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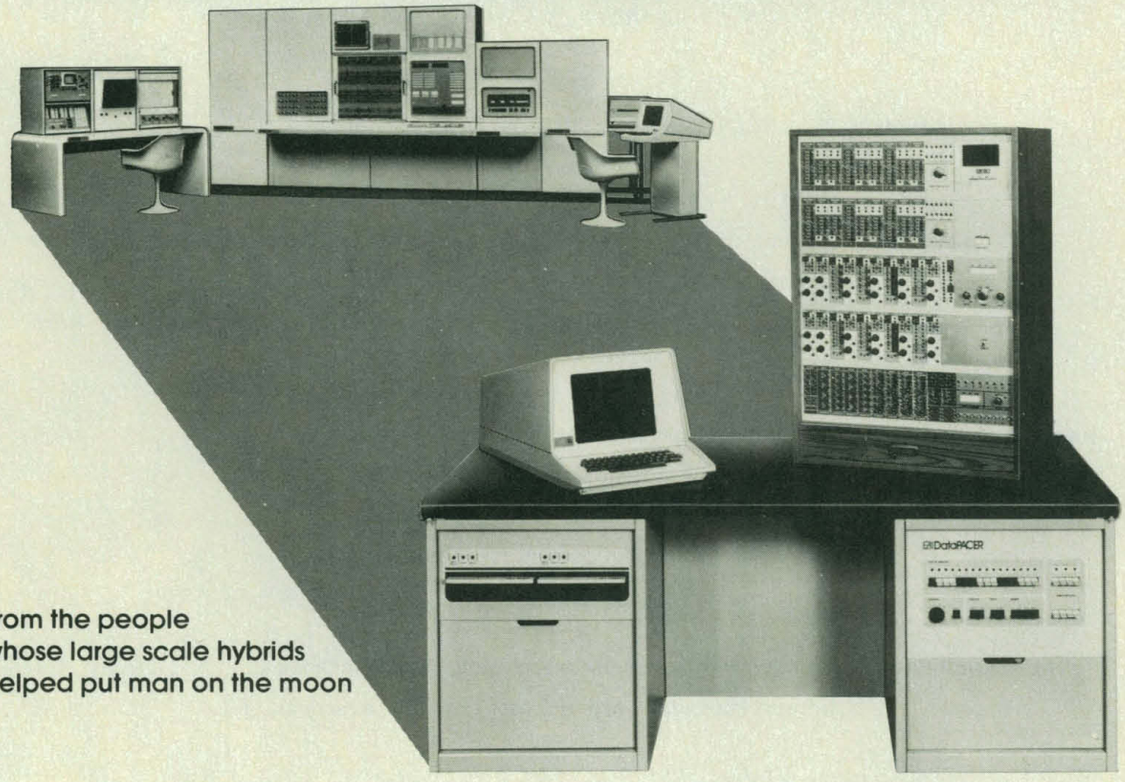

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COVER

Solid animal figurines, probably representing deer, found in excavations at Snaketown, southern Arizona. The average length of each figurine is 13 centimeters. The figurines are "so much alike they could only have been made by a single craftsman. . . . The repetitiveness of the form seems to have had some value in the mind of the maker. If connected with productive magic, the greater the number of figures, the more potent and coercive the plea." [From *The Hohokam: Desert Farmers and Craftsmen* by Emil W. Haury, reviewed on page 1234]

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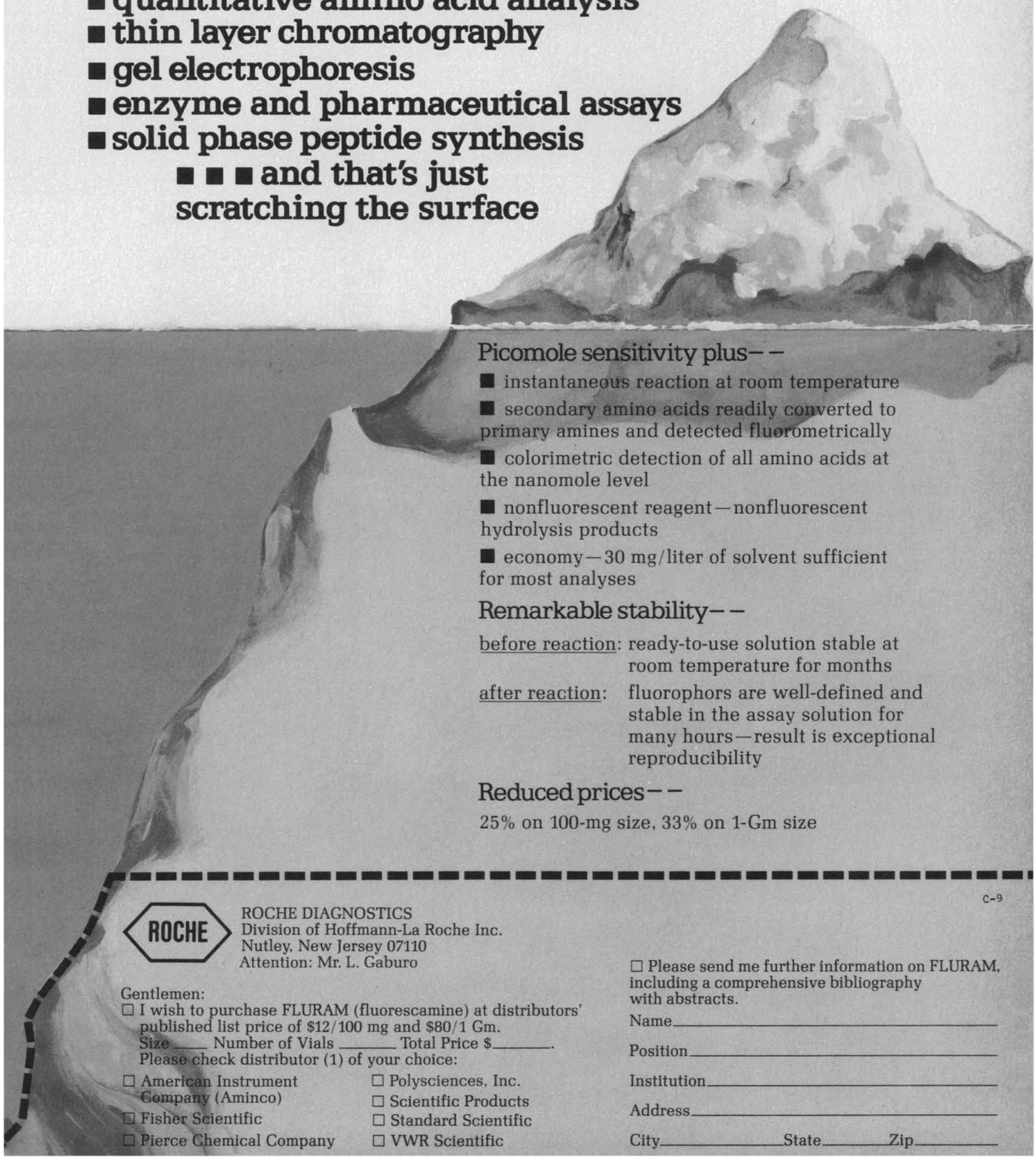

