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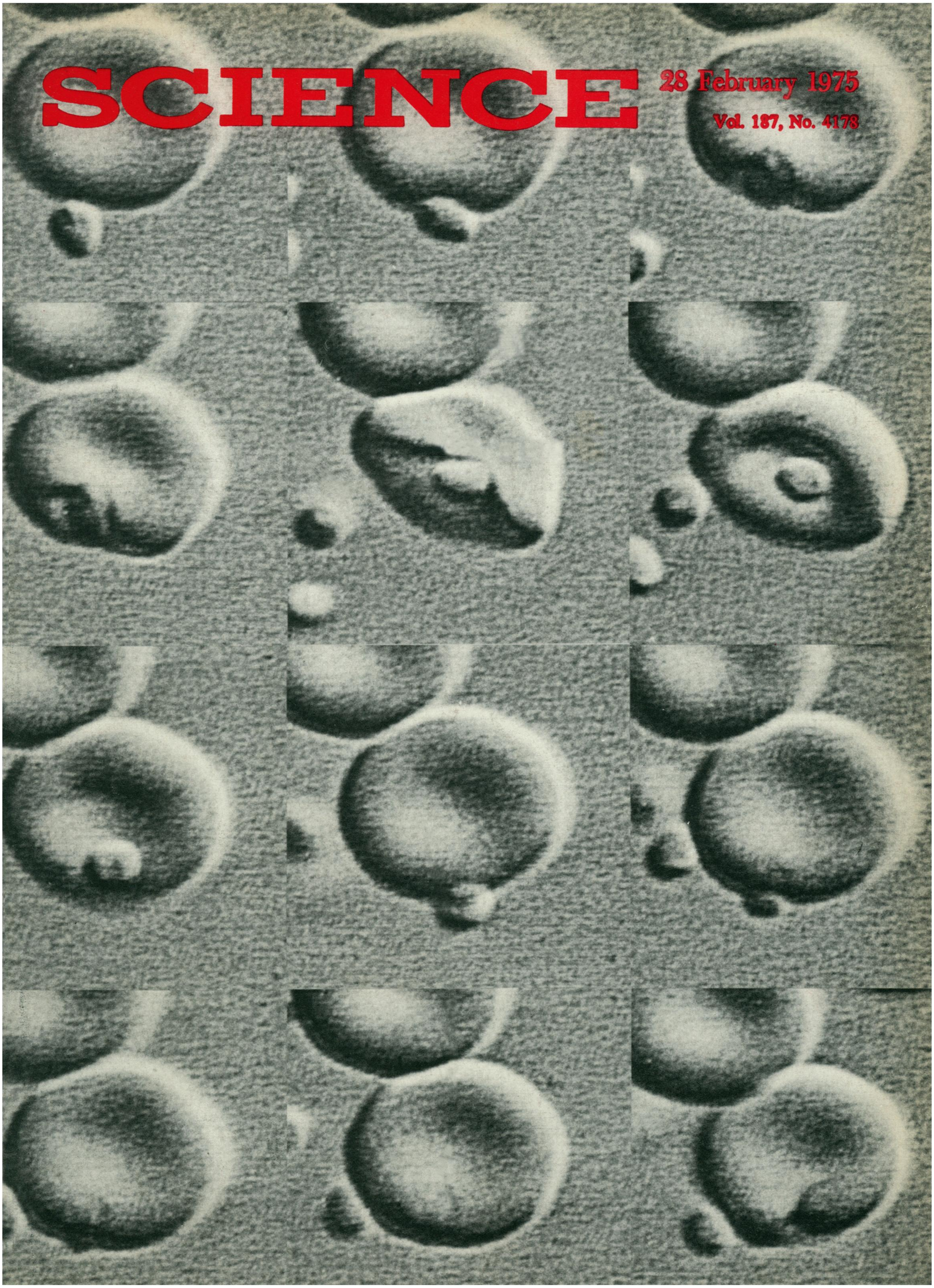

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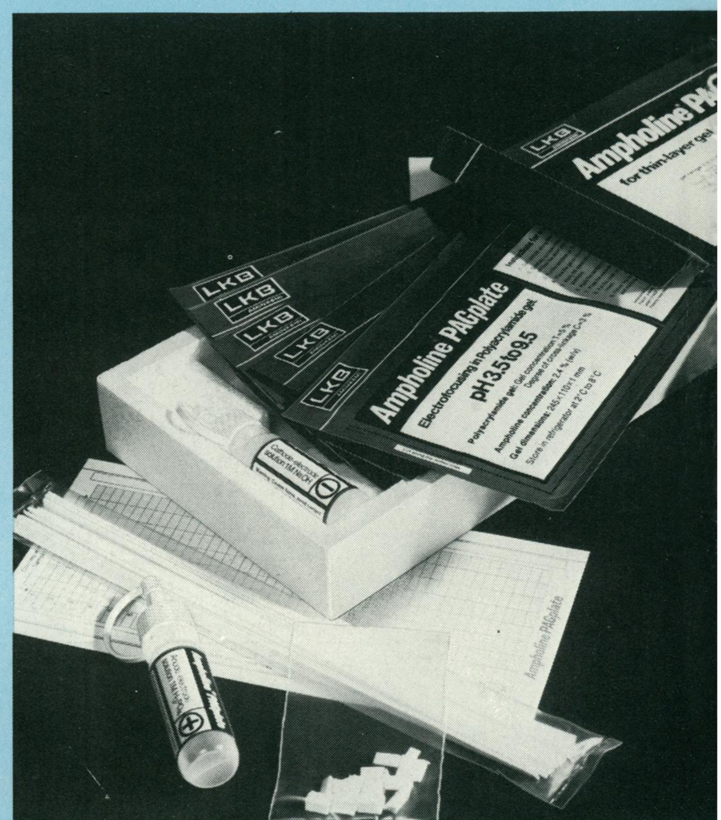

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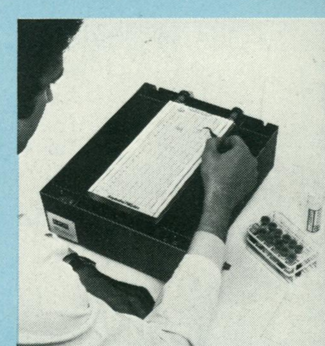

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COVER

Invasion of erythrocytes by malaria merozoites (× 5000). See page 748. [James A. Dvorak *et al.*, National Institutes of Health, Bethesda, Maryland]

