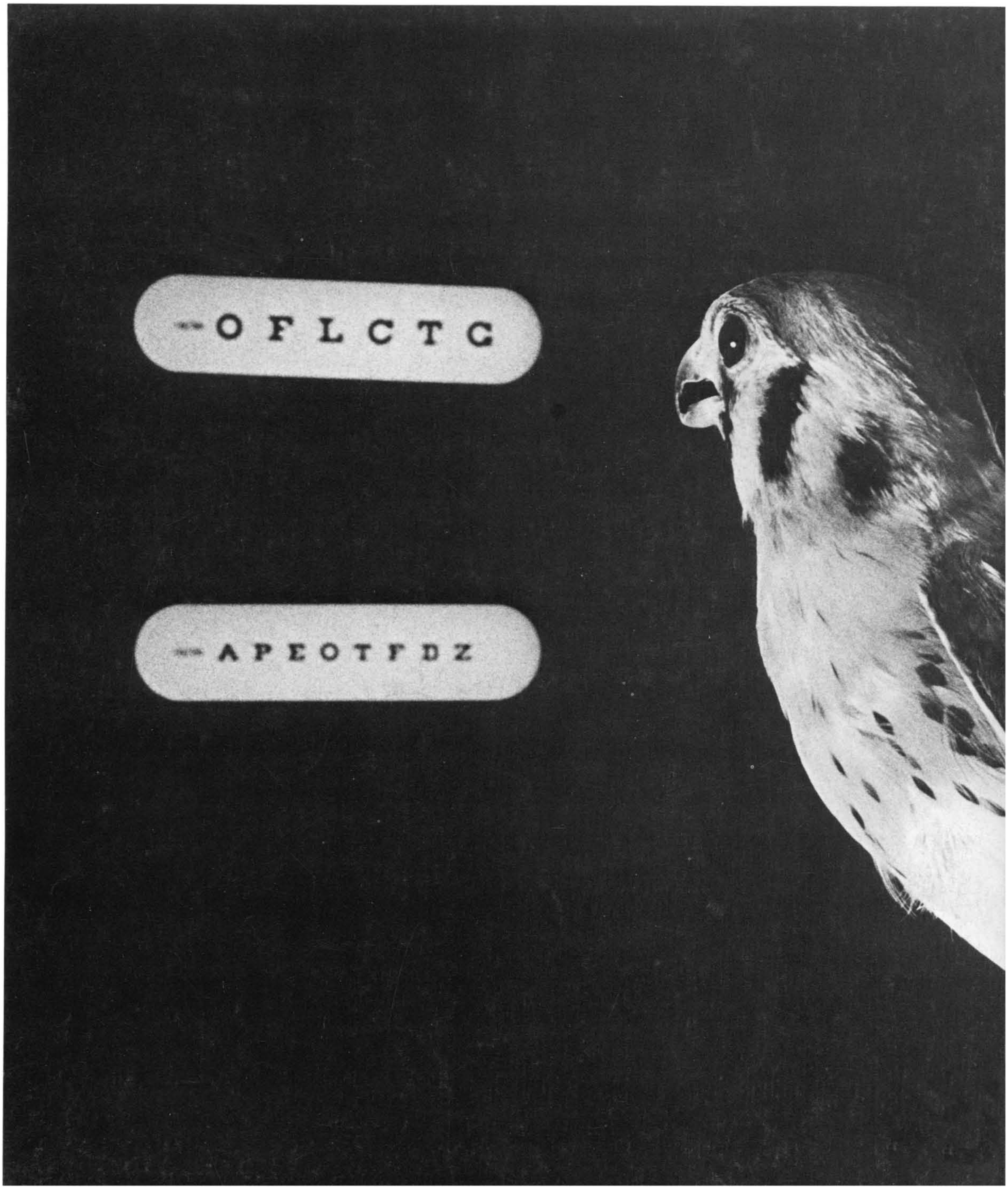
SCIENCE

16 April 1976
Volume 192, No. 4236

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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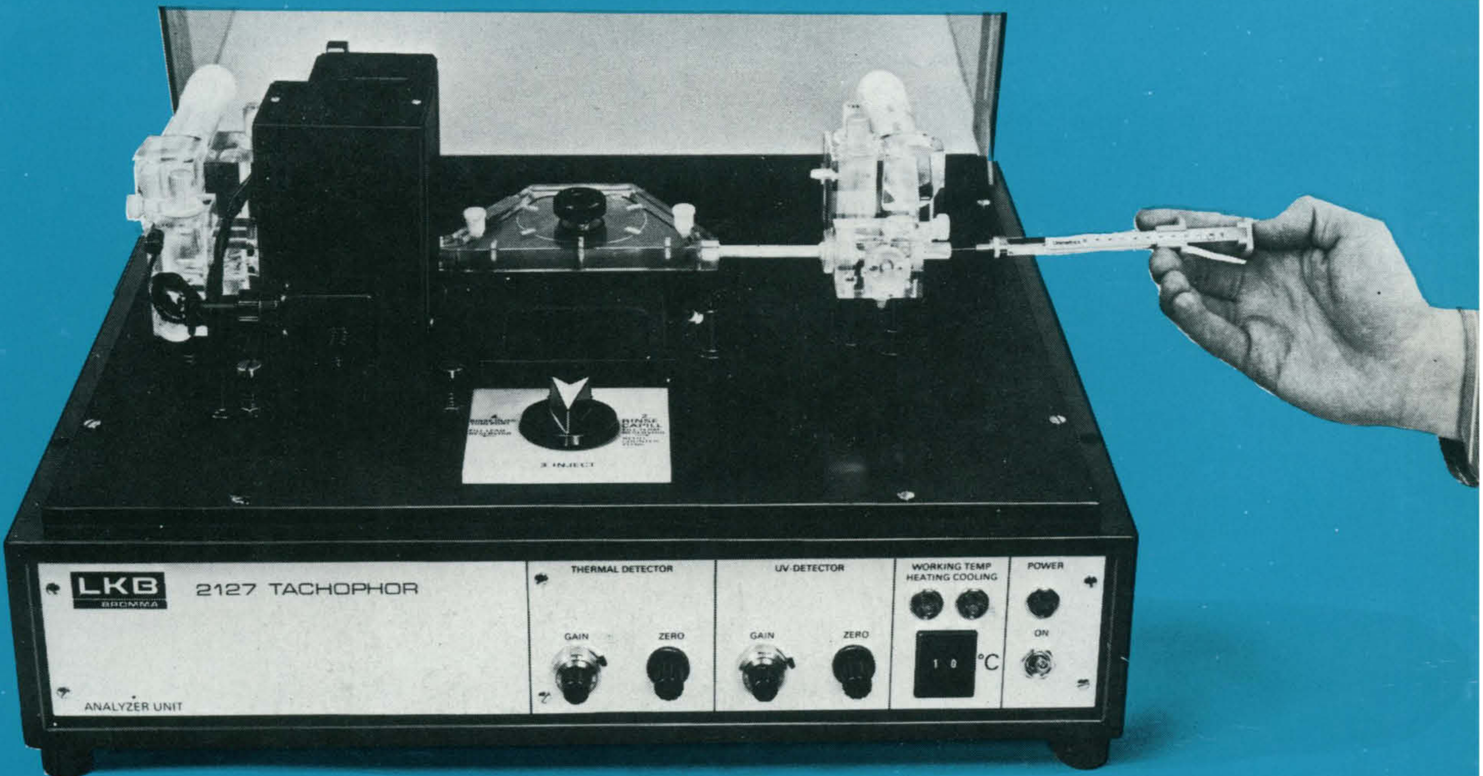

...with the LKB Tachophor

The LKB 2127 Tachophor utilizes the isotachophoresis principle for separating ions to give you results in 30 minutes or less. Ion species from metals to proteins can be separated easily and with high resolution. No pretreatment of the sample such as deproteinization or concentration is necessary. A typical separation of nucleotides or low molecular protolytes takes only 20 to 30 minutes.

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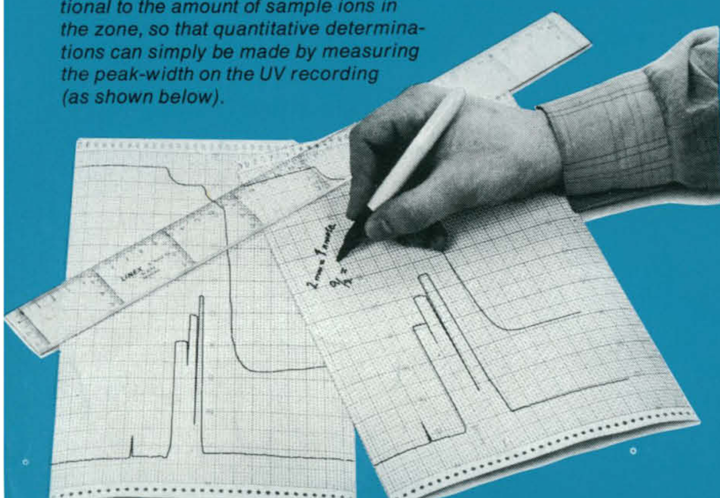

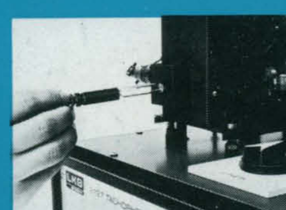

A twin-detector system, UV and thermal, gives you a complete picture of an analysed sample in the 0.1 to 50 μl range. The twin-buffer system using Ampholine® carrier ampholytes as 'spacers' gives you excellent separation and resolution of difficult peaks. And no stabilizing medium is required as in other electrophoresis methods. The UV lamp used in the LKB Tachophor detector system is a plug-in type that is very easy to change. The LKB Tachophor is easy to operate and maintain, with

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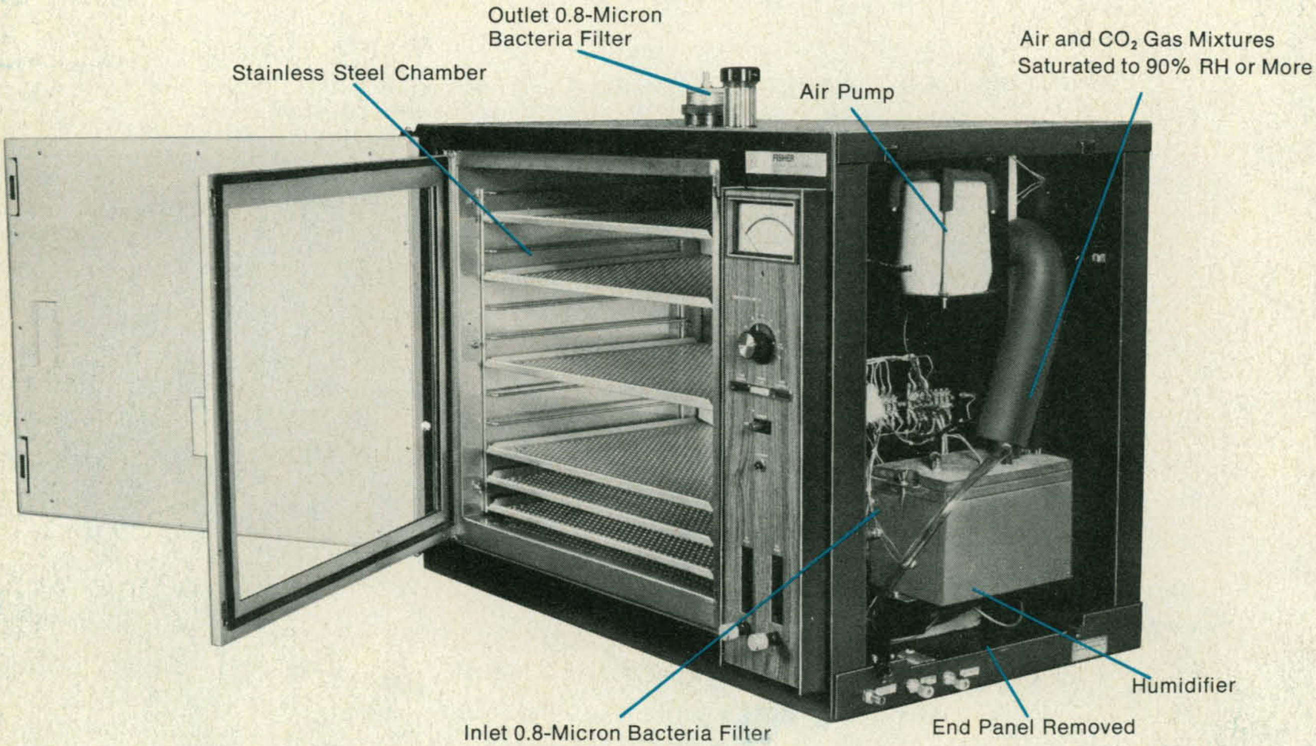

No other water-jacketed CO_2 incubator offers all the features of the Fisher Isotemp® Model 510

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The Isotemp Model 510 is fully described in an 8-page, illustrated brochure. Write for a copy.

