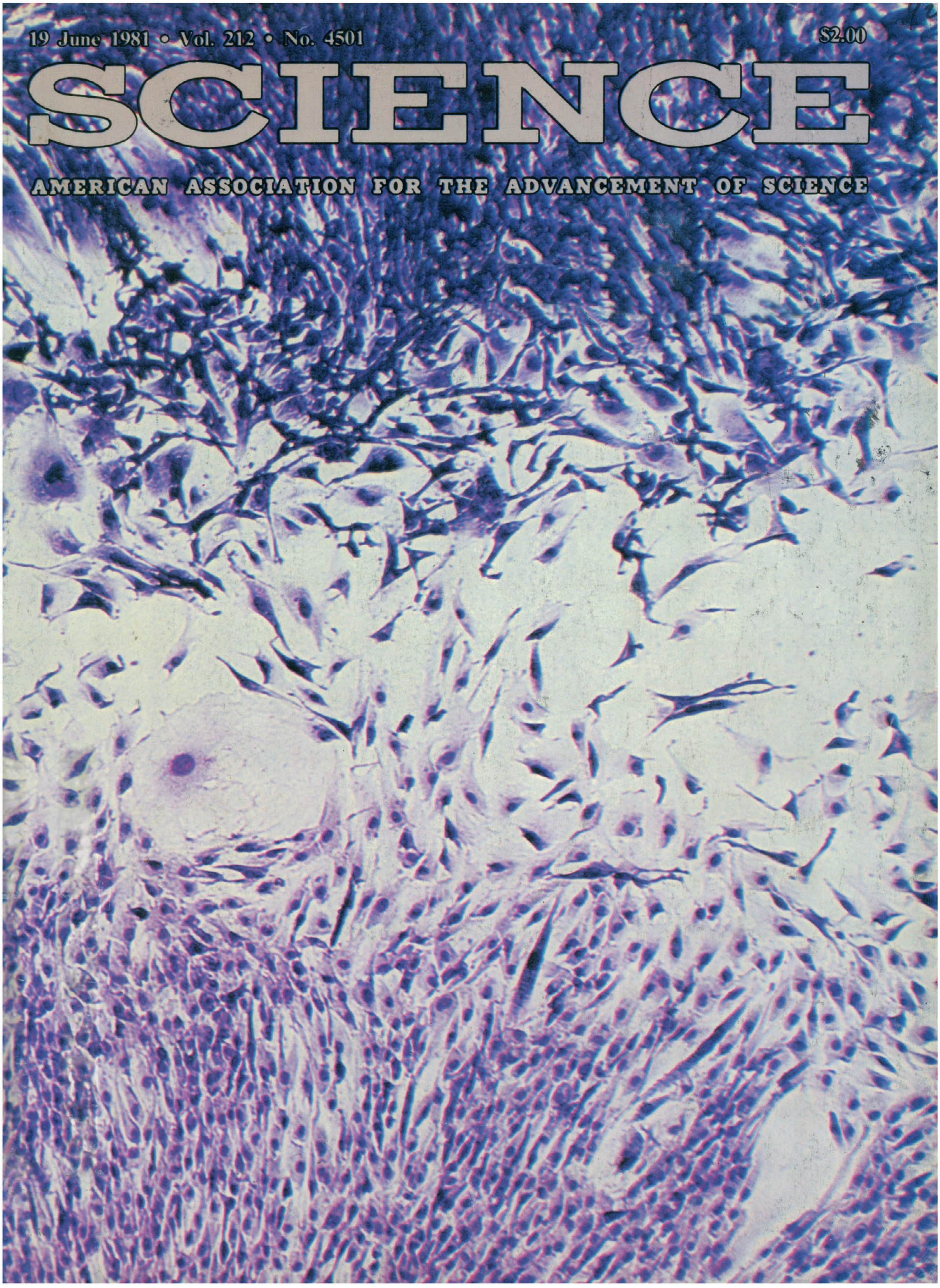
19 June 1981 • Vol. 212 • No. 4501

$2.00

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



The Beckman TJ-6 Centrifuge. Everyone says great things about it.

The TJ-6 is the most popular centrifuge ever introduced, whether it's the refrigerated or non-refrigerated version.

Users appreciate how quiet it is. They like the removable bowl that makes cleaning a snap. They like the colorful adapters which bring a new practicality and ease of handling to table-top centrifuges.

Owners are delighted with the TJ-6's excellent reliability. And if there is a problem, they know there are hundreds of Beckman service representatives nationwide—at least one in every major city in the U.S. and Canada.

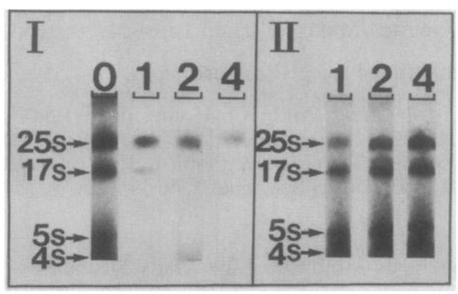
Send for Brochure SB-490 for a full description of this superior table-top centrifuge. Write to:

Beckman Instruments,
Inc., Spinco Division,
1117 California Avenue,
Palo Alto, CA 94304.

BECKMAN

Circle No. 363 on Readers' Service Card

Complete ElectroBlot™ system with gel chamber, grid, buffer pump and speed control, power supply and auxiliary power control $575. Less power supply $400.



Autoradiogram comparison shows rapid rate of RNA transfer from original gel I to DBM paper II. Numbers above gel and paper indicate hours of transfer.

ElectroBlot™
Transfers DNA, RNA, Proteins Faster and Better

E-C's new ElectroBlot™ surpasses ordinary blot transfer by electrophoretically transferring DNA, RNA, and proteins onto DBM paper and proteins onto nitrocellulose sheets.

Consider these advantages:
- transfers all size molecules easily
- transfer completed rapidly
- transfer is direct, no loss of resolution
- transfer efficiency 80% or better
- transfer may be conducted under cold room conditions

• Stellwag, E. J. and Dahlberg, A. E., *Nucleic Acids Res. 8:* 299, 1980

With ElectroBlot™, there is no messy handling, no diffusion, no damage losses. System utilizes unique high current, variable low voltage power supply. Doubles as a destainer.