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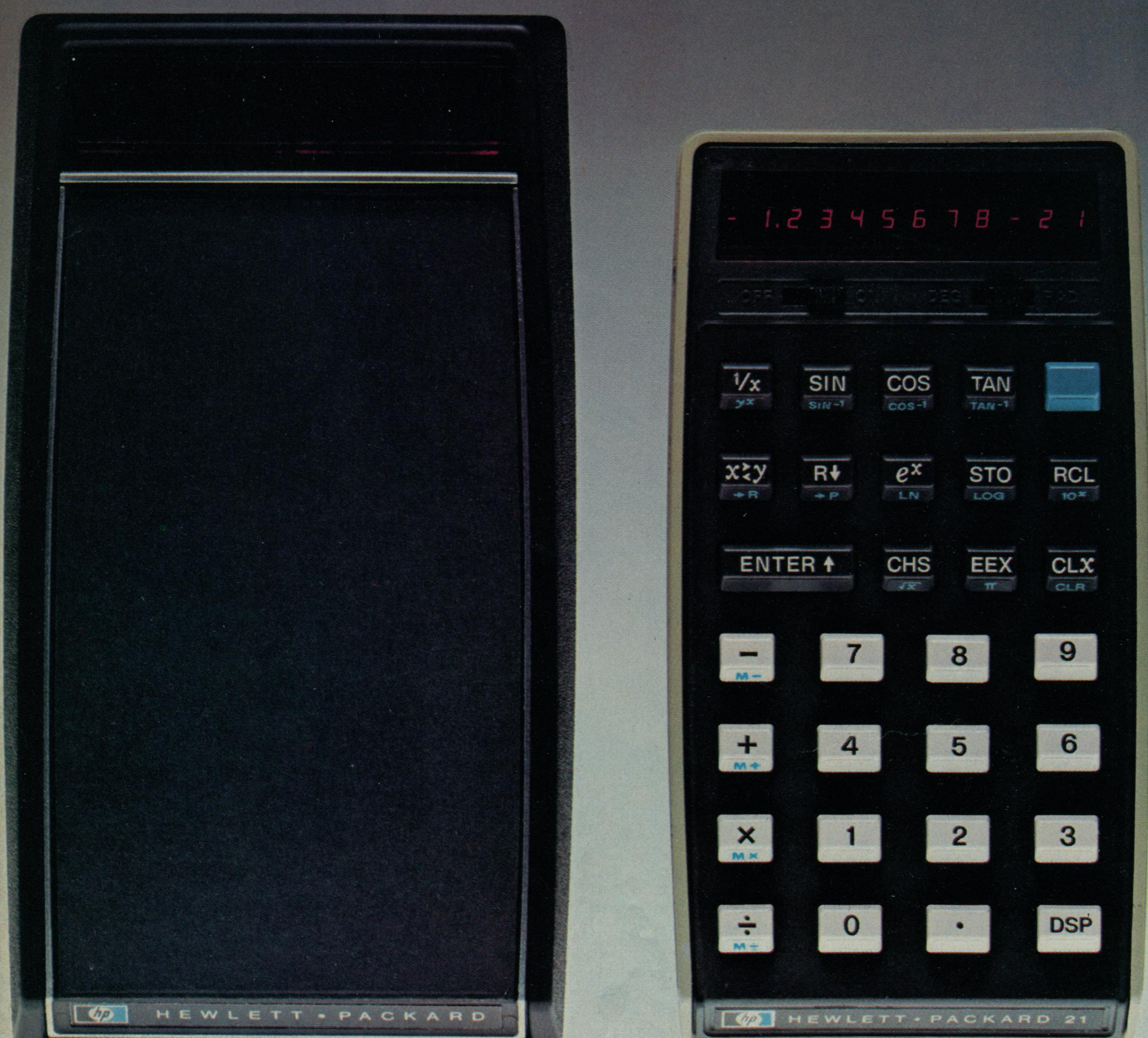

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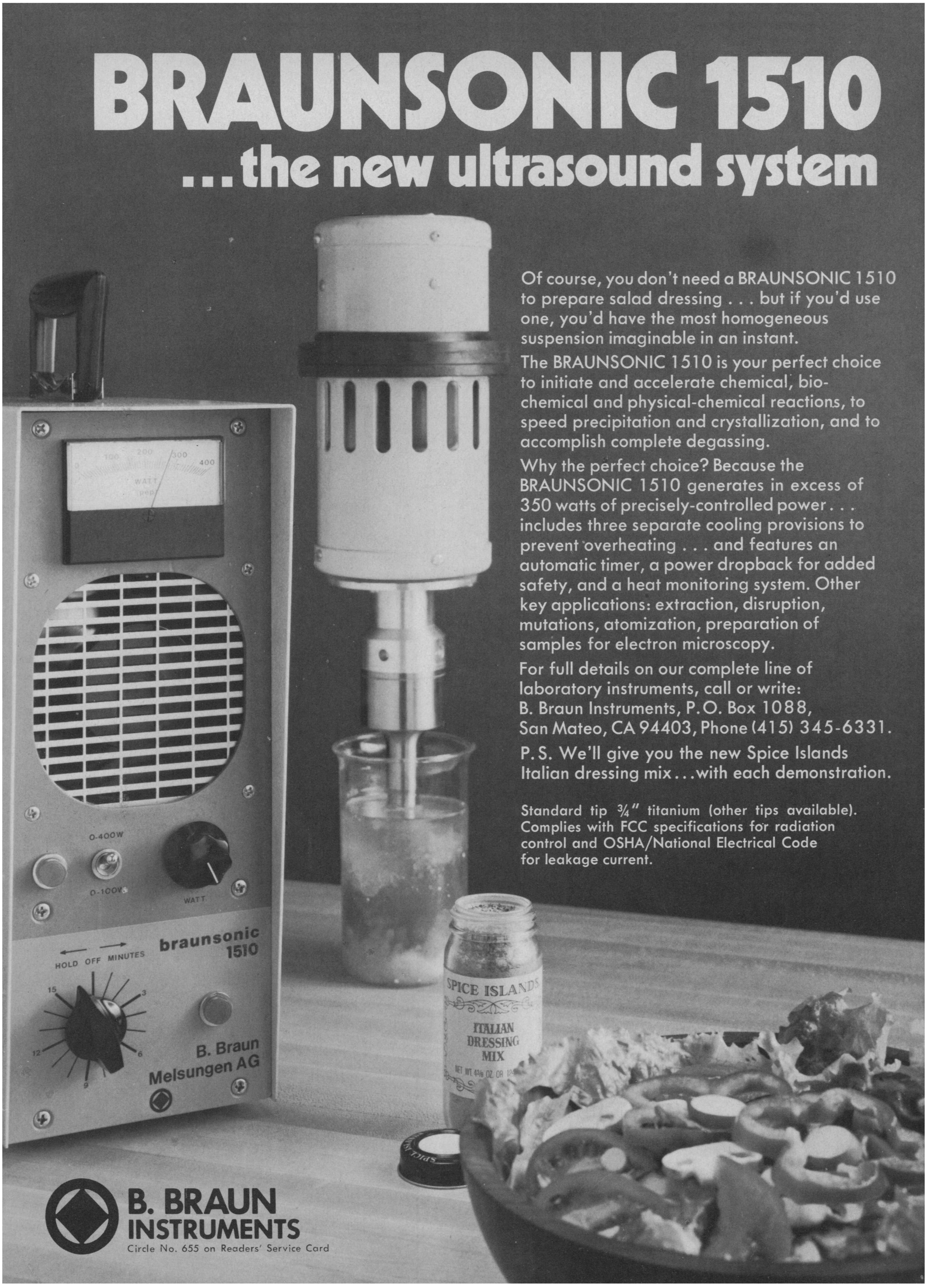

