected from the jugular veins of freshly slaughtered calves, with stomach fluid contamination carefully excluded. Processing is completed within 12 to 24 hours by refrigerated continuous-flow centrifugation and Millipore filtration. ***Sterilization is accomplished by filtration through a 0.22 micron pore size.***

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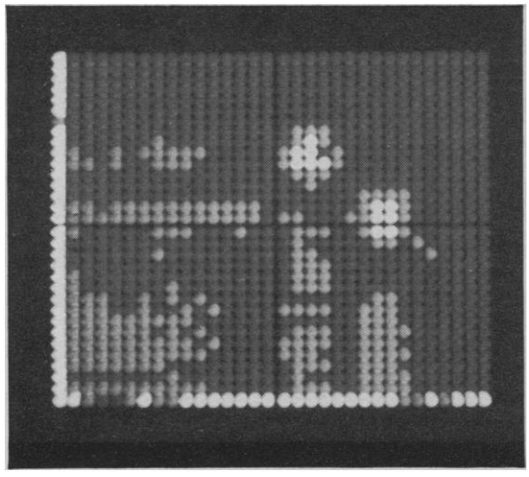

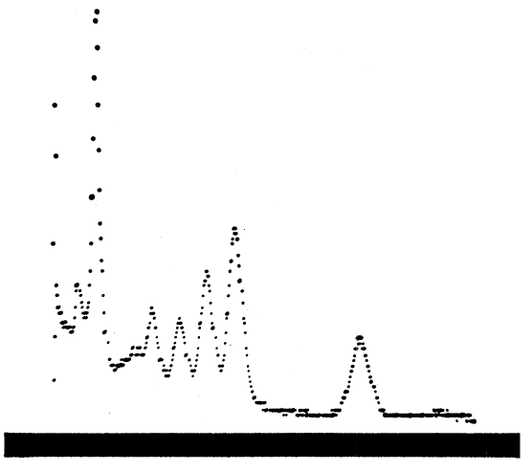

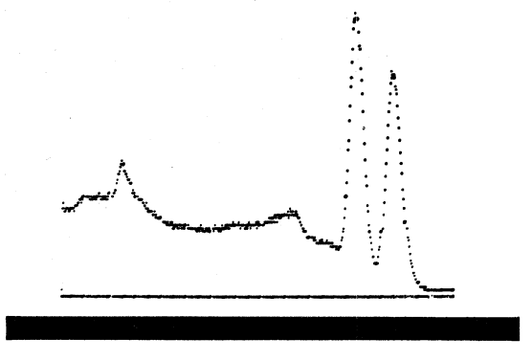

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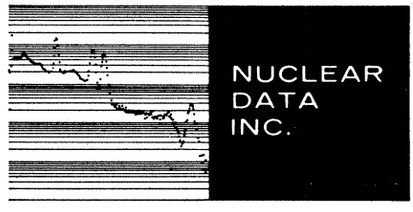

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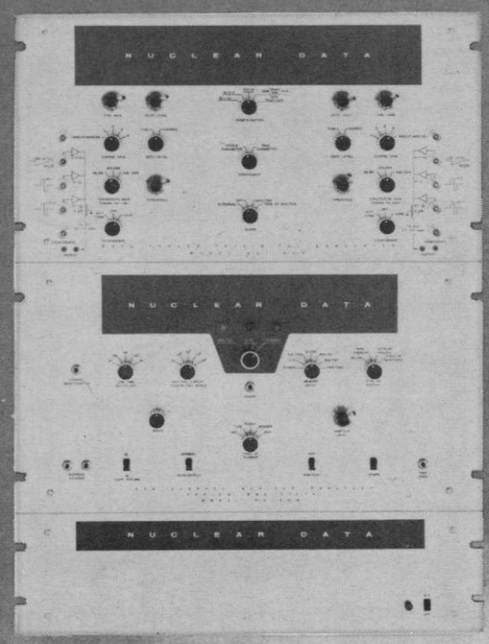

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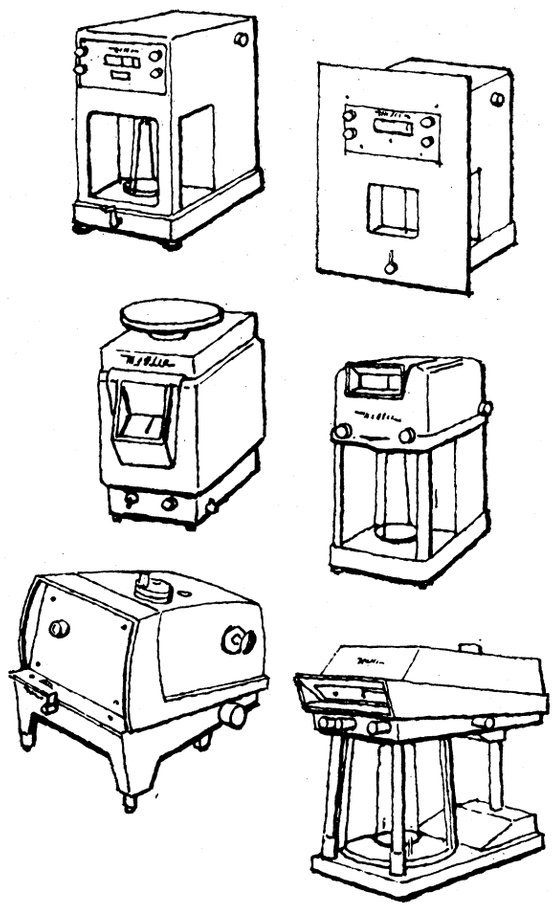

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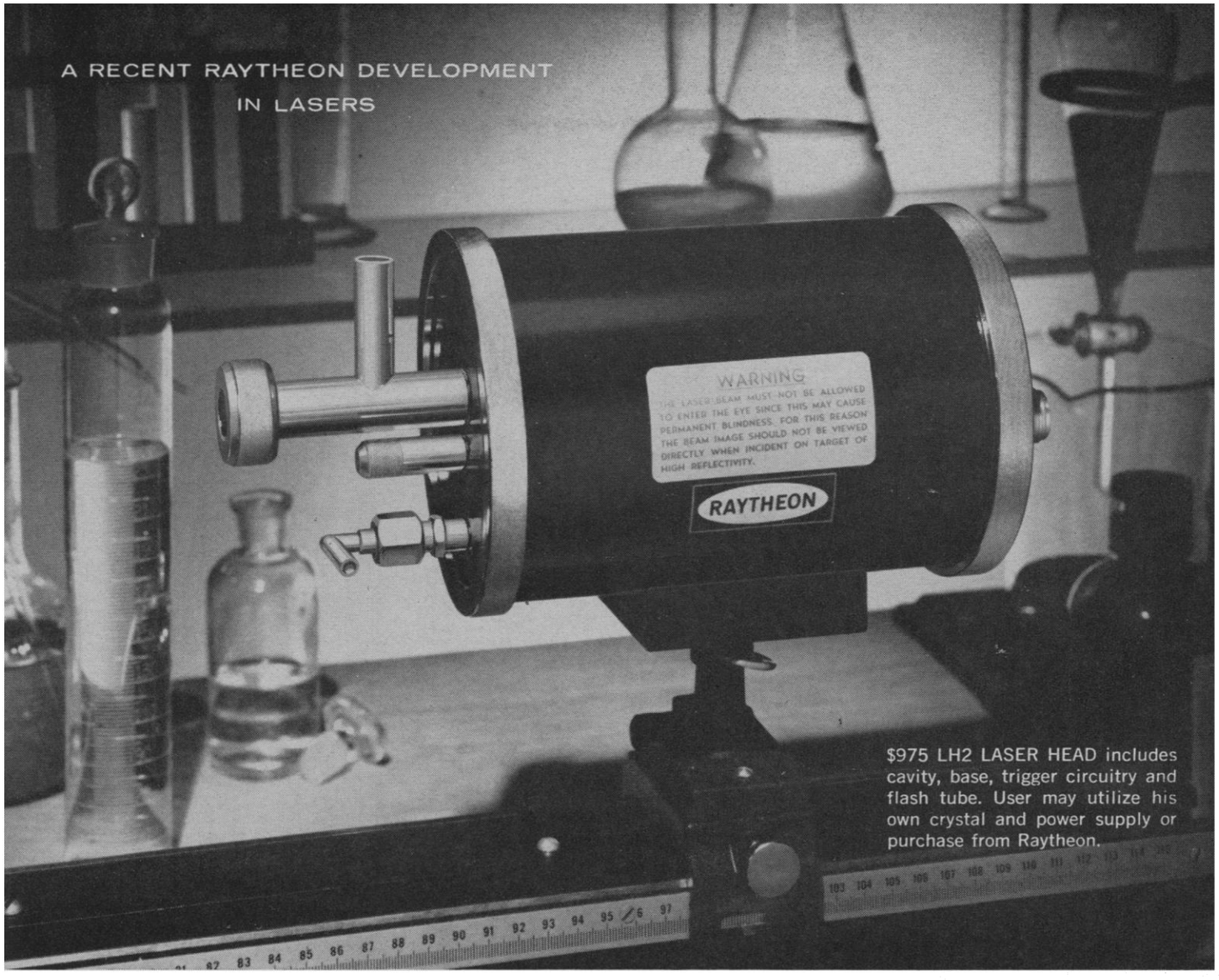

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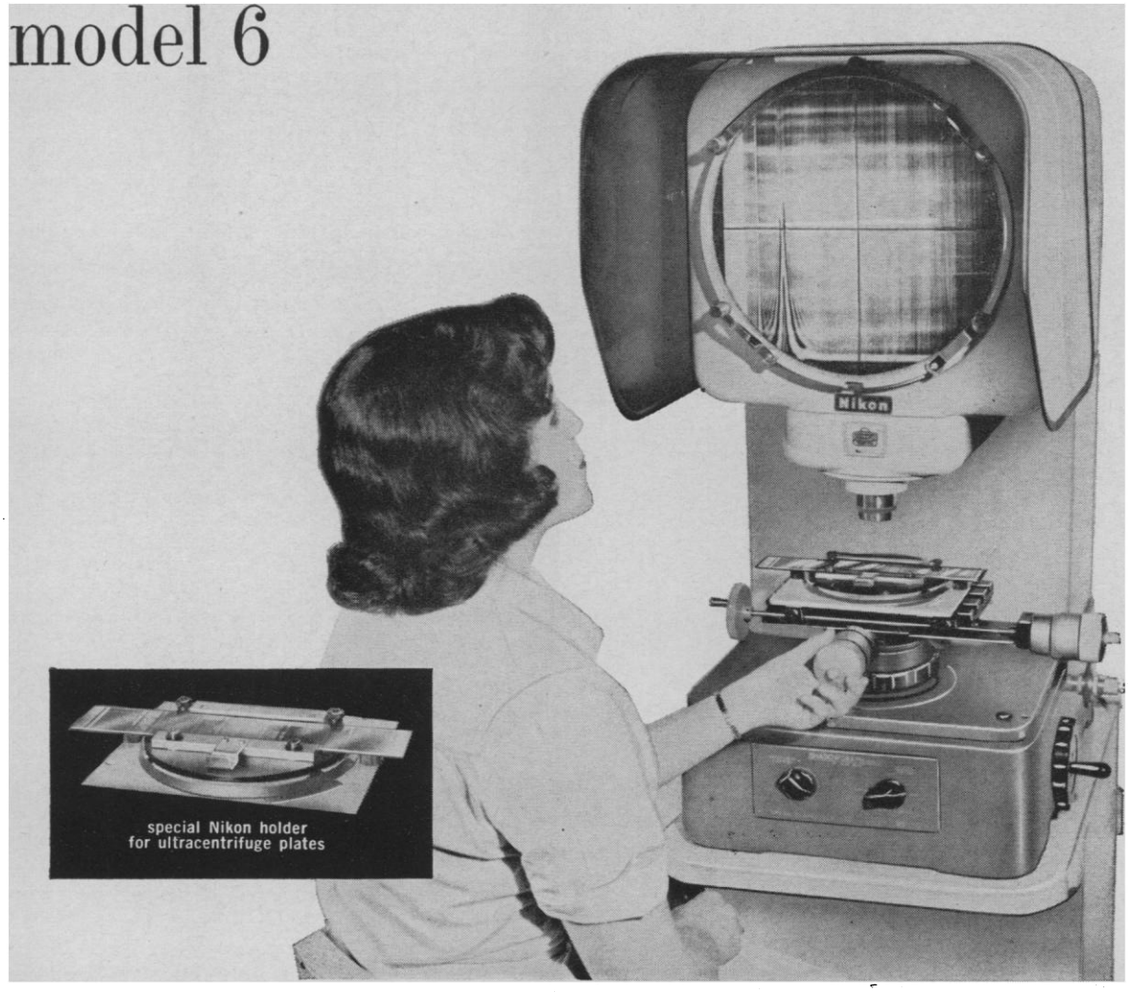

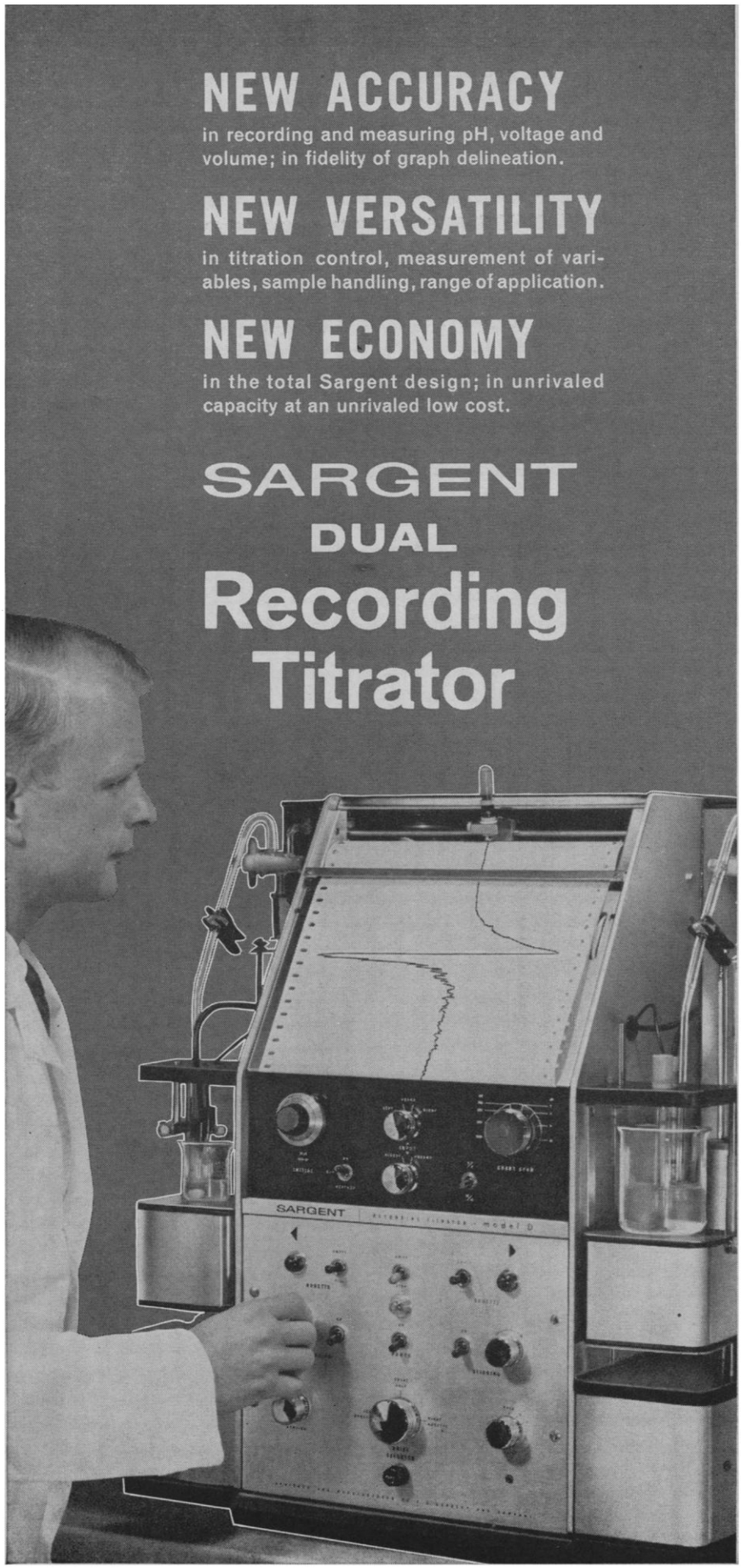

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Scale span: 1, 2, 5, 10 pH units and 100, 200, 500, 1000 millivolts.