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16 April 1976

Volume 192, No. 4236

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COVER

A small falcon, the American kestrel (*Falco sparverius*), looking at a Snellen chart. A comparative study of human and falcon visual acuity shows that the kestrel can resolve the upper line from a distance of 100 yards. See page 263. [Barry Stein, Nashville, Tennessee]

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1. Experimental "micro balloons"

Hollow glass spheres ($\sim$ 50 μm diameter) to be used as fuel pellets for laser-induced fusion. Jamin-Lebedeff interference contrast. Negative magnification: 250X.

2. Chromosomes

From a human lymphocyte showing trypsin-induced Giemsa bands (G-bands). Transmitted light. Planapo 63/1.4 Oil objective. Negative magnification: 1250X.

3. Plutonium microspheres

Autoradiograph of 10μm zirconia spheres containing alpha-emitting plutonium. Nomarski differential interference contrast. Negative magnification: 800X.

Photomicrographs 1, 2 & 3: Julie Langham Grilly, Los Alamos Scientific Laboratory.

4. Semiconductor

Tapered cross section after etch, showing emitter base, buried layer, isolation and resistor diffusions. Nomarski differential interference contrast. Negative magnification: 528X.

Photomicrograph: Motorola Semiconductor Products Division.

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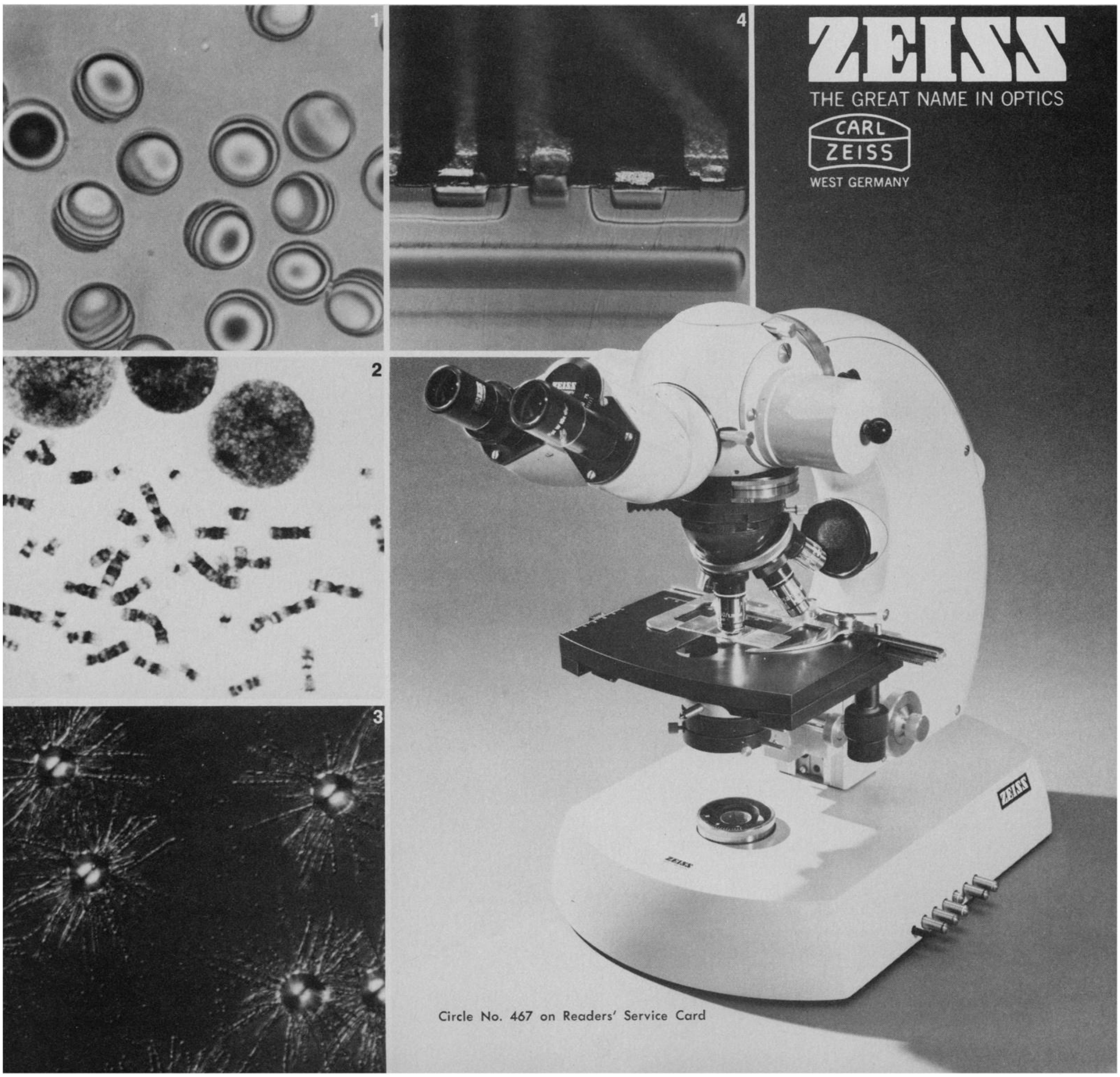

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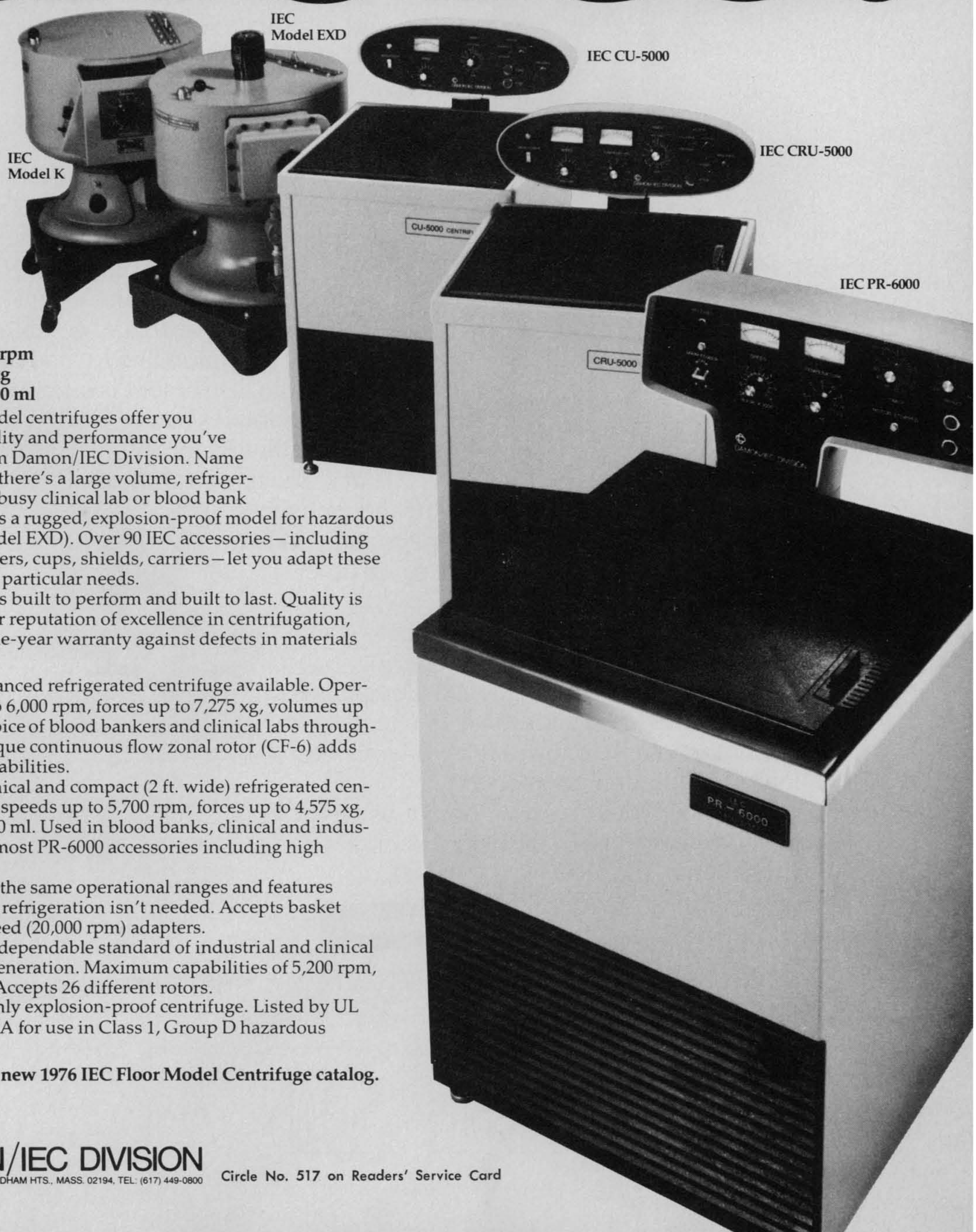

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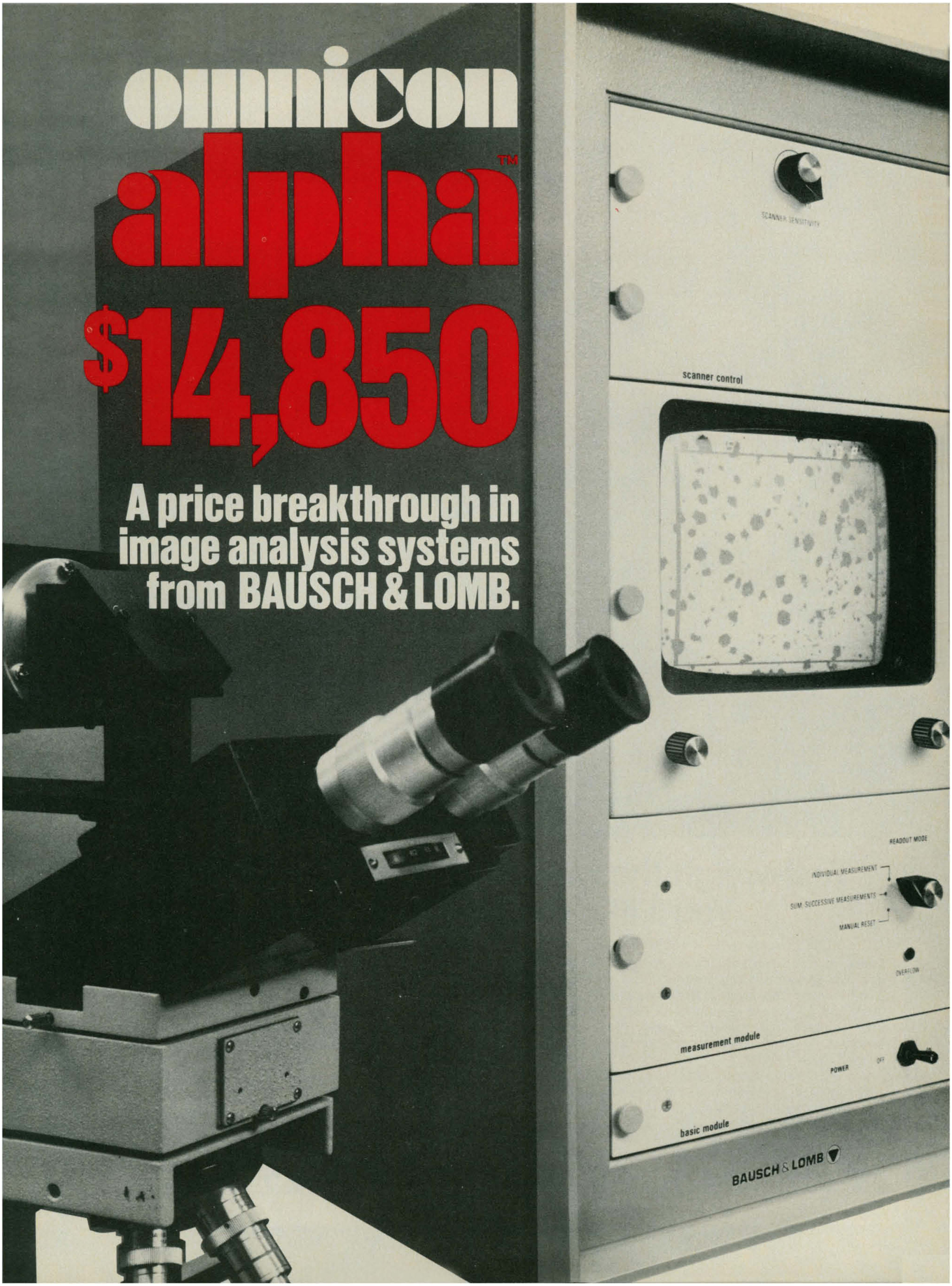
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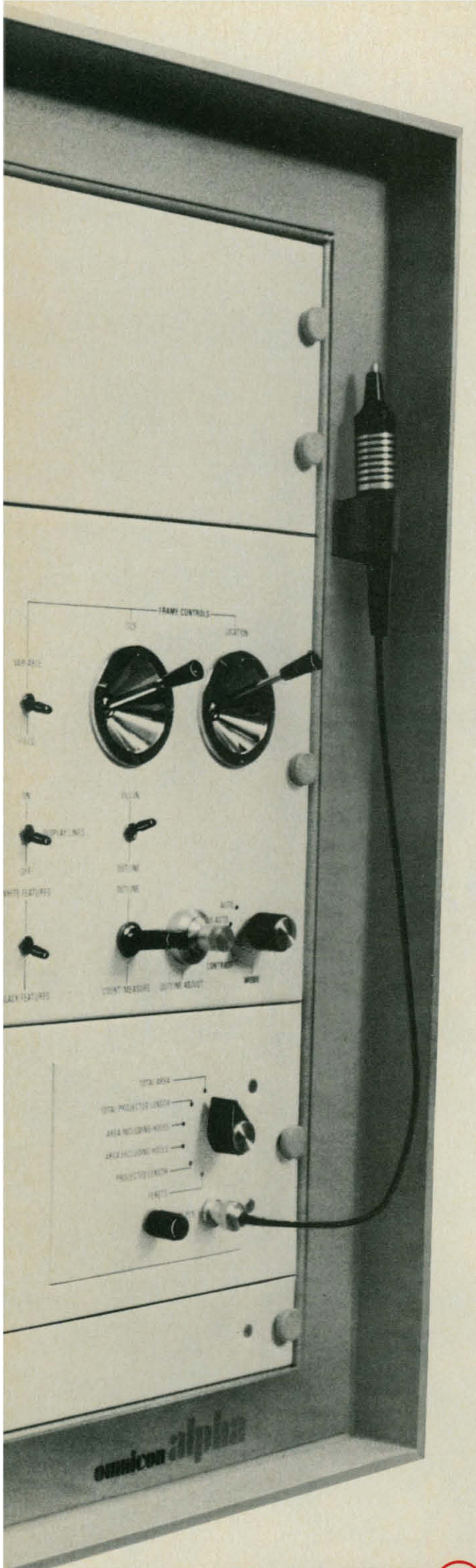