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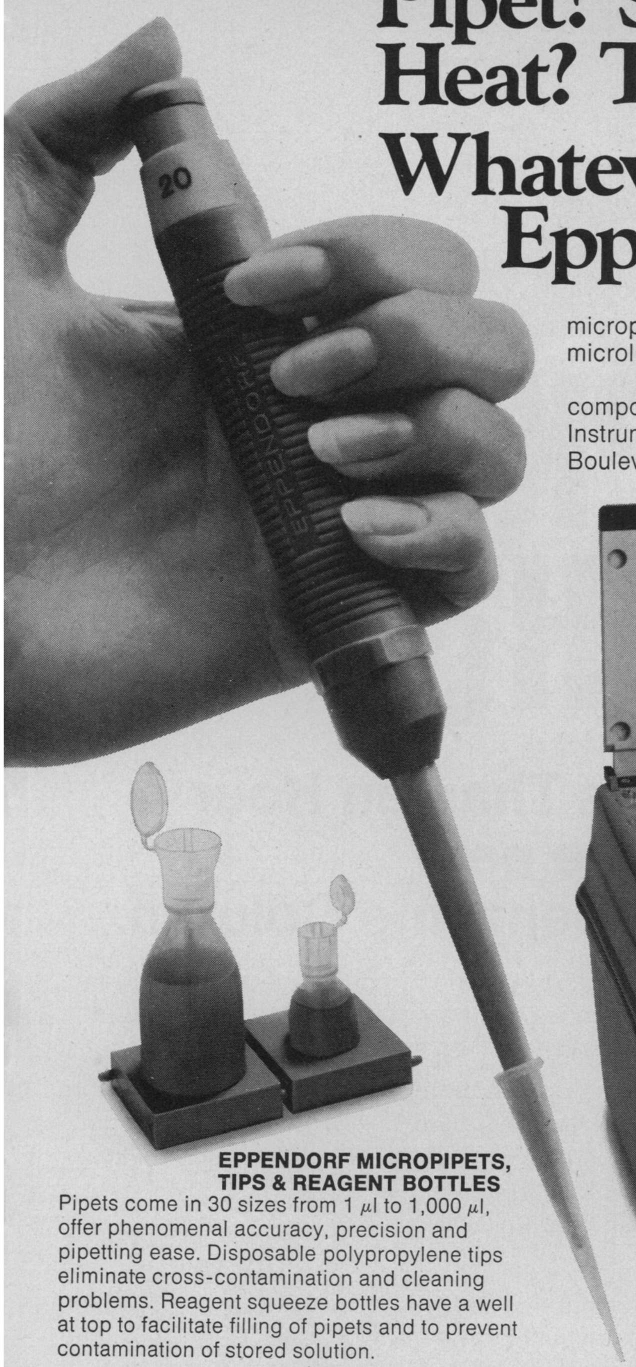

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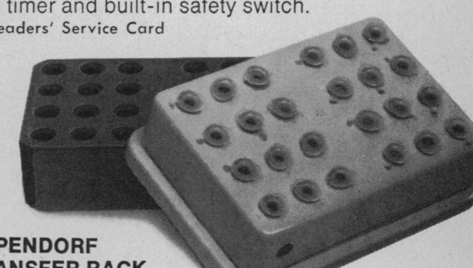

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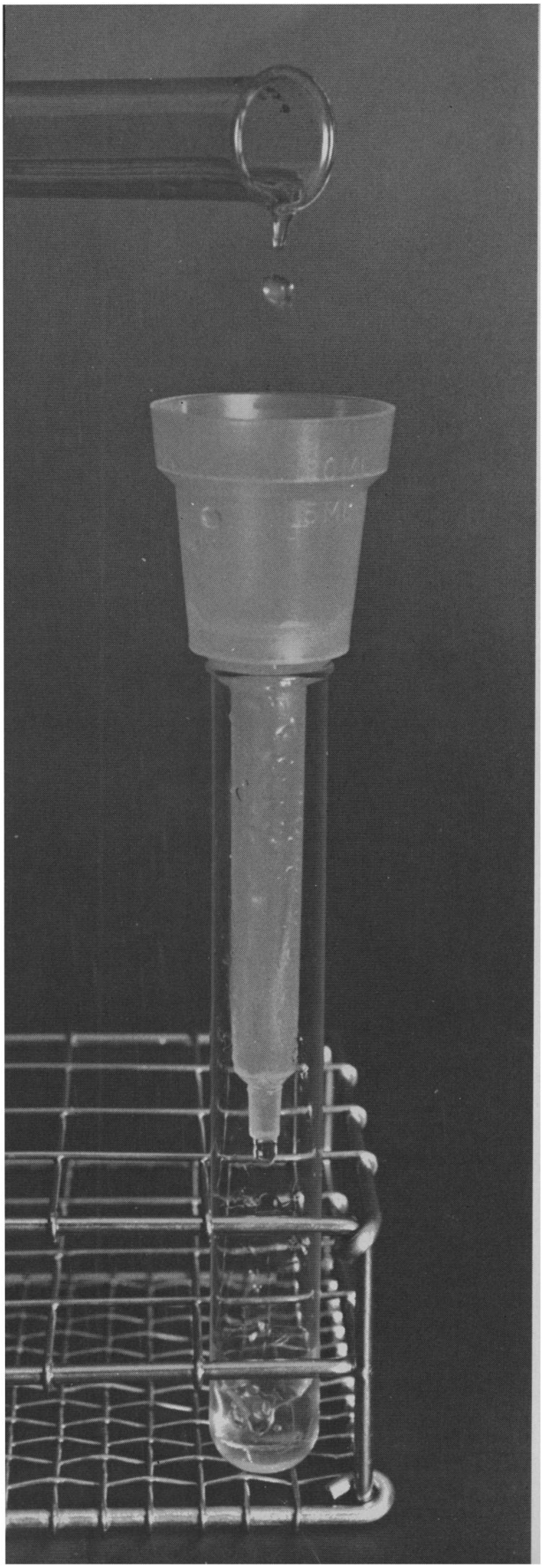

