# SCIENCE

24 January 1975

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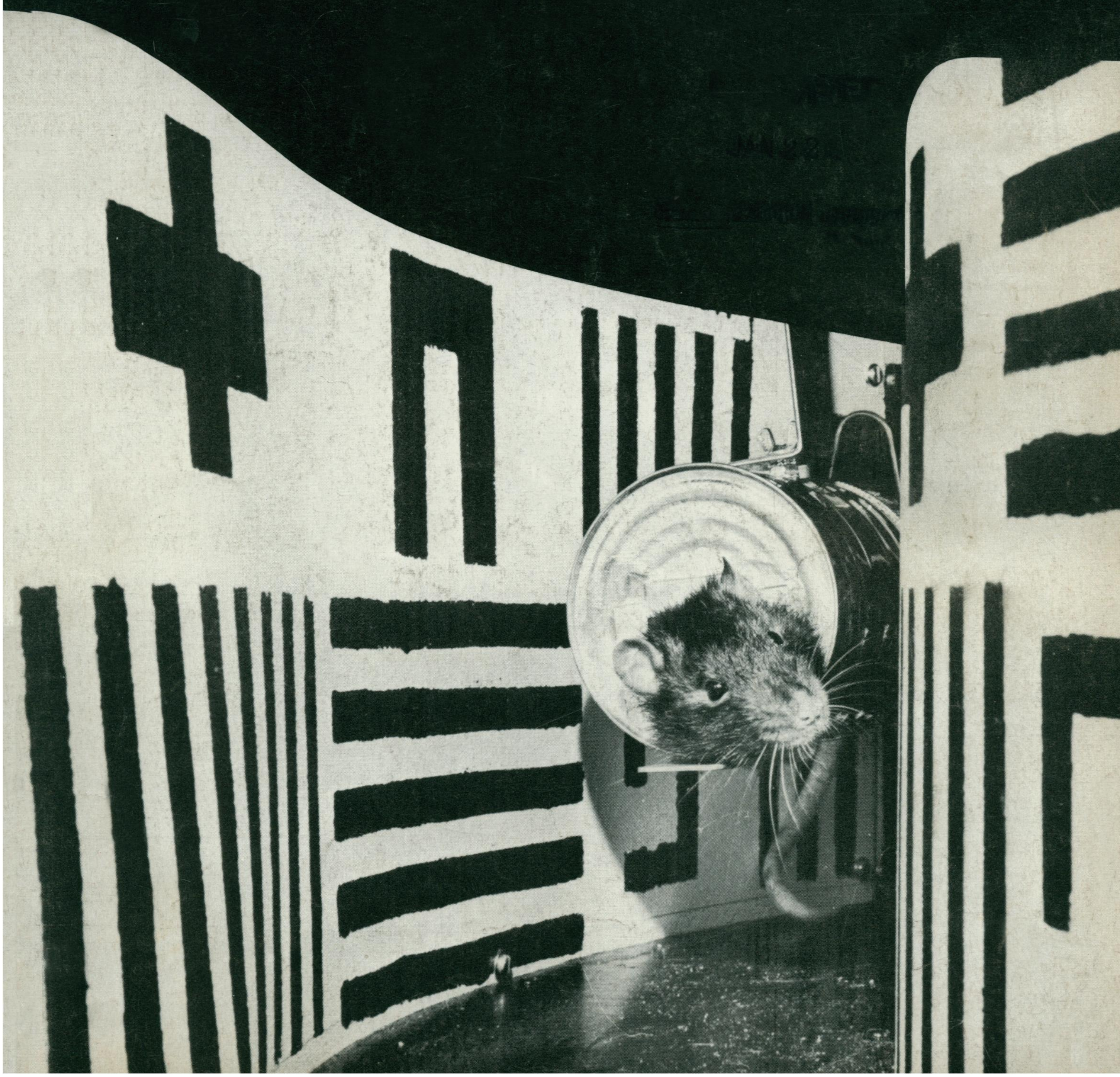
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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**Beckman**

24 January 1975

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# SCIENCE





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**COVER**

Rats transported through a patterned environment do not recover pattern vision after serial visual cortex lesion. Rats allowed free movement in such environments do recover. See page 265. [Michael J. Danley, Huntington Institute of Applied Medical Research, Pasadena, California]

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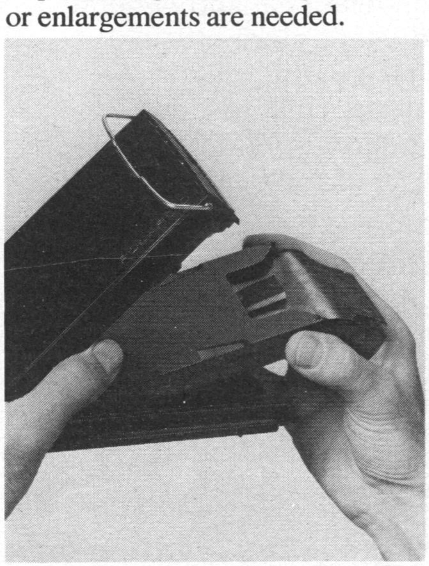