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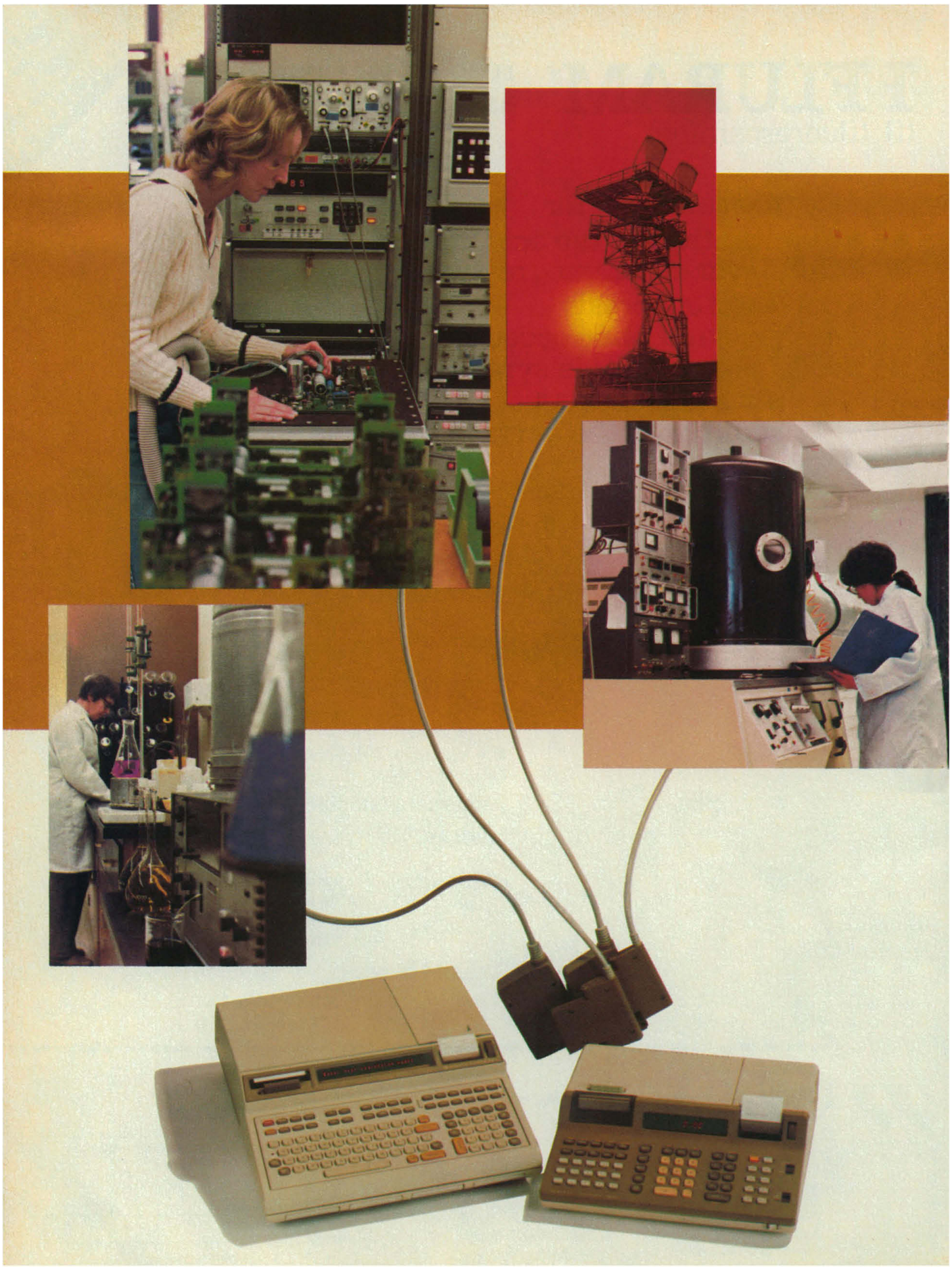

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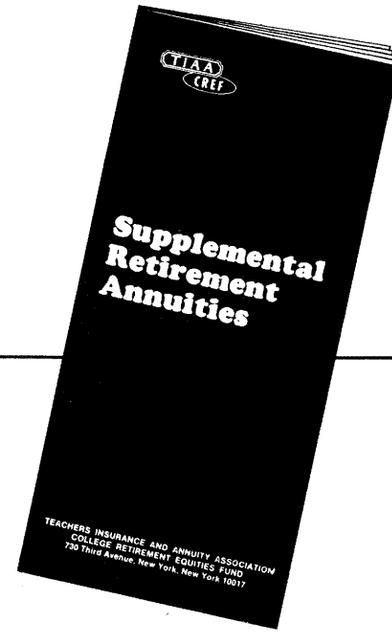