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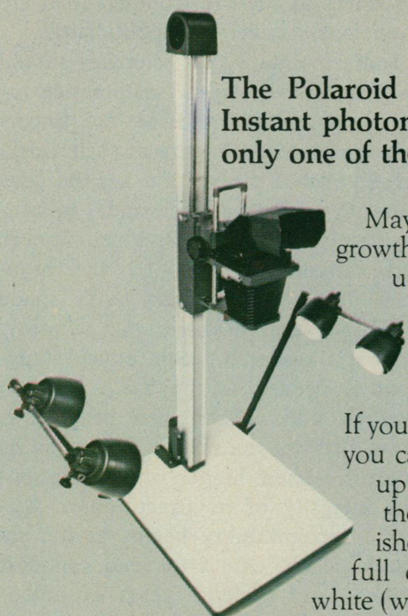

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XYY Chromosome Study

The ethical objection of Beckwith *et al.* (Letters, 31 Jan., p. 298) to the Harvard XYY study appears to be based upon a simplistic notion of distinguishing the behavior of people either on the basis of genetics or on the basis of social, economic, and familial conditions. Possible effects of the interaction of genetic and social factors are overlooked.

Beckwith *et al.* assume that the design of the study precludes obtaining information about the effects of informing parents about the XYY chromosome. This assumption is probably incorrect. It is likely that some of the informed parents will believe that the XYY chromosome is related to antisocial conduct and others will not, just as there is disagreement among scientists. And some parents may in the course of the experiment change their opinion about this. Thus, the beliefs and related child-rearing behaviors of the parents in the study will probably range along a continuum, allowing a meaningful assessment to be made of any effects of child-rearing practices and of the XYY chromosome.

Genetic and ethical problems do not go away by ignoring them. They should both be subject to thoughtful investigation which balances the risks of knowledge against the benefits, if any, of ignorance.

R. KIRKLAND SCHWITZGEBEL
Department of Psychiatry,
Laboratory of Community Psychiatry,
Harvard Medical School,
Boston, Massachusetts 02115

Accountability in Science

The recent disclosure of yet another possible breach in the integrity of scientific research raises some hard questions about the public's right to oversee the conduct of science. Both in the Summerlin affair of last April, in which a Sloan-Kettering cancer researcher was given a psychiatric leave after tampering with skin-graft data, and in the current case at Harvard, in which a student is suspected of forging experimental results, the research in question was supported both directly and indirectly through public funds. Yet, the actions which have been taken to date have involved internal "housecleaning" with little or no public access to the facts or involvement with the issues. Why should research scientists be any less accountable to the public for the consequences of their misconduct than are physicians, lawyers, or politicians?

Some maintain that scientists should be sequestered from malpractice or malfeasance by virtue of the impersonal and indirect nature of their work. Behind such a proposition lies the false assumption that scientific data, in contrast to the surgeon's scalpel, "never hurts anyone. After all," the argument goes, "it's the use that's made of science that deserves our scrutiny, not basic research." But ethical judgment is needed at the basic research level as well. Those who practice it know that the nature of the scientific enterprise itself hinges on the scrupulous integrity of its practitioners. Scientific accountability begins at the research bench. One false lead can cost science (and society) years of potentially constructive work.

It is no accident that the current disturbing events are occurring in transplantation immunology, a field still in its infancy. Transplantation immunology may now be in the same inchoate and explosively expansive stage that genetics was in in the Lysenko era of 25 years ago. When "normal" science, as Thomas Kuhn (*1*) described it, begins to falter, as new data repudiate old hypotheses, then basic research takes on new meanings—and basic researchers, new responsibilities. Immunologists today are struggling for coherent theories to incorporate seemingly divergent data. They are met at every turn by paradoxes and anomalies. The immune system can seemingly be turned to good or evil by a quirk of happenstance. Clinicians do not know how to predict when an immune response to a virus may cause a disease or cure it; or if they generate an immune reaction, whether it will stimulate cancer growth or retard it. Reproductive biologists are met with paradoxical success in the survival of the immunologically discrepant fetus and remain ignorant of the adaptive role of the mother's immune response.

Historians of science would recognize in these perturbing uncertainties a scientific field in flux, an old paradigm collapsing, and tentative new models proliferating. It is at just such a time that a field becomes most vulnerable to chicanery and deceit. Total objectivity becomes difficult for even the most scrupulous practitioner. Often it is im-

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possible for the average scientist to distinguish between a vagary of chance to be noted and placed aside and a potential breakthrough result which could unlock a logjam of inexplicable data. Others, like Newton and Mendel before them, consciously or unconsciously suppress variations in their data which "do not fit" in order to sustain the hypothesis they believe to be the right one. All of these perturbations of conduct and reasoning need not occur in the "perfect" practice of the scientific method, with its insistence on blind observation and reproducibility. But human foible, ambition, and the urgency to straighten things out often suppress the ideal.

A science in revolution fairly *invites* scientific entrepreneurs to ply their new hypotheses. It is these people who are simultaneously the most valuable and the most dangerous among the dramatis personae of the morality play of scientific discovery. One extra bit of egoism, one iota of self-aggrandizement and the play can become a tragedy. The stakes are enormous, the tensions great. Some are keen to take up the challenge; others succumb to what Lawrence Kubie (*2*) described as "the neurotic distortion of the creative process." There are those who have the courage to promulgate seemingly rash hypotheses selflessly, willingly taking responsibility for their actions by setting about to refute their own ideological progeny. This is when science is at its best.

Then there are those for whom the fragility of the times calls forth an opportunism that leads to a contamination of the free marketplace of ideas with forged data or rigged experiments. This happened in the Summerlin affair. These events are so troubling and potentially so damaging to the conduct of science that they call out for action.