Scale accuracy: ¼ percent.

Bridge power: mercury batteries.

Scale width: 240 mm, graduated in 100 units.

Displacement: continuously adjustable, direct reading to 10 pH units or 1000 millivolts plus and minus.

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Drive speeds: controlled automatic, fast constant and slow constant. Charts and burettes synchronized.

Burettes: motorized, precision, glass, displacement type with interchangeable 50 ml and 10 ml plungers and barrels, with fast refilling and flushing motors and automatic safety switches.

Delivery rates: approximately 10 ml per minute maximum, 1/15 ml per minute minimum.

Burette accuracy: 1/10 percent.

Stirring: magnetic variable speed.

Balancing speed: 3⅓ seconds full scale.

Automatic stop: precisely adjustable, cam actuated with ¼ scale overrun, restarting, repeating.

Polarizing adapters: interchangeable, plug in, mercury battery powered.

Burette fittings: interchangeable, duplicate for either flexible tubing or all glass interconnection, the latter with standard taper and ball joint unions and Teflon stopcock plugs.

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Beaker supports: swinging, height adjustable, with self-contained stirring motors.

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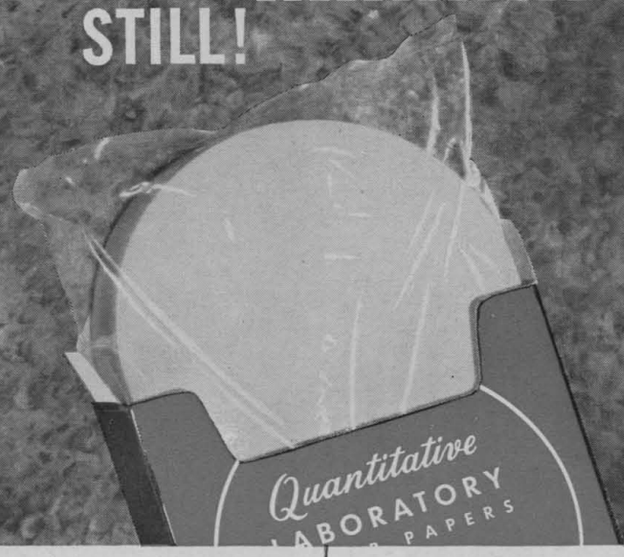

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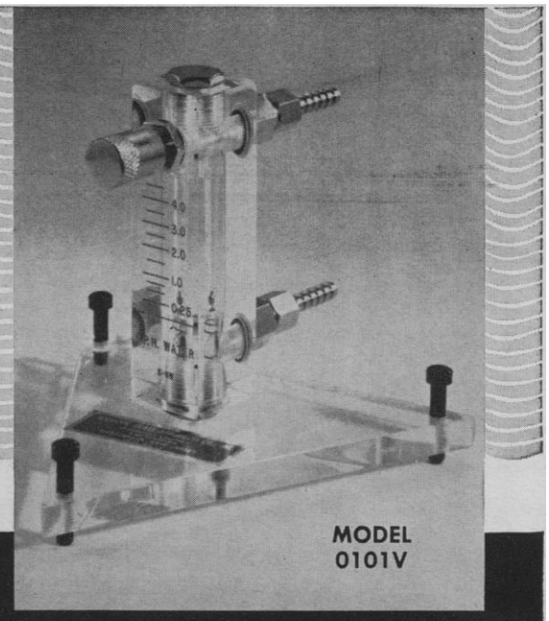
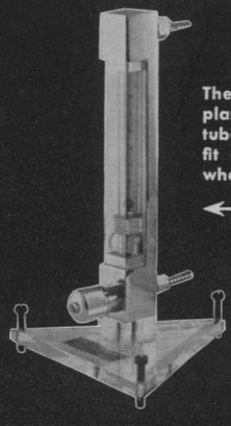
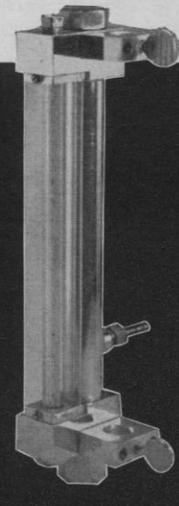
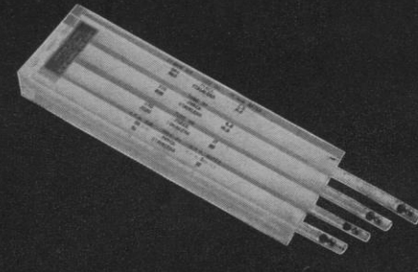




These two units have acrylic plastic cases for housing the tubes or elements. The cases fit on back of the Flowmeters when not in use.





Model K-0305-150 Kit . . . with easy-out tube feature. Measures a wide range of flows. The four metering tubes are interchangeable.

Model K-DM-5 Kit . . . for measuring and reproducing low gas flow rates. Uses, interchangeably, four metering elements covering a flow range of 0.1 cc/min to 2.75 CFH air.

Model "A" Kit . . . for extremely corrosive liquids or gases requiring all-glass tubing. Each tube has a 0-150 scale with 1 mm. fused graduations.

These four flowmeters are featured in "What's New" No. 46, sent on request. All are of novel design, all are precisely calibrated, and all are easy to read. Because of limited space, we are presenting information here on Model 0101V only.

Model 0101V is a little purge meter encased in a solid block of clear, shatterproof, acrylic plastic. A built-in valve permits convenient control of all flow settings. The scale is permanently etched in red. The metering tube (reamed into the meter body) is about 40 mm. long. Stainless steel springs serve as float stops. All threads are ⅛" N.P.T. Operating pressure is 100 PSI at 70°F, operating temperature 160°F. The meter is supplied with base and chromed hose ends. Buna-N O-rings prevent leakage.

MODEL 0101V—CATALOG NO. F-7240X

Tube and Float No.	1PA	1SA	2PA	2PW	2PC	2SA	3PW	3SA	3SW	4SC	5SA	5SW	5SC
Dia. of Tube	1/16"	1/16"	1/8"	1/8"	1/8"	1/8"	5/32"	5/32"	5/32"	7/32"	1/4"	1/4"	1/4"
GPH Water	—	—	—	0.01-0.24	—	—	0.1-2.0	—	0.25-4.5	—	—	1.0-20	—
CC/MIN Water	—	—	—	—	1.0-18	—	—	—	—	20-400	—	—	100-1300
SCFH Air	0.01-0.20	0.05-0.60	0.1-2.0	—	- -	0.25-4.0	—	1.0-20	—	—	5.0-90	—	—
Each	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50	$16.50

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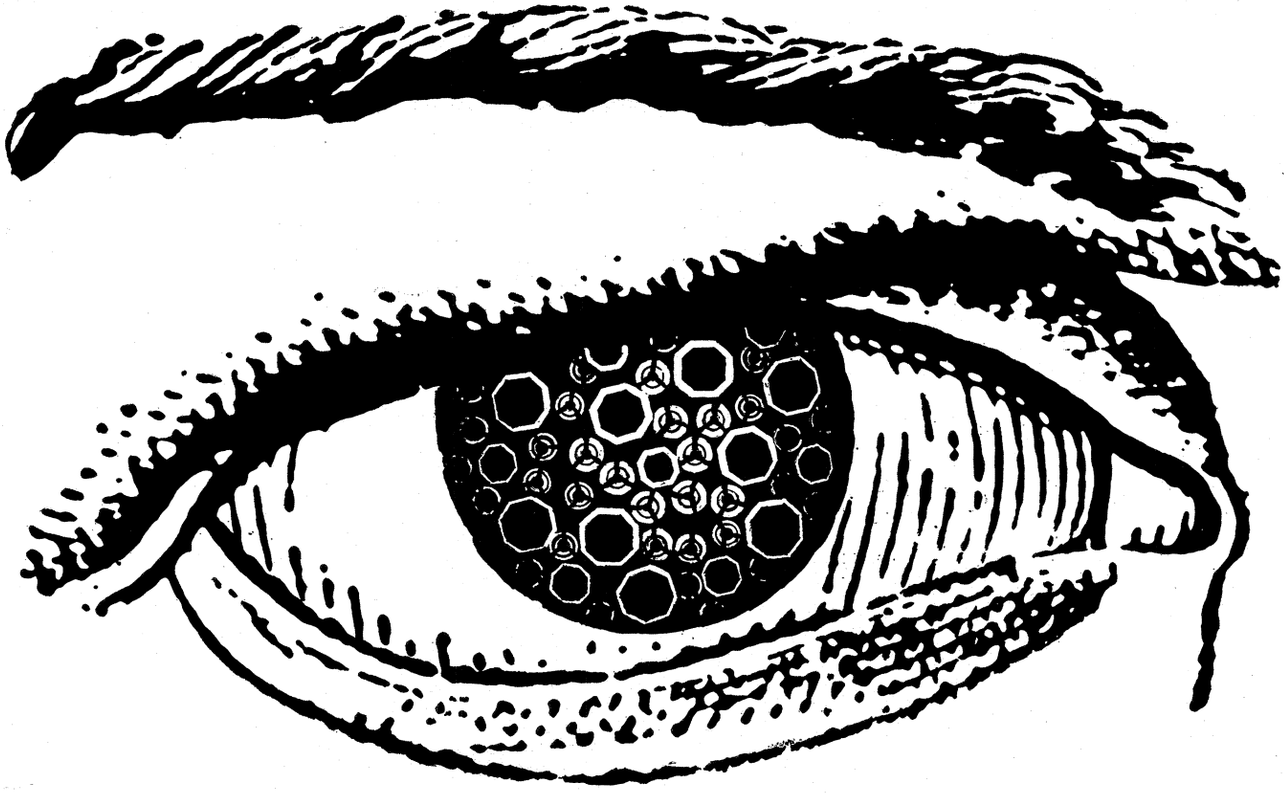

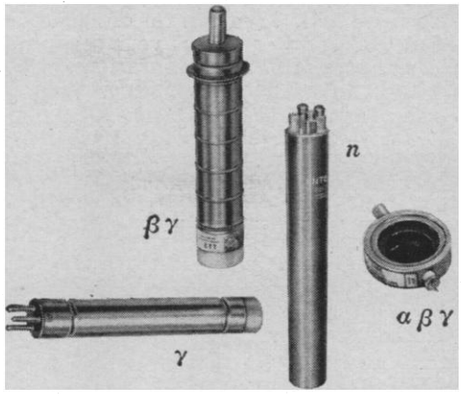

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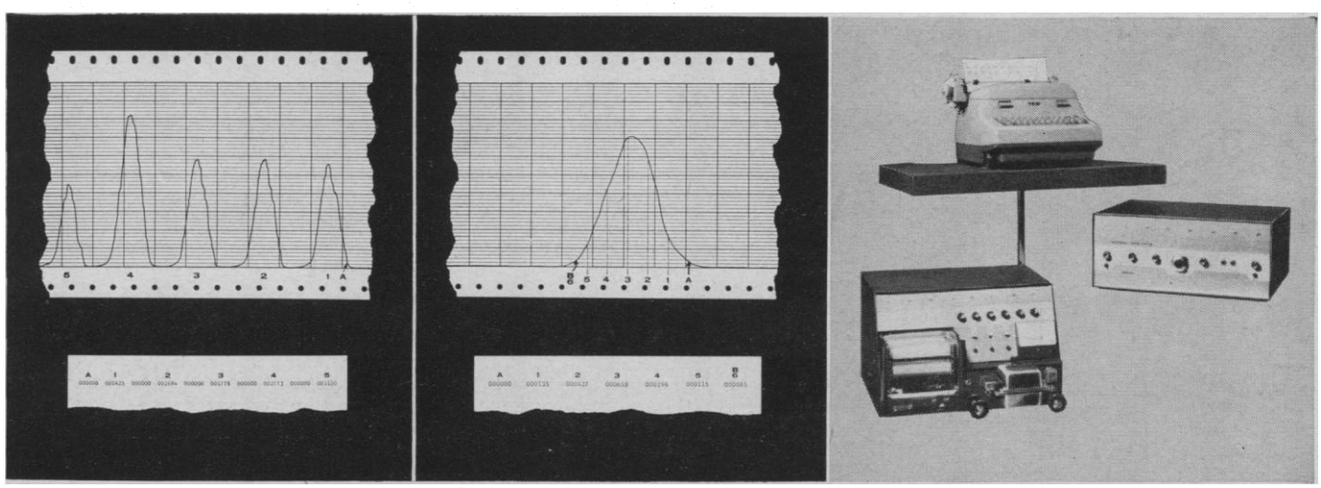
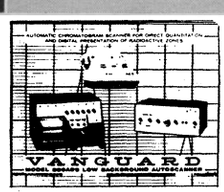


Shown above are the two modes of Data Presentation available with the model 880ADS. Digital information obtained in the Peak Print mode (left) and the Interval Print mode (right) is utilized through all phases of the quantitating procedure.



WRITE FOR THIS BOOKLET . . . Outlines distinctive features and operational characteristics of the Vanguard Model 880ADS Low Background AUTOSCANNER.

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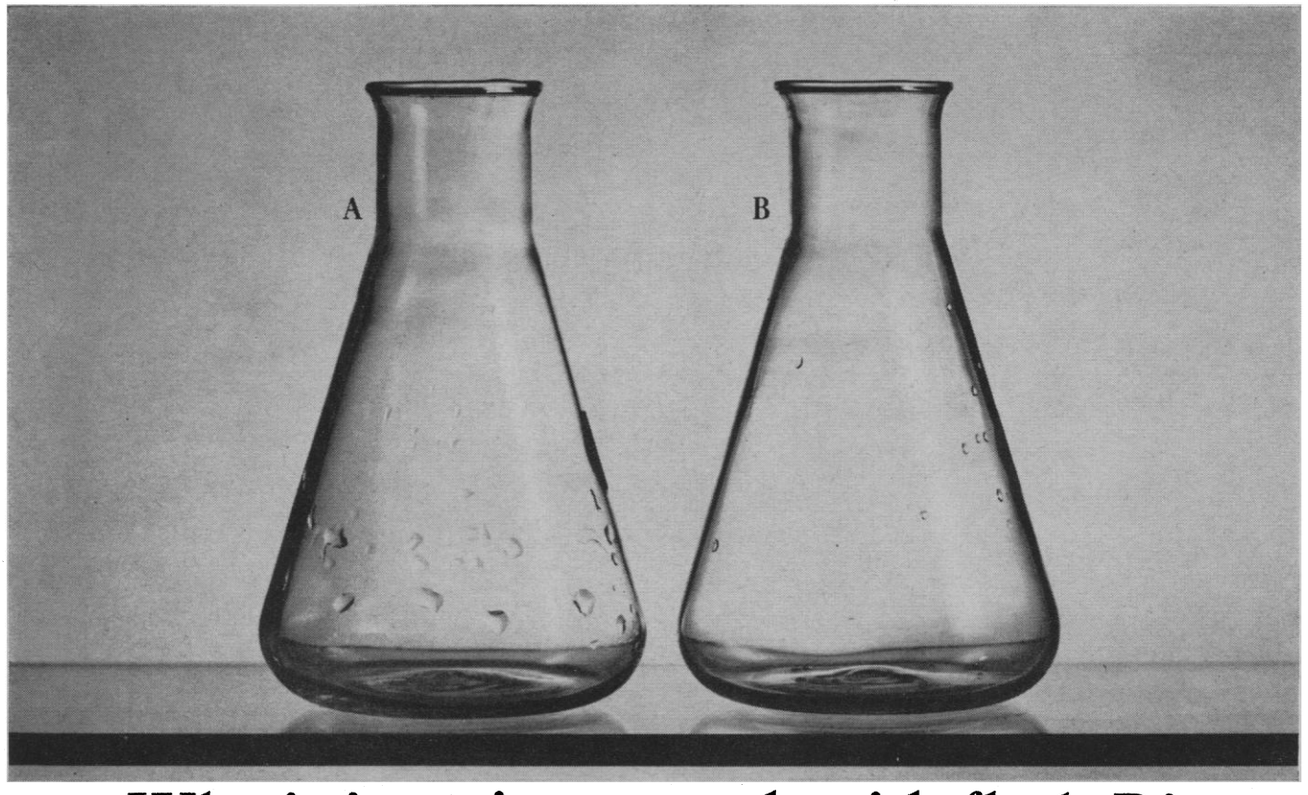

Why is it easier to work with flask B?