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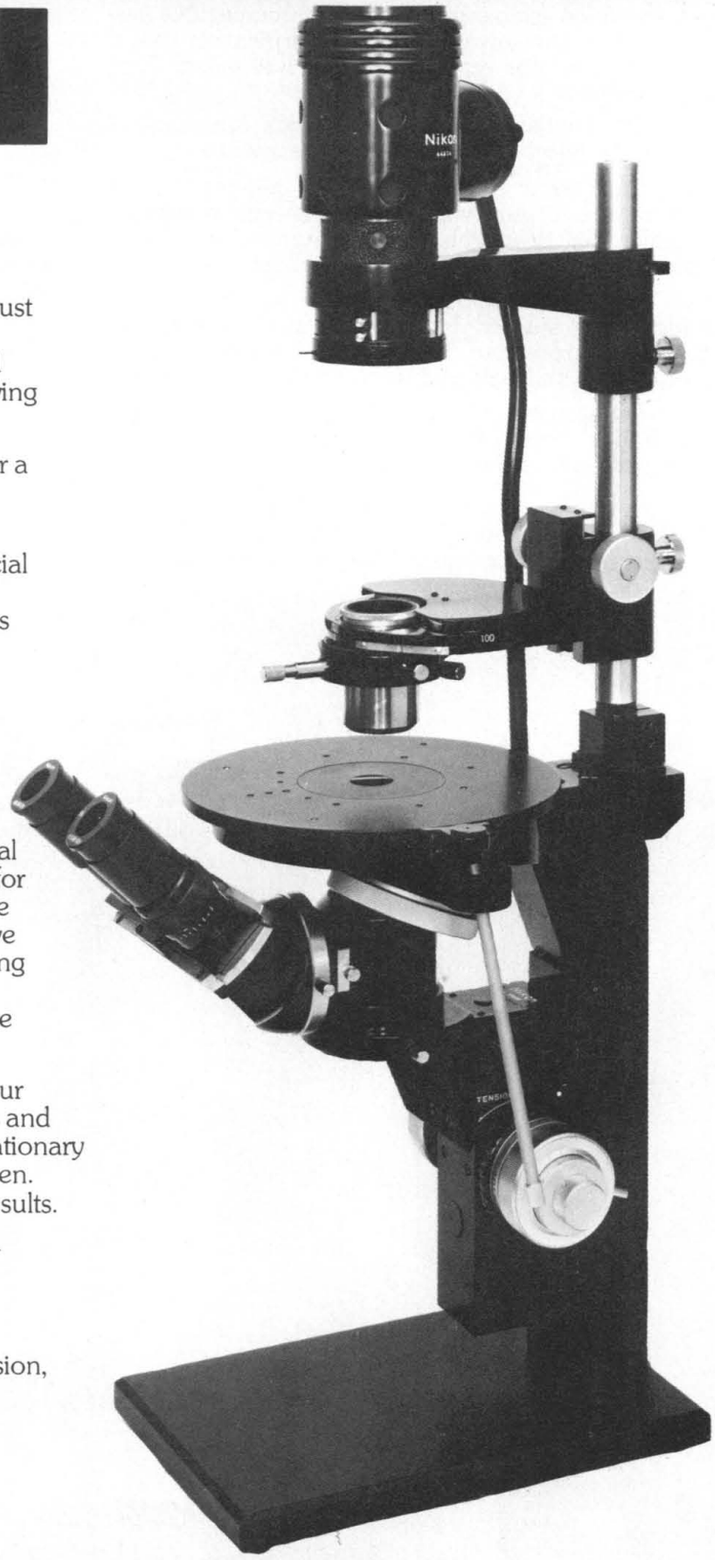

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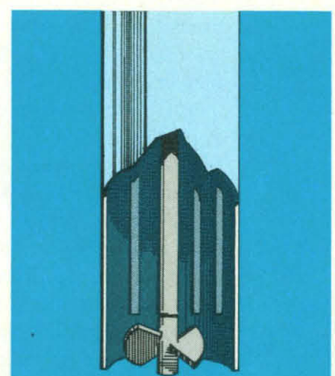

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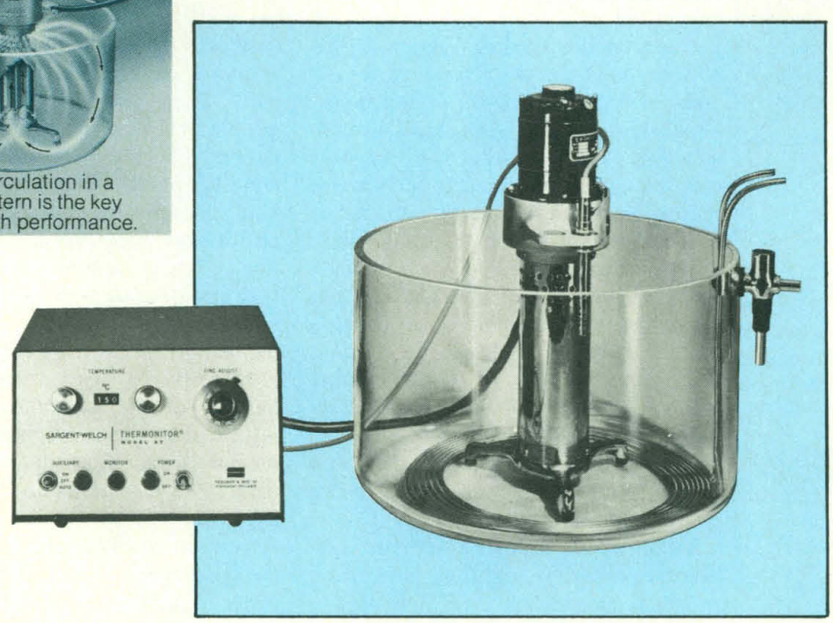

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LETTERS

Research Funding for Completed Work?

I have just returned from a meeting of a governmental group which is charged with distributing $200,000 among the submitters of over $2 million worth of proposals. We are having to go through a lot of chaff for very little wheat. My acquaintances in the National Science Foundation and the Energy Research and Development Administration tell me that they are overwhelmed by the tremendous number of proposals they must read over and have evaluated. It sometimes takes many months and telephone calls to get even an acknowledgment that a proposal has been received by them. Too much time and creative energy are wasted.

Being a reasonably successful researcher who has not been particularly successful at getting grant money, who finds it fatiguing and demoralizing to ask for money with a promise, but who finds it invigorating and stimulating to do the work and exhibit the results, I would like to suggest the following.

A substantial fraction of all governmental grant money should be made available to pay for work which has already been completed. The doer of a worthy piece of work should submit to the appropriate funding agency a final publication (hopefully from a reviewed, archives-type journal) or a final report which describes his work, together with a budget which includes the expenses entailed in its performance, including a reasonable profit for the investigator or his organization. Evaluation of work already performed could be made by technical peers as it is now, and since it would be the work itself which is being evaluated, there would be no need to identify the worker in this evaluation process. The work would stand or fall on its own merit. It is inherently easier to evaluate work that has already been done than it is to anticipate the value of a proposed piece of work.

Some of my most successful colleagues advise me that they now spend as much as half of their time in the pursuit of funding and a substantial fraction of their remaining time in the performance of peripheral jobs having to do with the financing of their research. How much less wasteful it would be if they and the people in the granting agencies could be relieved of the need to wade through tons of proposals that are generated in a shotgun approach to securing funds.

It is pertinent that young people need help in getting started. It is also pertinent that there are some projects for which the expenditure is so great that no individual or organization could afford to take the risk involved in performing them without a guarantee of governmental funding. Such matters could be handled as they are now. But a substantial amount of research supported by the government could be handled in the way that I suggest.