For more information call Technical Service collect at 813-344-1644 or write:

E-C Apparatus Corporation
3831 Tyrone Blvd. N.
St. Petersburg, Florida
33709

Circle No. 370 on Readers' Service Card

ISSN 0036-8075

19 June 1981

Volume 212, No. 4501

SCIENCE

SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with **The Science Monthly**® Copyright © 1981 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): $43. Domestic institutional subscription (51 issues): $80. Foreign postage extra: Canada $24, other (surface mail) $27, air-surface via Amsterdam $55. First class, airmail, school-year, and student rates on request. Single copies $2 ($2.50 by mail); back issues $3 ($3.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Edge of a morphologically transformed colony (top) of Syrian hamster embryo cells contrasted with the edge of a normal colony. Morphologically transformed cells, which progress to neoplastic cells, are characterized by disoriented, basophilic cells with a decreased nuclear/cytoplasmic ratio. Transformed colonies are induced by many carcinogens, for example, benzo[*a*]pyrene and diethylstilbestrol. Diethylstilbestrol, however, transforms the cells without measurable gene mutation at two loci (about × 47). See page 1402. [Chester Reather, Johns Hopkins University, Baltimore, Maryland]

What to look for in a lab balance.

QUALITY you can feel whenever you operate a switch, slide a poise.

PRECISION you can see every time you make a weight determination.

CONVENIENCE you'll appreciate in time savings, ease of use, simplicity of operation.

JOB SUITABILITY — you can choose from a wide selection of over 60 models — without compromise.

RELIABILITY you can depend on, day after day, even under severe conditions.

VALUE — you know it when you see it. That elusive combination of all of these benefits — at a price you can afford. There's one sure way to get it all.

ASK FOR OHAUS.

OHAUS® Ohaus Scale Corporation
29 Hanover Road, Florham Park, N.J. 07932
(201) 377-9000

44-061

☐ Please send me the complete Ohaus catalog of over 60 different models of balances for the laboratory.

☐ Please have a representative arrange a no-obligation demonstration. I'm particularly interested in ______________ My phone number: ( ) ______

Name ______________ Title ______________

Organization ______________

Address ______________

City ______________ State ______________ Zip ______

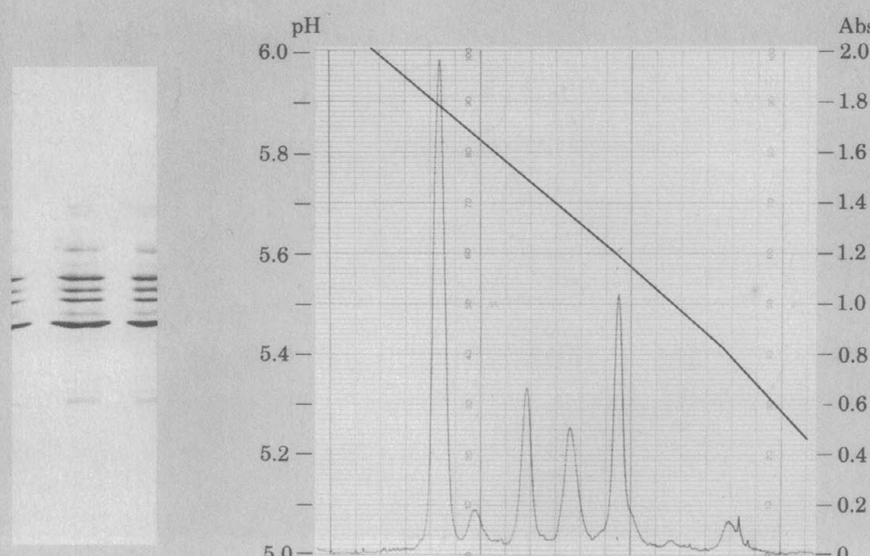
My application is ______________

A. Ohaus Dial-O-Gram® Model 1650 balance — 2610 g x 0.1 g B. Ohaus Dial-O-Gram® Model 310 balance — 310 g x 0.01 g
C. Ohaus Model 300 electronic balance — 300 g x 0.01 g D. Ohaus Harvard Trip Model 1550 SD balance — 2000 g x 0.1 g


SORVALL
RC-3

Reveal the secrets hidden in your high resolution gels with a beam of laser light

Penetrate the closely stacked bands of an electrofocusing gel with an intense laser beam only microns in width and uncover a wealth of quantitative information.



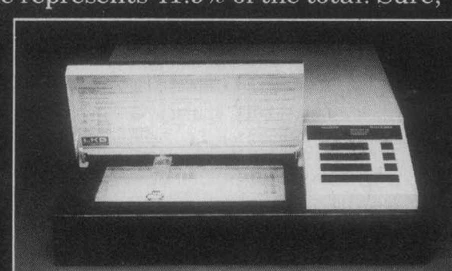
Distribution of Major Isozymes of Carbonic Anhydrase from Bovine Erythrocytes.

pI*	Percent Composition**
5.90	41.9 ± 0.5 %
5.75	17.6 ± 0.8
5.67	15.6 ± 0.6
5.60	24.9 ± 0.6

* at 10°C ** mean values based on five scans of a single sample

Laser densitometric analysis of the four major isozymes of carbonic anhydrase

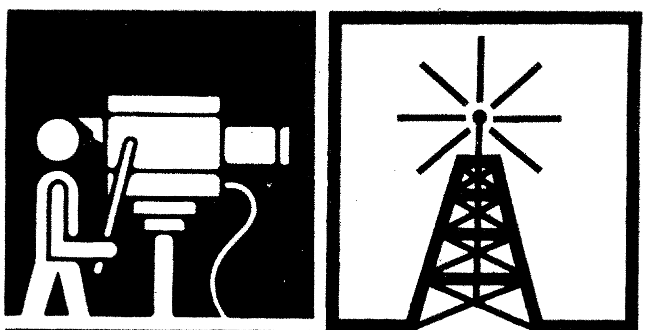
There's more information to be gained than meets the eye. Looking at carbonic anhydrase on a stained electrofocusing gel will show you the four major isozymes. But it takes laser densitometry to tell you that the predominant isozyme represents 41.9% of the total. Sure, there can be problems with stains. But this analysis was valid over a concentration range covering two orders of magnitude, from 0.1 to 10.0 mg/ml. And isozymes bind with very similar staining affinities. For precision, the gel was scanned in different positions five times, automatically. It took less than six minutes, including the integration. How was it done? With the new UltroScan Laser Densitometer, from LKB – the experts in electrofocusing. Contact them today, to see what a laser can do for your gels.