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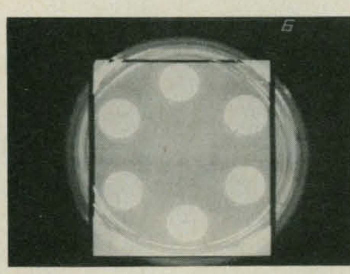
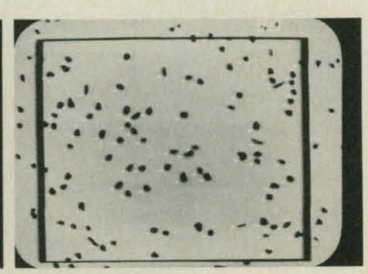


Omnicon alpha correctly detects the six zones of inhibition in petri dish analysis.



A count in one field of view of particles from a sieve sample.

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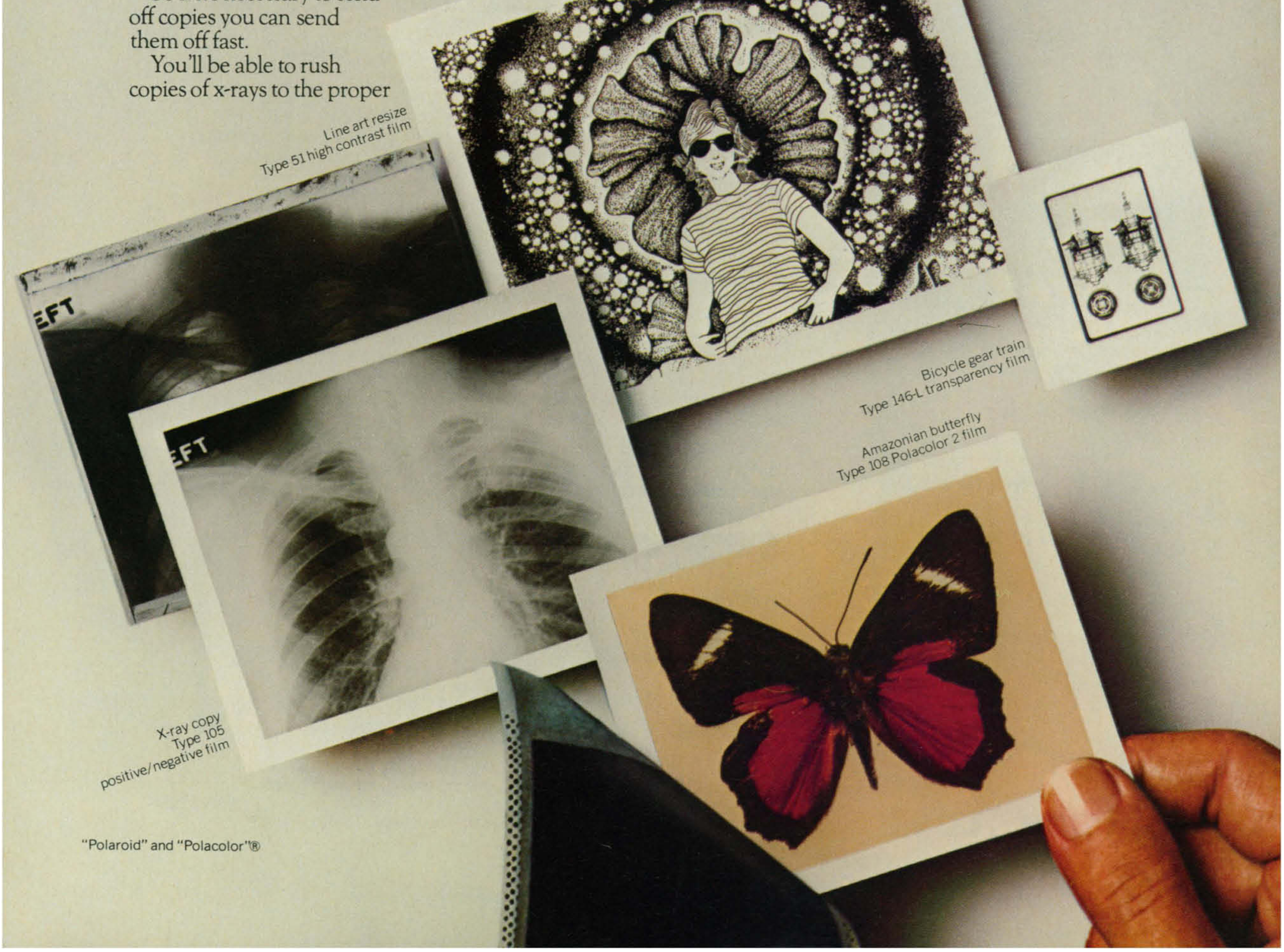

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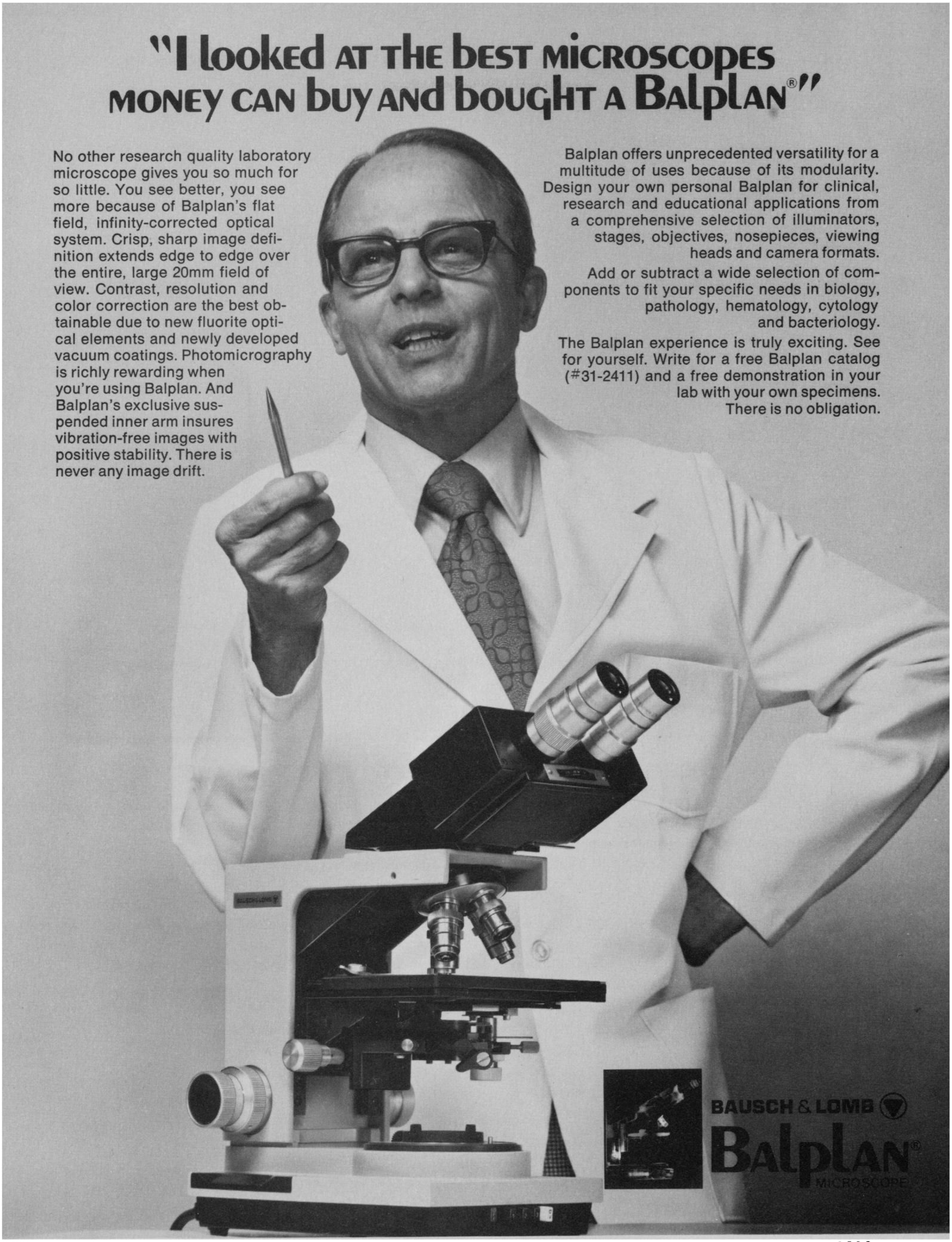

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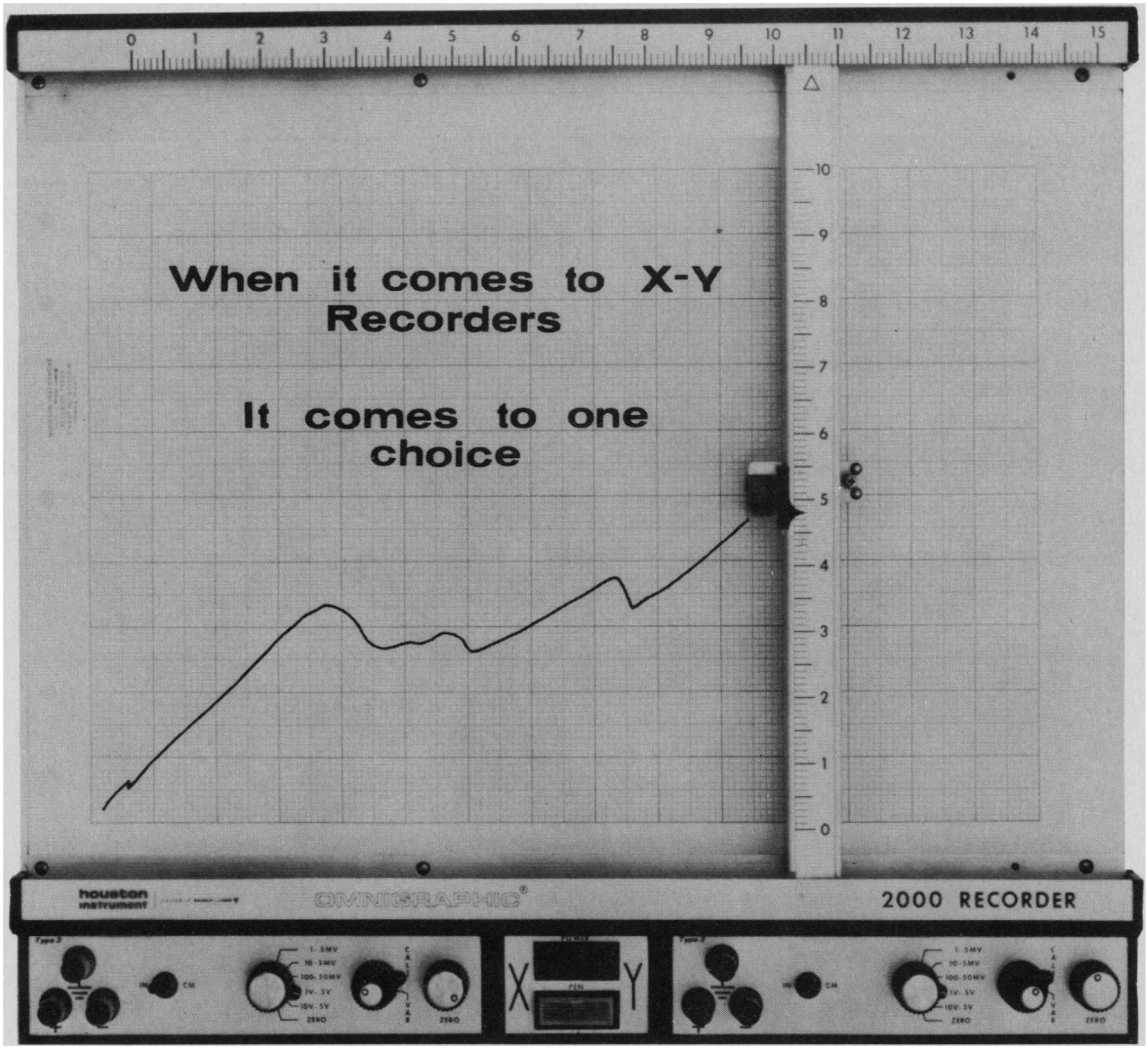