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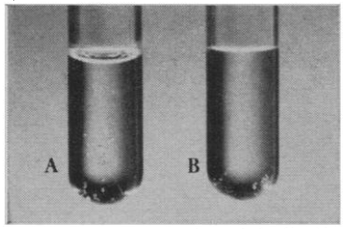

Just where is the surface of the liquid in tube A? With ordinary meniscus surface you can't be sure. In Siliclad-treated tube B liquid forms flat surface, allows more accurate determination.

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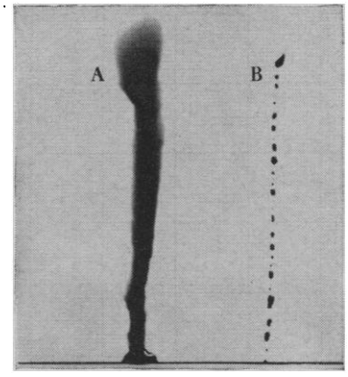
Siliclad-treated surfaces resist heat, moisture, and most common chemicals. Use it for treating ceramic, metal, and plastic surfaces and also for glass and rubber. Siliclad coating resists extreme temperature changes and oxidation. It is nontoxic to body tissues.

Siliclad, when diluted with ordinary tap water, makes 25 pints of solution.

**Note:* Siliclad should not be used for glass items which depend on capillary action or adhesion to perform properly.



ACTUAL PHOTOGRAPH

Equal amounts of blood dropped simultaneously on glass plate at 90° angle.
A. Blood on untreated surface clings to glass, spreads slowly down glass, pools at bottom edge.
B. Blood on Siliclad-treated surface runs down glass plate immediately. Does not cling, stick, or pool at bottom edge of plate. Gentle tapping of glass plate removes few "beads" remaining.

References: (1) Levin, H. L.: Milit. Med. *121*:397 (Dec.) 1957. (2) Harkins, G. A.: J. Thoracic & Cardiovas. Surg. *40*:549 (Oct.) 1960. (3) Cantor, M. O.: Am. J. Surg. *100*:584 (Oct.) 1960.

Price: Siliclad Concentrate, 4-oz. bottle, each $4.00; 1 doz. 4-oz. bottles, $40.00.

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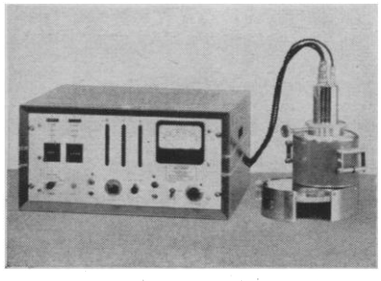

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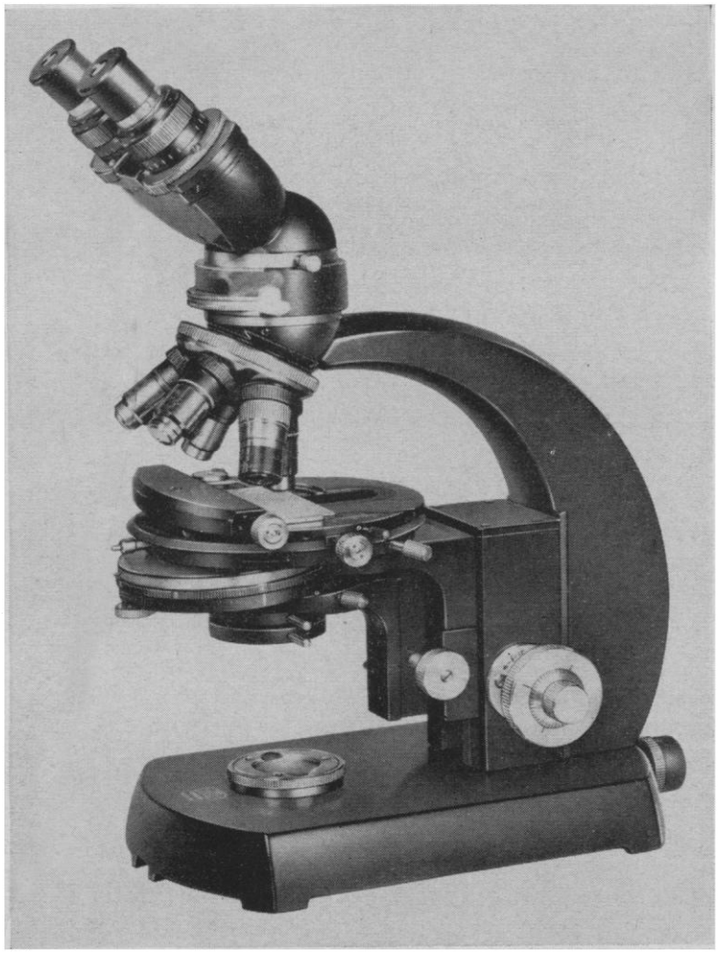

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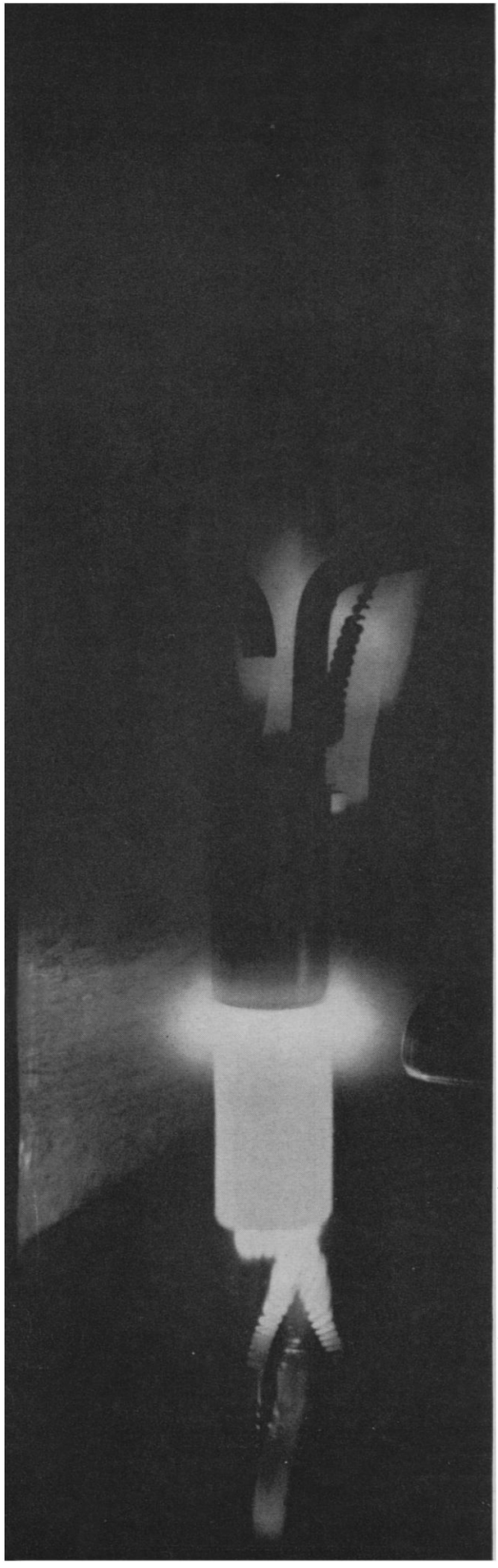

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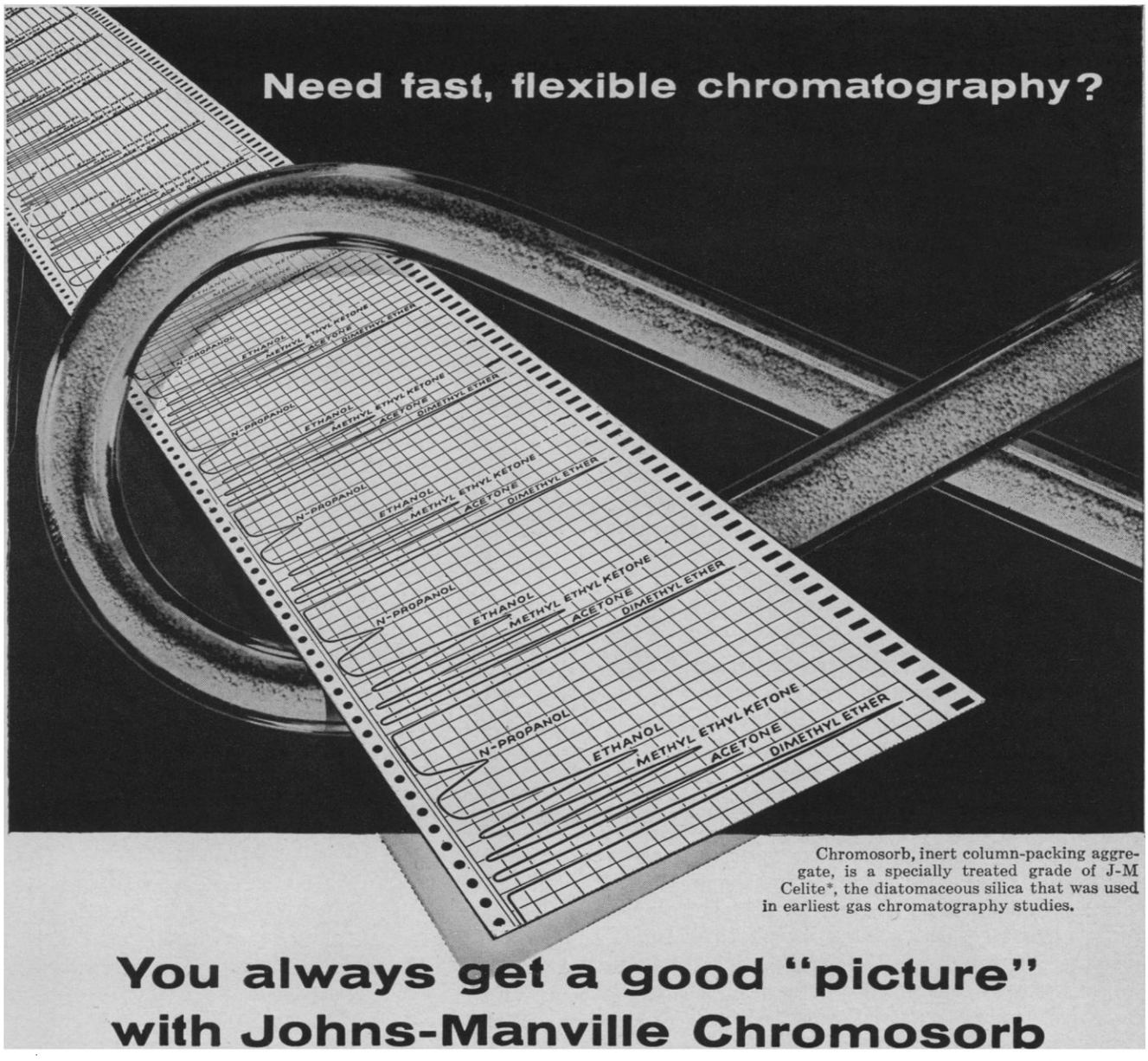

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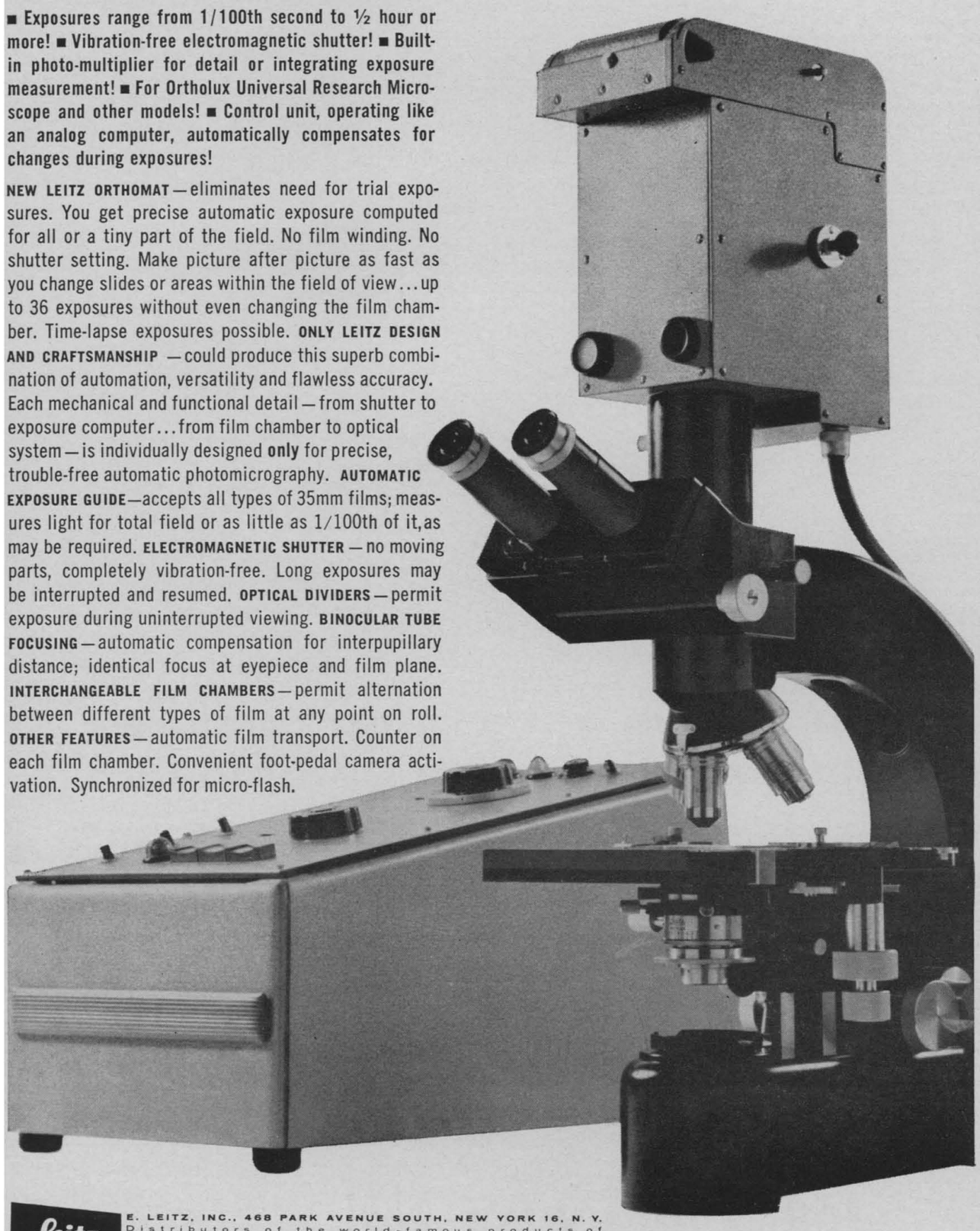

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13 April 1962, Volume 136, Number 3511 **SCIENCE**

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Science for the Public

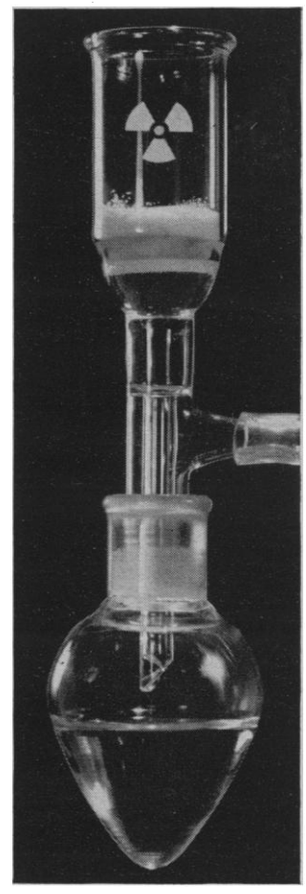
On 21 April, with all the fanfare the city can command, Seattle will open the first world's fair to be held in the U.S. for 23 years. Scientists have a special interest, for science is given star billing with six and a half acres of popular scientific exhibits.

Early in 1958, officers of the Seattle World's Fair commission came to Washington to explore the possibility of scientific cooperation in planning for a fair that would emphasize the century ahead. Because their initial plans looked good, we invited them to return a few days later; the Parliament of Science that the AAAS held in 1958 gave an opportunity to let them meet representatives of scientific organizations and agencies of government, including several of the men who had planned the U.S. contributions to the scientific exhibits at the Brussels World's Fair of 1958. When the Seattle visitors asked if scientists would be willing to help plan a large, popular, science exhibit, the answer was *Yes*. The Brussels plans were not turning out as well as had been hoped, and the scientists were confident that much better popular exhibits could be designed. Thus a partnership was born. The National Academy of Sciences, the National Science Foundation, and the AAAS helped the fair commissioners to select a board of scientific advisers. That board was quickly appointed and soon at work in planning exhibits that they hoped would interest and inform several million visitors to the fair.