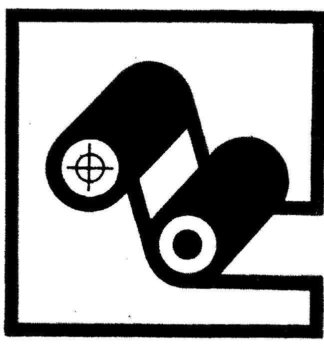


LKB

Head office: LKB-Produkter AB, Box 305, S-161 26 Bromma, Sweden. Tel. 08-98 00 40, telex 10492
Main US sales office: LKB Instruments, Inc. 12221 Parklawn Drive, Rockville, MD 20852. Tel. 301-881 25 10, telex 230 89 682
UK sales office: LKB Instruments Ltd, 232 Addington Road, S. Croydon, Surrey CR2 8YD, England. Tel. 01-657 8822, telex 264414
Other sales offices in: Athens (for Middle East), Copenhagen, Ghent, The Hague, Hong Kong, Munich, Paris, Rome, Turku, Vienna

1981 AAAS Westinghouse Science Journalism Awards





Television

Radio

Print

Rules

The aim of this competition is to encourage and recognize outstanding reporting on the sciences and their engineering and technological applications in newspapers, general circulation magazines, radio, and television. The following categories are not eligible: items on the field of medicine, items published originally in AAAS publications or produced by AAAS; reports by employees of the AAAS or Westinghouse Electric Corporation.

- Each entrant may submit three entries for any one category.

Print

- An entry for a newspaper competition may be any of the following: a single story; a series of articles; or a group of three unrelated stories, articles, editorials, or columns published during the contest year. A magazine entry may be a single story or series published during the contest year.
- A completed entry blank must be submitted together with seven copies of each entry in the form of tear sheets, clippings, reprints, or syndicate copy (**not over 8½" x 11"**), showing name and date of the publication. **ENTRIES MUST NOT BE ELABORATE!**

Broadcast

- An entry for the radio or television competition may be an individual news story, feature, or a series, regardless of length, broadcast during the contest year on either public or commercial stations. Entries must be comprised of scripted material. Interviews are not eligible.
- A completed entry blank must be submitted together with a cassette in the case of radio and copy of the script or a ¾" videocassette in the case of television and copy of the script.
- Each entry must have been published or broadcast within the United States during the contest year—1 October 1980 through 30 September 1981. (In case of a series, more than half of the items comprising it must have been published or broadcast during the contest year.) The date on the issue in which an article appeared will be considered as the date of publication. All entries must be postmarked on or before midnight, 15 October 1981.
- Persons other than the author may submit entries in accordance with these rules. Entries will not be returned.
- Winners of the 1980 Awards are not eligible for the 1981 awards. Persons winning three times are no longer eligible.
- The Judging Committee, whose decisions are final, will choose the winners. There are five awards of $1,000: for the winning entry in the over 100,000 daily circulation newspapers competition; for the winning entry in the under 100,000 circulation newspapers competition; for the winning entry in the general circulation magazine competition; for the winning entry in the radio competition; and for the winning entry in the television competition. For award purposes, newspaper circulation will be sworn ABC daily circulation as of 30 September 1981. The Judging Committee may cite other entries for honorable mention.
- The awards will be presented at the dinner meeting of the National Association of Science Writers during the Annual Meeting of the American Association for the Advancement of Science in January 1982. Travel and hotel expenses of the awards winners will be paid. Entrants agree that, if they win, they will be present to receive their awards, unless prevented by circumstances beyond their control.

Grayce A. Finger

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

1515 Massachusetts Avenue, N.W. Washington, D.C. 20005

CAHN The accepted standard for precision weighing.

Cahn Instruments, for over twenty years the leader in instrumentation for accurate weight measurements at the microgram level, now provides a wide choice of balances for your specific applications.

Microbalances

Cahn Series-20 Automatic Electrobalances®: Select the one that best fits your needs. Rugged and reliable in design, Series-20 Microbalances are used whenever accurate and

highly precise weighings are required. Examples include quantitative and instrumental analysis, filter weighing, standards preparation, biological samples, etc.

- □ 0.0000001 g (0.1 microgram) sensitivity
- □ Automatic weighing
- □ Exclusive "No Penalty" tare
- □ Portable, use on any reasonably flat surface
- □ Five models to choose from

Circle Reader Service Card No. 380

Semi-Microbalances

Cahn Toploading Millibalances®: Fast accurate weighing of small samples. Used widely in biomedical and biological research, quality control and checkweighing applications.

- □ 0.00001 g (10 microgram) sensitivity
- □ Fast, accurate weighing
- □ No special environment required