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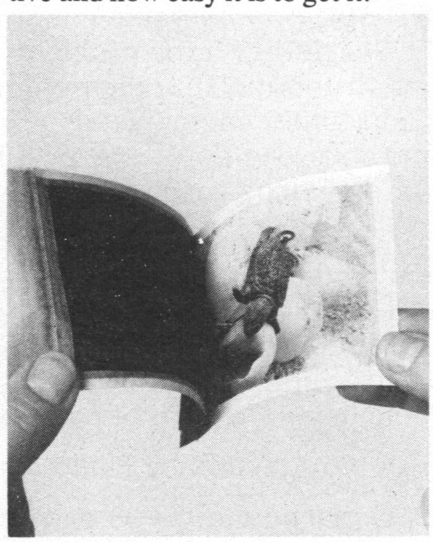

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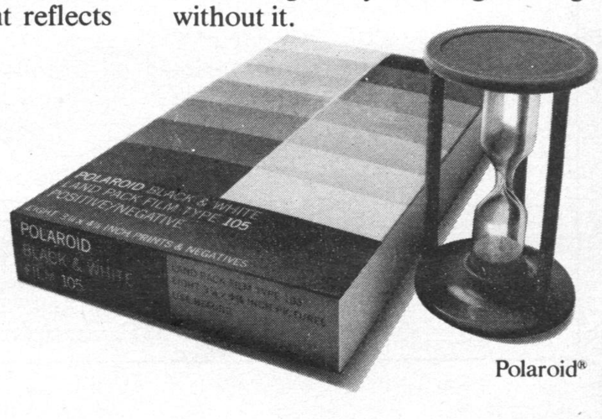


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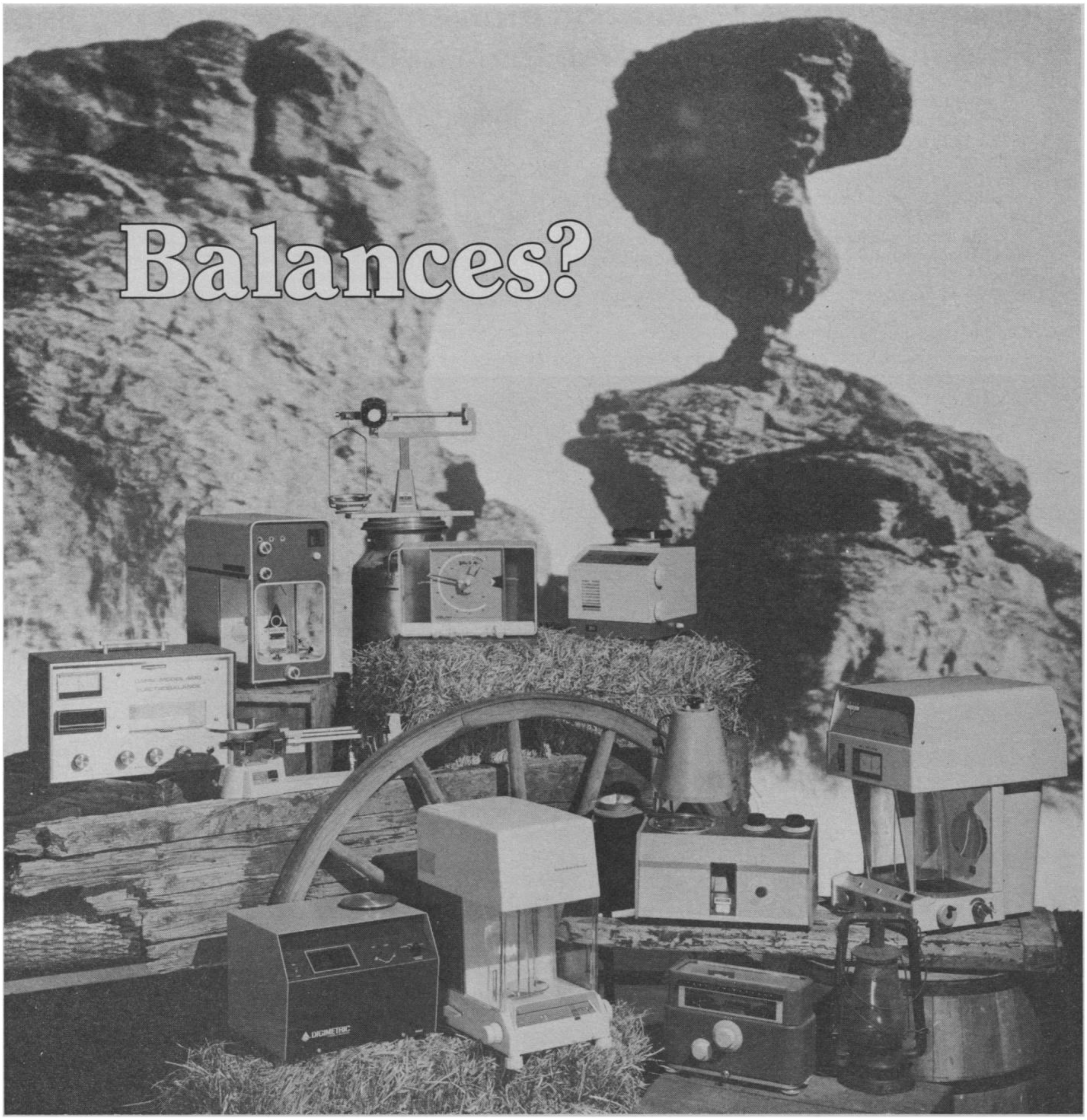
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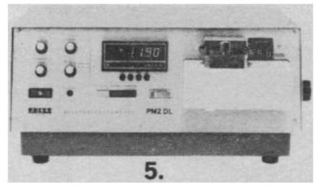