Now, many headaches later, the fair is about to open. The headaches came from a variety of sources. When Congress appropriated $9 million for the U.S. Science Exhibit, managing responsibility was given to a newly created office in the Department of Commerce; it should have been assigned to an agency with scientific interests. The first board of advisers was replaced by another, but partially overlapping, group appointed by the Department of Commerce. The Commerce Department staff was completely replaced when the administration changed in January 1961. To fill gaps between appointments of a succession of science coordinators, the National Science Foundation, the Bureau of Standards, and the AAAS loaned staff members for periods of a few weeks to a few months. Not until the summer of 1961, when Athelstan Spilhaus became director, was there a scientist in charge.

Throughout the whole venture, many scientists have contributed their time and ideas with great generosity. Visitors to the fair will not know who was responsible for what they see, but science—in a generalized sense—will be hurt if the exhibits are poor, or will benefit if the exhibits are good. Many scientists have wanted to make certain that the exhibits are good, and have worked hard toward that end.

A major purpose of any world's fair is to attract dollars and visitors to the city in which it is held. The fair in Seattle is no exception, and so it will have something for everybody. Among the attractions, science will be prominently displayed and spectacularly housed. The exhibits might have profited from greater continuity of planning and less necessity of final rushing. But visitors to the fair should find them interesting, informative, and in some cases exciting presentations of scientific principles, methods, and problems—a magnificent effort to increase the public understanding of science.—D.W.



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together with improved optics, makes it possible to obtain linear results for a number of colorimetric analyses over quite a wide range and permits the estimation of steroids with an accuracy of about ±4 percent.

In the discussion of this paper, D. F. Johnson (National Institutes of Health) described an automated apparatus for performing gradient elution column chromatography. This apparatus consists of an automatically regulated gradient and a stream splitter that separates the column effluent into two portions. The solvent is evaporated, and the samples are redissolved in solvents appropriate either for ultraviolet absorption measurement or for a color reaction such as blue tetrazolium reduction. It is also possible to obtain samples for measuring radioactivity.

The subsequent discussion concerned a number of commercially available devices for scanning paper chromatographic strips for radioactivity.

E. C. Horning (Baylor University) discussed the application of vapor-phase chromatography to the separation and identification of steroid mixtures. He considered selection of liquid phases and thermal programming and reviewed his own important contributions to the separation of various groups of steroid hormone metabolites. H. H. Wotiz (Boston University) described his work on the separation of synthetic mixtures of the three major estrogens—estrone, estradiol, and estriol—as well as analyses of urinary extracts for these three substances. There was general agreement that vapor-phase chromatography is potentially an extremely powerful tool for repetitive analysis of multicomponent mixtures.

In the closing session A. M. Bongiovanni (Children's Hospital of Philadelphia) discussed various clinically observed disorders of adrenal function and their exploration by means of urinary steroid assays. It was evident from his remarks that more rapid and efficient analytical methods would help the clinician to reach important decisions quickly and to explore abnormalities of steroid metabolism that result in less dramatic changes in the excretion pattern.

Other participants at the conference were Jack Anderson (Technicon Instruments Corporation), Saul Aronow (Massachusetts General Hospital), W. Averill (Perkin-Elmer Corporation), E. Beaulieu (Columbia), R. Borth (Geneva, Switzerland), Michael Brennan (Henry Ford Hospital), Ralph I. Dorf-

man (Worcester Foundation), E. L. Durrum (Beckman Instruments), Kristen Eik-Nes (University of Utah), Leon Hellman (Sloan-Kettering Institute), Raymond Jonnard (Prudential Insurance Company), C. F. Kossack (International Business Machines), Seymour Lieberman (Columbia), Avery A. Sandberg (Roswell Park Memorial Institute), and J. F. Tait (Worcester Foundation).

A limited number of transcripts of this conference is available from the American Cancer Society, Inc., 521 West 57th Street, New York 19.

LEWIS L. ENGEL
Massachusetts General Hospital and
Department of Biological Chemistry, Harvard Medical School, Boston

Forthcoming Events

April

14–18. Federation of American Societies for Experimental Biology, Atlantic City, N.J. (M. O. Lee, 9650 Wisconsin Ave., Washington 14)

14–19. American Inst. of Nutrition, Atlantic City, N.J. (A. E. Schaefer, Bldg. 16-A, Natl. Institutes of Health, Bethesda 14, Md.)

14–19. American Soc. of Biological Chemists, Inc., Atlantic City, N.J. (F. W. Putnam, Dept. of Biochemistry, Univ. of Florida College of Medicine, Gainesville)

15–18. American College Personnel Assoc., Chicago, Ill. (B. A. Kirk, Counseling Center, Univ. of California, Berkeley)

15–18. National Education Assoc., Council of Mathematics Teachers, San Francisco, Calif. (Chief of Information, Dept. of the Army, Washington 25)

16–18. Flight Test Instrument Symp., intern., Cranfield, England. (College of Aeronautics, Cranfield)

16–18. Spins and Phonons, conf., Bristol, England. (P. M. Llewellyn, H. H. Sills Physics Laboratory, Royal Fort, Bristol 8)

16–19. American Personnel and Guidance Assoc., annual, Chicago, Ill. (J. Fishbein, Science Research Associates, 259 E. Erie St., Chicago 11)

16–19. Interactions between Mathematical Research and High-Speed Computing, symp., American Mathematical Soc.–Assoc. for Computing Machinery, Atlantic City, N.J. (E. Pitcher, AMS, 190 Hope St., Providence 6, R.I.)

16–19. Paleoclimatology and Paleopedology, symp., International Soc. for Plant Geography and Ecology, Stolzenau, Germany. [R. Tüxen, Intern. Vereinigung für Vegetationskunde, Stolzenau (Weser)]

16–19. Vacuum Ultraviolet Radiation Physics, intern. conf., Los Angeles, Calif. (G. L. Weissler, Univ. of Southern California, Los Angeles 7)

16–20. American Physiological Soc., Atlantic City, N.J. (R. G. Daggs, APS, 9650 Wisconsin Ave., Washington 14)

16–20. American Soc. for Pharmacology and Experimental Therapeutics, Atlantic

City, N.J. (H. G. Mandel, George Washington Univ. School of Medicine, 1337 H St., NW, Washington 5)

16–20. Reactor Safety and Hazards Evaluation Techniques, symp., Vienna, Austria. (Intern. Atomic Energy Agency, 11 Kaerntnerring, Vienna 1)

17–18. Conference on Permafrost, Ottawa, Ont., Canada. (R. J. E. Brown, Div. of Building Research, Natl. Research Council, Ottawa 2)

17–20. International Mineralogical Assoc., Washington, D.C. (D. J. Fisher, Dept. of Geology, Univ. of Chicago, Chicago 37, Ill.)

17–20. Sector-Focused Cyclotrons, conf., Los Angeles, Calif. (B. T. Wright, Dept. of Physics, Univ. of California, Los Angeles 24)

18–20. American Inst. of Electrical Engineers, Fort Wayne, Ind. (R. S. Gardner, AIEE, 33 W. 39 St., New York 18)

18–20. Information Retrieval in Action, conf., Cleveland, Ohio. (Center for Documentation and Communication, Western Reserve Univ., 10831 Magnolia Dr., Cleveland 6)

18–28. World Seed Congr., Rome, Italy. (Intern. Agency Liaison Branch, Office of the Director General, Food and Agriculture Organization of the U.N., Viale delle Terme di Caracalla, Rome)

19. Southern California Acad. of Sciences, Los Angeles. (G. Sibley, Los Angeles County Museum, 900 Exposition Blvd., Los Angeles 7)

19–20. Southern Municipal and Industrial Waste Conf., Chapel Hill, N.C. (Dept. of Sanitary Engineering, Univ. of North Carolina, Box 899, Chapel Hill)

19–21. Southern Soc. for Philosophy and Psychology, Memphis, Tenn. (D. R. Kenshalo, Dept. of Psychology, Florida State Univ., Tallahassee)

20–22. Czechoslovak Soc. of Arts and Sciences in America, 1st natl. congr., Washington, D.C. (M. Rechcigl, Jr., 1703 Mark Lane, Rockville, Md.)

21. Pennsylvania Acad. of Science, Pittsburgh. (K. B. Hoover, Messiah College, Grantham, Pa.)

21–21 Oct. World's Fair of Science, Century 21 Exposition, Seattle, Wash. (J. Rockey, c/o Seattle World's Fair, Seattle)

22–26. Association of American Geographers, Miami Beach, Fla. (M. F. Burrill, AAG, 1785 Massachusetts Ave., NW, Washington, D.C.)

23–25. Canadian Inst. of Mining and Metallurgy, annual, Ottawa, Ont. (C. Gerow, CIMM, 1117 St. Catherine St., W. Montreal 2, Quebec, Canada)

23–25. Meteorological Uses of Rockets and Satellites, symp., Washington, D.C. (World Meteorological Organization, 41, Avenue Giuseppe Motta, Geneva, Switzerland)

23–25. Pan American Congr. of Gastroenterology, New York, N.Y. (C. A. Flood, 180 Fort Washington Ave., New York 32)

23–26. American Physical Soc., Washington, D.C. (K. K. Darrow, APS, Columbia Univ., New York 27)

23–27. International Conf. on Palynology, Tucson, Ariz. (G. O. W. Kremp, Geochronology Laboratories, Univ. of Arizona, Tucson)

23–27. Problems in Education and Re-

search in Tropical Biology, conf., San Jose, Costa Rica. (J. M. Savage, Dept. of Biology, Univ. of Southern Calif., Los Angeles 7)

23–5. Television Arts and Sciences, intern. symp. and festival, Montreux, Switzerland. (Intern. Television Symp., 8, Grand-Rue, Montreux)

24–25. Building Research Inst., spring conf., Washington, D.C. (M. C. Coon, Jr., BRI, 2101 Constitution Ave., NW, Washington 25)

24–25. Managing Petroleum and Petrochemical Operations, conf., San Antonio, Tex. (J. Harmon, Southwest Research Inst., 8500 Culebra Rd., San Antonio 6)

24–26. Mathematical Theory of Automata, intern. symp., New York, N.Y. (Symposium Committee, Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N. Y.)

25. Rocket Propulsion, symp., Cranfield, Bletchley, England. (Secretary, British Interplanetary Soc., 12 Bessborough Gardens, London, S.W.1, England)

25–27. International Federation of Associations of Textile Chemists and Colorists, annual, Amsterdam, Netherlands. (J. Boulton, Dean House, 19, Piccadilly, Bradford 1, Yorks, England)

25–27. Present Status and Future Prospects of Television and Motion Pictures as Media for Medical Education, intern. conf., Milan, Italy. (L. L. Leveridge, Medical Television Unit, New York Univ. Medical Center, 550 First Ave., New York 16)

25–27. Pulp and Paper Instrumentation Symp, natl., Jacksonville, Fla. (L. G. Good, Systems Service Corp., P.O. Box 952, Charlotte, N.C.)

27–28. Idaho Acad. of Science, annual, Moscow. (L. M. Stanford, College of Idaho, Caldwell)

27–29. Oklahoma Acad. of Science, Woodward. (A. D. Buck, Northern Oklahoma Junior College, Tonkawa)

27–29. West Virginia Acad. of Science, Bethany. (J. D. Draper, Dept. of Chemistry, West Virginia Univ., Morgantown)

28. Mississippi Acad. of Sciences, Inc., Jackson. (C. Q. Sheely, Mississippi State Univ., State College)

29–2. International Acad. of Pathology–American Assoc. of Pathologists and Bacteriologists, Montreal, Canada. (F. K. Mostofi, c/o Armed Forces Inst. of Pathology, Washington 25)

29–2. National Workshop on Aging, American Home Economics Assoc., Lafayette, Ind. (A. J. Bricker, AHEA, 1600 20th St., NW, Washington 9)

29–3. American Ceramic Soc., annual, New York, N.Y. (C. S. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio)

29–4. Society of Motion Picture and Television Engineers, annual, Los Angeles, Calif. (H. Teitelbaum, SMPTE, 55 W. 42 St., New York 36)

30–1. International Acad. of Pathology, annual, Montreal, Canada. (M. Davis, Intersociety Committee on Pathology Information, 1785 Massachusetts Ave., NW, Washington 6)

30–1. International Acetylene Assoc., annual, Toronto, Canada. (L. Matthews, 30 E. 42 St., New York 17)

30–2. American Soc. of Mechanical Engineers, Design Engineering Div., Phil-

adelphia, Pa. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

30–2. Association of Iron and Steel Engineers, Detroit, Mich. (T. J. Ess, AISE, 1010 Empire Bldg., Pittsburgh 22, Pa.)

30–2. Instrumental Methods of Analysis, natl. symp., Instrument Soc. of America, Pittsburgh, Pa. (E. E. Buckston, Works Engineering Dept., Union Carbide Chemicals Co., P.O. Box 8004, S. Charleston 3, W.Va.)

30–2. Role of Food in World Peace, intern. symp., Columbus, Ohio. (R. M. Kottman, College of Agriculture, Ohio State Univ., Columbus 10)

30–3. Mid-America Spectroscopy, annual symp., Soc. for Applied Spectroscopy, Chicago, Ill. (J. R. Ferraro, Argonne, Natl. Laboratory, 9700 S. Cass Ave., Argonne, Ill.)

30–4. Compressed Air and Hydraulics, intern. conf. and exhibition, London, England. (W. G. H. Chesher, c/o John Trundell and Partners Ltd., St. Richard's House, Eversholt St., London, N.W.1)

30–5. Automobile Technical Congr., intern., London, England. (Automobile Div., Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1)

May

1–3. Biologistics for Space Systems, symp. and workshop, Dayton, Ohio. (Col. A. I. Karstens, Aerospace Medical Research Laboratories, Aeronautical Systems Div., Wright-Patterson AFB, Ohio)

1–3. Joint Computer Conf., San Francisco, Calif. (R. I. Tanaka, Computer Systems-Logical Design, Lockheed Missiles & Space Co., Palo Alto, Calif.)

1–4. Conference on Radiodiagnosis and Radiotherapy, Southern Rhodesia. (P. E. S. Palmer, P.O. Box 958, Bulawayo, Southern Rhodesia)

1–4. Gamma Alpha Graduate Scientific Fraternity, St. Paul, Minn. (W. T. Keeton, Dept. of Entomology, Cornell Univ., Ithaca, N.Y.)

1–4. Permeability, intern. symp., Wageningen, Netherlands. (Centrum voor Plantenfysiologisch Onderzoek, Landbouwhogeschool, Herenstraat 18, Wageningen)

1–5. Latin American Iron and Steel Inst., Buenos Aires, Argentina. (F. A. Tupper, Moneda 1140–6° Piso, Casilla 13810, Santiago, Chile)

2. International Symp. on Crop Protection, Ghent, Belgium. (I. J. Van den Brande, Institut Agronomique de l'Etat, Coupure Gauche 233, Ghent)

2–3. Iron and Steel Inst., annual, London, England. (ISI, 4 Grosvenor Gardens, London, S.W.1)

2–4. American Assoc. of Pathologists and Bacteriologists, annual, Montreal, Canada. (Intersociety Committee on Pathology Information, 1785 Massachusetts Ave., NW, Washington 6)

2–4. European Corrosion Conf., Paris, France. (Société de Chimie Industrielle, 28, rue St. Dominique, Paris 7°)

2–4. Institute of Management Sciences, Toronto, Canada. (T. Fabian, c/o *Mathematica*, 76 Nassau St., Princeton, N.J.)

2–5. Air Force Systems Command Management Conf., Monterey, Calif. (Office of Information, AFSC, Andrews AFB, Washington 25)

2–5. Midwestern Psychological Assoc., Chicago, Ill. (D. R. Meyer, 1314 Kinnear Rd., Columbus 12, Ohio)

2–5. National Science Fair-International, Seattle, Wash. (Science Service, 1719 N St., NW, Washington 6)

2–6. Film Techniques, conf., Budapest, Hungary. (Hungarian Soc. of Optics, Acoustics and Film Techniques, Szabadság tér 17, Budapest V)

2–8. Space Science Symp., intern., Washington, D.C. (Secretary, Committee on Space Research, 28 Nieuwe Schoolstraat, The Hague, Netherlands)

3. Electronic Marketing Seminar, intern., San Diego, Calif. (E. T. Clare, Cohu Electronics, Inc., Box 623, San Diego)

3–4. Human Factors in Electronics, intern. congr., Long Beach, Calif. (C. Hopkins, Hughes Aircraft Co., Culver City, Calif.)