Circle Reader Service Card No. 381

Analytical Balances

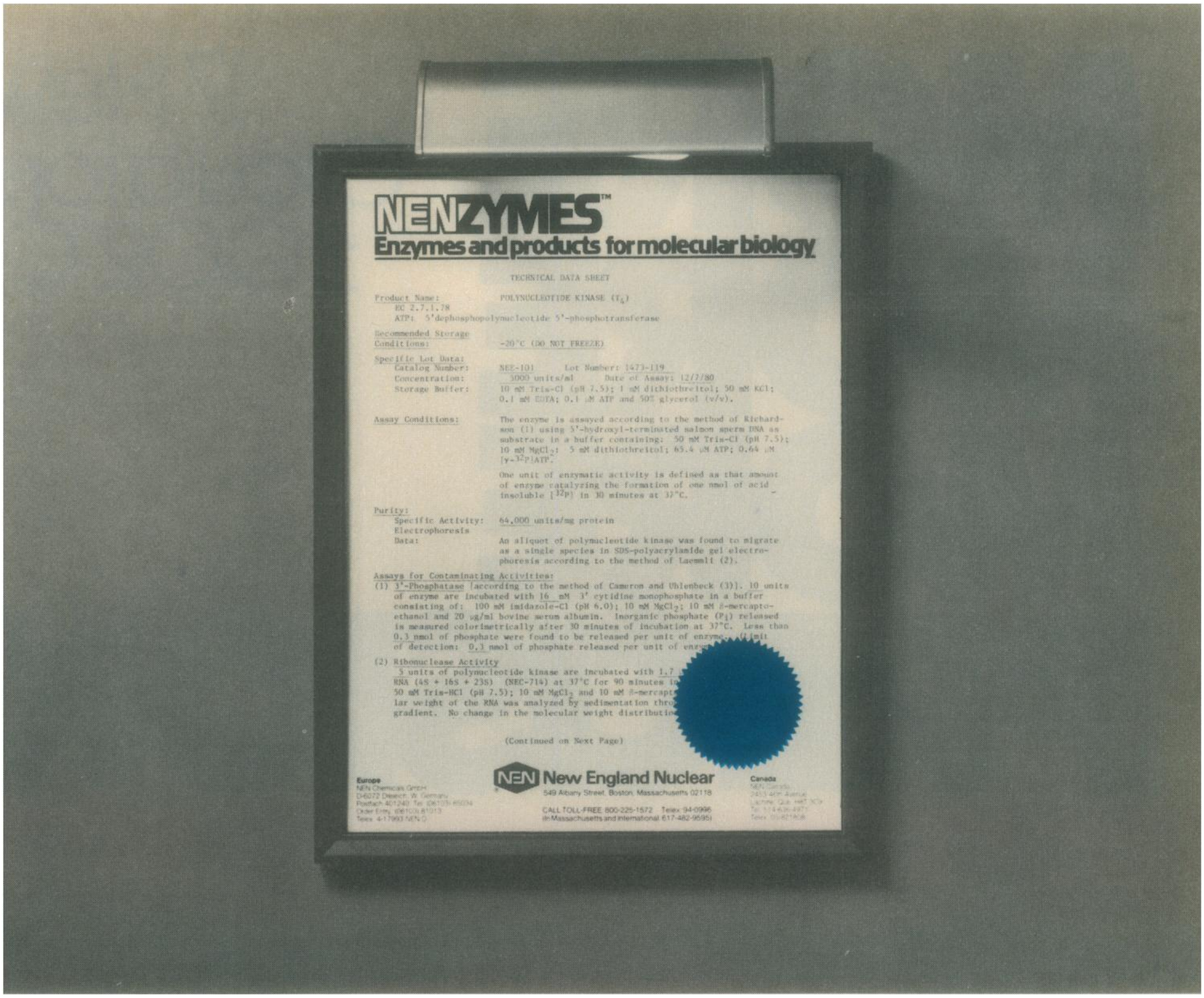
The TA 450: A Microprocessor Controlled Toploading Analytical Balance at the price of a mechanical balance. The TA 450 combines the precision and accuracy of the classical analytical balance with the speed and ease of operation of an electronic toploading balance.

- □ 0.0001 g (0.1 milligram) sensitivity
- □ Unique "StayPut" airhood for easy access to the weighing chamber
- □ Full range (+ or −) push-button tare
- □ Push-button storage and recall of weighings
- □ Two year warranty

Circle Reader Service Card No. 382

CAHN ...Where weighing a little means a lot.

Cahn Instruments, Inc. 16207 South Carmenita Road, Cerritos, CA 90701 Phone (213) 926-3378 TWX 910-583-4806



It was worth it.

At first we weren't making our own enzymes. We were buying them. Then we learned something you probably know already – enzymes pure and reliable enough for DNA-RNA studies are not easy to come by.

So we made our own, to our own standards. And before long other researchers wanted to buy *ours,* for the same good reasons.

So we named them NENZYMES and produce them in quantity, but we still subject them to the same very rigorous tests as before. And we provide complete testing data – so you'll know exactly what you're getting.

It's a lot of work to make and test the purest enzymes, but it's worth it. There are enough variables in molecular biology research as it is.

DNA Polymerase I, Large Fragment DNA Polymerase I (Klenow Fragment), T_4-Polynucleotide Kinase, T_4-DNA Ligase, and RNA Polymerase. Plasmid pBR-322 and ϕX174 (RF I) DNA also available. Call collect for complete information.

NEN New England Nuclear®

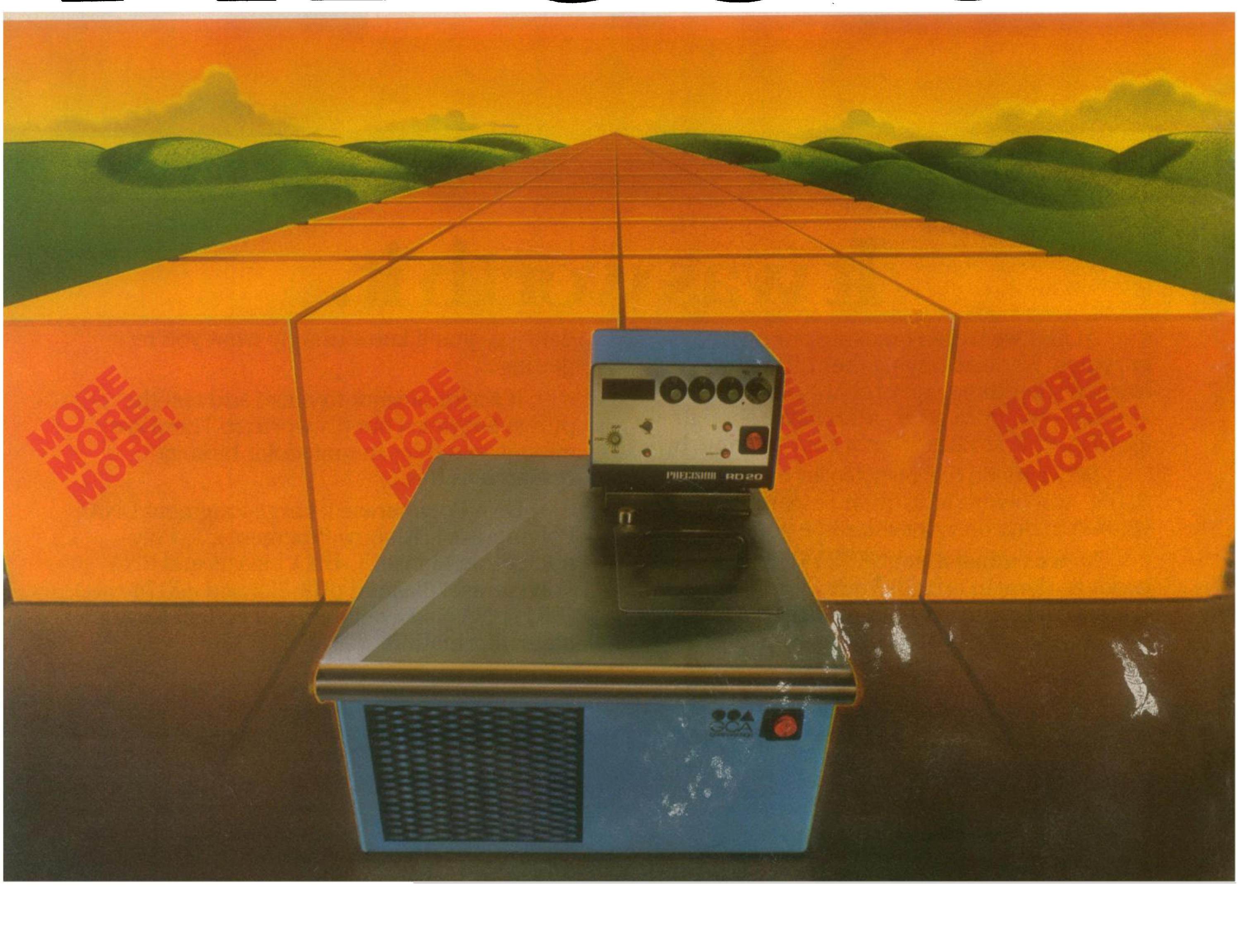
549 Albany Street, Boston, Massachusetts 02118
Call toll free: 800-225-1572 Telex: 94-0996
(In Massachusetts and International: 617-482-9595)