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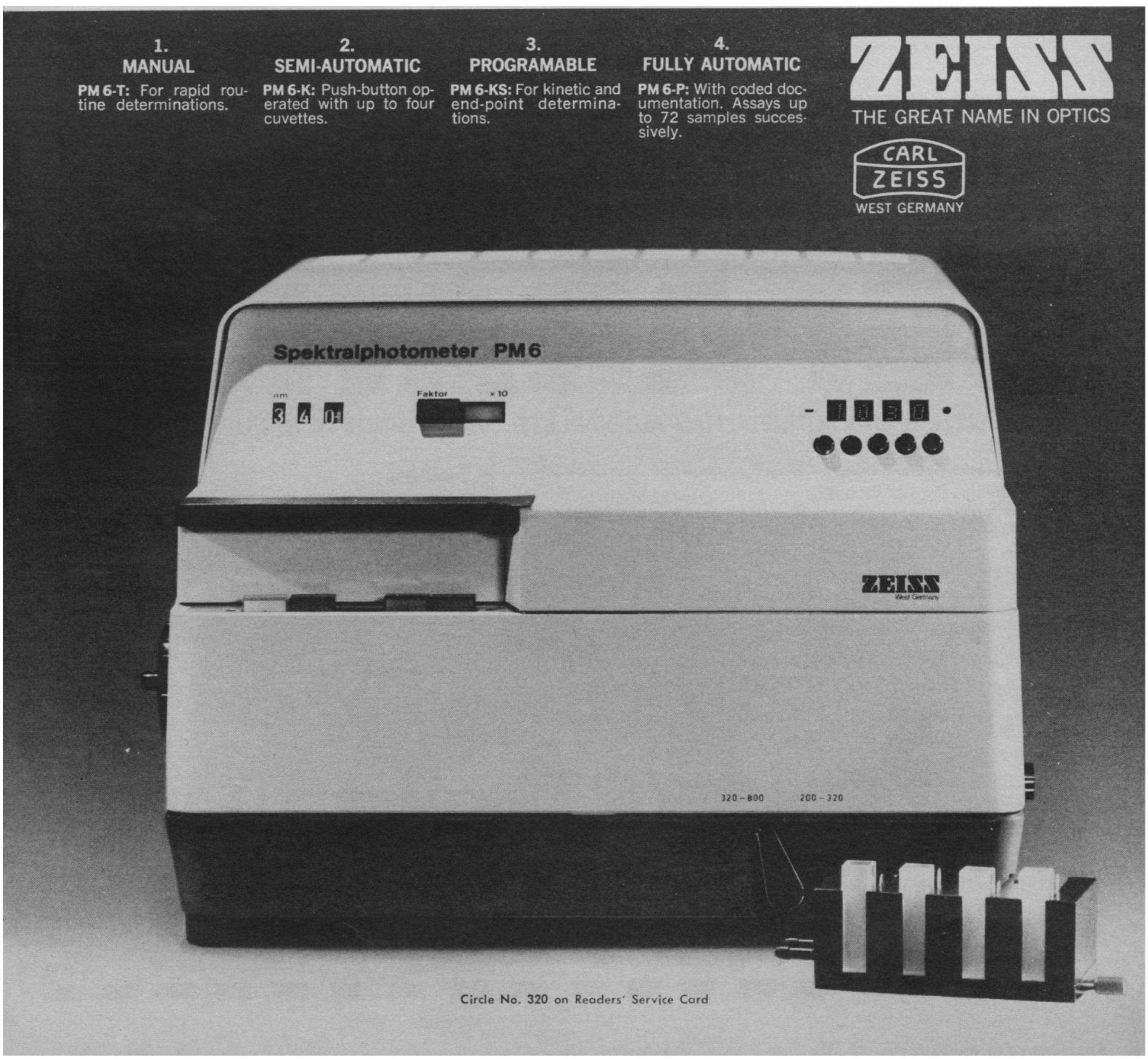