3–5. Institute of Hospital Administrators, annual, Cardiff, Wales, England. (J. F. Milne, 75 Portland Pl., London, W.1)

3–5. Kansas Acad. of Science, Pittsburgh. (G. A. Leisman, Dept. of Biology, Kansas State Teachers College, Emporia)

3–5. Ohio Acad. of Science, Toledo. (G. W. Burns, 505 King Ave., Columbus 1, Ohio)

3–5. Society for American Archaeology, Tucson, Ariz. (J. B. Wheat, Univ. of Colorado Museum, Boulder)

3–5. University Computing Centres, intern. conf., Mexico, D.F., Mexico. (Centro Electrónico de Cálculo, Universidad Nacional Autónoma de México, México, D.F.)

3–7. German Soc. of Metallurgy and Mining, Berlin. (Gesellschaft Deutscher Metallhütten and Bergleute, Schliessfach 51, Clausthal-Zellerfeld, Germany)

4. North Carolina Acad. of Science, Winston-Salem. (J. A. Yarbrough, Meredith College, Raleigh, N.C.)

4–5. Colorado-Wyoming Acad. of Science, Greeley, Colo. (R. G. Beidleman, Zoology Dept., Colorado College, Colorado Springs)

4–5. Minnesota Acad. of Science, annual, Winona. (J. P. Emanuel, 206 E. Howard, Winona)

4–5. North Dakota Acad. of Science, Fargo. (B. G. Gustafson, Box 573, Union Station, Grand Forks, N.D.)

4–5. Population Assoc. of America, Madison, Wis. (K. B. Mayer, Dept. of Sociology and Anthropology, Brown Univ., Providence, R.I.)

4–5. South Dakota Acad. of Science, Vermillion. (T. Van Bruggen, Dept. of Botany, Univ. of South Dakota, Vermillion)

4–6. Protides of the Biological Fluids, colloquim, Bruges, Belgium. (H. Peeters, Sint Jans Hospitaal, Bruges)

4–6. Wisconsin Acad. of Sciences, Arts and Letters, La Crosse. (T. J. McLaughlin, Univ. of Wisconsin, 3203 N. Downer Ave., Milwaukee 11)

5–6. Academy of Psychoanalysis, annual, Toronto, Canada. (J. H. Merin, 125 E. 65 St., New York 21)

5–6. Society of Biological Psychiatry, annual, Toronto, Canada. (G. N. Thompson, 2010 Wilshire Blvd., Los Angeles 57, Calif.)

5–7. International Congr. of Medical

Laboratory Technologists, Cologne, Germany. (M. Gesunsheitsverwaitung, Intern. Assoc. of Medical Laboratory Technologists, Cologne)

6–9. Bockus Alumni Intern. Soc. of Gastroenterology, annual, Geneva, Switzerland. (J. L. A. Roth, Graduate Medical Bldg., Suite 302, 419 S. 19 St., Philadelphia 46, Pa.)

6–9. National Power Instrumentation Symp., Fort Worth, Tex. (C. W. Macune, Westronics, Inc., 3605 McCart, Fort Worth 10)

6–10. American Soc. for Microbiology, annual, Kansas City, Mo. (P. Gerhardt, Dept. of Bacteriology, Univ. of Michigan, Ann Arbor)

6–10. Electrochemical Soc., annual, Los Angeles, Calif. (R. K. Shannon, 1860 Broadway, New York 23)

6–10. French Soc. of Ophthalmology, Paris. (M. A. Dollfus, FSO, 27, rue du Faubourg-Saint-Jacques, Paris 16°)

6–12. World Congr. of Gastroenterology, Munich, Germany. (G. A. Martini, Martinstr. 52, Hamburg 20, Germany)

7. League against Trachoma, annual, Paris, France. (J. Sédan, Ligue contre le Trachoma, 94, rue Sylvabelle, Marseilles, France)

7–8. American Inst. of Mining, Metallurgical and Petroleum Engineers, Soc. of Petroleum Engineers' Secondary Recovery Symp., Wichita Falls, Tex. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

7–9. American Oil Chemists' Soc., annual, New Orleans, La. (W. O. Lundberg, Hormel Inst., Univ. of Minnesota, 801 16 Ave., NE, Austin)

7–9. Implications of Organic Peroxides in Radiobiology, intern. symp., Argonne, Ill. (R. N. Feinstein, Div. of Biological and Medical Research, Argonne Natl. Laboratory, Argonne)

7–9. National Watershed Congr., annual, Columbus, Ohio. (C. R. Gutermuth, Wildlife Management Inst., Washington, D.C.)

7–11. American Psychiatric Assoc., Toronto, Canada. (C. H. H. Branch, 156 Westminster Ave., Salt Lake City, Utah)

7–11. American Soc. of Tool and Manufacturing Engineers, annual convention and tool exposition, Cleveland, Ohio. (A. Cervenka, Vanderbilt Blvd., Oakdale, N.Y.)

7–11. Radiation Damage in Solids and Reactor Materials, symp., Intern. Atomic Energy Agency, Venice, Italy. (IAEA, 11 Kärntner Ring, Vienna 1, Austria)

7–11. Society of Photographic Scientists and Engineers, annual, Boston, Mass. (E. S. Cobb, Box 1609, Main Post Office, Washington, D.C.)

7–12. International Conf. of Marine Engineers, London, England. (Inst. of Marine Engineers, Memorial Bldg., 76 Mark Lane, London, E.C.3)

7–12. International Seed Testing Assoc., annual congr., Lisbon, Portugal. (A. F. Schoorel, ISTA, Binnenhaven 1, Wageningen, Netherlands)

8. American Soc. of Safety Engineers, Chicago, Ill. (A. C. Blackman, ASSE, 5 N. Wabash Ave., Chicago 2)

8. World Health Assembly, annual, Geneva, Switzerland. (World Health Organization, Palais des Nations, Geneva)

8–10. American Soc. of Lubrication Engineers, annual, St. Louis, Mo. (A. E. Cichelli, Bethlehem Steel Co., 701 E. Third St., Bethlehem, Pa.)

8–10. World Commission on Vocational Rehabilitation, annual, Washington, D.C. (D. Warms, Intern. Soc. for Rehabilitation of the Disabled, 701 First Ave., New York 17)

8–19. Latin American Meeting on Higher Agricultural Education, Medellín, Colombia. (Intern. Agency Liaison Branch, Office of Director General, U.N. Food and Agriculture Organization, Viale delle Terme di Caracalla, Rome, Italy)

9–11. Conference on Mucous Secretions, New York, N.Y. (S. Jakowska, Natl. Cystic Fibrosis Research Foundation, 521 Fifth Ave., New York 17)

9–11. Operations Research Soc. of America, Washington, D.C. (G. D. Shellard, New York Life Insurance Co., 51 Madison Ave., New York 10)

9–12. Glass Technology Conf., Baden-Baden, Germany. (Deutsche Glastechnische Gesellschaft, Bockenheimerlandstr. 126, Frankfurt am Main)

9–12. Science Writers Seminar, intern., Seattle, Wash. (Intern. Press Inst., Münstergasse 9, Zurich 1, Switzerland)

9–12. Virginia Acad. of Science, Norfolk. (P. M. Patterson, Hollins College Branch, Roanoke)

9–19. Prediction of Volcanic Eruptions and the Relationship between Magmas and the Nature of Volcanic Eruptions, symp., Tokyo, Japan. (Secretary, Organizing Committee, c/o Science Council of Japan, Ueno Park, Tokyo)

10–12. Meetings on Diabetes, University of Paris, Paris, France. (M. Rathery, Hotel-Dieu, Paris)

10. Glass Container Technology, seminar, New York, N.Y. (Packaging Inst., 342 Madison Ave., New York 17)

10. Vitamins and Transplantation Immunity, Assoc. of Vitamin Chemists, Chicago, Ill. (H. S. Perdue, Abbott Laboratories, N. Chicago)

10–11. American Inst. of Chemists, Inc., Chicago, Ill. (J. Kotrady, c/o AIC, 60 E. 42 St., New York 17)

10–12. Food Protection, intern. symp., Ames, Iowa. (J. C. Ayres, Dept. of Dairy and Food Industry, Iowa State Univ., Ames)

12. International College of Surgeons, clinical meeting, London, England. (Secretary, ICS, 1516 Lake Shore Dr., Chicago 10, Ill.)

13–16. American Acad. of Dental Medicine, annual, Baltimore, Md. (P. Block, 36 N. Luzerne Ave., Baltimore)

13–16. Transfer of Calcium and Strontium across Biological Membranes, conf., Ithaca, N.Y. (R. H. Wasserman, Dept. of Physical Biology, New York State Veterinary College, Cornell Univ., Ithaca)

13–17. American Industrial Hygiene Assoc., conf., Washington, D.C. (W. S. Johnson, Bethlehem Steel Co., Bethlehem, Pa.)

14–16. National Aerospace Electronics Conf., Dayton, Ohio. (Inst. of the Aerospace Sciences, 2 E. 64 St., New York 21)

14–16. Technical Assoc. of the Pulp and Paper Industry, coating conf., annual, Cincinnati, Ohio. (TAPPI, 155 E. 44 St., New York 16)

14–18. American Soc. of Civil Engineers, convention, Omaha, Neb. (W. H. Wisely, 345 E. 47 St., New York 17)

14–18. Hormonal Steroids, intern. congr., Milan, Italy. (L. Martini, Instituto de Farmacologia e Terapia, 21 Via A. del Sarto, Milan)

14–19. International Office of Epizootics, Paris, France (Office Internationale des Epizooties, 12, rue de Prony, Paris)

15–16. Council on Medical Television, annual, Bethesda, Md. (J. F. Huber, CMT, Inst. for Advancement of Medical Communication, 33 E. 68 St., New York 21)

15–17. World Food Forum, Washington, D.C. (J. K. McClarren, U.S. Dept. of Agriculture, 409 Administration Bldg., Washington 25)

15–19. International College of Surgeons, European federation, surgical congr., Amsterdam, Netherlands. (J. Blazenburg, ICS Netherlands Section, A. Perkstraat 57, Hilversum, Netherlands)

16. Design of Talking and Writing Machines for the Rehabilitation of Communication Disabilities, conf., New York, N.Y. (C. Berkeley, Foundation for Medical Technology, 2 E. 63 St., New York 21)

16–17. Navy Medical-Dental TV Workshop, Bethesda, Md. (Inst. for Advancement of Medical Communication, 33 E. 68 St., New York 21)

16–18. Conference on Dust, Scheveningen, Netherlands. (Fachgruppe Staubtechnik, Prinz-Georg-Str. 77/79, Düsseldorf 10, Germany)

16–18. Noise Abatement, intern. congr., Salzburg, Austria. (Osterreichischer Arbeitsring für Lärmbekämpfung, Stubenring 1, Vienna 1, Austria)

16–26. Large Electric Systems, intern. conf., Paris, France. (ICLES, 112 Boulevard Haussmann, Paris 8°)

17–19. American Inst. of Industrial Engineers, annual, Atlantic City, N.J. (W. J. Jaffe, Newark College of Engineering, Newark, N.J.)

17–19. Eccrine, Apocrine, and Holocrine Glands, symp., Madison, Wis. (Div. of Postgraduate Medical Education, University of Wisconsin Medical School, Madison 6)

17–19. Nepiology, intern. conf., Catania, Sicily. (S. Rapisardi, Via Mavilla 37, Catania)

17–19. Paralanguage and Kinesics, conf., Bloomington, Ind. (T. A. Sebeok, Research Center in Anthropology, Rayl House, Indiana Univ., Bloomington)

17–20. International Medical Soc. of Endoscopic Photocinematography, Television and Radiocinematography, Louvain, Belgium. (J. M. Dubois de Montreynaud, Société Médicale Internationale d'Endoscopie et de Radiocinématographie, 4, rue du Général-Baratier, Rheims, France)

17–31. Special Libraries Assoc., Washington, D.C. (J. B. North, Missile and Space Div., Lockheed Aircraft Corp., 50-14, Palo Alto, Calif.)

18–19. Indiana Acad. of Science, Mitchell. (W. W. Bloom, Valparaiso Univ., Valparaiso, Ind.)

18–29. European Plastics and Rubber Conf., Paris, France. (Du Mont Publicity Co., 18 Queensberry Place, London, S.W.7, England)

19–20. International Assoc. for the Study of the Liver, Munich, Germany. (G. A. Martini, c/o Universitäts Krankenhaus, Eppendorf, Hamburg, Germany)

20–23. American Inst. of Chemical Engineers, natl., Baltimore, Md. (F. J. Van Antwerpen, AICE, 345 E. 47 St., New York 17)

20–23. Humidity and Moisture, intern. symp., Washington, D.C. (W. A. Wildhack, Natl. Bureau of Standards, Washington 25)

20–23. Radiation Research Soc., annual, Colorado Springs, Colo. (E. L. Powers, RRS, Argonne Natl. Laboratory, Argonne, Ill.)

20–24. Air Pollution Control Assoc., annual, Chicago, Ill. (D. A. Sullivan, APCA, 4400 Fifth Ave., Pittsburgh, Pa.).

20–24. American Assoc. of Cereal Chemists, Saint Louis Park, Minn. (B. S. Miller, Dept. of Flour and Feed Milling, Kansas State Univ., Manhattan)

21–22. Society of American Military Engineers, annual, Washington, D.C. (SAME, 808 Mills Bldg., Washington 6)

21–23. National Aerospace Instrumentation Symp., Washington, D.C. (C. Creveling, Goddard Space Flight Center, Greenbelt, Md.)

21–24. Air Pollution Instrumentation Symp., Chicago. Ill. (D. F. Adams, Div. of Industrial Research, Washington State Univ., Pullman)

21–25. Max Planck Inst. for the Advancement of Science, general assembly, Düsseldorf, Germany. (MPIAS, Kaiserswerther Str. 164, Düsseldorf)

21–25. Plastic and Reconstructive Surgery of the Eye and Adnexa, intern. symp., New York, N.Y. (R. Troutman, Manhattan Eye, Ear & Throat Hospital, 210 E. 64 St., New York 21)

21–25. Thermodynamics of Nuclear Materials, symp., Vienna, Austria. (Intern. Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

21–26. Ceramic Congr., intern., Copenhagen, Denmark. (Arbejdsgivere, Indenfor de Keramiske Industrier, Nørre Volgade 34, Copenhagen K)

21–26. Rubber Technology Congr., annual, London, England. (Secretary, Institution of the Rubber Industry, 4, Kensington Palace Gardens, London, W.8)

22–24. National Microwave Theory and Techniques, symp., Inst. of Radio Engineers, Boulder, Colo. (L. G. Cumming, IRE, 1 E. 79 St., New York 21)

22–24. Self-Organizing Systems, conf., Chicago, Ill. (G. T. Jacobi, Armour Research Foundation, 10 W. 35 St., Chicago 16)

22–25. Rationalizing Consumption of Electric Power, intern. symp., Warsaw, Poland. (Ministry of Mines and Power, Krucza 36, Warsaw)

22–25. Rubber Technology Conf., Scarborough, England. (Institution of the Rub-

ber Industry, 4 Kensington Palace Gardens, London, W.8)

22–26. Disposal and Utilization of Solid Domestic and Industrial Wastes, intern. congr., Essen, Germany. (Haus der Technik, Schliessfach 668, Essen)

22–26. International Medico-Athletic Federation, congr., Santiago, Chile. (G. La Cava, Via A. Serra, 104, Rome, Italy)

23–24. Forming and Testing of Sheet Metal, intern. colloquium, Düsseldorf, Germany. (J. Hooper, Intern. Deep Drawing Research Group, John Adam St., Adelphi, London, W.C.2, England)

23–25. American Soc. for Quality Control, annual, Cincinnati, Ohio. (A. W. Wortham, Texas Instruments, Inc., P.O. Box 5474, Dallas 22)

24–26. Institute of Radio Engineers, conf. on space communications, Seattle, Wash. (IRE, 1 E. 79 St., New York 21)

24–26. International Assoc. for Bronchology, Bruges, Belgium. (R. Pannier, c/o Service de Pneumo-Phtisologie, Hôpital Saint-Jean, Bruges)

26–30. International Federation for Hygiene and Preventive Medicine, intern. congr., Vienna, Austria. (E. Musil, IFHPM, Mariahilfer Strasse 177, Vienna XV)

27–30. Chemical Inst. of Canada, annual conf. and exhibition, Edmonton. (CIC, 48 Rideau St., Ottawa 2, Ont.)