NEN Chemicals GmbH: D-6072 Dreieich, W. Germany, Postfach 401240, Tel. (06103) 85034, Telex 4-17993 NEN D
NEN Canada: 2453 46th Avenue, Lachine, Que. H8T 3C9; Tel. 514-636-4971, Telex 05-821808

Circle No. 387 on Readers' Service Card

MORE MORE MORE PRECISION

17 New Circulators, ±0.02°C*



LETTERS

Alternative to Peer Review?

Rustum Roy's alternative to the peer review system (Editorial, 27 Mar., p. 1377) is simple and beautiful; but it has a design flaw similar to that of the early superhighways whose capacity was determined by measuring preconstruction point-to-point demand without considering the added demand that would result from the convenience of having the superhighway. The current (verifiable) proliferation of refereed journals and the concomitant (and less readily demonstrable) lower quality of accepted papers are surely due, in part, to the use of numbers in deciding promotions in academe. Given this precursor, it is not difficult to envision the added impetus toward low-quality publication, and (worse yet) the ultimate impact on quality of graduate degrees that would result from attaching dollars to such quantitative measures as numbers of refereed papers and numbers of graduate degrees. Inefficient as it is, imperfect as it is, the peer review system has a qualitative component based on informed judgment which we cannot afford to lose.

JON C. LIEBMAN
Department of Civil Engineering, University of Illinois, Urbana 61801

I read Roy's editorial with disbelief. In order to reduce the work load associated with peer review of grant applications, he proposes basing research support on a formula linking the funding level to "productivity" measured solely by numbers of publications, Ph.D.'s, and so forth. There is no mention of the *quality* of the research these numbers would represent. Roy's proposal would not promote good science, but it would promote the proliferation and duplication of shorter, less significant research publications; it would also encourage institutions to cheapen their degree requirements to turn out more (perhaps less qualified) Ph.D.'s. If individuals or institutions chose to maintain standards and not succumb to the demands of the formula, their funding would be drawn away by those who did.

I agree that peer review requires significant effort, but its very value is in assessing quality rather than counting papers. If research funding were based on the formula suggested by Roy, a serious decrease in quality would be guaranteed.

RICHARD L. MCCREERY
Department of Chemistry, Ohio State University, Columbus 43210

While peer review as currently practiced may not be the most desirable or efficient form of resource allocation, Roy's proposal for a productivity-based formula of block grants seems even less desirable because it raises more questions than it answers.

First, with respect to training, there are a great many institutions receiving public research funds which have no or minimal graduate programs. Those institutions supporting training, in turn, often base the size of their enrollments on stipends available, not program caliber. Both of these considerations immediately would distort any formula for training. Furthermore, the question of overabundance is ignored. Is it wise to base increased funding upon the continued production of unusable talent? These issues are not easily addressed by productivity figures alone.

Second, a funding formula based on publication is certain to exacerbate the already too real problem of fragmentation of data and duplicate reporting. How many more gratuitous coauthorships would appear, and how will junior authorship be counted? What body will decide what an adequately refereed journal is in a given field? Who will want to publish in nonrefereed forums?

Third, a formula based on a history of past support from a number of grouped sources ignores the fact that most research dollars are targeted toward highly specific goals. Within the National Institutes of Health alone, for example, some congressionally mandated spending extends to the program level within a single institute. Roy may be in a department and discipline where research falls into a single identifiable category, but this is the exception, not the rule. How would funding agencies be able to carry out their mandates, and who would be accountable for the pursuit of categorical research?

Fourth, using the amount of industrial and private support received by a department to allocate public dollars does not seem justifiable, since in many areas of research the amount of private support is minimal. A small private contribution, therefore, could disproportionately divert public resources. This is especially true where institutions have sought to perform contract work for private firms.

It is easy to criticize a well-characterized system and to recognize its inefficiencies. It is much more difficult to propose a comprehensive, viable alternative. There is no a priori reason to believe that an administrative formula and substitute peer review by journal referees and institutional committees is structurally superior to the current sys-

of the above were initiated, the taxpayers would be saved a lot of money and the peer review system would remain intact.

MICHAEL W. BERNS
Department of Developmental and Cell Biology, University of California, Irvine 92717

I sense in all the above letters an aura of the ancien régime. None shows an awareness of the emerging issue given form by Milton Friedman (*1*): Why should the public support science at all? I answer this implicitly in my formula.

Morawetz's point (included also by Easter) is an essential detail I could not cover in the space of the editorial. The key American science funding innovations were funding from multiple sources and funding directly to the principal investigator. Provision for preserving those could be achieved if the National Science Foundation (NSF) or the National Institutes of Health required (with appropriate flexibility) *something like* a 70 (to principal investigators), 20 (to departments), and 10 (to institutions) split. While Easter has done me the justice of reading the editorial, he seems to miss the very purpose of the coefficients. They are there for agencies (as representatives of the public) to decide most of the issues he raises; not what science should be done, but what should receive *public* support.

