SCIENCE

21 January 1972

Vol. 175, No. 4019

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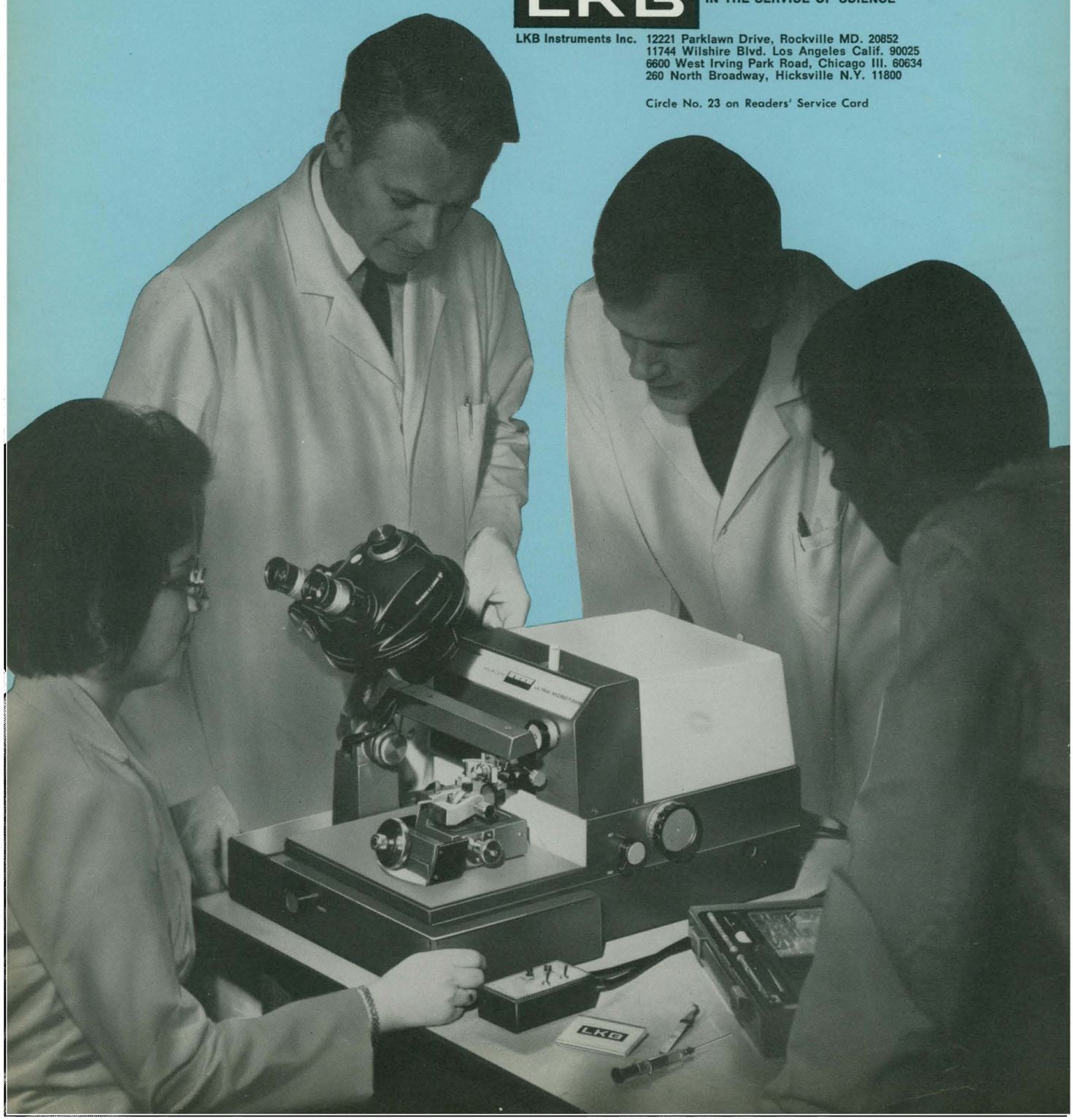

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SCIENCE

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Marmes rock-shelter, archeological site in southern Washington, was flooded by reservoir in 1969. Flooding terminated excavations which were yielding a 10,000-year record of prehistory and the earliest well-documented human remains in the Western Hemisphere. See page 267. [Harvey S. Rice, Washington State University, Pullman]