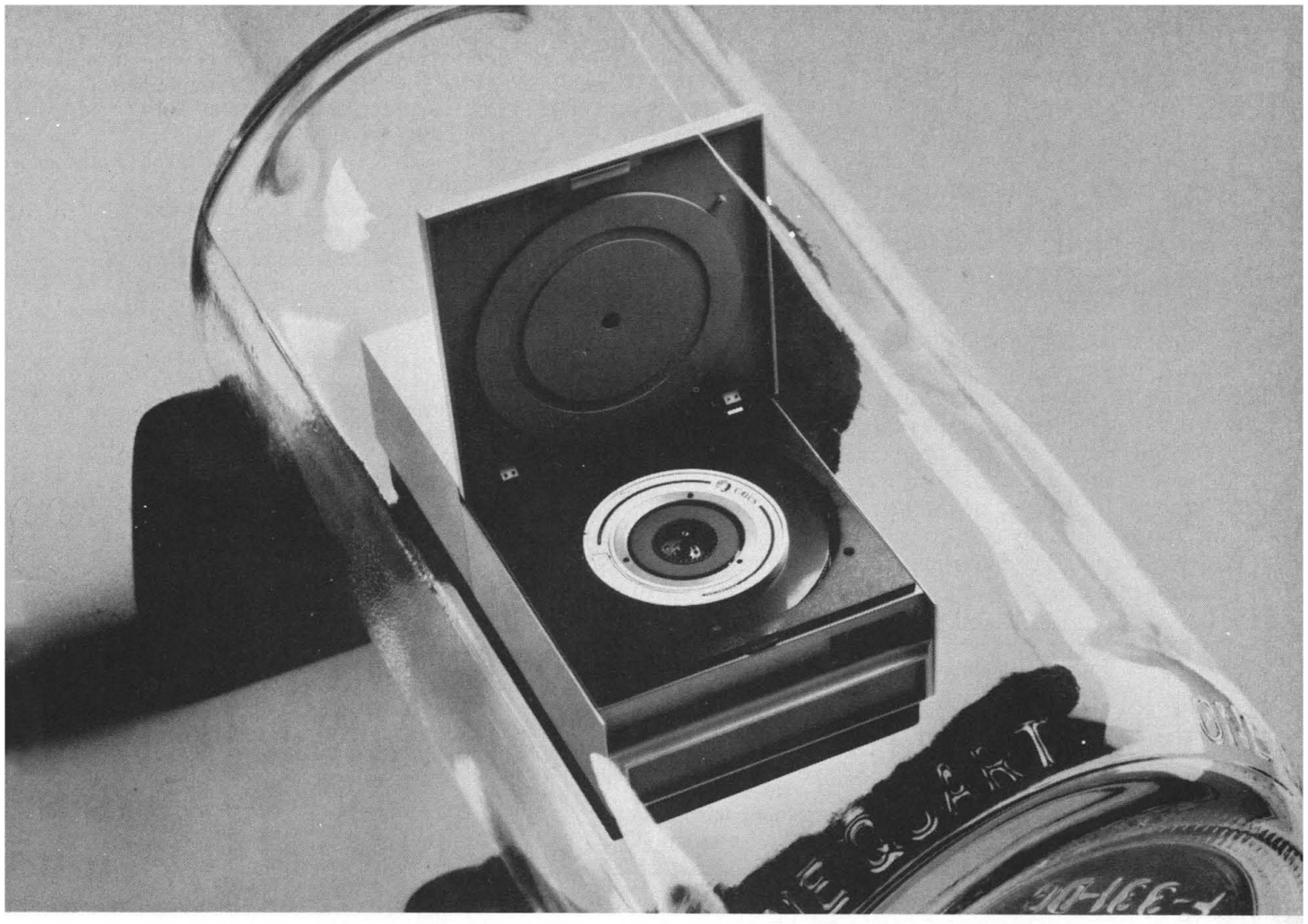
Such a system would help make disbursement of federal funding more competitive, fair, and in the spirit of a free society. It would give creative people more time in which to work on their ideas than they now have and make them less dependent on membership and conformity to an establishment for success.

EDWARD A. FLETCHER
Department of Mechanical Engineering, University of Minnesota, Minneapolis 55455

Recombinant DNA Guidelines: Environmental Impact Statement

In June of this year, the National Institutes of Health (NIH), with the concurrence of the Secretary of Health, Education, and Welfare and the Assistant Secretary for Health, issued guidelines to govern the conduct of NIH-supported research on recombinant DNA molecules. These guidelines, developed over an 18-month period, involved the participation of both the scientific community and the public. They prohibit certain kinds of experiments and allow others to go forward under special safety conditions. The provisions afford protection with a wide margin of safety to workers and the environment while permitting this important research to proceed.

In response to the requests from a number of public commentators, the NIH undertook to prepare an Environmental Impact Statement on recombinant DNA research activity, in accordance with the National Environmental Policy Act of 1969. The development of the guidelines, as noted in my decision paper accompanying them, was in large part tantamount to conducting an Environmental Impact Assessment. A formal assessment was made, however, and a Draft Environmental Impact Statement was prepared, with a view to promoting public understanding of the issuance of the guidelines. Notice of the availability of this draft document appeared in the *Federal Register* of 8 September (p. 37842). It was also published in full in the



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Federal Register of 9 September (p. 38425) for general comment by the public and the scientific community.

The NIH also welcomes comments from the readers of *Science*. Copies of the document are available from Dr. Rudolf G. Wanner, Associate Director for Environmental Health and Safety, Division of Research Services. His address is Room 4051, Building 12A, National Institutes of Health, Bethesda, Maryland 20014. Comments on the draft statement should be submitted to the Director, National Institutes of Health, Bethesda, Maryland 20014, by 18 October 1976.

DONALD S. FREDRICKSON
National Institutes of Health, Bethesda, Maryland 20014

Fusion as an Energy Option

The recent series of *Science* articles on fusion power by William D. Metz (Research News, 25 June, p. 1320; 2 July, p. 38; 23 July, p. 307) accurately expresses many of the current concerns of the utility industry about the U.S. fusion program. The articles, however, fail to express the utilities' belief in the need for development of fusion as a commercially and environmentally viable energy source and their confidence that, with proper management, this can be carried out successfully. Fusion power is one of the very few energy options that can provide central-station electric power on a scale sufficient to meet our future needs.

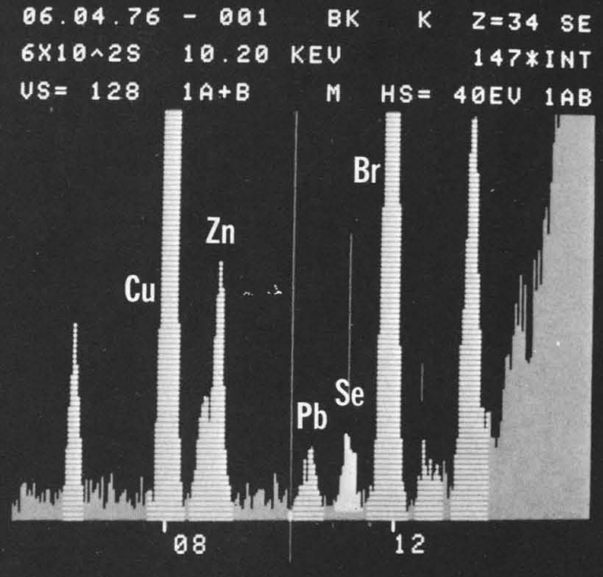
Although the *Science* articles are exceptionally well researched and technically informative, the editorial comments contained therein and in Philip H. Abelson's editorial of 23 July (p. 279) tend to put fusion in an unjustifiably grim perspective. First, the technological problems of neutron damage to materials and of containment and disposal of radioactive by-products have long been known to fusion researchers, if not to the public. It is encouraging that the engineering problems of fusion have been recognized early and are already being tackled.