It is a disservice to science and society alike to treat such events as isolated and idiosyncratic. My experience as a transplantation immunologist at three major laboratories in this country strongly suggests that Summerlin-like observations are the rule, not the exception. Indeed, as Karl Popper has emphasized, the vitality of a science may depend on the number and richness of falsifiable hypotheses available as grist for the scientific mill. However, the proliferation of false (rather than falsifiable) hypotheses may also be a sinister symptom of the heightened stakes for scientific success in research areas, such as cancer or immunology, in which public expectations have been grossly inflated. Scientists in fast-breaking areas and "normal" science alike ought now to take seriously the implications of misconduct on the part of their colleagues. Some laboratories have already instituted internal checks to verify novel results. But such checks themselves are likely to have a chilling effect on innovative research. The line must be strictly drawn between proffering serious hypotheses, simple speculation, and outright fabrication. Somehow, the recognition must be engendered in scientist and citizen that the scientist who intentionally forges or misrepresents basic research data is no simple miscreant or neurotic. Such persons misuse the public trust as well as public funds and should not be shielded behind a veil of "psychiatric illness" or bureaucratic maneuvering. Scientists must be willing to look at the systems which create these perturbations—both in society and in their own enterprise—and begin to undertake a searching analysis of their roots.

MARC LAPPÉ
Institute for Society, Ethics and the Life Sciences, Hastings Center, Hastings-on-Hudson, New York 10706

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1. T. Kuhn, *The Structure of Scientific Revolutions* (Univ. of Chicago Press, Chicago, ed. 2, 1970).
2. L. Kubie, *The Neurotic Distortion of the Creative Process* (Farrar, Straus & Giroux, New York, 1961).

Laser Fusion Research

The article "Laser fusion: One milepost passed—millions more to go" by William D. Metz (Research News, 27 Dec. 1974, p. 1193) seems to imply that only government and private companies are involved in significant work in this field. Actually, the academic community—specifically, the University of Rochester—has been active in this area from the time that laser fusion was first declassified in the late 1960's. More recently, the University of Rochester has joined with industry and government in a long-range commitment to the development of controlled thermonuclear fusion as a future energy source.

This collaboration has resulted in the only suprakilojoule, subnanosecond laser target irradiation facility presently operating. Data from this facility (thousands of on-target shots with neutron measurements carried out as a standard diagnostic) are published in the scientific literature. (Incidentally, Metz's article mentions the General Electric Company's participation in laser fusion research but does not explain that GE is one of five major participants in the University of Rochester's Laser Fusion Feasibility Project; other principal sponsors are the EXXON Research and Engineering Company, the Northeast Utilities Service Company, and the New York State Atomic and Space Development Authority.)

The academic community has been a primary source of many new ideas in laser fusion and related research. At Rochester, the laser fusion project is completely unclassified; thus, all information generated through its activities is made public. One laser fusion breeding concept (reenergizing used fuel rods from fission reactors) has been developed by researchers at Rochester. The university has filed several patents relating to this concept, and the patents will be made available to others through licensing.

Compared to efforts in governmental and private industrial laboratories, university-based programs in fusion research appear relatively small. However, in a field that is largely idea-limited, universities have a major contribution to make in developing the scientific understanding necessary to develop this process as a future energy source. The kind of collaboration exemplified by the Rochester project—involving government, industry, and university—is a pioneering one that seems to hold much promise, and we hope it will serve as a model for cooperative research in other areas.

MOSHE J. LUBIN
Laboratory for Laser Energetics,
University of Rochester,
Rochester, New York 14627

Immigration Policy

Charles B. Keely, in his well-balanced article "Immigration composition and population policy" (16 Aug. 1974, p. 587), correctly laments the poor quality of U.S. immigration and emigration data, especially the latter. But better data are likely to be slow in coming. Based on past experience, one might estimate that it will take two or more years for Congress to authorize such data collection and appropriate necessary funds, another 2 years for transition to the new system, and 6 years to accumulate the experience needed to describe in detail what is happening. Unfortunately, we do not have a decade to wait. The question of the demographic significance of immigration will likely mature in the next few years. As a result, decisions will have to be made with the deficient data now available, as is the case with most political questions.

Beyond this, more accurate data may not help much in deciding the role that demographic considerations should play in setting U.S. immigration policy. What will count is the policy-maker's appreciation of the significance of additional population growth for the United States. Those who do not see additional growth as a problem are not likely to be moved by more accurate statistics. Those concerned about additional growth will find little solace in refinement of the figures. As Keely points out, it is a value judgment.

The projected addition of some 15 million to our population through legal immigration between 1970 and 2000 (*1*) is a responsibility not to be taken lightly. (Illegal immigration, which also needs to be addressed, will add an additional and perhaps even larger number.) As competition for resources grows abroad and our domestic supplies dwindle, we may find ourselves hard pressed to provide for today's numbers, much less those that will be added by natural increase and net immigration. The situation calls for great prudence in making any additions to our population, from whatever source.

The main numeric limitations on immigration were established 50 years ago, when there were 100 million fewer people in the United States and the world setting was quite different. These limits should be reevaluated in the light of today's world. Demographic concerns should take their place alongside the more traditional ones in the setting of our immigration policy. Unfortunately, immigration law is complex and controversial. The public is not well informed on the topic. These conditions make a reasoned public debate of this sensitive and complex topic difficult, but it must be attempted. Keely's article is a useful step in this direction.

Finally, it is possible to envision a world in which international migration could be relatively free of restrictions. A basic requisite would be a social