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LETTERS

## The Future of Fusion

R. F. Post and F. L. Ribe (1 Nov. 1974, p. 397) offer an encouraging picture of the status of fusion research. I have little doubt that acceptable fusion reactors will come into being, but how large the required research and development effort must be, in time and in overall cost, is only somewhat less uncertain than it was a decade ago. I wonder, therefore, what guidance there is for those who plan the nation's energy program in statements such as ". . . in less than a decade sufficient scientific knowledge to ensure the practical achievement of fusion power will have been established."

Those of us who have lived through the development of fission reactor engineering recognize that the statement amounts only to a hope that the work of the next 10 years will not reveal insoluble problems. The real engineering task of scaling the power levels upward can then begin. We know that the upward steps cannot be too large, factors of 10 often being the upper limit. We know also that each such step requires 5 to 10 years and hundreds of millions of dollars to effect. This is discouraging from the point of view of a nation that is energy-hungry. The road from a few watts of fusion energy to units that can feed 500 megawatts into the electric energy grids is likely to be long and tortuous. Experience with nuclear power in the past three decades has demonstrated more than once how distant the practical, acceptable power systems can be from experimental laboratory successes. Engineering perspective has not been common among physicists on whom we depend for basic theoretical and laboratory demonstrations.

What should the nation's energy planners have gained from the article by Post and Ribe? That fusion research should be strongly supported is beyond question. It would be unfortunate, however, if "fusion enthusiasm" were to detract from substantially larger funding for the development of improved fission reactors and acceptable fission breeders. A carefully planned program for achieving the required national nuclear sophistication is also needed. Nor should the hope for fusion be permitted to detract from energy conservation efforts, from interim emphasis on coal products, or from the long-range benefits of solar resources.

It seems to me that the nation's planners are entitled to a better perspective on energy than the research community has been giving them.

V. L. Parsegian
*Rensselaer Polytechnic Institute, Troy, New York 12181*

Post and Ribe make several points which we believe are seriously misleading. The most important of these is stated in the article as follows: "We propose that fusion should be considered as the ultimate source of energy, and that other sources of energy, including conventional nuclear power, should be considered as interim sources."

For those of us concerned with the development of *all* viable technical options for future energy development, such a statement is very controversial. It implies (i) that fusion is certain to be a proven energy source and (ii) that it will be available as a national option in a short enough period of time that nuclear fission power will be unnecessary. Both of these implications are manifestly in error. The present fusion energy program is primarily devoted to establishing the scientific feasibility of this process. Until that is done, it would be an enormous risk for both industrial nations and the world to consider fusion as a sure future energy option.

If we assume that the scientific programs now under way do establish in the laboratory that fusion can be successfully demonstrated as an energy source, it still remains a major development to assemble an engineering configuration that meets the end-use requirements of reliability and economics. The most optimistic projections for such a successful outcome indicate that it would be a minimum of 20 years before such a demonstration could be made and, more realistically, it is likely to take at least 30 years, even if success is met along every step of the way.

If one takes into account the time required for the integration into utility systems of a new commercial power source, the time interval from a first commercial demonstration to the manufacture and use of even a limited number of new power plants is at least 10 years and is usually longer. Thus the "interim" referred to in the article is clearly a minimum of 30 years under the most optimistic circumstances and, realistically, 40 or more years if we make the happy assumption that the fusion concept can meet scientific, engineering, and economic criteria. Such a time period can hardly be considered by any econometric or technical measures as an "interim" period.

In contrast, what is now considered conventional nuclear fission is producing electricity on a full-scale basis in operating electric utility systems and, in some cases, is responsible for more than one-third of the total energy production of such utility systems. Among those electric utilities that have both nuclear fission and fossil fuel plants, there seems to be a consensus that their choice for future expansion would be nuclear fission power. They base this choice on the economics, reliability, and continuously improving performance of nuclear plants. Nuclear fission power stations are a "here and now" commercial option.

The second principal point made by Post and Ribe is that ". . . the amount of induced radioactivity is to a considerable degree at the disposal of the plant designer in the fusion case, while it is an inherent property of the fuel in the fission case." This statement is technically correct. However, what is omitted is the corresponding statement that, in the case of fission, the release of radioactivity to the atmosphere and thus to the public is also under the control of the plant designer. Further, the engineering solutions in the case of fusion plants are still highly hypothetical, whereas the containment devices and the containment options in the case of nuclear fission plants are well developed and well known. The issue that remains in the case of our present nuclear power stations is the degree of containment in relation to economic investment. While we hope that the development of fusion concepts will permit the operation of fusion plants with a minimal amount of induced radioactivities (principally because this will improve their economic viability), we nevertheless have to recognize that the developments in this area are still at an exploratory level; we don't know what can, in fact, be achieved with the materials now known to man or with what might be available in the next 10 to 20 years. Figure 10 in the article by Post and Ribe illustrates this point, although the implications are not adequately reflected in the text.