27–2. International Federation of Prestressing, 4th congr., Rome, Italy. (IFP, 6, rue Paul Valéry, Paris, 16°)

28–29. World Heavy Water Reactor Technology, Canadian Nuclear Assoc., annual conf., Ottawa. (Manager, CNA, 19 Richmond St. West, Toronto 1, Ont.)

28–30. American Assoc. for Contamination Control, 1st annual, San Francisco, Calif. (D. M. Petersen, Central Vacuum Corp., 3008 E. Olympic Blvd., Los Angeles 23, Calif.)

28–30. Biology of the Transuranic Elements, symp., Richland, Wash. (R. C. Thompson, Hanford Biology Laboratory, General Electric Co., Richland)

28–30. Heavy Water Reactors, Canadian Nuclear Assoc., annual conf., Ottawa, Ont., (CNA, 19 Richmond St. West, Toronto 1)

28–30. International Discussion on Heat Treating, Lausanne, Switzerland. (Institut für Härterei-Technik, Postfach 13, Bremen-St. Magnus, Germany)

28–1. Modern Techniques of Computation and Industrial Automation, colloquium, Paris, France. (Assoc. Française de Régulation et d'Automatisme, 19, rue Blanche, Paris 9°)

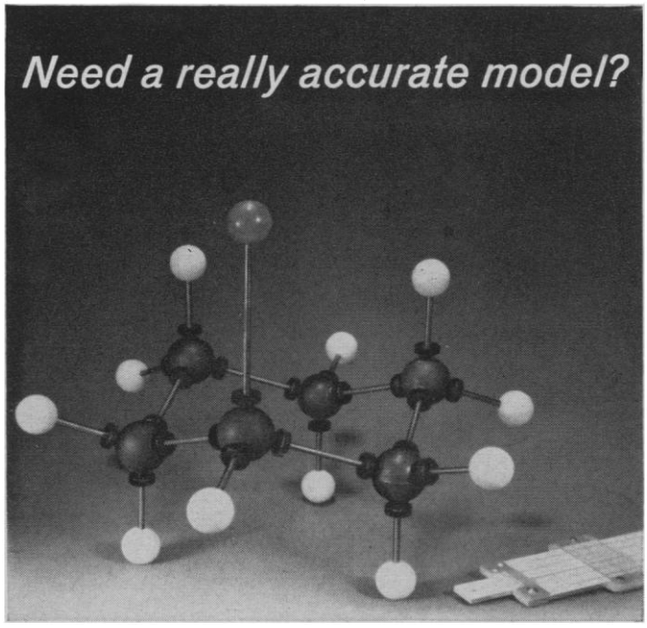
28–2. International Ophthalmic Optical Congr., Berlin, Germany. (G. H. Giles, Intern. Optical League, 65 Brook St., London, W.1, England)

28–2. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, N.Y. (UN, New York)

29–22. World Meteorological Organization, congr., Geneva, Switzerland. (WMO, 41, Avenue Giuseppe Motta, Geneva)

29–31. Tissue Culture Assoc., annual, Washington, D.C. (R. E. Stevenson, Natl. Cancer Inst., Bethesda 14, Md.)

29–2. American College of Cardiology, Inc., Denver, Colo. (I. Brotman, 1746 K St., NW, Washington, D.C.)



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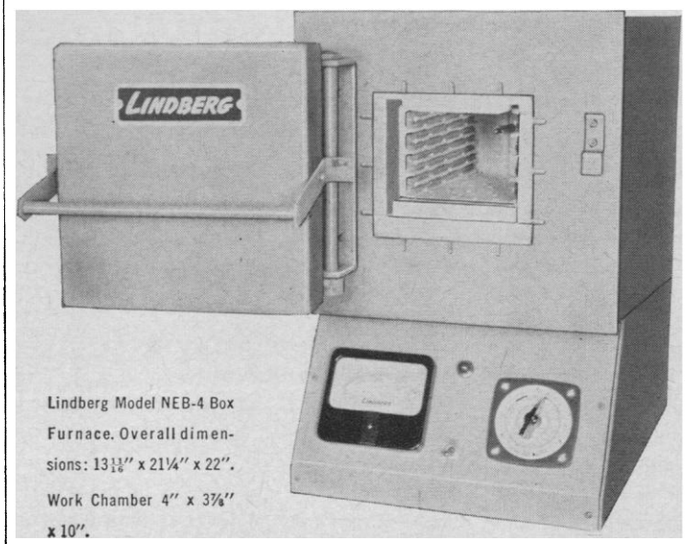

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the past! This simple procedure is, alas, unacceptable to the "analyticist," to whom the past is, for unexplainable reasons, tabu.

In spite of these disagreements in method we are in full agreement with Dorn's conclusions that "man's ability to control his environment" can avert a population catastrophy "provided he rapidly develops cultural substitutes for those harsh but effective governors of his high reproductive potential," because his suggestion is precisely our thesis. We observed that the growth phenomenon of the human population in the past is typical of an open-loop system that is composed of cooperative elements following a superadditive composition rule. An intrinsic instability of such systems, which manifests itself in a pathologically rapid growth, can be avoided by converting the open-loop system into a closed-loop system. Hence, we suggested a "population servo," which, first of all, has to provide a feedback that informs the system of its present state. Dorn's paper serves our purpose admirably.

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1. H. F. Dorn, *Science* **135**, 283 (1962).
2. H. von Foerster, P. M. Mora, L. W. Amiot, *ibid.* **132**, 1291 (1960).
3. ———, *ibid.* **133**, 943 (1961); **133**, 1932 (1961).
4. *Webster's New World Dictionary of the American Language* (World Publishing Co., Cleveland, college ed., 1959).
5. *U.N. Publ. No. St/SOA/Ser. A/17* (1953); *U.N. Preview* 4 (July 1957); *U.N. Population Bull. No. 14* (1958); *U.N. Population Bull. No. 15* (1959).
6. N. Wiener, *Extrapolation, Interpolation, and Smoothing of Stationary Time Series* (Wiley, New York, 1950).

Girdles and Griddles

With much delight I read the following comment by Bancroft W. Sitterly, in his review of *Man's Conquest of the Stars*, by Pierre Rousseau [*Science* **135**, 35 (5 Jan. 1962)]: "The translation seems to convey well the spirit of the French original. One grotesque slip in this English edition is the statement, repeated on a number of pages, that the galactic system has the form of a *girdle*-cake! But I found no other."

A light sponge-cake batter, perhaps, baked in a fine corset with steel stays—the comparison does seem laughable (although it is not entirely disagreeable to imagine the grace of a wasp-waisted

belle, or even the fine abundance of a generous matriarch, repeated on a cosmic scale: *das Ewig-Weibliche* . . .).

In justice to Michael Bullock, who appears to be the translator in question, I should like to point out that according to the *New English Dictionary, girdle* is a respectable variant form of *griddle* "by metathesis of *r*." It is defined as a "circular plate of iron which is suspended over the fire and upon which cakes are baked or toasted." The first example of this usage is dated about 1400. There is an entry for *girdle* in this sense as a combining form, "as *girdle-cake*. . . ."

According to Nancy Mitford, a recognized authority on *U* diction, "girdle-cake" might be mentioned casually in a conversation in London. Fanny Wincham (whose husband, pastoral theologian at Oxford, has been named ambassador to Paris) and Uncle Matthew are having tea:

"Delicious girdlecake."

"Comes from the Shelter—they've got a Scotch cook there now" [*Don't Tell Alfred* (Harper, New York, 1961)].

An American edition of *Man's Conquest of the Stars* might well explain that the galactic system has the form of a griddle cake, a hot cake, a pancake; but it seems that the English edition is within its rights.

MARY ANN HARRELL
4607 Connecticut Avenue, NW, Washington, D.C.

Electroplax and Nerve Activity

In his article "Chemical factors controlling nerve activity" (*1*), D. Nachmansohn refers to a protein which I have isolated from the electric organ of the electric eel as the "physiological acetylcholine receptor." Although initial results suggested such a role for the protein (*2*), recent studies on its properties led to a change in my interpretation of the nature of the material. This new interpretation was presented at the 1st International Pharmacology Meeting, held in Stockholm in August 1961; since the paper has not yet appeared in print (*3*), I am writing to restate my views.

The following points must be considered in assessing the possible function of the protein.

1) Binding of acetylcholine (ACh) and some depolarizing agents to the protein is very weak as compared to their high activity in physiological processes.

However, other depolarizing agents—for example, noracetylcholine-12, norcholine-12, and pyridinealdoxime dodeciodide—have a high affinity for the protein, yet these compounds in vivo are considerably less active than ACh (*4*). Moreover, the binding of noracetylcholine-12 and norcholine-12 is about equal, though as analogues of ACh and choline, respectively, large differences in affinity would be expected.

2) Schoffeniels and I recently found that binding of *d*-tubocurarine (0.02 mg/ml) to the purified protein is not affected by carbamylcholine (1 mg/ml). Competition between these drugs for the physiological receptor is well documented.

3) Immunohistochemical studies reveal that the protein is localized in or near the conducting and nonconducting membranes of electroplax (*5*). The ACh receptor would be expected to be localized only at the conducting membrane.

4) The amount of purified protein obtained from electric tissue is much greater than would be expected for the ACh receptor substance of the end-plate region.

From these and other considerations it is now concluded that the protein is a membrane component which is distinct from the physiological ACh receptor substance. Nevertheless, the protein may have a role in the electrical activity of conducting membranes. Thus, the effectiveness with which a series of drugs blocked axonal conduction paralleled quite closely their affinity for the protein (*6*). *d*-Tubocurarine, chlorisondamine, and protamine, which bind strongly to the protein, also block activity in squid axons, but only after treatment of the nerve with cobra venom (*6*). Compounds which combine weakly with the protein (for example, ACh, carbamylcholine, decamethonium, neostigmine, and dimethylaminoethyl acetate), in 0.1M concentration, did not affect squid-axon activity, even after treatment of the nerve with cobra venom. Acetylcholine in $10^{-6}M$ concentration acts at the neuromuscular junction. These compounds do block activity in detergent-treated sciatic nerve, but only in 0.1M concentration (*7*). *d*-Tubocurarine is far more active, while choline, which ordinarily has 1/1000 the physiological activity of ACh, equaled it in activity (*7*). Although *d*-tubocurarine blocks at the node of Ranvier (*8*), Dettbarn has found no effect of acetylcholine at this locus (*9*),

where the active membrane is covered by a thin and porous structure.

These findings are consistent with a newer concept (*3*)—that the purified electroplax protein may be identical with, or may closely resemble, the component of conducting membranes with which drugs combine when they produce their effects. It differs from the physiological ACh receptor, particularly with respect to its affinity for ACh, carbamylcholine, decamethonium, neostigmine, and dimethylaminoethyl acetate. On this basis one might explain the weak action of these compounds on nerve conduction, in contradistinction to their high potency at the end-plate.

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Ehrenpreis raises the question whether the protein which he isolated from electric tissue is indeed the acetylcholine (ACh) receptor protein. He explains why he now disagrees with the interpretation accepted by him when he worked in my laboratory.

Isolation of proteins has become a commonly used procedure, and in the case of enzymes no problem exists as to identification. In the case of the receptor protein the main difficulty confronting us has indeed been the question whether the protein isolated is identical with the physiological receptor postulated to react with ACh in the elementary process of conduction. This identification is impossible solely on the basis of test-tube studies. It has been achieved essentially in the studies on intact cells—in particular, in the studies on the monocellular electroplax preparation carried out by Henry Higman, Philip Rosenberg, and Eva Bartels and developed during the last 2 years to a high degree of sensitivity for evaluating structure-activity relationships (*1*, *2*). Ehrenpreis was not directly associated with these investigations; his

opinion is, therefore, based on second-hand and, unfortunately, incomplete information.

When my associates and I first offered evidence, in experiments on the electroplax, for the existence of a cell constituent distinctly different from ACh-esterase, we were struck by the observation that the compounds, reacting with the receptor only and not affecting the esterase, blocked electrical activity in two different ways: one type blocked with, the other without, depolarization. The former type had the biological action on the receptor postulated for ACh, the latter had only an inhibitory effect. In analogy with enzyme chemistry we referred to the first type as receptor activators, to the second as receptor inhibitors (*3*). Acetylcholine, carbamylcholine, dacamethonium, and others belong to the first type, procaine, tetracaine, curare, and others to the second type.

1) When the protein in question was isolated by Ehrenpreis, he tested by equilibrium dialysis the binding strength of a series of tertiary, monoquaternary, and diquaternary compounds, known from the electroplax studies to interact with the receptor. The protein studies were still quite preliminary and are being carried out only now on a quantitative basis, by S. Beychok and H. B. Higman.

Nevertheless, it became indeed apparent, as I mentioned in my Herter lecture (*4*), that a marked difference exists between the binding strength in vitro and the potency of action on the living cell when receptor activators and inhibitors are compared. When several series of receptor inhibitors were tested, there appeared a parallelism between their binding strength and their efficiency in blocking electrical activity. A striking example of this parallelism is offered by the local anesthetics procaine, tetracaine, and dibucaine—compounds closely related in structure to ACh, but tertiary nitrogen derivatives and receptor inhibitors (*1*, *5*). It has been, moreover, shown in experiments on the electroplax that tetracaine and ACh compete for the same cell constituent (*2*).

According to the quite preliminary studies in vitro it seems that the binding strength of receptor activators, such as ACh, carbamylcholine, prostigmine, and so forth, to the protein may be weak when compared with their high potency on the cell. However, it must be stressed that the available information is tentative and far from being quantitative. No binding constants have been determined thus far. Binding between micro- and macromolecules is necessary for interaction. For the proposed physiological role of the receptor protein it is necessary to postulate a large rate constant for the combination of receptor and ACh. This, of course, yields no information about the equilibrium (binding) constant. Clearly, if the rate of dissociation is correspondingly great, the equilibrium constant for binding, by definition, will be low. Moreover, we do not know how many of the receptors and how many active sites on each receptor must be activated for a maximum response. In view of all these uncertainties, no statement is at present justified as to the quantitative relationships until extensive further studies will have clarified the situation.

But binding forms only part of biological activity. It is a prerequisite, permitting something additional to happen. We know from enzyme chemistry that binding of competitive inhibitors may be very strong but that the complex is nevertheless inactive. The dis-

sociation constant of the prostigmine–ACh-esterase complex is 10^{-7}, that of acetylcholine–ACh-esterase is 10^{-3}, but the activity in the latter case is extraordinary. The enzyme has a very high turnover number with ACh; it is one of the fastest acting enyzmes known. Moreover, if one compares ethanolamine with the mono- and dimethyl aminoethanol, one finds that each methyl group increases the binding by a factor of 7. Addition of a third methyl group does not contribute to binding at all. But if we compare the enzyme activity toward aminoethyl acetate with that toward the ester containing one, two, and three methyl groups, we find that the trimethyl ester (ACh) has a tenfold higher rate of acetyl enzyme formation than the dimethyl derivative. In the hydrolytic process there is a large increase of ΔS^*, the entropy of activation, in going from the dimethyl to the trimethyl ester, indicating that in the active phase some molecular rearrangement of the enzyme must take place in the activated complex (*6*). Butyrylcholine is more strongly bound to the enzyme than is ACh, but its V_{max} is 1/150 as large.

A difference similar to that found with ACh-esterase has been observed in the reaction of mono-, di-, and trimethylaminoethyl acetate with the receptor of the electroplax (*7*). The dimethyl compound has a potency 10 to 20 times that of the monomethyl analogue. This is a factor not too different from that found in the interaction with the enzyme and may conceivably be attributed to increased binding by the methyl group. But the trimethyl analogue, ACh, has a potency 200 times that of the dimethyl analogue. It would be extremely difficult to attribute such an enormous increase in potency to the contribution to binding of one additional methyl group, especially since there is good reason to believe, on the basis of the esterase studies, that this third methyl group does not contribute at all to binding to the protein. Clearly, factors other than binding help to determine the potency of action.

The long-chain analogues of ACh offer a special problem. Owing to strong van der Waals forces they react quite strongly with a great number of proteins in addition to those of the ACh system, and also with other macromolecules; their mode of action is quite complex and still under investigation. They cannot be readily classified in either of the two categories.