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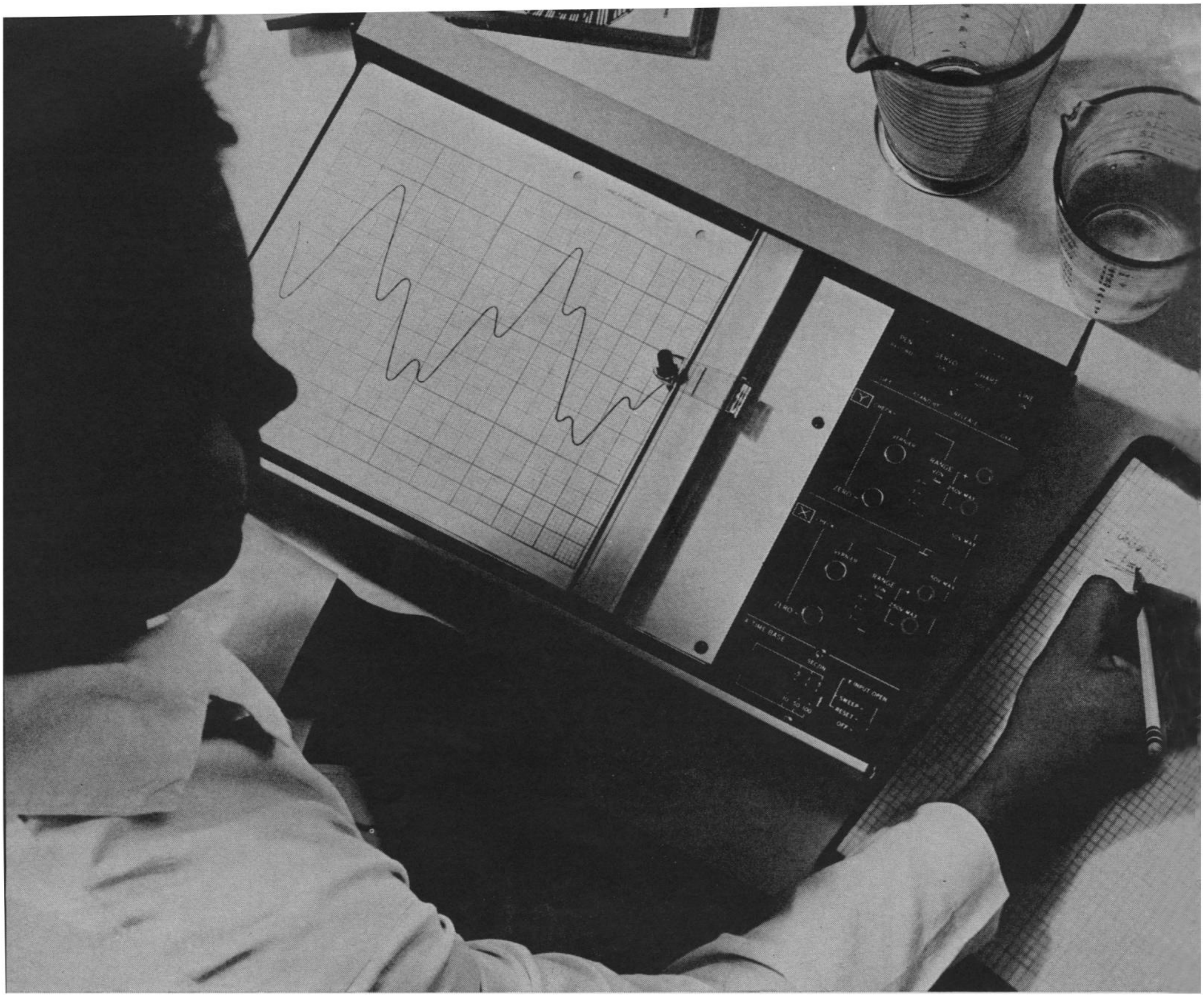

and environmental situation in which there were few incentives for people to move. This in turn would require relatively stable populations and equitable distribution of opportunity and wealth, hardly a description of today's world. Without these conditions, it appears that open immigration policies are about to be added to the growing list of casualties of continued population growth and resource depletion.

JOHN H. TANTON
Immigration Study Committee, Zero Population Growth, Washington, D.C. 20036

References

1. *Population and the American Future: The Report of the Commission on Population Growth and the American Future* (New American Library, New York, 1972), p. 201.

Tanton correctly points out that decisions often have to be made with deficient data. Current immigration data are not equal to the task of providing needed insights into the effects of proposed changes in immigration policy. I agree that population considerations should be included in immigration policy, but political, economic, and social considerations also have a place in such deliberations. Tanton's discussion and conclusion indicate the paramount importance he gives to population. Restrictionism has previously been viewed as an answer to problems in the United States. Our experience should warn us to tread carefully. Ansley Coale's evaluation (*1*) of immigration's contribution to population growth should give us pause about considering radical cutbacks of immigration as a way of checking the effects of population growth.

Concern for the quality of life should also cause us to be vigilant about equity in our laws and about repressive administration and enforcement, which affect not only aliens but native-born and naturalized citizens. Our shared concern about population growth should not blind us to the complex effects of immigration policy and administration. We should seriously ponder whether mere survival is enough.

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References

1. A. J. Coale, in *Commission on Population Growth and the American Future: Research Reports*, vol. 1, *Demographic and Social Aspects of Population Growth*, C. F. Westoff and R. Parke, Jr., Eds. (Government Printing Office, Washington, D.C., 1972), pp. 589–603.

Obvious Question

I was much interested in Irving H. Page's editorial "A sense of the history of discovery" (27 Dec. 1974, p. 1161), especially the description of the ludicrous circumstances under which Fleming discovered penicillin. I think I can add a further ludicrous note to the discovery of penicillin.

When I was an undergraduate in medical school and taking a bacteriology course (in 1914), we learned how to grow bacteria on agar plates. One day my plate had a number of black spots on it surrounded by clear halos. I asked the instructor what those clear halos were containing a black spot in the center; I don't recall his exact words, but the tenor of his response was, "Those are molds: you were careless in your technique and you got your plate contaminated by molds. You must be more careful."

I am sure that bit of knowledge was not his alone. The other instructors and the professor of bacteriology must have known also of the black spots surrounded by clear zones. There must have been hundreds of bacteriologists around the world at that time who had seen this same thing. Incredibly, it seems that the perfectly obvious question, "If something diffuses out from a colony of molds which will prevent bacterial growth in culture, might this also prevent infection in man?" seems not to have occurred to any of them. Why didn't that so very obvious question occur to me? Instead, I went back to my place thoroughly chastened, having been chided before the whole class for carelessness in technique. Before the day was over, all my classmates knew that molds destroyed bacterial growth. They were all reasonably intelligent; why didn't the question occur to one of them?

If a reasonably intelligent and curious high school student had wandered in to visit the laboratory, he, being thoroughly disinterested, might very well have asked, after the situation was explained to him, "Is that what you use in sick people to kill bacteria?"

It has always seemed to me that this was a prime example of how extremely obtuse even intelligent people may be. After all, the only reason we were studying bacteriology was to learn how to control infectious diseases!

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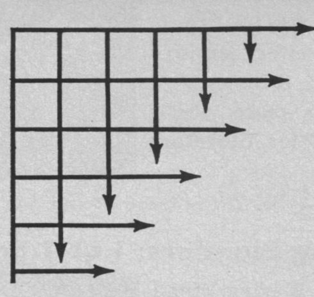

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28 February 1975, Volume 187, Number 4178

SCIENCE

The Ford Budget: New Signals for Science?

One embattled federal budget director used to say that budgets achieve only the uniform distribution of dissatisfaction. The 1976 budget, the first by President Ford, is in part the customary recital of griefs and apprehensions. But it also invites some small celebrations. Not the least of these is the substantial buildup in funds for research and development.

The new spending authority for federal R & D is scheduled to cross the $20 billion annual barrier in fiscal year 1976 and reach the level of $22.6 billion. Actual money outlays within fiscal 1976 will be somewhat less, but still a substantial $21.7 billion. The percentage rise from current levels is 15 percent in budget authority and 11 percent in outlays. True, the distribution pattern has a certain tiresome familiarity. Out of a $2.8 billion increase, $2.1 billion is for defense and space programs. About $0.7 billion represents the increase for civilian R & D, a good part of which is mortgaged to inflation.