The letters by Berns, McCreery, Kalt, and Liebman are excellent examples of the reactions of much of the science community to innovation on our own turf: they merely defend the status quo. I presented a philosophical rationale for a formula system based on value to society, as an alternative to the so-called peer review system, for the efficient and continued funding of nonmission research in the United States. None of the authors debates these major advantages. None notes the balance of four factors and the flexibility of the formula in being able—if need be—to accommodate some of their own proclivities.

However, two egregious but very common errors in the arguments of Berns, McCreery, Kalt, and Liebman need to be laid to rest. First is the notion that the peer review system is in some mysterious way linked with the progress of science and is responsible for the "still strongest research system in the world," and, second, that peer review is able to find or define "quality."

Since most of the fundamentals of quantum mechanics, organic synthesis, and DNA structure managed to be discovered without the blessing of peer review, the basic claim is without foundation. In spite of the different funding systems of Japan, Germany, the Soviet Union, and Britain, which also seem to do good science and technology, these claims persist. What is the best science? Is it better science to win two more Nobel prizes than to teach 4 to 5 years of physics, chemistry, and mathematics to most citizens of a country? None of the letters notes that systems without peer review also flourish in the United States. Some of the premier research institutions in this country, such as the Office of Naval Research (ONR) and the Defense Advanced Research Projects Agency, have supported basic research of the very highest quality without peer review at all. They rely on their own judgment of the investigators' competence and track record. A comparative study of "quality" of ONR- versus NSF-supported research might be definitive.

McCreery and Liebman make unsupported claims that "peer review" is actually able to predict the quality of *research not yet done*. To the contrary, as every journal editor knows, we cannot even judge the quality of *completed work* by peer review. Three sets of three reviewers can give mutually conflicting results. *Physical Review Letters* (*2*) has explicitly acknowledged these difficulties in its historic about-face on peer review of papers.

None of the letter writers mentions the extensive work of Elton and Rodgers (*3*), which has demonstrated the ability to duplicate the results of tedious, expensive "peer review" of departmental quality by simple, quantitative measures (including number of degrees). Despite Liebman's suggestion, where is there any quantitative study to show that a peer review process does better in producing research than even, say, a lottery selection among qualified applicants?

Finally, the concerns of McCreery, Liebman, and Kalt about a predicted lowering of standards by peer-reviewed journals (and by all universities) leaves them hoist by their own petard. If the peer reviewing of *completed* work is so unreliable and easily manipulated, how does one expect it to be accurate and honest as a predictor? They also do not mention that the literature explosion and the multiple authorship they decry happened in the heyday of "peer review." These trends will continue; their effect on the formula I propose is trivial. Since they affect but one term, and since everybody would be working by the same rules, any such trends would be easily normalized out.

The letters and telephone calls I have

received, many from distinguished colleagues, suggest a real readiness for change. We look forward to some analysis and ideas from the NSF, the National Institutes of Health, and the General Accounting Office with respect to a comparison of funding mechanisms.

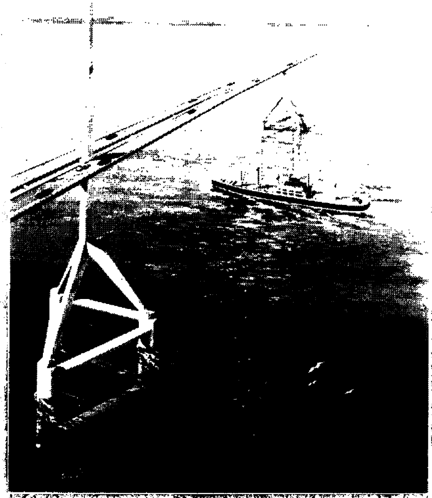
RUSTUM ROY
Materials Research Laboratory, Pennsylvania State University, University Park 16802

References

1. N. Wade, *Science* **210**, 33 (1980); *Newsweek* **97**, 99 (18 May 1981).
2. R. K. Adair and G. L. Trigg, *Phys. Rev. Lett.* **43**, 1969 (1979); D. Lazarus, *ibid.* **45**, 1605 (1980).
3. C. F. Elton and S. A. Rodgers, *Science* **174**, 565 (1971); *Am. Psychol.* **27**, 197 (1972).