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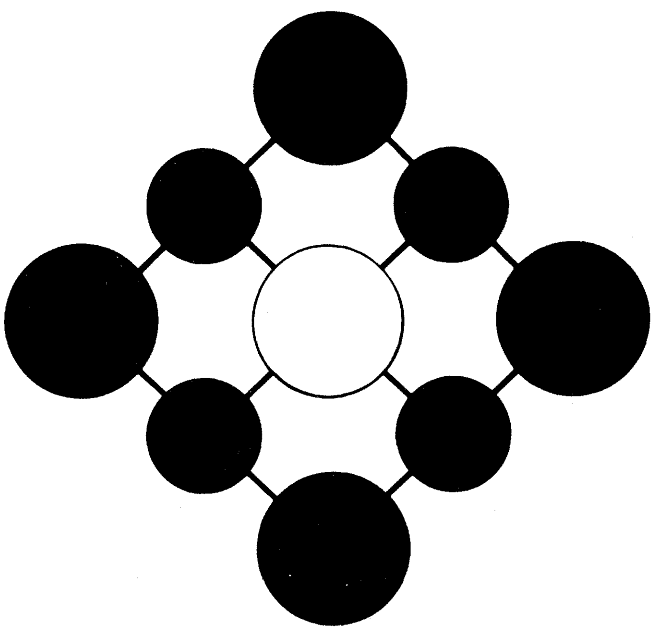

A New World of

Materials:

Renewable and Nonrenewable Resources

Edited by
Philip H. Abelson
and Allen L. Hammond

An important exploration of the new set of realities affecting the flow of raw materials—a probing of the increasing demand for them and the obstacles to their discovery and production.

A reliable flow of raw materials has been the fundamental factor in the health of the American economy and of the economies of all other industrial nations. While economic growth has begun once again in the United States and, more slowly, in Europe, it is predicated on a whole new reality of materials dramatically different from that of a decade ago. No longer can an abundance of basic commodities be taken for granted, and no longer can the supplying of any commodity be assumed continual. We have learned that the flow of existing materials is vulnerable to interruption by financial shifts, increased nationalization of foreign-owned properties, restriction of access to resources on public lands, and a host of other considerations born of the 1970's. In the development of substitute materials we must hurdle these obstacles and also adhere to new regulations for environmental protection.

In February 1976 *Science* devoted an entire issue to a critical in-depth look at these and related problems. The special issue contained 24 papers written by some of the country's foremost authorities. Thirteen more articles created by other, equally distinguished authors were added to the list, and the total is being published as a compendium to provide a meticulous look at *Materials: Renewable and Nonrenewable Resources.*

The compendium's authors probe the implications of national policy, energy constraints, environmental considerations on materials production and use, the perspectives in needs and supplies of resources, high technology materials, and renewable and reusable resources. They examine those materials issues most vital to industrial economics, the future of materials research, and the effect of the new realities on the quality of life.

The result is rare and refreshing—a detailed study which yields an identification of critical problems as well as the authors' consensus that, in principle, these problems are solvable. This overview must be studied by those involved in materials problems today, by those reaching for answers, and by all of us who will benefit from the solutions. Don't miss this vital collection of papers. A brief sampling of the compendium's contents reveals the importance of studying and dealing with these new realities.

Papers in the Compendium include
"Materials: Some Recent Trends and Issues"—Hans H. Landsberg
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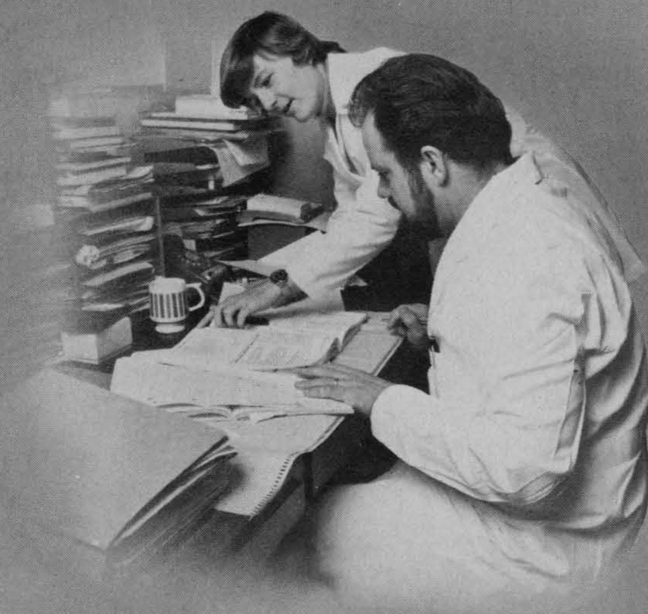

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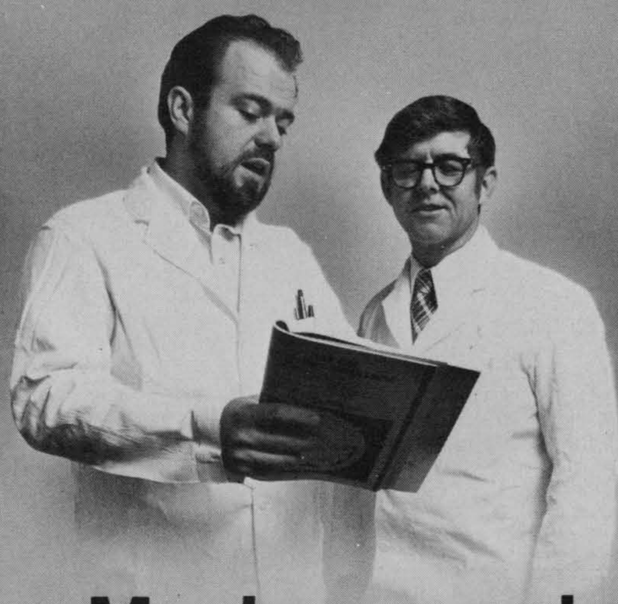

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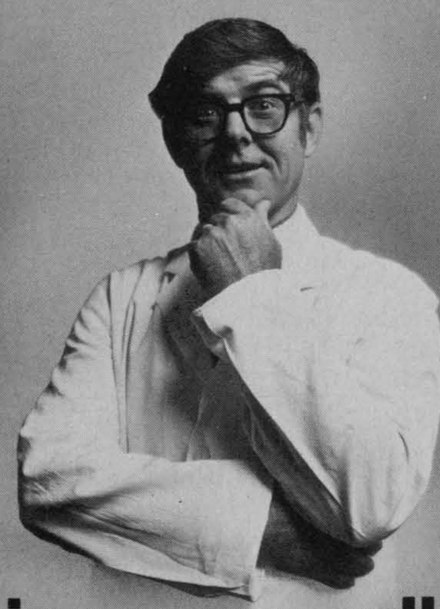

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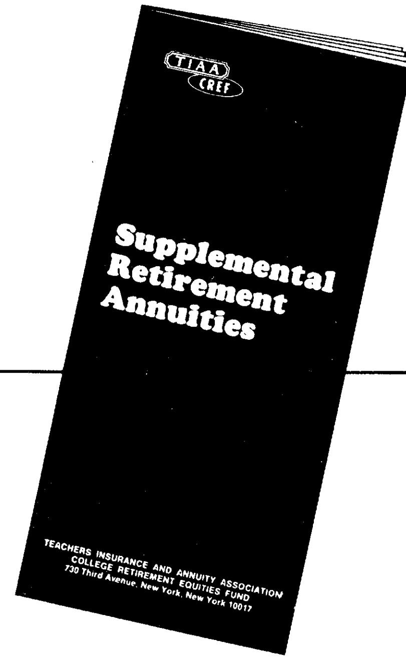

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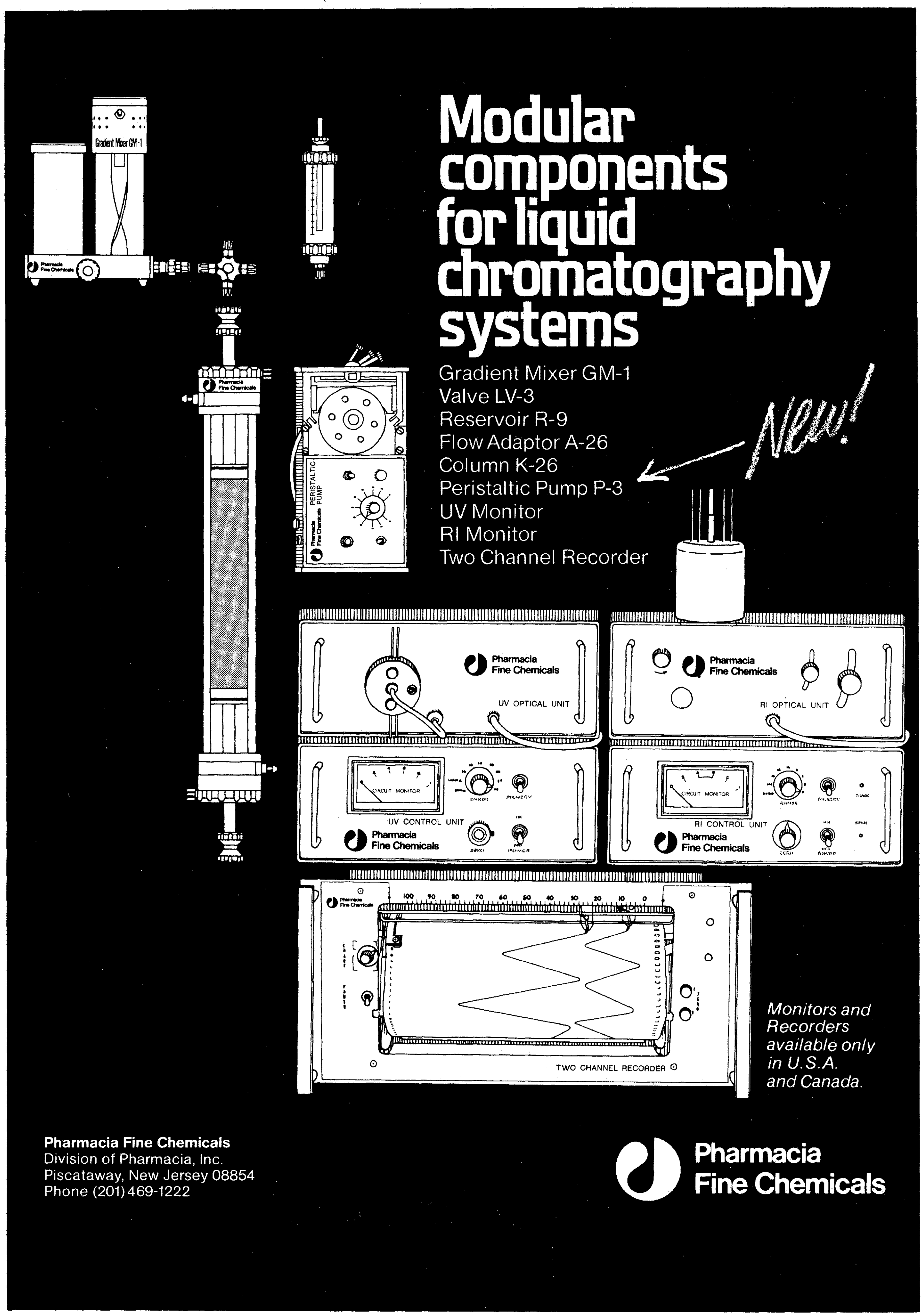