Still, the trend is favorable to science and engineering. Rising costs are acknowledged. The needs for greater research effort in energy, food, and transportation have not been ignored. The National Science Foundation came through the grinder in generally good shape. An important beginning has been provided for research in climate dynamics, a sign of awareness of the food production implications of climate changes and their consequent impact on world economic and political stability.

There never was a perfect budget. This one is no exception. Its economic strategy appears too cautious for the kind of year we face, but it has the admirable merit of recognizing the future economic risks of overstimulation. Its defense posture starts us on a new military buildup while we are still warming to the idea of détente. In the area of civilian science, the budget increases are targeted to such particular problems as energy and do not benefit general-purpose science across the board. Health research funds will be tighter, and university-based research will find little to cheer about. In fact, the treatment of the education sector generally is uninspired and disheartening, with sharp cuts in support for library resources and educational development. Congress will no doubt have a second thought in some of these areas.

However, some optimistic signs can be read into this budget. Somebody must be listening to the science adviser; the NSF science advisory apparatus obviously helped the Office of Management and Budget shape the R & D portions of the new budget. Priority judgments are being made and reflected in the budget. The antiscience aura of the two previous administrations seems to have disappeared with the transfer of the White House reins. The Ford budget offers a long-delayed opportunity for government and science to begin working together toward a long-range public policy approach to science and technology.

As Vice President Rockefeller ponders changes in the White House staff system to more effectively utilize science and technology in Executive branch policy-making, we hope he will think in these long-range terms. Science and engineering have a responsible and effective role to play at the presidential level in coping with the problems of choice on which the future hangs. These include the transnational questions of the uses of the sea, the environment, and the resources of the planet, together with the uses of science and technology in creating alternative social and economic structures which can help reduce dissatisfactions leading to conflict. All of them mingle science and technology with public policy.

We think we see fresh signals for science in the 1976 budget, but the real test is more than a quantitative growth in R & D dollars. The corner will be turned when the budget for science and technology is thought of and expressed less as a set of annual expenditure decisions and more as an investment strategy which matches the scale and intensity of the nation's agenda.—WILLIAM D. CAREY

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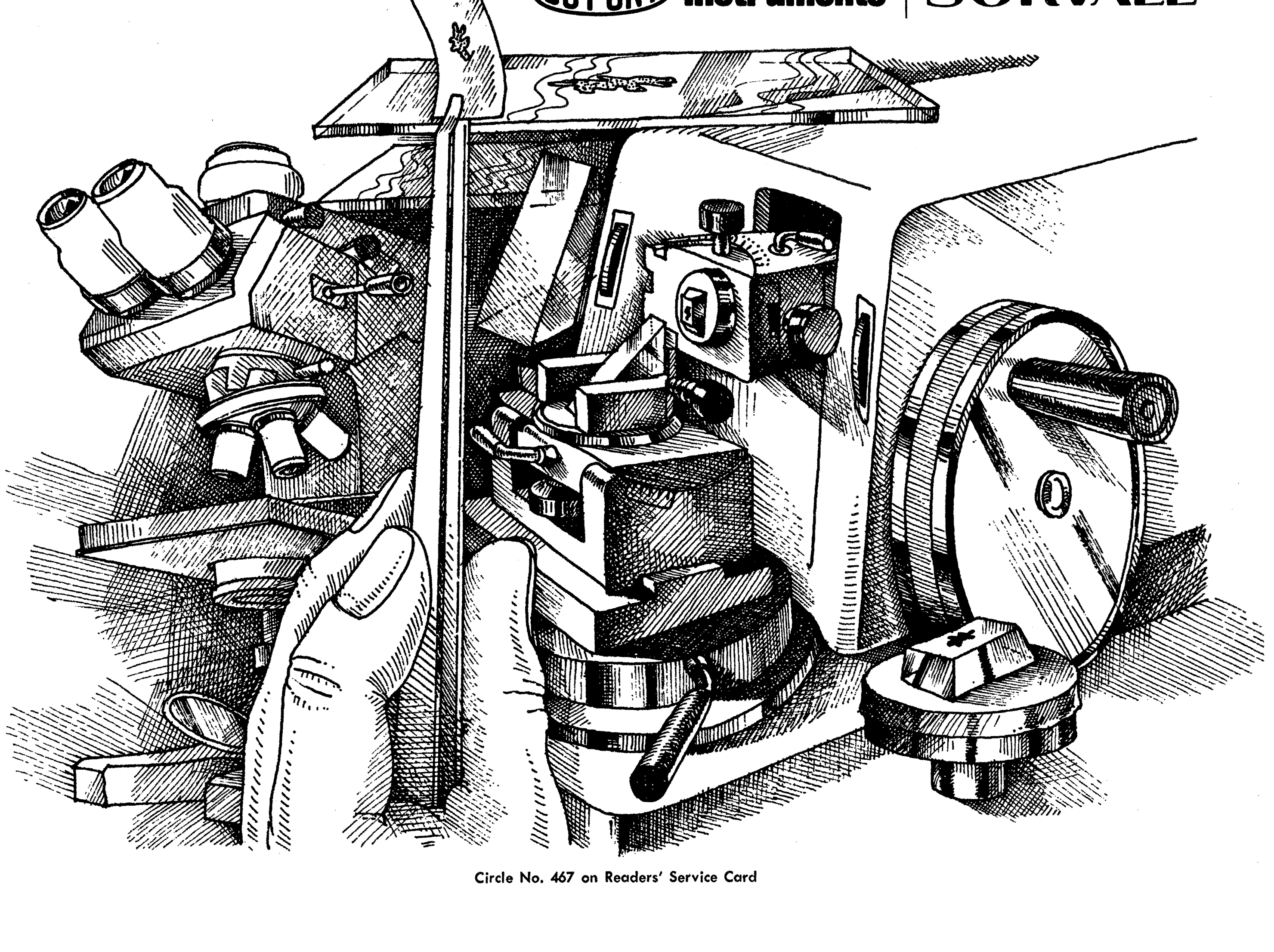

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Myocardial Enzyme Assay

Chemocolumns are packed ion-exchange columns for in vitro separation of myocardial creatine kinase and lactate dehydrogenase isozymes. The columns are packed with measured reagents. The serum sample (1 milliliter) is introduced and the myocardial fractions are obtained and concentrated in less than 1 hour for assay. Kits are available with 8, 16, or 24 Chemocolumns. E-C Apparatus Corporation. Circle 835.