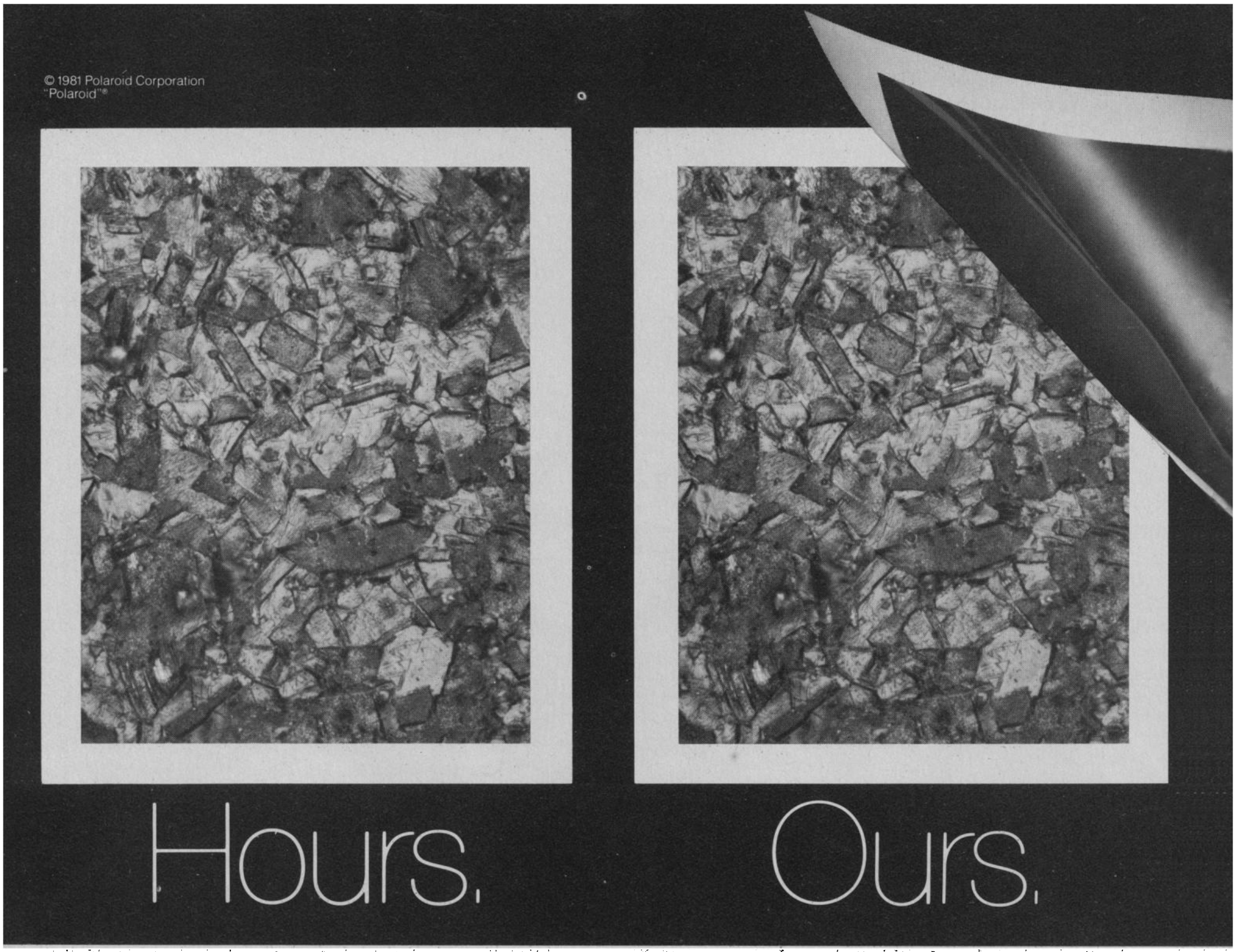
Bridge Design

In his review (15 May, p. 787) of *Long-Span Bridges* (New York Academy of Sciences, 1980), William Zuk does not mention the longest cable-stayed bridge design ever made as a possible future development.

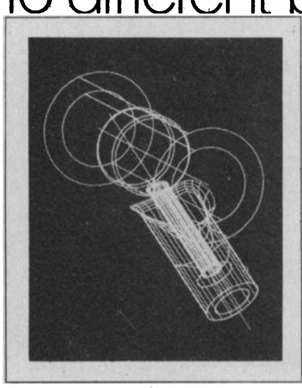


In 1969 M. M. Bascom and I did a rather detailed design study of a cable-stayed bridge for the Strait of Gibraltar in which the cables were suspended from a series of aluminum towers mounted on tension-leg platforms in water to 130-foot depths. Some 15 towers would have been required to cross the 8.2 nautical miles (13 kilometers). The largest ships would have passed easily under the deck and between the spans as shown in the accompanying photo. The design study was accepted by the sponsors, but the prospects of paying traffic were not sufficient to proceed further at that time.

WILLARD BASCOM
Southern California Coastal Water Research Project, Long Beach 90806



16 different black and white films. No waiting.


Type 084
High Speed

Compare the quality of the prints above, and you see why more and more technical, industrial and medical photographers want to work with Polaroid instant black and white films.

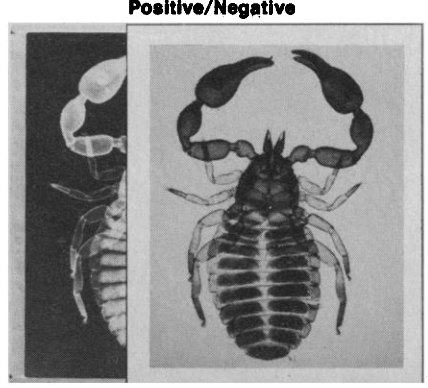
But another big reason they choose ours is choice: our films are available in a wide range of sizes, formats, speeds and emulsions.

Wherever exceptional tonal rendition is required, our fine grain films give you superb prints with virtually no graininess, as evidenced by Type 52, used for the metallograph above. It was delivered in seconds.

If you're photographing on the fringes of light and time, our high speed films will give you marvelous results in minute detail, in as little as 15 seconds.

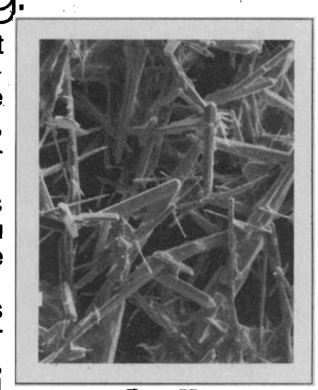
For line art, charts and artistic effects, our high contrast films hand over enhanced blacks and whites in 15-second prints, and 30-second transparencies.

And no film in the world simultaneously delivers a fully developed print *and* a high resolution negative as fast as our positive/negative films—which also allow you to make enlargements (up to 25 times, without objectionable graininess or loss of detail).


Type 665
Positive/Negative

But the biggest benefit of all is that each of our films tells you instantly whether the picture you took is what you want.

To find out which of our films may be most appropriate for the kind of work you're doing, see your local Polaroid professional film dealer, or write: Polaroid Corporation, Dept. 482, Cambridge, MA 02139. Or call Polaroid Technical Assistance, toll free in the continental U.S.: 800-225-1618. (In Massachusetts, call collect: 617-547-5177.)


Type 57
High Speed

We make sixteen different instant black and white professional films that are ready to give you the results you've been waiting for. Without the wait.

Polaroid
Instant Professional Films

19 June 1981, Volume 212, Number 4501

SCIENCE

Coal Research

Prepared under the auspices of the National Research Council, an authoritative book on coal has recently appeared that is the first comprehensive treatment of the subject in 18 years.* Publication now is particularly timely, for there is a growing consensus among energy experts that during the remainder of this century, coal will have the major role in replacing part of the energy and chemicals currently obtained from petroleum. About 75 percent of the coal used at present in the United States is burned by electrical utilities. Another 14 percent is used to make coke, and most of the remainder is burned for industrial heat. Heat energy from coal costs much less than that from petroleum. Large potential applications include gasification to produce methane, chemical feedstocks, and liquid fuels. Exports of coal are growing and are likely to become an important factor in global economics.

Research on coal has been conducted for more than 100 years. Through most of this century activity in fundamental research has been at a low level. In terms of constant dollars, support for coal research in the United States was about the same in 1970 as it was in 1910. From 1945 to 1973 the coal industry was barely able to exist in competition with petroleum and natural gas. Many of the studies that were conducted in the United States were performed by the Bureau of Mines. Some of that work as well as research elsewhere, notably in Germany, was devoted to efforts to establish general principles about coal, but these were not very successful. A principal reason is the great variability of the material.