Second, the early design studies of conceptual fusion reactors—unfortunately mislabeled "reference" designs—have quite naturally yielded cumbersome and expensive products. The purpose of these studies was to identify engineering problem areas; this aim is almost diametrically opposite to that of designing a power plant suitable for commercial application. Again, we are encouraged that this step has been taken

C&EN May 3, 1976

Heart disease, cancer linked to trace metals

The possibility that variations in dietary and environmental levels of selenium copper, zinc, and perhaps other metal



Spectrum for copper, zinc and selenium obtained from two microliters of human breast fluid.

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In this instance, the Kevex x-ray energy spectrometer measured the zinc-to-copper ratio and selenium concentration in two microliters of human breast fluid. A recent study shows a positive correlation between coronary mortality in 47 U.S. cities and the ratio of zinc-to-copper in cow milk of those areas. The connection between low cancer rate and high selenium diet was also reported for both cancer of the colon and breast cancer. (C & E News May 3, 1976).

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and are confident that future designs will bear little resemblance to these "protozoic" behemoths.

Third, the comparison in Abelson's editorial between the cost ($10 billion) of a 10-megawatt fusion plant and that of a 10-Mw solar electric plant ($100 million) is deceptive. The 10-Mw figure for fusion is a nominally chosen small positive number to indicate breakeven; fusion reactors would not come in such small sizes. If a fusion reactor took 1000 Mw to energize and produced 1010 Mw of electric power, it would have a net output of 10 Mw. However, if the plasma confinement time turned out to be twice as long as assumed (and this is well within the present range of uncertainty), the same reactor would produce 2020 Mw, for a net of 1020 Mw. By contrast, increasing the capacity of a 10-Mw solar plant to 1000 Mw would entail a 100-fold duplication of collecting panels and energy storage facilities. Furthermore, the $100 million figure quoted above is for a single solar electric installation; the $10 billion figure is the integrated cost of the entire fusion R & D program up to 1990.

The cost of developing fusion into a commercial energy source will be comparable to that of any major space, military, or weapons program; its importance to national security could be just as great. The technological problems of putting an American on the moon were staggering; yet they were solved when the nation put its resources behind the space program. Similarly, fusion needs the strong and consistent support of the public and of Congress if it is to become a reality. Without such support the program is destined to failure.

Regardless of how the program has fared in the past, the necessary dialogue between the users (the utilities) and the developers (the government) is now under way. The Electric Power Research Institute (EPRI) and the utilities believe that the fusion program should, at this time, remain broad-based while moving purposefully toward the goal of commercialization. By working closely with the Energy Research and Development Administration (ERDA), EPRI is reflecting utility viewpoints and design requirements into the national R & D effort. The inherent flexibility of fusion, which gives it many options for achieving our energy goals—in terms of plasma configurations, heating methods, fuels, and energy converters, as well as of hybrid schemes such as fission fuel production and waste burning and synthetic chemical fuel production—gives us confidence in the eventual success of the development effort.

The utility industry supports fusion research not only through EPRI but also through individual corporations, such as the Texas Atomic Energy Research Foundation, the Wisconsin Electric Utilities Research Foundation, and Northeast Utilities. Together with ERDA, we feel that, if the fusion R & D program is not prematurely condemned for identifying its problems, these obstacles can be overcome or circumvented. Furthermore, we fully expect that the requirements of the utility industry and of society will be taken into account as the program proceeds toward commercial application.

WILLIAM C. GOUGH
Fusion Power Program,
Electric Power Research Institute,
3412 Hillview Avenue,
Post Office Box 10412,
Palo Alto, California 94303

FRANCIS F. CHEN
EPRI Fusion Advisory Committee,
Department of Engineering and Applied Science, University of California,
Los Angeles 90024

MICHAEL LOTKER
EPRI Fusion Program Committee,
Northeast Utilities,
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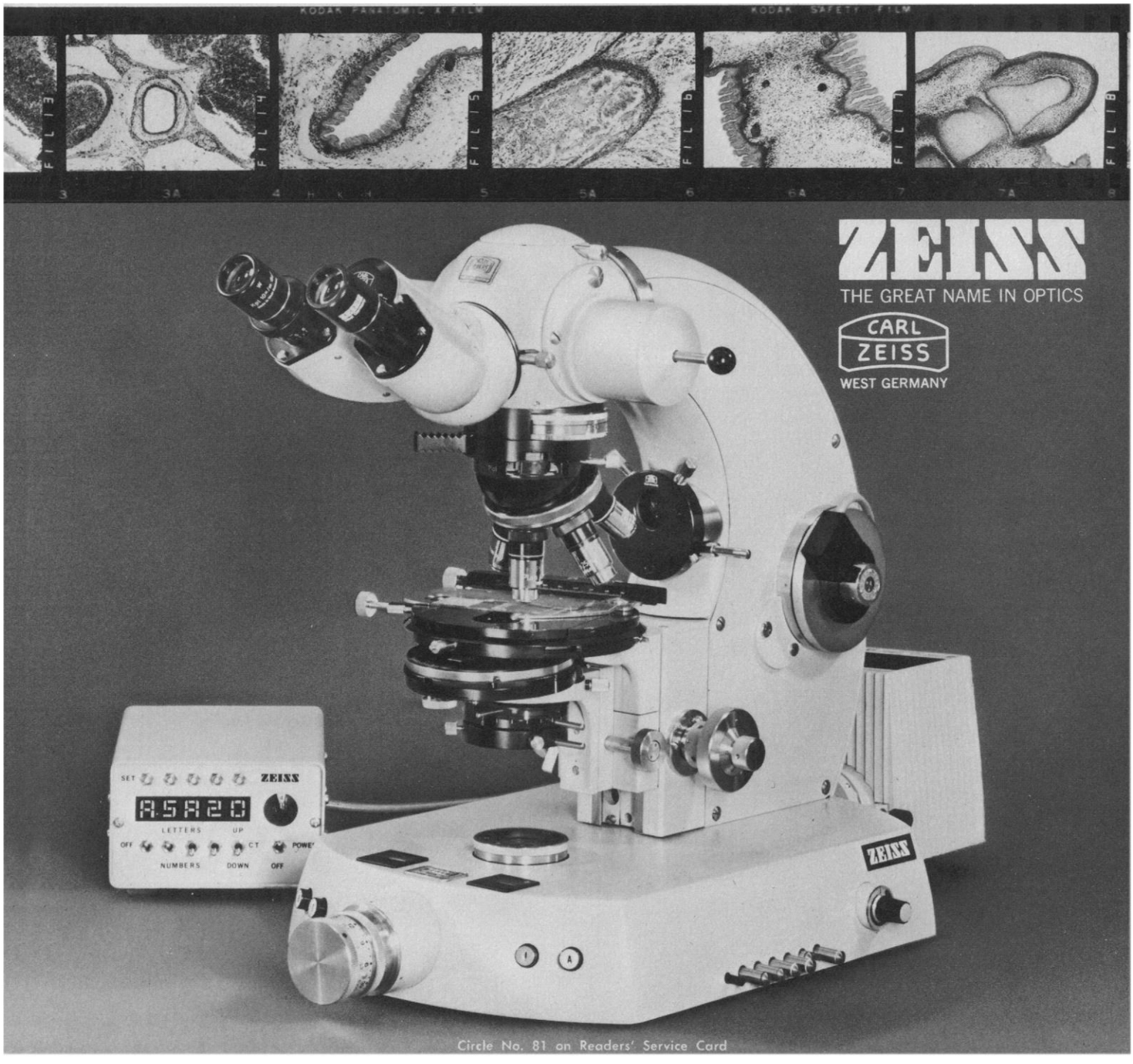