Computer for Clinical Applications

The Programmable Data Logger is designed to monitor up to 15 instruments simultaneously, to perform calculations with the data, and to carry out administrative functions as well. The system is based on a PDP 11/10 minicomputer and is programmable in the BASIC language. Its chief advantage lies in cost effectiveness, in that it performs administrative chores in addition to collecting and recording data from automatic chemical analyzers and other clinical apparatus. Digital Equipment Corporation. Circle 836.

Newly offered instrumentation, apparatus, and laboratory materials of interest to researchers in all disciplines in academic, industrial, and government organizations are featured in this space. Emphasis is given to purpose, chief characteristics, and availability of products and materials. Endorsement by *Science* or AAAS is not implied. Additional information may be obtained from the manufacturers or suppliers named by circling the appropriate number on the Readers' Service Card (see pages 698A and 762C) and placing it in the mailbox. Postage is free.—RICHARD G. SOMMER

Antibiotic Susceptibility Testing

Autobac 1 is an automated system for rapidly testing the susceptibility of bacteria to antibiotics. Results are available in 3 to 5 hours and methodology is standardized. Key components are a cuvette designed to distribute the sample to 12 elution disks that are impregnated with antibiotics, an incubator/shaker, an automated photometer that reads the amount of growth in each chamber and compares it with the control after incubation, and a computing printer that gives the ratio of growth in the test chambers to growth in control and interprets these ratios on the basis of values derived with Kirby-Bauer methodology. The advantages of Autobac 1 are gains in time, ease of operation, and standardization of procedures in relation to usual methods. Pfizer Incorporated, Diagnostics Division. Circle 837.

Radiochromatogram Imaging System

The Radiochromatogram Spark Chamber is a rapid, sensitive imaging system that records the distribution of radioactivity on electrophoresis gel slabs or papers and on thin-layer plates. It produces a two-dimensional black-and-white record of distribution of alpha, beta, and gamma emitting compounds. The system is nondestructive; an epidioscope print-projection system of fixed magnification transfers the print images from a Polaroid print directly onto the original radiochromatogram. Baird-Atomic, Incorporated, Nuclear Division. Circle 838.

Computer for Centrifugal Analyzer

A third-generation computer module fully automates the CentrifiChem Analyzer. The computer has 16K of core memory, which is expandable to 25K. It is capable of handling files of 48 patients, organizing the test load, preparing work lists, programming one or two CentrifiChem Analyzers, and delivering complete summary reports for each patient. Each report lists test results, flags abnormal values, and gives the lab's normal values for each test. The computer features a terminal with a display screen so that the operator's conversational instructions and the machine's responses are instantly available for evaluation. Union Carbide Corporation. Circle 840.

Arc Rule

Model 510 will produce a true arc of any radius from 27.25 to 216.9 inches by means of micrometer head adjustments and settings. It can be used to produce true arcs where camber rather than a radius is specified. The device provides accuracy in applications beyond the scope of the beam compass. Hunter Associates. Circle 844.

Hydrographic Mapping

A Mobile Mapping System is available for hydrographic surveys and estuarine and river bottom analysis. Bottom contours may be generated, which with annotated plots of temperature or conductivity (or any other parameters) provide portrayal of thermal plumes, tidal phenomena, mixing and flushing activities, and many others. The system is portable and highly suited to use with small craft. It features a procedure for generating immediate data reduction and plots. Environmental Devices Corporation. Circle 842.

Gamma Counting System

The Auto In-V-tron 4000 is a benchtop instrument with a capacity of 190 samples. It is designed for radioimmunoassay applications. A thermal printer displays alphanumeric data as percent or counts per minute and also displays sample or position number, counting time or counts for each sample. Various sizes of vials and tubes are accommodated and ten-tube racks allow the device to be loaded and unloaded rapidly. Other features include manual or automatic mode selection, automatic background subtraction, and function indicators. The cabinet is modular in design for easier service with an electric interlock and lead shielding for increased safety to the operator. Nuclear Systems, Incorporated. Circle 839.

End-Point Analyzer

The model 5091 offers automation from sample pickup to data printing. It features sequentially programmed sampling, absorbancy measurements, analog-digital conversion, factor multiplication, and zero adjustment. There are 16 measuring wavelengths from 302 to 772 nanometers with a push-button mercury-cadmium lamp changeover. It requires only microliter-sized samples of specimen and reagent and it can process up to 240 samples per hour in color-coded chain links to facilitate identification. Eppendorf-Brinkmann, Incorporated. Circle 845.

Literature

Catalog of Clinical Procedures includes Rapid Stat kits and prepared diagnostic reagents. Pierce Chemical Company. Circle 846.

Clinical Catalog is a 32-page compendium of supplies and equipment for a hematology laboratory. Curtin Matheson Scientific, Incorporated. Circle 847.

Infrared Reference Spectra Collection of Germicides contains more than 300 items. Sadtler Research Laboratories, Incorporated. Circle 857.

Nalgene Labware describes products of various types of plastic construction for all laboratory operations. Nalge Company. Circle 851.

(Continued from page 730)

perform the data processing work. Richard A. Berman, an associate director of the hospital, who was previously an analyst for the Cost of Living Council, was given the main staff responsibility at the hospital.

According to Thompson, the resulting analysis proved that patient mix varied from year to year sufficiently to affect hospital costs.

But the more striking finding was that costs decreased dramatically as the number of cases of a specific diagnosis rose. As a final report said: "As physicians and hospital personnel improve their knowledge of certain illnesses and perfect their treatment procedures, it requires fewer hospital resources (as measured by gross charges) to treat the patient." In other words, teaching hospitals that get only a few cases of many kinds of illnesses are bound to consume more resources. Conversely, as a hospital standardizes its treatment of a particular illness, it often learns how to use fewer resources for such treatment.

Between 1972 and 1973, for diagnoses where the hospital treated fewer than four cases, the average charges rose in 52 percent of such cases. In contrast, when the hospital treated a large number of cases of a given kind, average charges dropped. Between 1972 and 1973, for example, the average charges dropped in 83 percent of diagnostic categories of which the hospital treated 100 or more cases.

But the specific examples of such drops in gross charges are of interest as well, all the more so in view of the fact that 1972 and 1973, the years for which the data were compiled, saw cost inflation in the health industry despite government controls. One diagnostic category, fibromyoma of the uterus with complications which involved hysterectomy, cost on the average $3382 in 1972 when NYH treated two such cases. In 1973, however, the NYH treated 95 of these cases, and the average charge per case dropped to $2015. One of the doctors at the hospital expressed little surprise at these results. "At the startup of open heart surgery we did a lot of dumb things. You learn by doing. And now, the price of open heart surgery has come down," the doctor said. So far, there have been no detailed explanations of why the drops in charges took place, since the data has only been available