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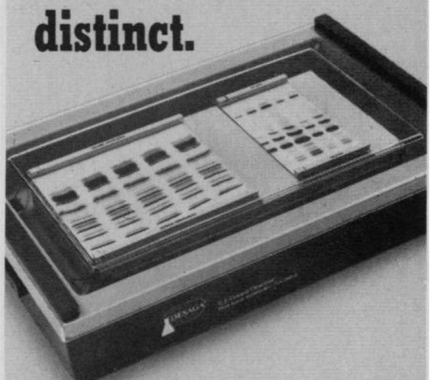

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LETTERS

Solar Energy

Philip H. Abelson's splendid editorial "Energy from biomass" (26 Mar., p. 1221) was encouraging to me, and I'm sure to many others. One begins to become a bit insecure about criticizing proponents of either conventional or breeder reactors. When one has suggested that coal, solar energy, geothermal energy, winds and tides, and perhaps, in a major way, conservation might alleviate mankind's hunger for ergs, even distinguished physicists and at least one former Atomic Energy Commission director suggest that signees of such statements of opinion on the nuclear power explosion and the impending plutonium economy are "knee-jerk liberals" who should stick to their knitting, be it biology, physics, chemistry, or any other narrow form of science. Abelson is joined by many concerned and well-informed persons who objectively estimate that the period 1985 to 1990 will see the end of supplies of easily accessible petroleum and high-grade uranium ore. Large petroleum corporations and electric power producers, at home and abroad, have already begun the conversion to nuclear fuel. A major solar energy effort by the government, and by the nation's scientific research centers, might just manage to unburden us, in a decade or so, of much of our heavy dependence on a nuclear future. It would also help assuage our concerns about long-term waste disposal, accidents in transportation and reprocessing of plutonium-enriched reactor products, and the inevitable diversion to weaponry.

CHRISTIAN B. ANFINSEN
National Institutes of Health, Bethesda, Maryland 20014

Pakistan Plant Symposium

The first international symposium ever held in Pakistan took place 1 to 7 March in Lahore and was entitled Genetic Control of Diversity in Plants. The meeting was an attempt to bring together basic plant geneticists, biochemists, and molecular biologists with applied workers who are trying to improve crop plants, particularly those in the Orient. Perhaps the most important consequence of the meeting was the setting up of lines of communication between basic scientists from the West and applied scientists from Pakistan. For example, wheat breeders were to be seen eagerly talking with wheat biochemists and experts on the nutritional aspects of wheat.

The chairman of the meeting was Amir Muhammed, vice-chancellor of the University of Agriculture, Lyallpur, Pakistan, long known in the West for his work on the enzymology of the photoreactivating enzyme from yeast. The guiding spirit behind the organization was Alexander Hollaender, who has been a highly successful organizer of international symposia in a number of developing countries.

Among those who took part in the proceedings were Sir Otto Frankel from Australia, who made an effective plea for preservation of diverse genes in plant species used in agriculture and their wild relatives; Johanna Dobereiner from Brazil, who described her work on nitrogen fixation in grasses; Michael Gale from England, who gave a beautifully clear talk on the relationship between gibberellin insensitivity and dwarfism in wheat and how this could be used in breeding; and Hans Doll and Bjorn Eggum from Denmark, who spoke on the biochemistry and nutritional aspects of cereal proteins. R. C. von Borstel from Edmonton, Alberta, Canada, will be responsible for editing the published volume of the meeting's proceedings.

JANE K. SETLOW
Department of Biology, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973

Nuclear Power: How Do the People Decide?

Philip M. Boffey (News and Comment, 30 Jan., p. 360) notes that in at least eight states initiative measures to halt or postpone building of nuclear power plants are being or have been recently circulated and reports on legal issues raised over the division of authority between the federal and state governments with respect to matters of regulation of nuclear power reactors. The points raised in this useful article and elsewhere in *Science*'s continued coverage of this significant issue of public policy are valid and important.

The increasing use of the ballot, either through referendum or initiative to deal with the complex issues involving the siting and regulation of nuclear power plants, raises not only the constitutional issues of division of powers between the federal government and the states, but also another issue of immense constitu-

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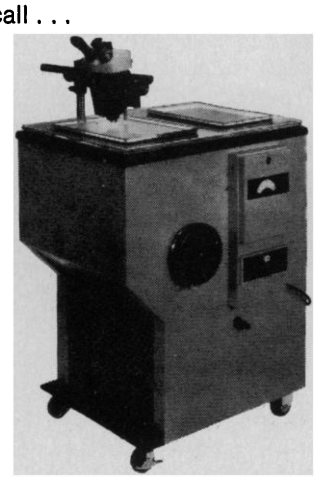

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tional importance. Our federal government is a representative government, probably the best designed in human history. The representative chain from citizen-voter to the elected officers of government to the appointed officers of government is a unique and outstanding feature of the American political system. The framers of the Constitution did not provide for ballot issues, but that government policy should be determined by the representatives of the people—chosen because of their capacity to get the facts and weigh the relationships of one problem to another. While the framers of the Constitution wisely did not prescribe the precise way in which the states should regulate their political affairs, and while the Constitution is formally silent on the question of ballot issues, the framers clearly intended that state and local government should be operated on the representative principle as well. Article IV, Section 4, of the Constitution says: "The United States shall guarantee to every State in this Union a Republican Form of Government." This is the only specific reference in the Constitution to the form or structure of state government. It clearly gives to the federal government some measure of responsibility for overseeing the political structure of state and local government and has been interpreted to authorize "Congress and, perhaps to a lesser extent, the President and the Supreme Court to superintend the acts and the structure of the state governments and to inhibit any tendencies in a state that might deprive its people of Republican government" (*1*).

Action both by Congress (in admitting states to the Union which, as territories, had initiatives and referenda) and by the Supreme Court (in reviewing cases in which the guarantee clause was offered as the basis for striking down initiatives and referenda) has firmly, up to now, upheld the constitutionality of the initiative and the referendum. But these decisions were made early in this century in cases which, as far as this constitutional condition is concerned, were argued narrowly. Moreover, this was also before the Warren Court substantially broadened judicial intervention on behalf of the political rights of American citizens. The possibility that the courts might in the near future declare the initiative and referendum unconstitutional is slight, but the history of the judiciary on the issue of political rights certainly leaves that possibility open. More important, while the court has been reluctant to open this immense issue, there has been no reluctance whatsoever on the part of the court or of the other two branches of

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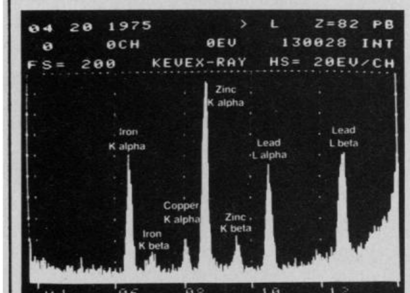

The KEVEX fruit fly multi-element analysis. Object: detect trace amounts of lead. Result: minimum detection for lead was found to be 5 nanograms. Also detected were iron, copper and zinc.

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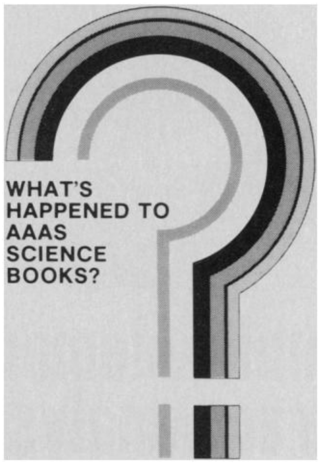

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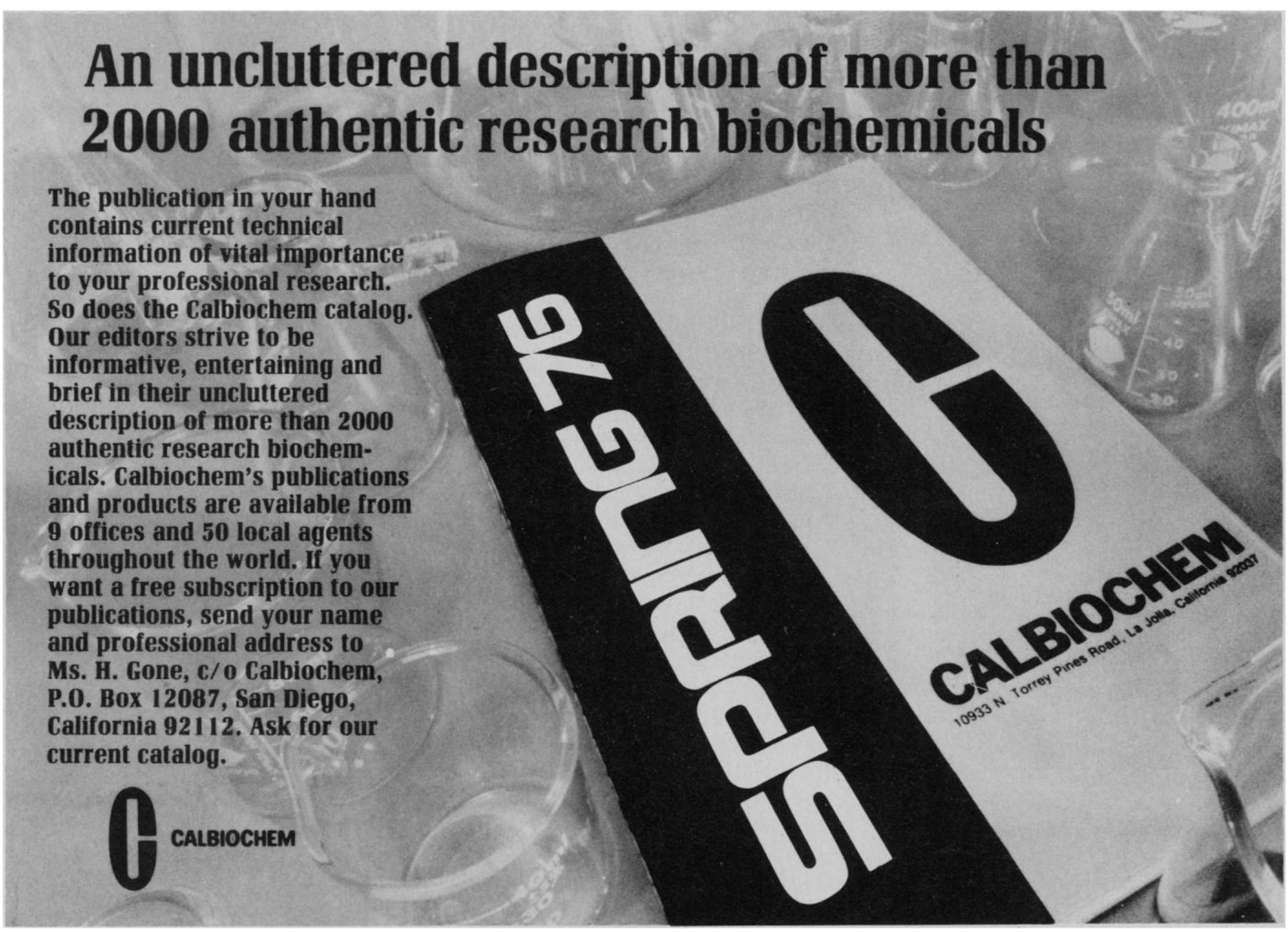

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government to enter, with the court's approval, into rather direct management of the manner in which state and local government conduct the people's business.

Legal and constitutional arguments aside, the wisdom of deciding issues as complex, technical, and difficult as nuclear plant siting by statewide ballot is clearly in question. My own view is that the very complexity of the nuclear issue illustrates the wisdom of the founders in decreeing a representative form of government. The record of local and state voters in deciding ballot issues is better than many suppose. But situations in which a weighing of scientific questions complicates questions of risk and economic alternatives in the light of substantial technical disagreement are simply not likely to produce an appropriate result. As a state citizen I would feel deprived of my right to a representative government if a decision on nuclear siting were made by a public debate which was not an informed one (and I personally think an informed public debate on this subject is impossible) and in which the persons I had elected to public office to make decisions for me did not have an opportunity to engage in the give and take of the legislative process.

The emotion of the debate over nuclear plants must not be allowed to distort the necessary discussion of what is the wisest way to make such decisions. The Bicentennial year is a good time to discuss the quality of the process by which we govern ourselves as well as the issues resolved in that process.