The remainder of the article is a review of magnetic fusion development, with the notable exception of laser fusion. The last paragraph appears to be a reply to our article (*1*) published in the *Journal of the British Nuclear Energy Society*, in which we attempted to present a balanced perspective of both fission and fusion and their potential roles. Although the quantitative analysis in our article could now be updated, we believe our general conclusions are still valid and overriding for long-range policy. It is our position that nuclear fission power plants as presently developed commercially and the development of fast breeder reactors are essential if we are to provide a viable supplement to fossil fuel resources in the next several generations. We also believe that energetic development of the fusion concept should proceed at as rapid a pace as the technology permits in order to provide another energy option. We recognize the potential advantages of fusion, but we are concerned that Post and Ribe tend to denigrate the need for fission power on the assumption that there is no uncertainty concerning the success of fusion. What do we do if the optimism about fusion turns out to be unjustified?

It has been pointed out that the fusion enthusiasts fear a success of the fast breeder reactor might possibly destroy future support for the fusion program. It is true that a successful fast breeder reactor will, from a resource point of view, reduce the need for a successful fusion power plant. However, the very differences and advantages fusion might have in terms of its overall environmental and social implications would make it desirable as an option. We deeply regret the apparent implication that, for the fusion program to maintain its financial support, it is necessary to undermine support for conventional nuclear power and the fast breeder reactor. Both concepts need to be pursued with enthusiasm and support.

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**References**

1. C. Starr and W. Häfele, *J. Brit. Nucl. Energy Soc.* **13**, 131 (1974).

We appreciate the comments by Parsegian and by Starr and Häfele as additional contributions to finding the wisest path to meeting man's future needs for energy. While they agree that fusion is an extremely desirable future energy source and should be pursued vigorously, there are areas of concern in both letters which we should address. As we interpret their comments, they could be paraphrased briefly as follows: "Since fusion power is as yet unproved, is it not possible that we underestimate the time and effort needed to achieve it and thus are being premature in proposing now that fusion power development should occupy a special place in energy planning, relative to presently existing sources—particularly nuclear fission?"

As we mentioned in our article, in the absence of working fusion reactors the position we advocate necessarily involves uncertainties. These we recognize and accept. Nevertheless what we are asking for in essence is a commitment to the future—a commitment that recognizes that we desperately need future energy sources that are more than simply practical and economical. They must at the same time satisfy considerations of minimal environmental impact and of safety in its broadest sense—both physical and political. In the future these latter issues may well come to dominate. Is it not possible that, in the future, society might place a premium on those energy sources which enhance its own safety and political security? As we indicated, during an interim period—the length of which we did not estimate—present-day energy sources, including nuclear fission, will have their day. What we espouse is a national frame of mind that will take *all* factors into account in pursuing energy research and development. In this spirit we would have to accept the possibility that fusion, too, might in time be augmented or even displaced by some still more desirable ultimate energy source. What we have asserted is that fusion could take on the task of satisfying man's energy needs for the future and that it could evolve toward an increasingly safe and environmentally attractive system. Figures 10, 11, and 12 in our article give some comparisons that illustrate the point, including the fact that the fusion reactor designer should have options for reducing the hazard potential that are a priori not open to the fission reactor designer.

We do not feel that our article

argues against research and development of other energy sources—including fission. What we do argue against is a national policy that would require that fission power—or anything else—*must* precede and thereby delay or exclude the inception of fusion.

In our democratic society, decisions are ideally arrived at by integrating the input from all sources. We therefore agree with Parsegian on the need for the broadest input possible to what we all feel is perhaps the most critical technical-political issue that we in this century have been asked to resolve—from whence will come the energy to build a better future world?