2) It is true that carbamylcholine in a concentration of 1 mg/ml did not show competitive action with curare in a concentration of 0.02 mg/ml; but Ehrenpreis failed to mention that at a higher ratio curare binding was almost completely suppressed by carbamylcholine. The former finding just means, again, that the binding of the activator (carbamylcholine) is very much poorer than that of the inhibitor (curare). The binding of an activator in equilibrium may easily be 1000 times poorer than that of an inhibitor.

3) The immunochemical studies referred to by Ehrenpreis consisted of a few exploratory and quite tentative experiments carried out by a student. Unfortunately, the protein used as the antigen for preparing antibodies was not pure, and the data are, therefore, questionable. The results were full of contradiction, and the experiments were discontinued. In any case, the presence of ACh receptor in the membrane surrounding the whole cell would be consistent with the presence of ACh-esterase. As in several other nonconducting membranes, the system may be

associated with ion flux regulation, even though the membrane has not the prerequisites for impulse conduction.

4) The amount of receptor protein seems to represent approximately 0.1 to 0.2 percent of the total protein; this percentage is far from surprising for an organ so highly specialized in its function. Acetylcholine esterase forms about the same fraction of the total protein. The evaluation of the amount of the receptor in the end-plate region is completely speculative and can easily be off by 1 to 2 orders of magnitude. If it were true that there was not more receptor protein in the electroplax than was expected to be present at the synapse, then this fact would form a serious difficulty for the assumption that the ACh system plays an essential role in the generation of bioelectric potentials.

Surprisingly, however, Ehrenpreis in his new interpretation admits that the protein may have some still-undefined function in the electrical activity of the conducting membrane. He argues that curare, but not ACh, affects axonal conduction either on special preparations [Ranvier node (*8*)] or after chemical pretreatment with detergent or cobra venom (*9*, *10*). Therefore, he concludes, the protein isolated is not the ACh receptor protein, which is present only at the synapse. He thus implicitly accepts the notion of a fundamental difference between synaptic transmission and axonal conduction.

The striking demonstration that curare blocks axonal conduction, and not only synaptic transmission as was believed for a century, should be reason enough for reevaluating the role of ACh in nerve activity, since it is generally accepted that curare acts as an antimetabolite of ACh. Tertiary, lipid-soluble analogues of ACh, such as local anesthetics and diphenylhydramine, act in similar concentrations and in a similar way on the synaptic junction of the electroplax and on the giant axon of the squid (*10*). These new developments support rather than invalidate the explanation offered many years ago—namely, that the failure of ACh to act on axonal conduction must be attributable to the presence of structural barriers surrounding axonal conducting membranes and preventing lipid-insoluble compounds, such as curare and ACh, from reacting with the ACh receptor protein. Cobra venom only reduces, but does not remove, the barriers, as is clear from the experiments reported (*10*). After ex-

posure to the venom of the cottonmouth moccasin, which is much more potent in reducing the barriers than is cobra venom, curare acts in much lower concentrations, and in this case ACh, too, is effective (*11*). At the Ranvier node the conducting membrane is covered not by heavy myelin but by a complex structure seen in the electron microscope; this structure apparently permits curare and tertiary analogues of ACh, the latter in extremely low concentrations, to act on the membrane, although ACh itself does not act. There are amazingly great variations in permeability of different axons with respect to very closely related nitrogen derivatives (*12*). In addition to the direct action of ACh after treatment with moccasin venom, direct effects have been observed on desheathed vagus (*13*) and even on sheathed somatic fibers (*14*). In these preparations the structural barriers seem to be insufficient to protect the membrane. Obviously, ACh must act in all these places on a macromolecule endowed with special properties and associated with axonal electrical activity; otherwise it could not produce its effects. Nevertheless, the physiological significance of these pharmacological actions, considered by themselves, may appear open to question. However, in conjunction with the huge amount of biochemical evidence accumulated in support of the interpretation that ACh has a role in the generation and propagation of electric currents—such evidence as the presence of ACh, ACh-esterase, and choline acetylase in the conducting fiber; the inseparable association of electrical and enzyme activity; and the effect of local anesthetics—the evidence of a direct action of ACh becomes pertinent and indicates the presence of an ACh receptor in the axon. Both the biological and the chemical arguments offered by Ehrenpreis fail to support his new interpretation.

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A Two-Way Affair

Edmund W. Sinnott [*Science* **135**, 278 (26 Jan. 1962)] assumes that such letters as he suggests [to individuals in the U.S.S.R.] would reach the person addressed. I have serious doubts about that. I know from experience that letters from the United States are not exactly welcomed behind the iron curtain. This includes letters to relatives.

The spread of good will must be a two-way effort to have any value. I wonder if Sinnott can show us a letter, similar in content to his, published in a leading journal of science of the U.S.S.R.

WILLIAM EISENMAN
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As Eisenman points out, good will is a two-way affair, but this does not mean that we should wait for someone on the other side to make the first overture. There is a wide interchange of friendly correspondence between American and Soviet scientists, and my suggestion simply is that in connection with this, or as an extension of it, there be more formally expressed the desire for sincere good will between our peoples.

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Science Curriculum in Argentina

Garrett Hardin's review entitled "The 'two cultures' within biology" [*Science* **134**, 548 (1961)] has somewhat belatedly come to my attention.

With reference to his query and comment, "What is to be done? Possibly planning within universities can put a brake on the speciation process by requiring physical scientists to take at least one biology course . . . ," I

would like to inform your readers that this same problem has been overcome in the School of [Exact and Natural] Sciences of the University of Buenos Aires. This School, one of the ten comprising the University of Buenos Aires, one of the largest universities of the Latin world (with an enrollment of over 50,000), deals with teaching and research in the basic sciences and includes at present six large departments (physics; inorganic, analytical, and physical chemistry; biological chemistry; meteorology; biology; and geology) plus partnership in the School of Engineering of the Department of Industries.

The impact of science and technology in the development of the huge natural resources of Latin America within an imperatively short period is obvious. The leaders in overhauling methods in the School of Sciences have been aware of this, as well as of the problem raised by Hardin. Hence, *all* students of the School (including, of course, the ever more numerous students of mathematics and physics) are required to take a short but intensive course in biology. One of the arguments for establishing this requirement was that no student of the sciences can utterly ignore one of the main fields of science. Insofar as the "other" sciences are concerned, the curriculum establishes also at least two full semesters of physics and two of chemistry for all students of the School.

Notwithstanding the fact that the overhaul mentioned has been partially based on the university system that has found great favor in the United States, the obligatory courses that I have pointed out give students of all branches a broader view of science *in toto*.

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Statue of Claude Bernard

C. D. Leake [*Science* **134**, 2069 (1961)] was quite right in his statement, which appeared under the excellent photograph of a bronze memorial of the celebrated physiologist Claude Bernard (1813–78), that this statue was melted by Germans who occupied Paris during World War II. It may interest readers to know that in 1946 a new monument, in stone, was erected on the same spot in front of the Collège de France (Fig. 1). Bernard's pose is different in this second statue, although the memorial is approximately of the same size.

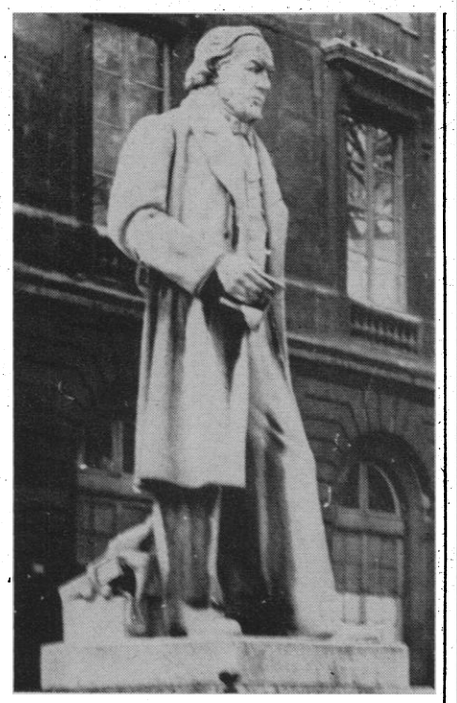

Fig. 1. The new statue of Claude Bernard. [E. Fauré-Fremiet, Collège de France]

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Sparing Action of Folic Acid by Thymidine

The article by Grossowicz and Mandelbaum (*1*) was commented on by Bolinder (*2*). In reply, Grossowicz (*3*) stated that thymidine produced growth in our experiments but not in his system. However, we pointed out (*4*) that our results showed that although thymidine by itself was ineffective in promoting growth, it significantly reduced the requirement of *Leuconostoc citrovorum* for "citrovorum factor."

The current state of biochemical research in folic acid coenzymes has reached a degree of sophistication not discussed or expressed in the article by Grossowicz and Mandelbaum. Studies by Friedkin (*5*) indicate that the thymidylate synthetase reaction includes transfer of the 5,10-CH_2- group and dehydrogenation of 5,10-methylene tetrahydrofolic acid to dihydrofolic acid. The reduction of dihydrofolic acid

to tetrahydrofolic acid is a step in the renewal of the supply of 5,10-methylene tetrahydrofolic acid. This reduction is presumably not carried out readily by *L. citrovorum*, as shown by its defective response to folic acid and dihydrofolic acid as contrasted with its ready response to tetrahydrofolic acid (*6*). The addition of preformed thymidine would lessen the requirement for 5,10-methylene tetrahydrofolic acid. Although this evidence is inferential, it could account for the well-established sparing action of thymidine on the "citrovorum factor" requirement of *L. citrovorum* (*4*, *7*).

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Messages from Other Worlds

The article by S. von Hoerner [*Science* **134**, 1839 (1961)] gave us very interesting estimates of the probabilities of radio communication with other civilizations in space.

A small thought of my own is that notice of the existence, location, and communication system of such a civilization might reach us by means other than direct radio transmission. If an earlier civilization was as egocentric as our own, it would probably want to leave a record of its existence and communicate its knowledge to successor civilizations. It would need, for this purpose, objects that would be maintenance-free, would attract attention, and would carry much information in a small space for millions of years.

If such a speculation has any merit, one might want to take a new look at meteorites, comets, and other space travelers for possible messages. Might the organic compounds in meteorites contain coded information? Also, could one intercept comets to obtain material for analysis?

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Studies of Starvation

As referee editors of several physiological and nutritional journals, we are perturbed by the continuing submission of mediocre papers dealing with starvation. Usually the only experimental method used consists in starving rats to a near-terminal condition and then determining one of the many parameters which can be affected by starvation. Sometimes determination of the duration of survival on a given diet is the only "technique" employed. Previously obtained information, available in the U.S. and foreign literature—often admittedly older literature because of the very simplicity of the techniques used —is generally ignored.

The application of the "findings" to problems of human survival involves questionable extrapolations. What little new information, if any, is obtained in these studies does not seem to us to be commensurate with the suffering inflicted on the animals. There is little doubt that we need to know more about the physiological mechanisms involved in resisting starvation and about the pathological consequences of prolonged undernutrition, whether continuous or intermittent. We would certainly approve for publication papers in which a great many pertinent correlations are studied in order to close the book, at least for a while, on death by starvation. But we find it difficult to approve of these piecemeal dissections which have resulted, and which will continue to result in perhaps dozens of papers, none of them definitive.

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Electronics and the Life Sciences

In their article "Biomedical electronics: potentialities and problems" [*Science* **135**, 198 (1962)], Robert Ledley and Lee Lusted argue the need for conditions which are more favorable to the development of "biomedical electronics." They review the highly important role which electronics has played in the development of devices and systems of major contemporary importance and foresee a similar role for electronics in

the life sciences. It would be most difficult to disagree *in toto* with this prediction.

Nevertheless, the totality of what these writers would seem to offer to medicine and to the biological sciences is only in part the subject matter normally associated with electronics. Rather, the entire field of engineering and those branches of science now largely pursued by those who have engineering training (the so-called engineering sciences) seem to be involved. Let us follow the authors' list, in part. "Measurement and analysis of small electric potentials" is an electrochemical problem to which important contributions have been made by physical chemists and chemical engineers. "Electronic flowmeters" present serious problems in non-Newtonian fluid mechanics as well as in electronics. Governing the design of many "artificial organs" is the approach instituted by chemical engineers to the problems of interfluid transport through membranes and the fluid mechanics of the adjacent liquids—not primarily, as Ledley and Lusted state, "the extensive use of electronics in medicine." The investigation of "infrared detectors" and "ultrasonic receptors" in animals lies in areas of applied physics to which engineers of many types have contributed.

No engineer in any of these areas hesitates to acknowledge the great assistance he derives from the largely electronic instrumentation which he uses. Nonetheless, the application of this instrumentation to problems in the life sciences is a far less worthy objective than the application of the whole of engineering technique, analysis, and science to the goals of biological research.

Electronic instrumentation is primarily a *tool*, useful to those trained in its use and in utilization of the measurements it produces. Most of the important biological problems arising today cannot be solved simply by increasing budgets so that more sophisticated instruments can be brought to bear on these problems. Before the quantitative output can be analyzed—even, given a certain instrumentation capability, before one can decide what to measure—some analysis must be conducted. The biological scientist frequently needs assistance in these analyses, and this assistance can often best be obtained from a problem-oriented individual with training in one of the several branches of engineering.

Alternatively, the life scientist may wish to acquire knowledge that is available in any of the several branches of engineering in which similar problems have been attacked quantitatively. In either case the primary requirement appears to be for a biomedical engineering function (*1*) or even for a broader, "bioengineering" function (*2*) from which will follow naturally the demand for instrumentation. "Biomedical electronics" is an important but subservient function, reflecting the broad cooperation which is developing between life scientists and engineers.

Concerning specific proposals made or analyzed by Ledley and Lusted, a few comments are perhaps in order. I agree that a basic deterrent to biomedical electronics is a lack of financing. But in proposing more support for biomedical electronics per se, the authors are stressing the means with insufficient concern for the end. They attribute the reluctance of industry to participate in the development of electronic devices for medicine to "the prevalent opinion that there is a small market." They cite three other problems: (i) "finding what devices need to be made," (ii) "getting the devices tested," and (iii) "selling the instruments." All of these are facets of one problem: a shallow dialogue between the biological scientist, who knows the subtle morphology of the problem, and the engineer, with his sometimes naive but often useful ca-

pacity to build and analyze tenable physicochemical models.

At the end of their article Ledley and Lusted make a more general plea for increasing the depth and intensity of this dialogue, but even this discussion seems to be oriented toward finding uses for electronics rather than toward finding solutions for pressing problems in biology and medicine. They say, for example: "Because of the extensive mathematical training he has already received, it is usually easier for a physical scientist or an engineer to become a biomedical researcher than for a biomedical researcher to become a physicist or engineer. *Such an electronics trainee . . .*" (italics mine).

One is moved by the tremendous accomplishments of electrical engineers in this field to a high and unqualified admiration of their pioneering efforts. That they, as a group, should choose to fix the boundaries of this new and exciting area of cooperative research so as to make them in any way coincident with the boundaries of their own field is unbelievable.

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Notes

1. The term *biomedical* (without the suffix *electronics*) is a part of the name of Ledley's organization. Lusted is listed as a professor of "biomedical engineering." The recent Nebraska Conference was on "biomedical engineering." Johns Hopkins and the universities of Rochester and Pennsylvania have programs in "biomedical engineering."
2. Many institutions have been entertaining programs involving engineering and the biological sciences for many years. Columbia University has simply made medical applications a part of its long-standing activity in a broad area which we call "bioengineering."

Leonard quite correctly points out that the different engineering disciplines can contribute greatly to the advancement of biomedical research. If he feels our article implies that only electrical engineering or biomedical electronics can contribute to the progress of biomedical research, to the exclusion of other areas of engineering, then he has misinterpreted our intention. The main theme of our article is expressed in the first sentence: "The full application of electronic engineering technology to biomedical science is long overdue." We believe that such application, in many areas, is necessary (though clearly not sufficient in itself) to the general advance of biomedical science.