BREWSTER C. DENNY
Graduate School of Public Affairs, University of Washington, Seattle

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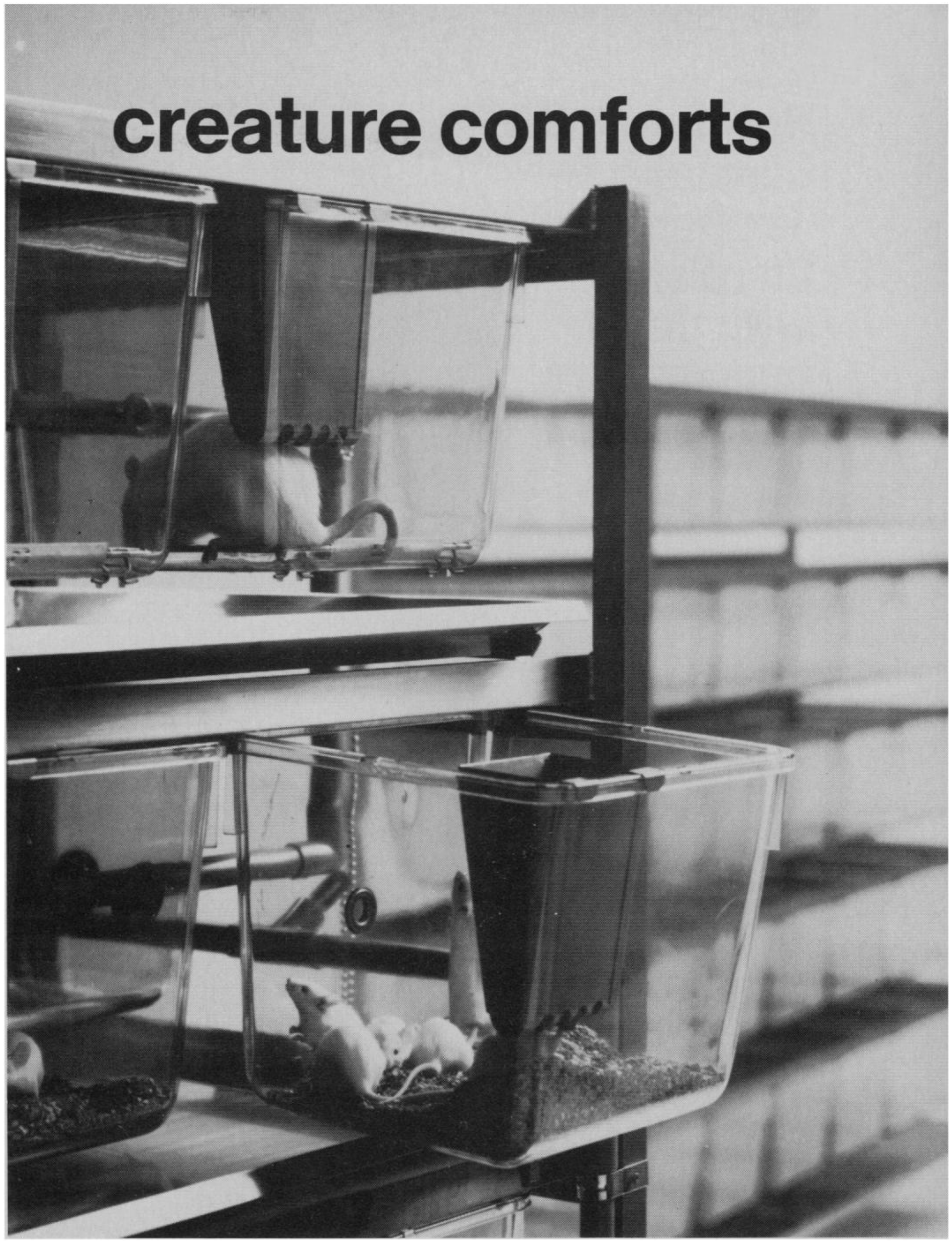
1. W. M. Wiecek, *The Guarantee Clause of the U.S. Constitution* (Cornell Univ. Press, Ithaca, N.Y., 1972), p. 1.

Random Drilling

H. W. Menard and George Sharman contend in their article "Scientific uses of random drilling models" (24 Oct. 1975, p. 337) that random drilling can find oil better than current industry practices. However, their treatment of the history of total U.S. oil exploration is misleading in at least five respects. First, the authors' random drilling simulation incorrectly uses total exploratory drilling for finding new fields. Actually, about half of this exploratory drilling has been within or near established fields and has no bearing on new-field discoveries. In ef-



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fect, the model thus gives simulated random drilling a completely undeserved twofold advantage. Second, most pre-1930 data are from the pre-geophysics era and have no applicability today. Third, the whole country was never open to exploratory drilling at one time, and the industry had no chance to find the biggest fields first, as does the computer model. Fourth, many of the authors' conclusions about recent giant-field discovery rates are open to serious question, because the raw data are quite inadequate. And, fifth, as noted by Menard and Sharman, major companies find about 60 percent of the oil with 10 percent of the wells—a clear illustration of the value of intensive scientific exploration.

The authors themselves are the first to reject their own ideal of "purely random drilling," since they limit their search to areas of sedimentary rocks. They thus acknowledge industry's first scientific guide to finding oil and successfully avoid misusing 40 percent of their model drilling in the barren areas of igneous and metamorphic rocks. They then opt for random search and choose not to make use of another simple, but powerful, guide—that oil, being less dense, floats on subsurface waters and therefore seeks the highest locations that the geology allows. Today, such prime potential field locations are detectable at most places from the surface by seismic techniques, and the area of search is again markedly and efficiently narrowed. Exploration is further focused on the best areas by additional, more detailed guides concerning the distributions of oil sources, reservoirs, seals, and traps (including stratigraphic ones). It is essential to make use of this immense body of knowledge, rather than to drill aimle

In sum, it seems to us that Menard and Sharman have given their computer nearly a twofold advantage by using wells in established fields, in addition to the proper new-field wildcat wells, to find only new-field oil. This does not even count the computer's ability to focus in a nonrandom way on sedimentary basins. Nor, more important, does it directly address the question of the ability of science in exploration. An unknown, but probably large, portion of industry's wildcat drilling has not been scientifically guided, as noted above, and should be eliminated before judging the impact of technology.

The main contribution of Menard and Sharman is their novel and reasonable field-size assessment of the relatively small undiscovered oil potential of the inland lower 48 states. Unfortunately, they seem to conclude that a likely cause of the declining discoveries is that ". . . the oil industry is no longer searching in the right places." This assertion seems untenable for the inland 48 states, which already is the most intensely drilled region of the world. Furthermore, a profound strength of the industry is that hundreds of different companies are searching with strong individual incentives and with many different ideas and hypotheses, including random drilling. Yet not one of these searchers has come forth recently with any new class of discovery that has altered the declining trends in the inland 48 states. Therefore, as Menard and Sharman at one point rightly conclude, the nation's only realistic hopes for future major oil and gas supplies rest in the frontier areas of the offshore and Alaska. But the right way to search in these hostile and costly environments is not by random drilling.

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Exxon Production Research Company, Post Office Box 2189, Houston, Texas 77001

THOMAS A. FITZGERALD
Exxon Corporation, 1251 Avenue of the Americas, New York 10020

Since our article was published, we have learned that many petroleum geologists have entertained doubts about the effectiveness of exploration. We have been informed of several comparisons between hypothetical grid drilling and actual exploration which showed little advantage in the latter.

White and Fitzgerald are among those who take a different view—in part because they read implications into our article which were not there and in part because they do not take our conclusions in context. We did not, for example, contend "that random drilling can find oil better than current industry practices," nor did we conclude that "the oil industry is no longer searching in the right places." We merely pointed out that scientific drilling did not do all that much better than random. We concluded from this that not everything is yet known about the factors controlling the distribution of oil. Consequently we believe that systematic drilling in less promising places should be encouraged by whatever incentives are necessary.

As to the specific points in the White and Fitzgerald letter:

1) Our data on "exploratory drilling" prior to 1945 are from Hubbert, as we cited (*1*). The data in early years are quite speculative. To the extent that they include holes within established fields they increase the odds that random drill-

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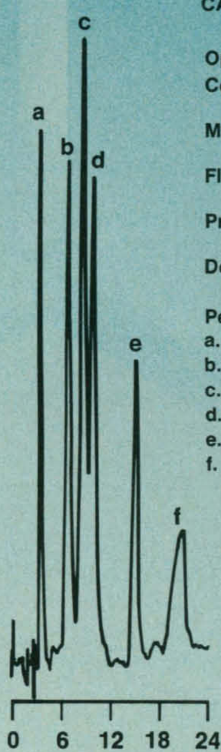

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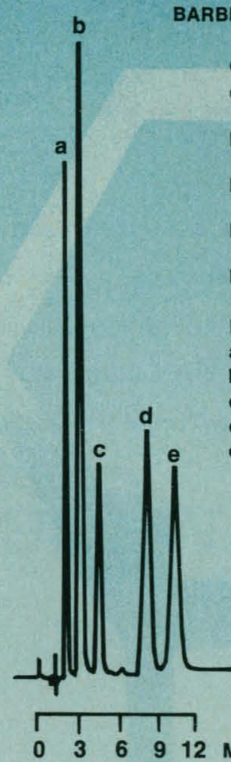

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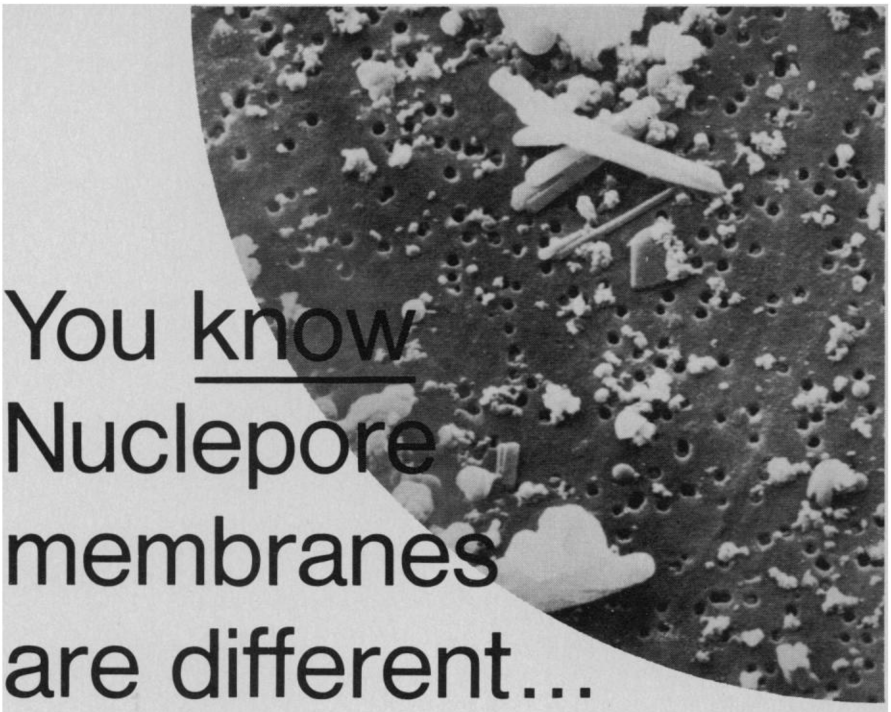

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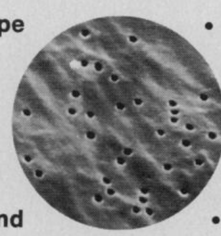

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ing will appear successful compared to the historical record.

2) We believe that the regular, consistent relationships that we developed indicate that the decline in the rate of exploratory success is largely a function of chance for a given technology. We do not contest the source of the pre-1930 data; indeed we said that the rate varies with the technology.

3) The whole country was not opened to exploratory drilling immediately, but that does not mean it was not available. The first five giant fields discovered were, respectively, in Pennsylvania, New York, California, Ohio, and Indiana. We are aware that the computer and industry had different targets. The question is, Why did industry explore as it did? Undoubtedly the answer is very complex, with legal and economic factors involved. One major company, for example, used to just lease on a checkerboard pattern. The fact remains that the system of exploration was not designed to sample the country and, hence, was not very good at it. It is not, therefore, necessarily the ideal way to proceed in the future.

4) We have taken our data since 1945 from the annual exploration summaries of the American Association of Petroleum Geologists. We do not accept the serious charge that "the raw data are quite inadequate." The point raised more likely reflects a misunderstanding of the limits of our analysis. Giant fields are still discovered with gratifying frequency in the United States, but in order to maintain a consistent sample we did not include gas fields anywhere or oil fields offshore or in Alaska.