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*Lawrence Livermore Laboratory,*
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FRED L. RIBE
*Los Alamos Scientific Laboratory,*
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## Thioctic Acid and Mushroom Poisoning

In Barbara J. Culliton's article "The destroying angel: A story of a search for an antidote" (News and Comment, 16 Aug. 1974, p. 600), Frederic C. Bartter, clinical director of the National Heart and Lung Institute at the National Institutes of Health, refers to experiments performed at the Food and Drug Administration (FDA) in which thioctic acid and glucose cured mushroom poisoning in dogs. As the unnamed researcher who conducted the experiments and analyzed the data, I wish to point out that my findings are reversed in Culliton's report. Bartter is quoted as saying, "So, in the later experiments we carefully maintained glucose levels in the dogs, just as you routinely would in a patient." In fact, I found that the low blood glucose levels in mushroom-poisoned dogs were *not* restored to normal by six hourly injections of dextrose and thioctic acid. Culliton continues, "It appears that this was the problem. When dogs receiving toxin and antidote were also given glucose, they survived. The researchers decided then that it is reasonable to use thioctic acid experimentally to try to save the lives of victims of the destroying angel." In fact, I found that four of five mushroom-poisoned dogs given thioctic acid and glucose and five of five mushroom-poisoned control dogs *died.* I reported this finding to my FDA colleagues, including Alan K. Done, who, as Culliton indicates, communicated with Bartter. Culliton's article suggests that there is renewed hope for victims of mushroom poisoning and appears to encourage doctors to request emergency shipments of thioctic acid antidote. Unfortunately, the negative results I obtained with thioctic acid in both mice and dogs do not justify this hope or course of action.

FREDERIC R. ALLEVA
*Bureau of Drugs,*
*Food and Drug Administration,*
*Washington, D.C. 20204*

As Culliton reported, I was asked to assume the IND (investigational new drug) application for thioctic acid on the basis of numerous more or less favorable reports of its clinical use from Europe, and a few from the United States.

I did indeed discuss with Alan Done experiments designed to test its efficacy in animals. He showed me reports of mouse studies which did not show a therapeutic effect for thioctic acid given in distilled water. We agreed that no test of the effectiveness of thioctic acid in which blood sugar was not maintained could be of value. This is because both amanitin poisoning and thioctic acid may produce hypoglycemia.

I wish to emphasize that I had no part in the design of the experiments which were then done on dogs. I was simply informed later (August 1974) by the Food and Drug Administration (FDA) that it was reasonable to proceed with the IND.

Recently (December 1974), I received the details of the dog studies. From them one may infer the reasons the FDA decided to proceed from the clinical evidence not to withhold thioctic acid from human subjects poisoned with amanitin. It was clear that dog studies designed as these were had done nothing to clarify the issue. Glucose had been given in tiny doses of 500 milligrams by six hourly injections (3 grams a day). Of course the dogs that died (four out of five) showed hypoglycemia. In human subjects, thioctic acid should be given with a sustained intravenous drip of glucose, and the total dose of glucose should be at least 100 grams a day. With this regimen, no human subject has been reported to show hypoglycemia.

FREDERIC C. BARTTER
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24 January 1975, Volume 187, Number 4173

# SCIENCE



## The World's Disparate Food Supplies

For decades the United States attempted to cope with an agricultural system that produced far more food than could be consumed or sold. But in the course of only 2 years, food stockpiles disappeared and prices soared. Relative complacency has been replaced by anxiety about the world's ability to feed its growing population. This concern has been fed by sympathy for those suffering acute hardships, as in the Sahel and in Bangladesh. It has also been fed by increases in prices at the supermarkets. Many now conclude that the world has reached the limit of its ability to feed even its present numbers adequately. Obviously, if the present birth rates are maintained eventual large-scale tragedy is inevitable. The question is *when* and *where*. A recently issued fact-filled report* does not attempt to answer these questions directly, but it provides a wealth of information about the problems.

One of the puzzling features of the present situation is that it has arisen despite a steady increase in global food production. Thus in the period 1954 to 1973, world production grew by 69 percent and, despite substantial population growth, per capita production climbed by 17 percent. In the developed countries per capita production jumped by 33 percent. The picture was not so favorable in the developing countries, where production increased by 75 percent but per capita output climbed only 8 percent. Among these countries great disparities exist, and some regions have fared better than others. For example, during much of the period 1954 to 1973 per capita production of Africa trended downward while that of Latin America was moving up. Some countries, such as the oil exporters, are rich and can easily afford to import food, and others, although poor, are surplus producers. The problems lie with those who tend to be chronically short of food, and are poor.

Further variations are encountered when the prospects for expansion of production are examined. For the world as a whole 45 percent of the land is suitable for crops but only 26 percent is used. In the Asian and Far East region 84 percent of the suitable land is in crops, while in Latin America only 23 percent is being so used. Thus, there is little room for expansion of the farming area in Bangladesh and India but a large potential in this hemisphere. The possibility of expanded production of food exists virtually everywhere through use of improved seeds and fertilizers. This is especially true of the developing countries, where yields today are only about half those of the developed countries.

Thus it appears that despite a growing population the world is nowhere close to universal famine. However, there are great differences in both current production per capita and future potentials. Unless the rich countries provide a combination of food, fertilizer, and technical assistance, some of the poorer countries face repeated famines arising, for example, from unfavorable weather.