Circle No. 81 on Readers' Service Card

24 September 1976, Volume 193, Number 4259 **SCIENCE**

Toward a New Partnership

With the fireworks spent and the tall ships back in home ports, we enter both the nation's third century and the second century of the American university. Unfortunately, after 100 years of coexistence, our universities and the federal government have reached what I believe is a mutually counterproductive stage in their relationship.

Recently, President Harold L. Enarson of Ohio State University addressed the Ohio congressional delegation on this subject. Some of his remarks are particularly appropriate to members of our science community: "A fundamental change is taking place in the relationship between Washington and the nation's colleges and universities, a change which I find deeply disturbing. Once we were partners working together to solve national problems. Now we view each other with suspicion, almost as adversaries. We overregulate on one hand and overreact on the other. We have placed our partnership in peril. And if it is to be restored, it urgently needs our attention and understanding."

These are strong words, but I hear them echoed by my colleagues in universities across the land. From my own campus vantage point, the idea and the substance of our partnership with the federal government are being eroded in two specific ways. First, federal policy is being formulated which, wittingly or unwittingly, undermines the independence that has always been the fundamental strength of American universities. For example, several bills pending in the Congress pertaining to federal funding of medical education contain provisions that may require ill-conceived changes in curriculum as a condition of award. While we are hopeful that these provisions will be omitted in the conference committee, the fact that they survived through both houses of Congress indicates the decline in trust in our relationship with the federal government.

A second factor eroding the partnership is manifested in the administrative procedures being developed to implement federal policy. For example, narrower and narrower interpretations by federal auditors have turned the straightforward principle of overhead or indirect cost recovery on federal grants and contracts into a maze of procedures that work against the very policies they are supposed to implement. The result in this instance is transforming what was once a *joint venture* with joint federal and university contributions into a federal "buyers' market."

The formulation of federal policy is a factor we can deal with much more effectively than we can with increasingly narrow procedural interpretations. Broad policy in fields such as science and health are debated and scrutinized openly in the Congress. I believe we can rebuild the partnership in this open area. However, our task is more difficult when administrative procedures are formulated and interpreted behind closed doors, and then issued without university input and usually without warning. True, many times the procedural changes and new interpretations are narrow in scope. Over time, however, their cumulative effect can change or even destroy fundamental policies that are critical to maintaining a strong science effort.

Having spent some time as a federal agency head myself, I recognize the need for guidelines to carry out the mandates of Congress and to ensure that public funds are expended in a rational and constructive manner. We all recognize that a reasonable level of federal regulation must be tolerated if we are to be the beneficiaries of federal resources. Colleges and universities must be accountable for their use of public funds and an agency has every right to expect such accountability. At the same time, we have every right to expect the independence necessary to carry out the work for which the funds were appropriated in the first place.—WILLIAM D. MCELROY, *Chancellor, University of California, San Diego, La Jolla 92093*

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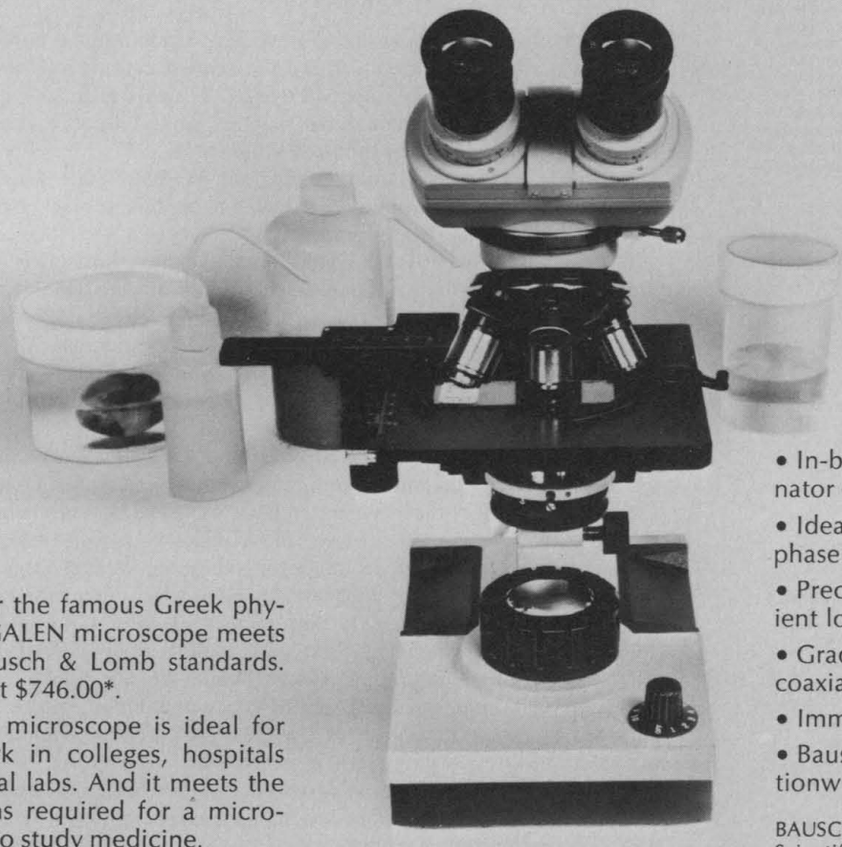