5) White and Fitzgerald seem to assume that the nonmajor companies do not use science and that the numbers quoted are a fair measure of "value." A senior official of a very large, nonmajor company has expressed the opinion that, despite the numbers, exploration by the major companies is less cost effective than that of the smaller companies.

Our introduction of the hypothetical method of random drilling was not intended to initiate a competition of industry versus computer, but rather was meant as a new perspective or standard for measuring the effectiveness of exploration.

W. H. MENARD, G. SHARMAN
Geological Research Division,
Scripps Institution of Oceanography,
University of California, San Diego,
La Jolla 92093

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1. M. K. Hubbert, *Am. Assoc. Pet. Geol. Bull.* **51**, 2207 (1967).

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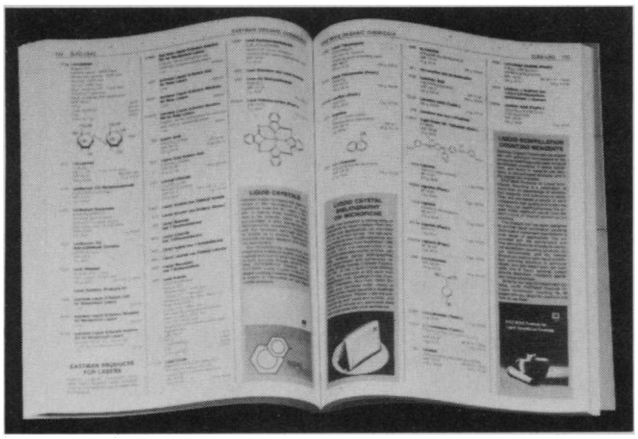

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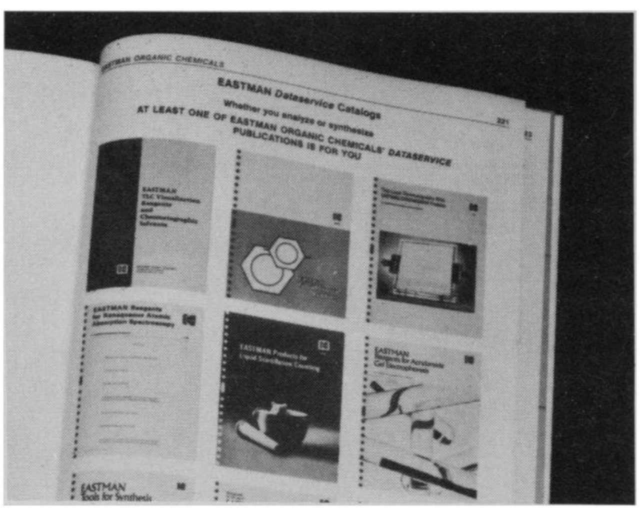

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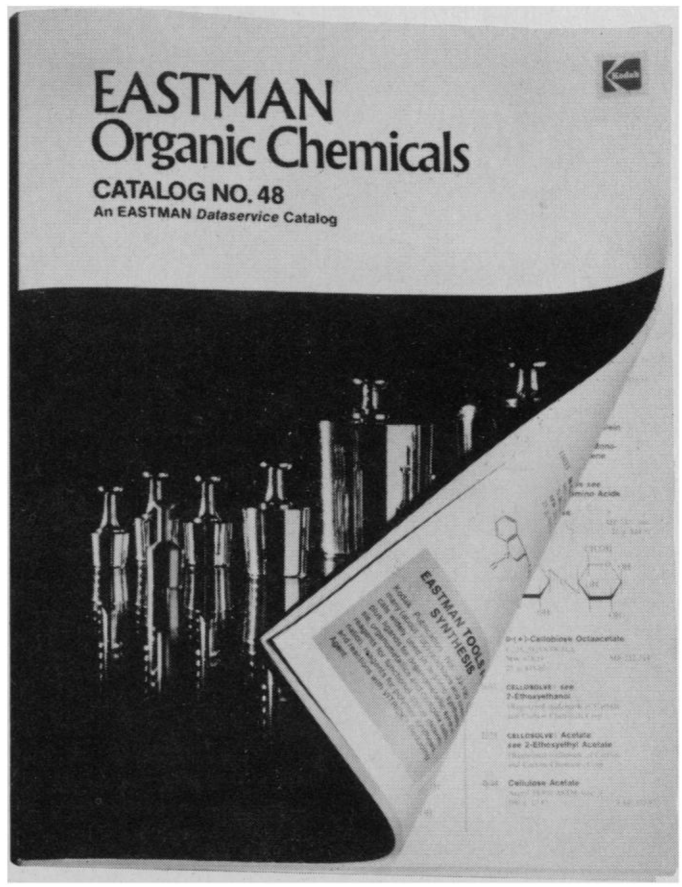

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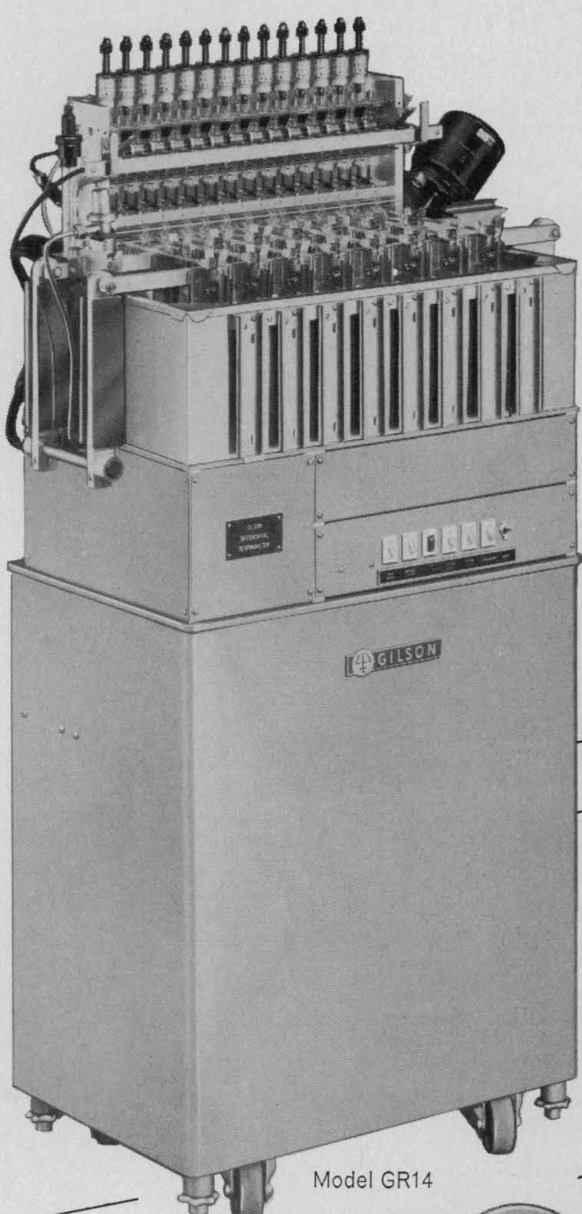

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The Week That Was

For the 113,000 members who did not attend the 142nd Annual Meeting of the AAAS in Boston, the Proceedings Issue will capture most of the sound but not enough of the light. As the annual meetings go, the 1976 version with its Bicentennial backdrop was, by common agreement, well above average. The scientific content was strong, sessions were overcrowded, policy debates were lively and on timely issues, there was a striking international flavor to the design of the meeting, and there was no evidence that anybody was bored. There was enough radical dissent to keep the record straight, but no interruption of the completion of appointed rounds. Facilities and escorts for the physically handicapped were available, and for the first time hundreds of physically handicapped scientists were in evidence, while the turnout of women and minority participants testified to a significant change. High school students came in droves, and a small army of press persons saw to it that the events were well reported. The local advisory committee, headed by Howard Johnson and Gerhard Bleicken, extended itself to raise funds and arrange special events, and the large crowd who attended the reception following Dr. Mead's presidential address disposed of historic quantities of a memorable clam chowder.

The context of the 1976 meeting also provided some contrasts with other years. The long winter of depressed funding for science seemed to be coming to an end, when measured against President Ford's substantial budget proposals. The Senate and House had each passed bills for new national science policy machinery, although the last act in that drama had yet to be written. An awareness of new and urgent dilemmas concerning policy for science and society was emerging, and concepts like "habitat" and "desertification" had emerged from being of specialized interest to being of general concern, adding to the already long list of intractable problems of energy, population, resources, food, climate, and environment. Institutional problems seemed to be increasing, touching now on the accountability and credibility of scientists taking sides in public controversies, and proposals for a scientific judiciary were gaining a kind of instant respectability. Euphoria over the federal R & D budget was dimmed by the realization that most of the buildup was designated for another lap in the weapons race, accompanied by Pentagon rhetoric to the effect that science and technology hold the key to America's hopes of prevailing a leading position in world affairs. Meanwhile, the fresh indicators were confirming general apprehensions about a decline in the rate and quality of industrial product and process innovation, boding little good for the long-term prospects of the nation's economy.

In short, the context of the meeting was not lacking in imponderables. Seven days in February hardly sufficed to absorb the content of a prolific menu of symposia, lectures, and special events, let alone to deliberate on the meanings of trends, risks, and uncertainties. The AAAS annual meeting is not a parliament of science, or even a convention of delegates elected by the members. More than 100,000 of us were not even there, and the 5,000 who did come had less ambitious things in mind.

Still, the meaning of trends and countertrends is central to coping with the ordeal of choices. These trends are not merely peripheral to decisions as to the right uses of science, technology, and, for that matter, all knowledge. We must find ways to address them, lest scientists one day be justly criticized for not caring what road we took as long as we kept marching. The Boston meeting is to be seen not just as an intellectual burst that briefly lighted up the skies but as a revealing glimpse of the distances that reason has still to travel.—WILLIAM D. CAREY, *Executive Officer, AAAS, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036*

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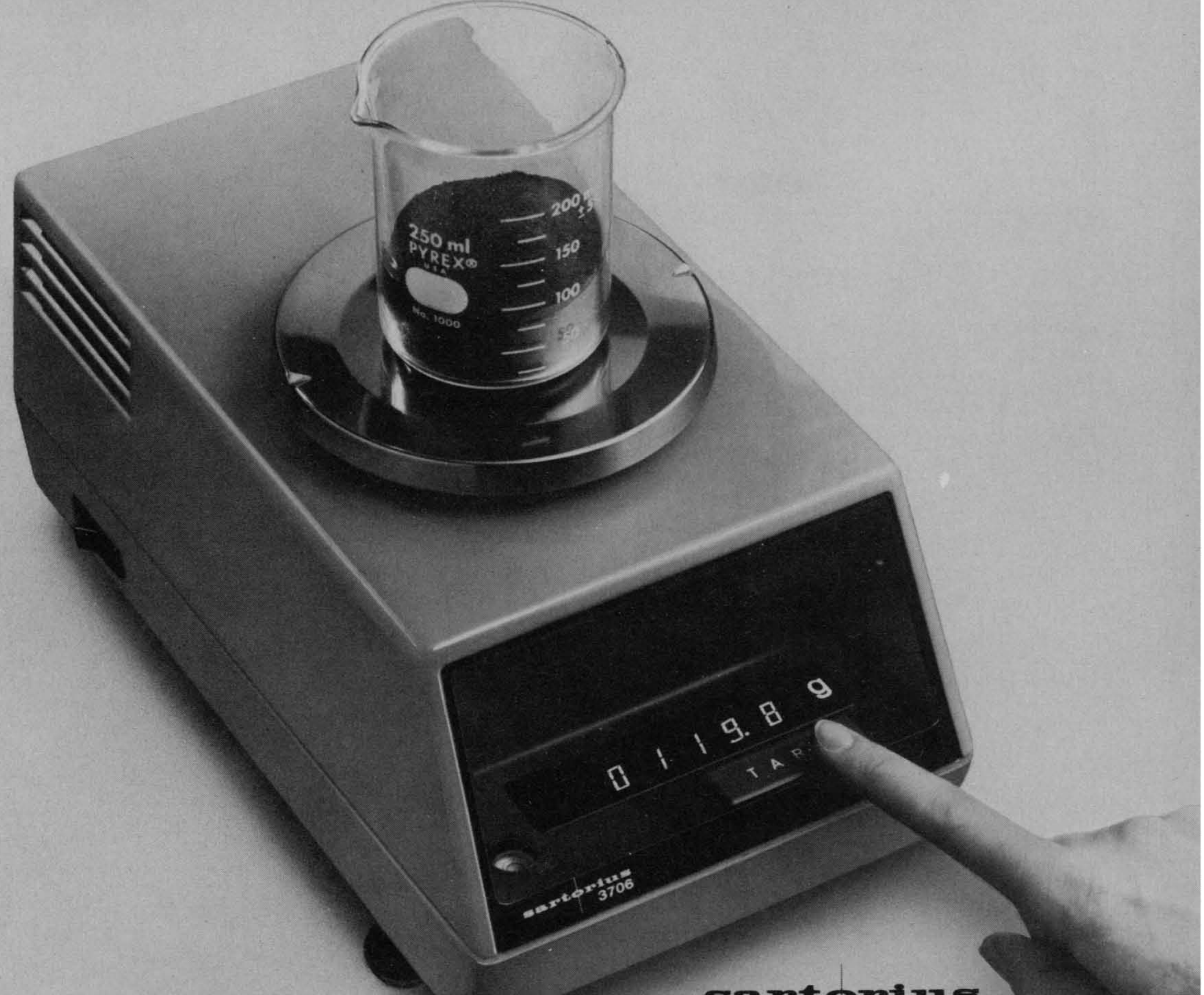

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(Continued from page 250)

Recent Advances in Studies on Cardiac Structure and Metabolism. vol. 8.