One of the proposals of the recent Rome Conference that should be implemented is the creation of a food reserve to help meet fluctuations in supplies. Existence of such a stockpile would facilitate making lifesaving shipments. It would also indirectly benefit almost all the world's peoples. Because of inelasticity in demand for food, small changes in the balance of supply and demand produce very large fluctuations in price, which could be smoothed out if a suitable food reserve existed. The annual cost for maintaining an effective global reserve has been estimated at only about $550 million to $800 million.

—PHILIP H. ABELSON

* *The World Food Situation and Prospects to 1985* (Foreign Agricultural Economic Report No. 98, Economic Research Service, U.S. Department of Agriculture, Washington, D.C., December 1974).

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**Background Correction System**

The BC-6 provides continuous measurement of total and background absorption and supplies a corrected readout for more accurate atomic absorption analysis. The BC-6 corrects for background absorption at wavelengths from 193.7 nanometers (arsenic) to 357.9 nanometers (chromium). It can extract a signal submerged in background as high as 1.0 absorbance unit and the beam modulation speed of 285 hertz ensures full correction even of rapidly changing signals. A hydrogen continuum lamp and a beam splitter achieve dual beam correction. The beam splitter may be deactivated to restore intensity near the limits of detection. Varian Instrument Division. Circle 794.

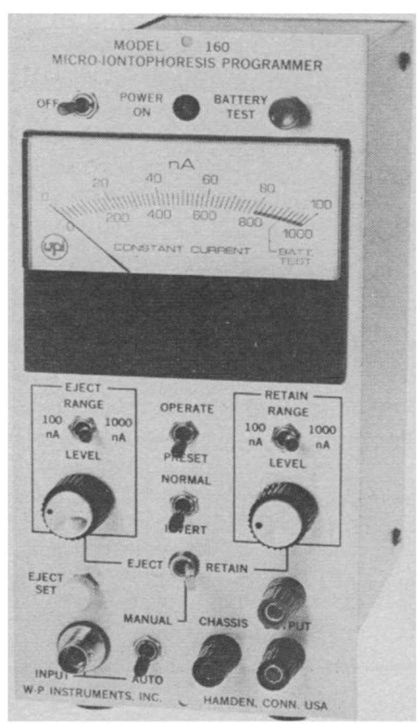


Fig. 1. The model 160 Micro-Iontophoresis Programmer automatically reverses the polarity of output currents when the operator switches modes. The color-coded panel and large meter face allow rapid error-free operation.

**Spectrophotometers**

The PM-6 spectrophotometer line consists of four models tailored for a complete variety of photometric analyses. Each model has sampling capabilities from manual to semi-automatic to fully automatic and kinetic determination. All four models feature two light sources, deuterium and hydrogen, with fully integrated power supplies. They use wide-range photomultipliers and are equipped with double-grating monochromators. Automatic blank reference is a feature that results in greater accuracy and reproducibility. Measurements are displayed in absorbance and concentration units on a four-digit meter. Carl Zeiss. Circle 796.

**Clinical Enzymology Assay**

The JCA-N6R simultaneously assays the activity of any six enzymes selected. The assay is based on the initial reaction rate method. The instrument is of the discrete type with a closed flow line. The reaction vessels serve as detection cells. Features include capacity for assay of up to 60 samples per hour and automated data reduction. The data output includes calibration curves and results in international units or in units of concentration. Cross-contamination is eliminated by cleansing of sampling, reaction, and detection systems between assays. JEOL, Limited. Circle 766.

**Micro-Iontophoresis Programmer**

Model 160 (Fig. 1) is a single channel battery-powered unit. It provides for manual or automatic drug and dye injections. Constant current output is used in "retain" or "eject" modes in ranges of 0 to 100 nanoamperes or 0 to 1000 nanoamperes and will drive into 1000 megohms and 100 megohms, respectively. Each mode may be preset to the desired current. Polarity of output currents is automatically reversed when modes are switched. W-P Instruments, Incorporated. Circle 775.

**Radiation Survey Meter**

The Gamma III is a pocket-sized detector and alarm system. Its range is from 1 milliroentgen per hour to 1 roentgen per hour. Its advantage as a dosimetry device is that overexposures

will be indicated immediately. It operates as a Geiger-Muller counter and it is powered by a 9-volt cell. Applications include any situation in which personnel or areas must be monitored for exposure to radioactivity. Atomic Products Corporation. Circle 787.

**Electric Current Interrupt Alarm**

The Sound/Off alarm device is installed at the electric outlet into which a critical device is plugged. If for any reason current to the device (refrigerator, recorder, centrifuge, incubator, and so forth) is interrupted, a loud piercing sound is emitted for up to 72 hours. The advantage is that the operator is warned immediately of current interruption and can act before valuable samples or specimens are damaged. The device also protects against theft. The alarm is powered by a 9-volt cell. Its function may be tested at any time by unplugging the critical device; if the alarm is operational, it will sound. David I. Wolsk and Associates. Circle 795.