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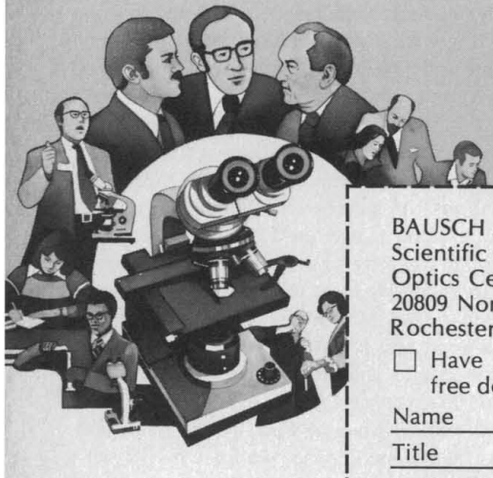

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Laboratory Flasks

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Refractor Telescope

Model 105 2-inch refractor is suitable for serious beginning observers. It features a coated, air-spaced, 50-millimeter achromatic objective. The altazimuth mounting provides accurate slow and fast controls for both altitude and azimuth motions. Other standard equipment includes a star diagonal; 28- and 78-power objectives; 4-power, 19-millimeter viewfinder with crossline; and a sturdy wooden tripod. A variety of accessories and attachments is available for terrestrial viewing, photography, and other applications. Unitron Instruments. Circle 698.

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A stereoscopic observation and measuring instrument has been developed for scanning electron microscopy. It produces three-dimensional images, magnified up to 500,000 times, which can be measured while under observation to a maximum of 300 angstroms for height and up to 30 angstroms for length and width on the Hitachi HFS-2 scanning electron microscope. It consists of two memory devices, a time-sequential three-dimensional television system with a PLZT electro-optical shutter, and a three-dimensional measuring unit. The specimen is tilted in the microscope column and electron beams are directed at it from two incident angles. The two images produced are stored in the memory devices and shown on a monitor timed alternately at one-sixtieth of a second and synchronized by the shutter. Hitachi. Circle 693.

Oxygen Detector

The Oxygen Indicating Tube is used in conjunction with a connecting tube and a multigas detector pump to determine oxygen concentration in ambient air and other gases. A stroke of the pump causes the tube to indicate percent of oxygen. To activate the system, the ends of the indicating and connecting tubes are broken, the two are joined by a rubber connector and the set is placed in the pump. Each connecting tube can be used four times and each indicating tube can be used once. The tubes are unaffected by moisture and may be used in temperatures from 0° to 90°C. If stored at less than 30°C, the tubes have a shelf life of 2 years. National Mine Service. Circle 696.

Literature

Electronic Kits are included in the fall catalog for television, test instruments, radio, stereo, auto accessories, clocks, and other do-it-yourself items. Heath. Circle 699.

Instruments at a Glance features a line of analytical products, such as gas and liquid chromatographs, spectrophotometers, mass spectrometers, electrometers, and data processors. Varian Instrument Group. Circle 700.

Neuroscience, Statistics, Psychology is a 1977 catalog of audiovisual programs and materials in these disciplines. Life Science Associates. Circle 701.

Chromatography Data Processors includes devices designed by chromatographers for evaluation of data collected with these analytic techniques. Laboratory Data Control. Circle 702.

2200 Portable Computing System is described in an illustrated brochure. Wang Laboratories. Circle 705.

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—RICHARD G. SOMMER

(Continued from page 1232)

can relax to the ground vibrational state by way of the V-T process. Thus, in order to determine in detail the effect of laser excitation on the reaction rate, the rates of five separate reactions must be differentiated. Such a complete analysis is yet to be accomplished.

Early experiments were performed by separate groups at the Naval Research Laboratory, Washington, D.C., consisting of Robert Gordon (now at the University of Illinois at Chicago Circle) and Ming Chen Lin, and at the National Bureau of Standards, consisting of Michael Kurylo, Andrew Kaldor (now at the Exxon Research and Engineering Company, Linden, New Jersey), Braun, and their associates. Although their data were not precisely in agreement, the two groups found that laser enhancement seemed to be about equally effective in producing both electronically excited and vibrationally excited nitrogen dioxide and that, overall, the reaction was enhanced by about a factor of 10.

Most recently, experiments over a wide range of temperatures by Gordon, Jerry Moy, and Ezra Bar-Ziv at the Chicago Circle campus led to the conclusion that about 43 percent of the vibrational energy in ozone was contributing to the reduction in the activation energy for the reaction yielding electronically excited nitrogen dioxide. Similar results have yet to be obtained for the reaction leading to vibrationally excited nitrogen dioxide.

Finally, Terrill Cool and Kin-Kwok Hui at Cornell have separately measured (at room temperature) the visible and infrared components of the chemiluminescence from the product nitrogen dioxide. They were able to determine that, not only does the laser excitation enhance both reactions, but that it preferentially enhances the production of electronically excited nitrogen dioxide as compared to vibrationally excited nitrogen dioxide by a ratio of 2 to 1. This result updates the earliest experiments, in which it was not possible to completely separate the contributions of each component to the overall reaction, and is also in agreement with the information theoretic analysis assertion that vibrational excitation is less and less effective for increasingly exothermic reactions.

In modern molecular dynamics, theorists calculate reaction rates from the trajectories of reactants and products over multidimensional surfaces (hypersurfaces) that represent the potential energy of the chemical system as a function of the relative positions of each molecule. The effect of vibrational excitation on a reaction rate, then, must be described in terms of changing these trajectories, and the different effects of different modes of excitation must be related to the details of these surfaces.

To test these ideas, some years ago, John Polanyi and Wing Hing Wong of the University of Toronto made trajectory calculations for a variety of model surfaces—that is, surfaces not related to any real chemical system. Polanyi and Wong found that, for simple exchange reactions of the type $AB + C \rightarrow A + BC$, increasing the translational energy of the reactants was most effective in enhancing the reaction rate when the energy barrier separating the reactants and products was at a maximum early in the collision—that is, as the reactants are still approaching one another. Vibrational excitation, on the other hand, was most effective when the energy barrier came late in the collision, as the products begin to separate.

In another study, Polanyi and Man Hung Mok discovered that predominantly exothermic reactions tend to have early barriers, whereas largely endothermic reactions tend to have late barriers. Philip Brooks and his associates at Rice University have experimentally confirmed these conclusions, at least in part, in their molecular beam experiments on the reaction $K + HCl \rightarrow H + KCl$. They found that laser excitation of the hydrogen chloride to its first vibrational state enhanced the reaction rate 100-fold. But increasing the translational energy by about the amount equivalent to the vibrational excitation had only 10 percent of this effect on the slightly endothermic (2 kcal/mole) reaction.