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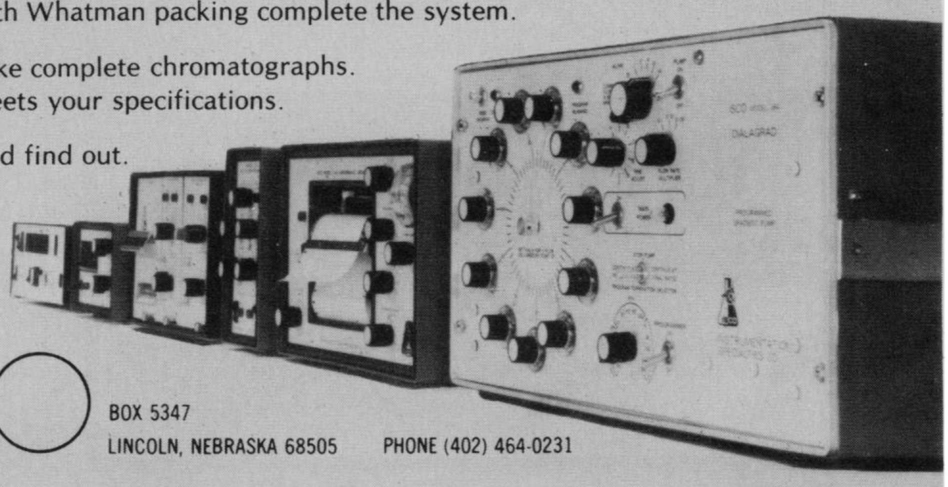

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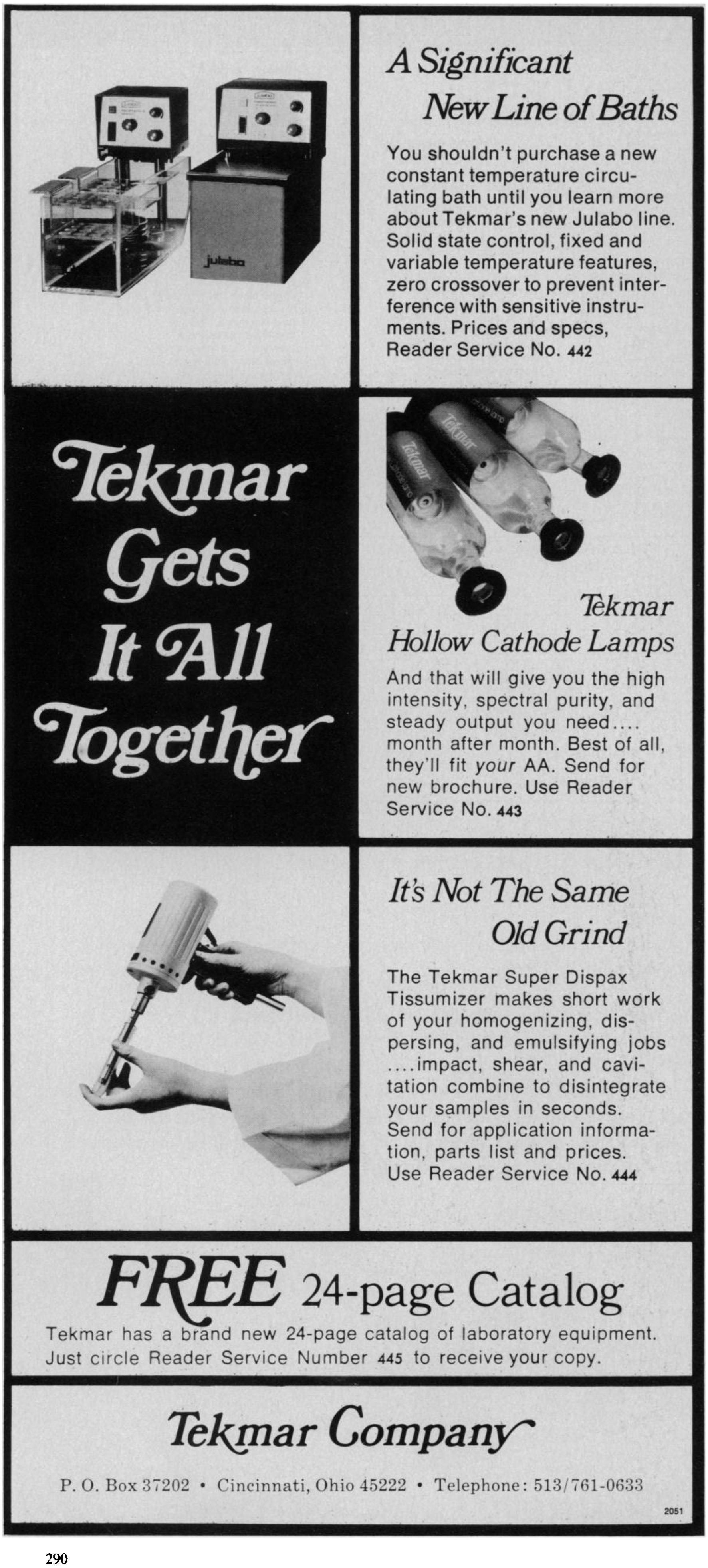

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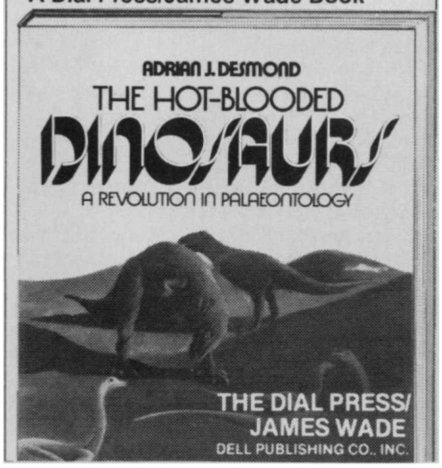

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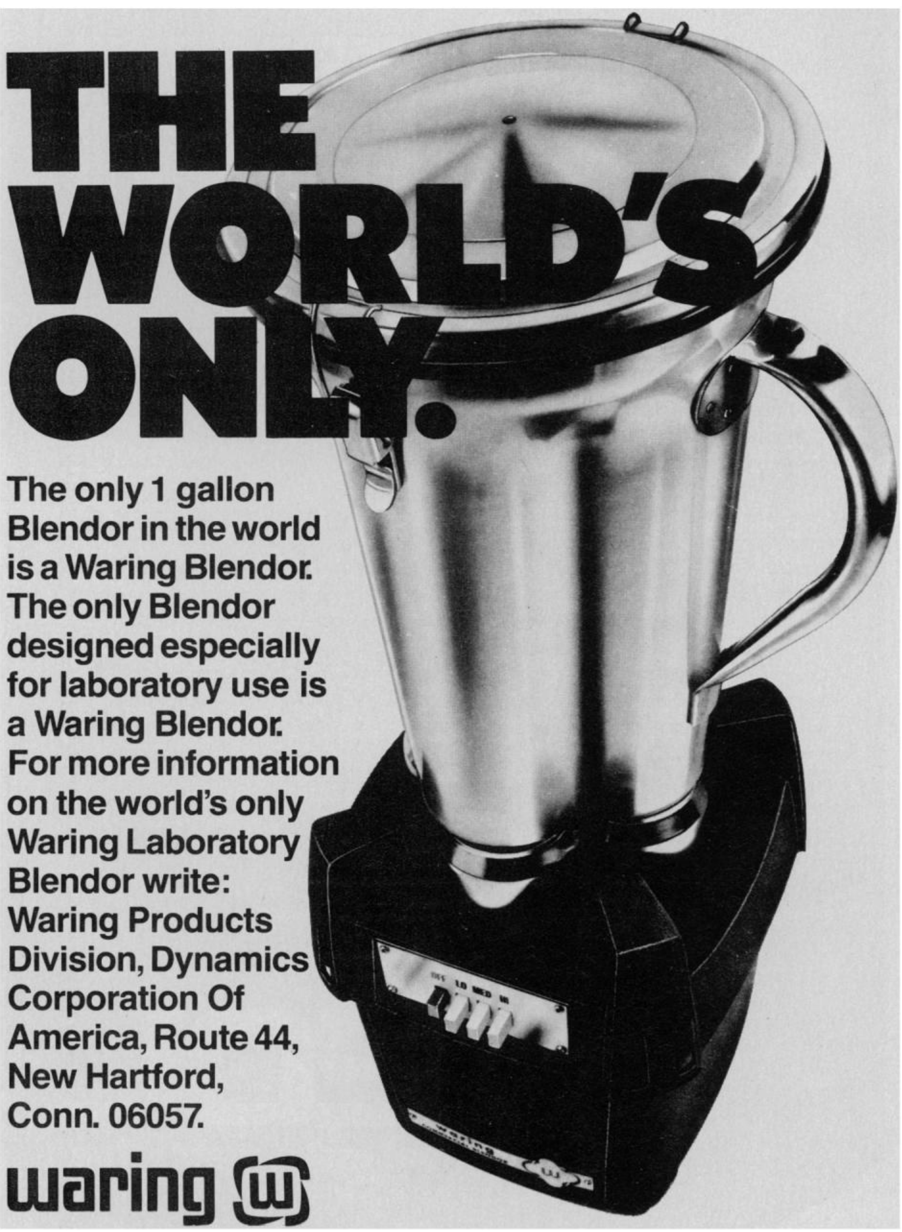

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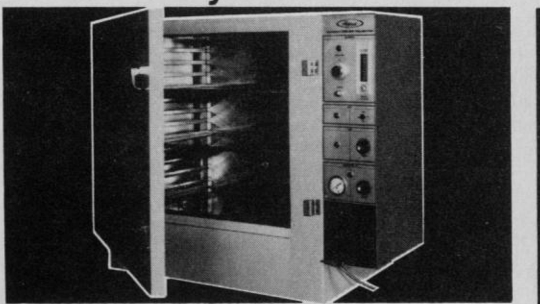

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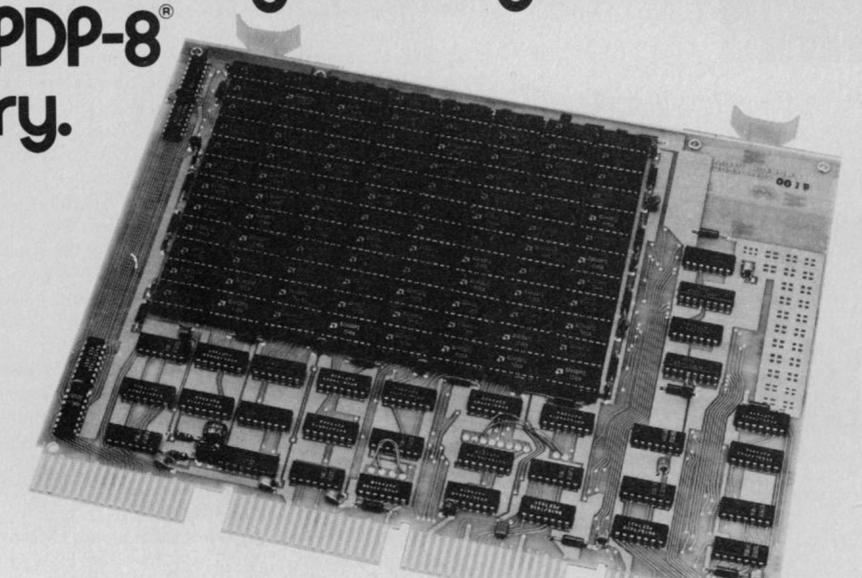

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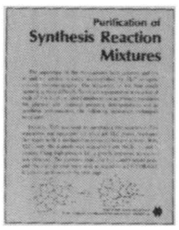

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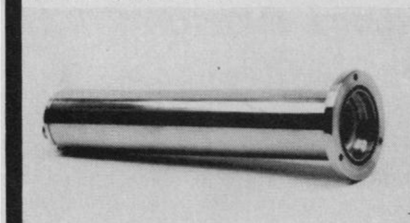

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