**Carbohydrate Standards**

Ultrex-grade sugars are high purity carbohydrates for chromatographic and biochemical standards. D(+)Mannose and D(+)xylose are now available for use in studies of labeled compounds. Analysis during production studied 31 parameters for mannose and 29 parameters for xylose including the ratio of anomeric forms present. Certificates of analysis accompany each product. Both xylose and mannose are available in 100-gram bottles. J. T. Baker Chemical Company. Circle 788.

**Chlorine Test Kit**

A water quality test kit now eliminates reagent handling and allows rapid determination of total chlorine residuals in sewage, drinking water, and swimming pools. Each kit consists of 30 CHEMet ampoules, a plastic tip-breaking device, a color comparator, and instructions. When the tip of a self-filling ampoule is broken in a sample a colorimetric reaction occurs. Test operator compares the sample to the standard to determine the chlorine content. Range is 0.1 to 2.0 parts per million and analysis requires 2 minutes. CHEMetrics, Incorporated. Circle 790.

**Cardiac Evaluation System**

Model 1525A is a stress-testing system. It includes a three-channel cardiograph, a large-screen continuous electrocardiogram display, and a heart-rate meter all mounted on a cart. The cart has space for a defibrillator and a phonocardiograph as well. The cardiograph provides a 12-lead record, marked and calibrated in 10 seconds. As much as 40 seconds of electrocardiogram trace may be displayed at once by cascading four traces. It is also possible to hold a selected trace on the screen indefinitely on one line while ongoing traces are monitored for comparison. Hewlett Packard Corporation, Medical Electronics Division. Circle 772.

**Coulometer**

The model 541 laboratory coulometer features a six-digit display with an accuracy of $\pm 0.1$ percent of full scale. Coulometric titration may be carried out with 0.2 microequivalent of sample. Gradual approach of the endpoint is possible for greater accuracy. Potentiostatic applications are simplified; the input is isolated from ground by a transformer and no more than 2 volts are required at the fastest counting rates because of low input impedance. There is also a panel meter for drift adjustment and interpolation of the least significant count. Koslow Scientific Company. Circle 792.

**Gel Filtration Medium**

Ultrogel is a polyacrylamide-agarose gel medium that consists of small, rigid, uniform spherical beads swollen to a diameter of from 60 to 140 micrometers. Ultrogel enables the operator to obtain high resolution and high flow rates, even with large molecules. Dilution and sample zone diffusion are minimized, too. Ultrogel is available in 1-liter bottles in four fractionation ranges from 6000 to 1 million daltons for globular proteins. LKB Instruments, Incorporated. Circle 791.

**Literature**

*Methods and Reagents for Amino Acid and Protein Chemistry* is a handbook with more than 600 references on methods, techniques, and materials in six sections. Pierce Chemical Company. Circle 797.

*The Specialty Gas Book* lists pure gases, gas mixtures, and gas handling equipment in more than 80 pages with suggestions for application and full specifications. Precision Gas Products Incorporated. Circle 798.

*Clean Room Catalog* lists standard and custom units for work rooms, laminar-flow work stations, inflatable rooms, and many other controlled environments. Biocology Systems, Incorporated. Circle 781.

*Liquid Chromatography Background and Applications Literature* is a four-page catalog of informative publications in organic synthesis, natural products research, pharmaceutical analysis, and many other fields. Water Associates Incorporated. Circle 799.

*Vitafiber Artificial Capillaries* describes hollow fiber systems with anisotropic, noncellulosic fibers to be used as a matrix for cell growth. Amicon Corporation, Scientific Systems Division. Circle 800.

*Controlled Pore Glass Chromatography Bibliography* contains more than 125 sources through August 1974. Electro-Nucleonics, Incorporated. Circle 806.

*Elastomers Handbook* lists current uses in product design and maintenance. DuPont and Company, Incorporated, Elastomer Chemicals Department. Circle 807.

*Products for Water Analysis* also describes technical data and procedures including those involving portable test kits and laboratory instrumentation. Hach Chemical Company. Circle 801.

*Chemical Apparatus* featuring grease-free joints is the topic of a 20-page brochure. Items include adapters, condensers, stopcocks, flasks, funnels, and others. Wheaton Scientific. Circle 802.

*chEM LABS Review* is a quarterly newsletter. The first issue includes an article on long-term column reproducibility among others and a section on "Aids for the Analyst." EM Laboratories, Incorporated. Circle 803.

*Analog Correction for Dilution: An Aid for Titrimetric Analysis* is the subject of Application Notes volume 9, No. 3. McKee-Pedersen Instruments. Circle 804.

*Multi-Dry Freeze Dryer* is a four-page bulletin devoted to this multiple purpose lyophilizer. FTS Systems Incorporated. Circle 805.

*Scientific Apparatus 1974–75* lists instruments for chemical analysis. Tekmar Company. Circle 808.