Thus, the trajectory calculation approach to molecular dynamics provides a measure of support for the empirically found correlations between the type of reaction and the effect of vibrational excitation or reaction rate. While this augurs well for the future of infrared photochemistry with lasers, researchers caution that the accumulation of much more basic photochemical data on a wide variety of compounds and the development of inexpensive, tunable, high-power lasers are both necessary before very many commercial-scale processes will be possible. At present, for example, in addition to the CO_2 laser, the only high-power infrared lasers for photochemistry include the carbon monoxide and hydrogen fluoride lasers, which emit light at wavelengths near 5 micrometers and 2.7 micrometers, respectively.

—ARTHUR L. ROBINSON

BOOKS RECEIVED

(Continued from page 1236)

lytical Chemistry and *Toxicological and Environmental Chemistry Reviews*.

Annual Review of Earth and Planetary Sciences. Vol. 4. Fred A. Donath, Francis G. Stehli, and George W. Wetherill, Eds. Annual Reviews, Palo Alto, Calif., 1976. x, 484 pp., illus. $15.

Assembly Language Programming and the IBM 360 and 370 Computers. Walter G. Rudd. Prentice-Hall, Englewood Cliffs, N.J., 1976. xx, 554 pp., illus. $16.95.

Biological Membranes. Their Structure and Function. Roger Harrison and George G. Lunt. Halsted (Wiley), New York, 1976. viii, 254 pp., illus. Paper, $9.95. Tertiary Level Biology.

The Bipersonal Field. Robert Langs. Aronson, New York, 1976. x, 468 pp. $20. Classical Psychoanalysis and Its Applications.

The Case of Leonid Plyushch. Tatyana Khodorovich, Ed. Translated from the Russian edition (Amsterdam, 1974) by Marite Sapiets, Peter Reddaway, and Caryl Emerson. Westview Press, Boulder, Colo., 1976. xviii, 152 pp. $10.75.

The Chinese. A Study of a Hong Kong Community. Cornelius Osgood. University of Arizona Press, Tucson, 1976. Three volumes, illus. Vol. 1, xviii + pp. 1–446; vol. 2, xvi + pp. 447–966; vol. 3, xiv + pp. 967–1264. In slipcase, $45.

Crime by Computer. Donn B. Parker. Scribner, New York, 1976. xii, 308 pp. $10.95.

Cultures and Time. L. Gardet and eight others. Unesco Press, Paris, 1976 (U.S. distributor, Unipub, New York). 246 pp. Paper, $14.85. At the Crossroads of Culture.

The Demographic Explosion. The Latin American Experience. Benjamin Viel. Translated from the Spanish edition (1970) and updated by James Walls. Irvington, New York, and Halsted (Wiley), New York, 1976. xiv, 250 pp. $14.95. The Irvington Population and Demography Series. A Population Reference Bureau Book.

Developmental Disorders. Assessment, Treatment, Education. Robert B. Johnston and Phyllis R. Magrab, Eds. University Park Press, Baltimore, 1976. xii, 532 pp., illus. $14.50.

A Dictionary of Chromatography. Ronald C. Denney. Halsted (Wiley), New York, 1976. xii, 192 pp., illus. $14.50.

Dictionary of Speech and Hearing. Anatomy and Physiology. Joseph F. Brown. Speech and Hearing Service, Sacramento, Calif., 1975. vi, 276 pp., illus. Cloth, $10; paper, $7.

Drought Hazard in the United States. A Research Assessment. Richard A. Warrick with Patricia B. Trainer, Earl J. Baker, and Waltraud Brinkmann. University of Colorado Institute of Behavioral Science, Boulder, 1975. xxiv, 200 pp., illus. Paper, $5. Program on Technology, Environment and Man Monograph Series.

Elementary Particles and Symmetries. Lewis Ryder. Gordon and Breach, New York, 1975. xxviii, 250 pp., illus. $22.50. Documents on Modern Physics.

Essays in Physics. Vol. 6. G. K. T. Conn and G. N. Fowler, Eds. Academic Press, New York, 1976. x, 158 pp., illus. Paper, $8.50.

Freud's 'Project' Re-Assessed. Preface to Contemporary Cognitive Theory and Neuropsychology. Karl H. Pribram and Merton M. Gill. Basic, New York, 1976. 192 pp., illus. $10.

Geology of the Olduvai Gorge. A Study of Sedimentation in a Semiarid Basin. Richard L. Hay. University of California Press, Berkeley, 1976. xvi, 204 pp., illus. + plates. $22.50.

Handbook of Iron Meteorites. Their History, Distribution, Composition and Structure. Vagn F. Buchwald. Published for the Center for Meteorite Studies, Arizona State University, by University of California Press, Berkeley, 1976. Three volumes, illus. Vol. 1, Iron Meteorites in General, xii + pp. 1–244 + index; vol. 2, Iron Meteorites: Abakan—Mejillones, vi + pp. 245–820 + index; vol. 3, Iron Meteorites: Merceditas—Zerhamra; Supplement, vi + pp. 821–1418 + index. Boxed, $140.

The Heroin Epidemics. A Study of Heroin Use in the United States, 1965–1975. Leon Gibson Hunt and Carl D. Chambers. Spectrum, New York, 1976 (distributor, Halsted [Wiley], New York). xiv, 146 pp., illus. $12.95. Sociomedical Science Series.

Information Chemistry. Computer Assisted Chemical Research Design. Papers from a seminar, Honolulu, July 1973. Shizuo Fujiwara and Harry B. Mark, Jr., Eds. University of Tokyo Press, Tokyo, 1976 (U.S. distributor, International Scholarly Book Services, Beaverton, Ore.). x, 386 pp., illus. $65.

The Innovative Millionaires. How They Succeed. Gene Bylinsky. Scribner, New York, 1976. xiv, 238 pp., illus. $9.95.

Introduction to Logic and Switching Theory. Nripendra N. Biswas. Gordon and Breach, New York, 1975. xiv, 354 pp., illus. $29.50.

The Journals of Jonathan Carver and Related Documents, 1766–1770. John Parker, Ed. Minnesota Historical Society Press, St. Paul, 1976. xii, 244 pp., illus. $10.50.

Laser Speckle and Related Phenomena. J. C. Dainty, Ed. Springer-Verlag, New York, 1975. xiv, 288 pp., illus. $38.90. Topics in Applied Physics, vol. 9.

Late-Glacial Chronology. Richard J. Lougee and Clara Rom Lougee. Vantage, New York, 1976. xxxiv, 554 pp., illus. + plates. $15.

Lipid Chromatographic Analysis. Vol. 2. Guido V. Marinetti, Ed. Dekker, New York, ed. 2, 1976. x + pp. 339–712. $34.50.

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