We should like to point out that in our article we considered mainly the tool—electronic engineering technology

—not electronic engineering science. Leonard's letter is apparently concerned more with the engineering scientific disciplines themselves than with the tools of engineering science. He says that "the biological scientist frequently needs assistance in these analyses, and this assistance can often best be obtained from a problem-oriented individual with training in one of the several branches of engineering." In a previous article, "Digital electronic computers in biomedical science" [*Science* **130**, 1225 (1959)], one of us (R.S.L.) stated, "I strongly believe that 'team' approaches, where the biologist has no . . . [engineering] training and the engineer . . . has no biological training, are foredoomed to failure. For the full significance of the extensively detailed and often subtle . . . use of . . . [engineering science] in biomedical science can be understood only by those well grounded in both fields." Whether or not any of the various engineering sciences—such as chemical, hydraulic, and mechanical, as well as electronic, engineering—is a *necessary* ingredient in biomedical research depends upon the particular problem being approached.

However, we believe that electronics as a tool *is* (or should be) in many cases a necessary ingredient of research. In order to lend weight to this point in our recent article, we described such use of electronic equipment as a necessary ingredient (but obviously not the only one) in many biomedical research activities, and we attempted to discuss the reason why fuller use of this important tool has not yet been made in biomedical research. We do place this electronic tool in a rather exalted position, because it is well known that advances in science closely parallel advances in instrumentation. However, we refute Leonard's accusation that we have attempted "to fix the boundaries of this new and exciting area of cooperative research so as to make them in any way coincident with the boundaries of [our] own field [of electronics]." As a matter of fact, we would like to call attention to a symposium on educational frontiers in biomedical engineering [*IRE Trans. on Bio-Medical Electronics* **BME-8**, No. 4 (1961)] in which the very broad field of biomedical engineering is discussed.

In conclusion, we would like to reiterate the view, stated in our article, that the "use of electronics in biomedical science [as a tool] holds promise of tremendous advances in the study of the origins of the life processes; it may

result in spectacular advances in medical science, which could have a definite effect on individual health and longevity; it might pave the way for the discovery and development of whole new technologies based on intimate knowledge of biological processes."

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A Concerted Attempt To Improve Relations with the Communists

Recent commentary concerning what scientists can do to help resolve the arms race seem to me to overlook one unique contribution that scientists as a group can make. This is to focus attention on treatment of the fundamental disease—the almost total ignorance of the problems and intentions of the "other side" evident on each side—as well as the symptoms and their treatment.

This is not to say that the symptoms can be or should be ignored. But it does seem preposterous to budget over $50 billion on military defense and a pittance, if that, on long-range defense measures aimed at resolving the underlying tensions by improving the reciprocal understanding and appreciation of strengths, as well as weaknesses, of the American and Russian societies. To attempt any such program openly will be attacked as treasonable by many citizens who have closed their minds to the problem and see issues only in clear-cut blacks and whites. Scientific objectivity certainly needs to be applied here, and in generous dosage.

The risks of such a procedure may seem enormous to those among us who are strongly and often vehemently *against* communism (and perhaps also democracy, or some particular religion, and the like) but who more and more fail to emphasize the values that they feel we should be *for*—except in what appear to be vacuous, emotion-laden shibboleths. The corresponding erosion of those freedoms for which our country has long stood is especially disturbing and is aggravated most dangerously, if not initiated, by many of these people. Surely it is time for scientists to take a more forthright and uncompromising position in support of our freedoms, and to emphasize the strengths

of our own political system which permit us to explore the path to more open communications and interchange, even of ideas, with the Iron Curtain countries. Are scientists to be frightened into political apathy by vociferous men with a frenzied fear of ideas and little faith in our political strengths?

Once we have achieved a breakthrough on the present reluctance to recognize some degree of mutual culpability in the nuclear armament impasse, regardless of the extent to which either side is more or less culpable, then the really difficult task of implementing improved understanding can be attacked. Scientific ingenuity, now so largely mobilized in the interests of short-range, symptomatic efforts, can be turned at least partly to the fundamentally more important long-range objectives. Even if we were completely innocent and the Soviets were 100 percent responsible for the present impasse, nevertheless it would still be in our own best interest to make a serious and concerted attempt to improve relations and thus get at the fundamental difficulty.

The overwhelming political need of our time is an opening of the channels of communication between the Western countries and the Communist countries —China even more than Russia, if present portents are reliable. Let the scientists use up some of their recently accumulated prestige, if need be, by taking the lead here. Who else is in a position to do so?

Critics of this point of view will of course point with great alarm to the past difficulties encountered in dealing with Communist personnel. That there have been difficulties cannot be denied. But surely the situation is not hopeless. Past rebuffs, even if they are seen as all on one side, cannot be allowed to dissuade us. The most important social role of the scientist in our time, in my opinion, is to seize upon this opportunity to utilize the spirit of free inquiry in science as a base from which we can develop an increasing amount of social and cultural interaction. A good example of the kinds of mutual benefit, in the form of enhanced cultural understanding, that can be achieved is given in the article by Konrad B. Krauskopf [*Science* **134**, 539 (1961)], in which he recounts his experiences on a scientific trip to the Soviet Union. It should be clear that I am not proposing merely an increase in the kind of "understanding" that seeks to assay Soviet motives, political or military, but rather a broad

attack on the general problem of getting to know the Russians, people and officials, in an atmosphere of genuine interest and tolerance rather than one of chronic suspicion and competition.

The objective outlined in this letter will require a redoubling of our efforts to open up lines of scientific communication, especially in regard to meetings and exchange visits, and such a move can be effectively spearheaded only by organizations like the AAAS. Advantage should be taken of the apparent readiness of the present Administration to act in a conciliatory manner from a position of military strength. Expression of support for AAAS officials in such endeavors can be offered by individual members, both in general and on specific issues that arise, and should be communicated to congressmen and other public officials.

If scientific opinion in this country can concentrate on this one major objective I feel that there will be some promise of our making at least a small crack in the Iron Curtain. And the social and political voice of the scientist will certainly become more potent when some such common objective is widely accepted and promoted within the scientific community.

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Science, Linguistics, Lexicography

The editorial "Say it *ain't* so" [*Science* **134**, 1493 (1961)] is a fair and reasonable commentary. Whether or not one agrees with the editor's views, no exception can be taken to the manner in which they are presented. It is to be regretted that the same cannot be said of the comments of Max S. Marshall [*ibid.* **135**, 739 (1962)] on this editorial. One scarcely expects to meet in the pages of *Science* techniques more commonly reserved to propaganda and the polemical diatribe.

It is unfortunate that a scientist of some professional stature sees fit to employ, in discussing a matter outside his specialty, an intemperance of language and inaccuracy of reporting that he assuredly neither would nor could employ in professional communication in his own field. The use of such pejorative terms as *ringleaders, proselytizing, self-styled,* and *make a mess of* seems as misplaced in scholarly comment as does the quoting of fragments out of context in such a manner as to completely obscure the intent of the original author; for example, "the advocates of 'observing precisely what happens when native speakers speak.' These are the self-styled structural linguists. . . ." (Marshall), versus Gove's actual statement, "The fundamental step in setting down postulates for *descriptive* linguistics is observing precisely what happens when native speakers speak. This is the essential *first step* required by scientific method" (italics mine). Does Marshall deny linguists alone the right to accumulate data, or does he hold the familiar, the accepted, the authoritarian to be the proper bases for all scholarly activity? No, this seems hardly likely in an adherent of one of the newer biological disciplines and one whose founder answered the criticisms of academicians of his day with clear-cut data.

To turn to the content as distinct from the manner, there are a few points in Marshall's letter that require special notice, if only because they appear as misconceptions in several reviews. The idea that the Merriam-Webster editorial process was in any fundamental way a clerical or mechanical tabulation is wholly false. On the contrary, this process involved the accumulation of data (citations) on a carefully planned basis designed to assemble from varied sources and levels of usage word samples adequate for analysis. The resultant material was then sub-

mitted to technically qualified editors who, in the light of their knowledge and experience, weighed the items included not solely for meanings exemplified but also with due attention to place of origin, character (as technical, scholarly, classical, popular) of publication, kind of writing and evidence of editing, and other indications of status.

Another misconception in holding which Marshall is not unique is the assumption that matter in angle brackets in a *Webster's Third New International* definition is a quotation of authority. As is specifically stated in the initial explanatory notes (p. 19*a*), "The matter enclosed in a pair of angle brackets *illustrates* an appropriate use of the word in context" (italics mine). The purely illustrative status of such material should be patent, even in the absence of such a statement, from the fact that much of it is anonymous. That an editor has occasionally out of abundant material chosen to illustrate a usage by an apt quotation from a ballplayer, a disorderly-house keeper, or a politician is rather indicative of his awareness of the living, democratic character of our language than of an attempt to establish false authorities.

As one whose training is fundamentally in "science" in the narrow sense apparently recognized by Marshall, I am perhaps no better qualified to defend than he to criticize the scientific status of linguistics. Yet I think the question is no more than one of definition. If science is equated with what is often distinguished as the natural sciences, then by definition linguistics is excluded. If we recognize that the esoteric mystique of science is as dated as alchemy or the benefit of clergy and go along with much of modern thought in stipulating that science is not any one discipline or any group of disciplines but is knowledge obtained by the scientific method, then a scholarly field that is subject to objective analysis is at least potentially a science. On this basis we may doubt the possibility of a science of religion or of literature or, in traditional terms, of grammar, but there can be as readily a science of linguistics as of bacteriology or genetics. The crux is the methods and aims of the practicing scholars. Individually, linguist, bacteriologist, or geneticist may be scientist or nonscientist, but each field lends itself to objective investigation and, insofar as its adherents practice this, it cannot in any normal sense be denied status as a science.

Personally, I doubt that any scholarly

or scientific linguist would call the classicists reactionaries on the basis of their belief in "a standard of quality in English" or their respect for "the accepted great in literature." While one might quibble over whose standard and whose acceptance, there are few indeed unwilling to acknowledge both the import of the classics as part of our cultural heritage and the desirability of nicety of expression. It is not to these the modern linguist objects but to attempts to restrain, by an authoritarian dominance, the normal evolution of language. If I write "Che cou'd not i' honor passe your worde vnchallenged" I am using 17th-century verbiage sanctioned by notable literary sources, but I would be more generally intelligible if I said "I could not honorably allow your remarks to pass unchallenged," and this, as a member of the Merriam-Webster editorial staff, I do say to Marshall.

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Though the challenge is somewhat personal, Kay does help to clarify the side he takes. Try J. Donald Adams [New York *Times Book Review* (11 Feb. 1962)] and Dwight Macdonald in his searching analysis [*New Yorker* (11 Mar. 1962)], or almost any other earlier comment on Webster 3, for more detail on points to which Kay and his associates have become hypersensitized.

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Simulation of Cognitive Processes

The computer simulation of human thinking presumably described by Newell and Simon [*Science* **134**, 2011 (1961)] is questionable on a number of counts, general and specific.

In the first place, the simulation is made to seem plausible because the authors first "postulate" that human beings behave exactly like computers. Then they "discover" that they can imitate on a computer the computer-like characteristics of man they have already postulated. The human use of *symbols* implies that, on some occasions at least, a human being considers both a symbol and what it symbolizes. Newell and Simon restrict their subjects

to symbol manipulations without meaning or understanding and then "find" that computers which do not understand the meanings of the symbols they manipulate behave exactly like human beings. It is unnecessary to say any more on this point, since there already exists in the literature a scathing indictment by O. H. Schmitt, the distinguished biophysicist, of this type of vicious-circle reasoning [*IRE National Convention, 1955* (1955), pp. 240–255].

In the second place, there is internal evidence that the experiments with the computer and subjects were not actually carried out as reported in the article. It is stated that "the subjects read the first expression, for example as, '(r) dot (tilde-p horseshoe q).' They made no use of the meanings of the expressions in their usual interpretation but simply manipulated them as organized collections of symbols." There are no parentheses around *R* in the original expression. Furthermore, unless the subjects were coached or understood the function of parentheses in symbolic logic, why didn't they read the expression as "R dot curve tilde p horseshoe q curve"? Without an understanding of grouping in symbolic logic, why should the subject say there are "two things"? Why not eight (number of symbols)? On this point, see the section on "Formality" in Quine's *Mathematical Logic*. The rules of grouping, of association, and of distribution are an important part of symbolic logic. Either the subject understood these rules or the report of the solution by symbol manipulation is contrived and not a description of an actual experiment.

A similar difficulty arises in the description of the computer program. In a program based on an algorithm, the phrase "not desirable" would be a colorful description of "reject" or "not applicable." But a so-called heuristic program would require a sharp distinction between rules which could be applied but wouldn't lead to anything ("not desirable") and rules which couldn't be applied because they were simply not applicable—that is, would lead to invalidity. Rules 3 and 4, although stated in the program to be "not desirable," are in fact "not applicable." This fact, together with the absence of formal rules for grouping and distribution, suggests strongly that the program as given in the article was never actually run on a computer.

The basic difficulty in articles of this type is that they involve what the editor of *Scientific American* has called "fraud by computer." Certainly a computer can simulate human thinking if the word *simulation* is defined as Webster has defined it: "1. Act of simulating or assuming an appearance which is feigned, or not true; pretense or profession meant to deceive. 2. Assumption of a superficial semblance, a counterfeit display."

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Taube, in his letter as in his book, *Computers and Common Sense*, appears to be unable to discuss the simulation of cognitive processes without words like *fraud*, insinuations about the honesty of those with whom he disagrees, and bad jokes about the word *simulation*. In view of his abusive tone, we think it fruitless to enter into discussion with him. We will limit ourselves to clarifying for readers some technical points related to his comments.

Were the logic expressions manipulated as meaningless symbols? The parenthesis signs were interpreted by both the General Problem Solver (GPS) program and the subjects—that is, treated as punctuation marks for identifying phrase structure in the logic expressions. This interpretation was built into the GPS program; the subjects had ac-

quired it previously, presumably from their acquaintance with algebra. To this extent the expressions were meaningful to both the human subjects and the interpreter of the program.

Does the program distinguish between "undesirability" and "inapplicability" of operators? The GPS contains both tests of desirability (involving comparison of the effects of an operator with current goals) and tests of applicability (involving comparisons of the operator with the input expression). *Either* test can be applied first. If, as in the case of rule 3 or 4, an operator is neither desirable nor applicable, it will be rejected by whichever test is applied first. At the time the simulation in the *Science* article was made, the version of GPS running on the IBM 7090 gave priority to the applicability test. To fit the behavior of subject 9, a hand-simulated variant was employed that altered the relation between the two tests, producing the result shown in the trace. This is a good example of the kinds of changes in GPS that are required to adapt it to individual differences among our subjects.

We might mention that our traces of runs on the IBM 7090 (about 800 of them), our hand simulations (several dozen), our recordings of human subjects (about 30 hours), and decks or tapes of our GPS program, written in IPL-V, can be made available to fellow scientists who wish to work with them and arrive at their own interpretations.

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Recording Animal Activity

In a recent issue of *Science* [**134**, 730 (1961)], Kavanau and Norris describe an excellent application of the "capacitance-sensing" activity technique in behavior studies of burrowing animals. However, they state that "although the method is highly versatile, it apparently has not been used heretofore to study animal movements."

This method of recording animal activity was used and reported by Backlund and Ekeroot 11 years ago in a paper entitled "An actograph for small terrestrial animals" [*Oikos* **2**, 213 (1950)]. These authors used the technique to record the activity of blowflies (*Calliphora erythrocephala*), and their paper has the advantage of including

the circuit diagram of the oscillator apparatus, which can be built in the laboratory. Unfortunately, they were not able to pursue their studies with this technique, but it is to be hoped that Kavanau and Norris will be able to use the method of Backlund and Ederoot to its fullest extent.

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We are indebted to D. K. Edwards for calling attention to the note of Backlund and Ekeroot. It substantiates our belief that the method has great potential for other applications.

Our use of the technique is quite different from that of the Swedish workers. They sought to record activity periods of blowflies confined under a petri dish, while our objective is to follow both the periodicities and the gross locomotory displacements of burrowing animals whose activities cannot be seen. We hope that others will apply the technique to new situations. Most biologists will find it more practical to use commercially available Hartley oscillators than to build their own.

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An Unfortunate Event

I am writing with reference to your note entitled "An unfortunate event" [*Science* **134**, 945 (1961)] concerning the report by Pande, Shukla, and Sekariah. Indian scientists are equally shocked over this disgraceful affair. This was brought to the notice of M. S. Thacker, director general of the Council of Scientific and Industrial Research, who is also the president of the Association of Scientific Workers of India. He, along with this body of Indian scientists, would like to inform you of our deep regret that such an unfortunate thing has happened.

We also take this opportunity to inform you that, at the initiative of Thacker, disciplinary action has been taken against the authors; one has been retired and the other two suspended. The matter is under investigation by an inquiry committee for determination of final punishment.

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