Samples of coal derived from many horizons and localities are in some ways different from each other. The sulfur content of coals ranges from 0.2 percent to about 7 percent. The ash fraction varies from a few percent to 30 percent or more. Wide differences are encountered in the chemical nature of the inorganic constituents. Oxygen content ranges from less than 3 percent in an anthracite coal to more than 30 percent in a lignite. These differences reflect variations in the composition of the original organic material, in burial environment, in associated inorganic matter, and in burial history. With the passage of time innumerable chemical reactions occur within the organic matter, leading to complex substances of high molecular weight. Small wonder that most consumption of coal has been by burning it and advances in technology have usually been based on empiricism rather than theory. But in the future, as uses increase, determined efforts will be made to improve the characterization and understanding of coal. In such efforts workers will build on the body of existing knowledge. This knowledge has been compiled by experts in the new book.

This volume (2,395 pages, about 10,000 citations, and 1,000 tables or figures) is the third in a series bearing the title *Chemistry of Coal Utilization*. Its 31 chapters cover the science of coal and the many facets of technology involved in its use. For example, there are chapters on the geology, petrography, physics, and chemistry of coal, and on pyrolysis, combustion, gasification, and liquefaction. Environmental aspects are also treated. The book was prepared by 60 authors and coauthors, all experts in their fields.

As might be expected, the quality of the chapters is not uniform. Some are more tightly written and contain more new information than others. A notable example is a chapter entitled "Coal ash—its effect on combustion systems." A good comprehension of this topic could lead to enhanced reliability of steam boilers and substantial savings of operating and capital costs. A principal blemish of the book is that part of the material in it is outdated. Some authors delivered quickly but others were slow; careful review procedures were also time-consuming, and the large size of the book contributed to delays at the publisher. Nevertheless, this is a uniquely valuable book. It is not for the casual reader, but serious scholars in the field of energy will find it a must.—PHILIP H. ABELSON

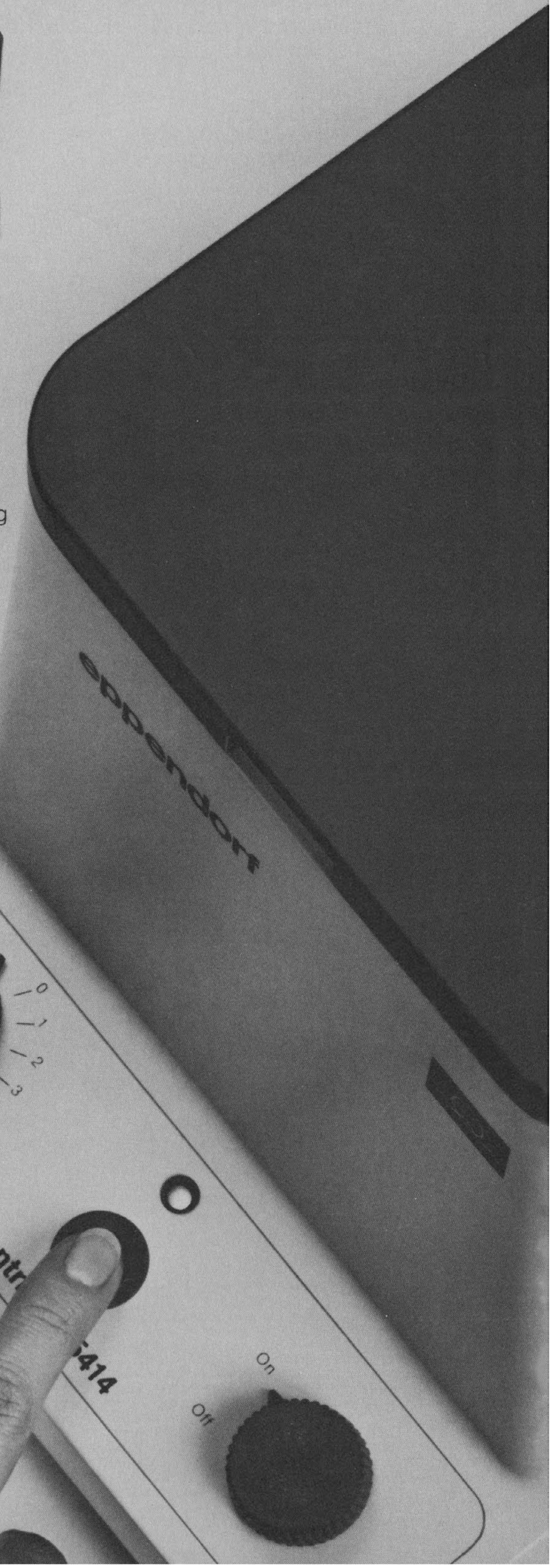
**Chemistry of Coal Utilization*. Second supplementary volume. Martin A. Elliott, Ed. (Wiley-Interscience, New York, 1981). $165.

NEW U.L. LISTED EPPENDORF® 5414 MICRO CENTRIFUGE WITH MOMENTARY SWITCH AND TIMING LIGHT.

This is the centrifuge that lets you spin a sample without spinning the timer dial. For spins of 60 seconds or less, simply hold down the Momentary Switch as long as necessary; a lighted diode flashes at 1-second intervals to let you time the spin. Longer centrifuging is controlled by the built-in 15- or 30-minute timer with automatic shut-off.

More convenient and more efficient than previous models, the 5414 reaches maximum speed in just 5 seconds, regardless of load. RCF has been increased to 15,600xG at 15,000 rpm for faster separations. The angled rotor head accepts twelve standard 1.5 ml Eppendorf Test Tubes, or 500 µl, 400 µl and 250 µl tubes using adapters. (For larger loads, Model 5413 spins up to forty tubes horizontally in four vertical carriers holding up to ten 1.5 ml, 400 µl or 250 µl tubes each. Maximum RCF is 8,800xG at 11,500 rpm.) On both models, a safety lid lock prevents operation with the top open.

For literature, write: Eppendorf Division, Brinkmann Instruments, Inc., Subsidiary of Sybron Corporation, Cantiague Road, Westbury, NY 11590; or call 516/334-7500. In Canada: Brinkmann Instruments (Canada), Ltd.



To spin for minutes, set the timer.

To spin for seconds, touch the button.

SYBRON | Brinkmann

For literature circle R S #333
For demonstration circle R S #334