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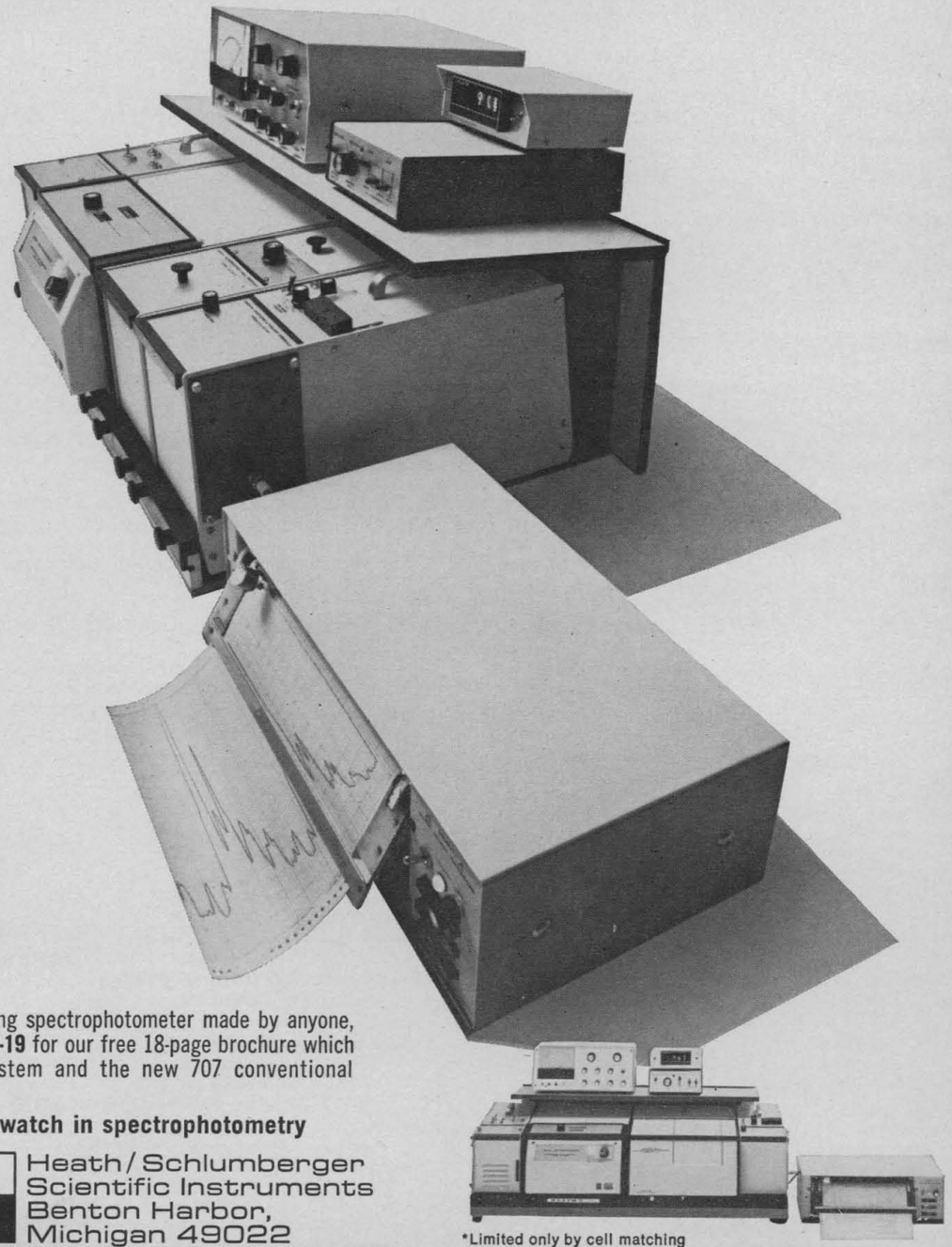

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1. Our 6AH Amino Acid Analyzer comes in a table top model. Their 121 is more like a table sized design.

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3. The 6AH sensitivity is rated at 5 nanomoles/2 mm and 1 nanomole/6 mm. The 121 rates 4 nanomoles/6 mm and 2 nanomoles/12 mm. Hmmmmm.

4. But wait. The 6AH has a dual plunger buffer pump design. The 121 is equipped with a single plunger.

5. Our 6AH accommodates 12 samples at a time or 36 with accessories. Theirs holds 72. But do you need 72? Ever?

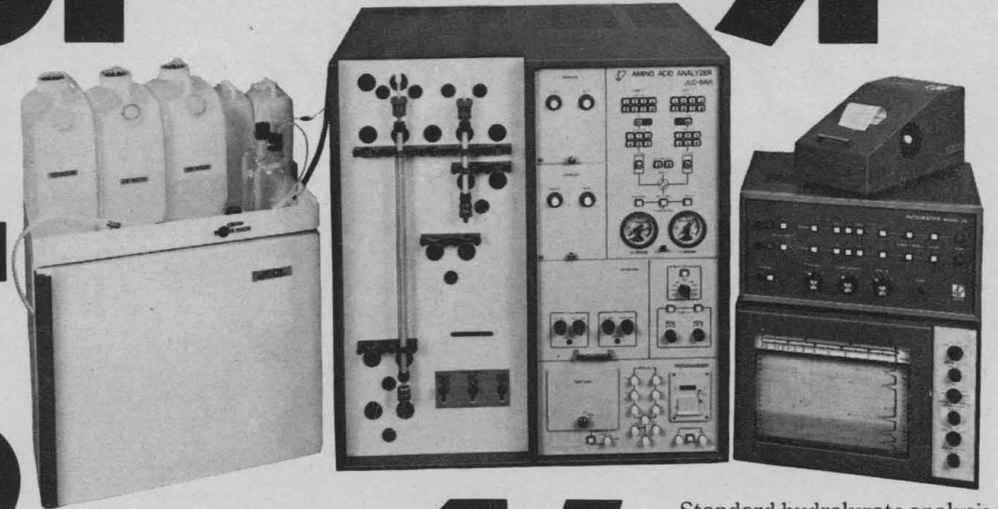
6. Both the 6AH and 121 have automatic temperature controls. This makes us both even.

7. The 6AH features a standard dual beam detector. The 121 has a single beam detector. We shine again.

8. Both the 6AH and 121 will take on over-lapping runs.

9. The 6AH has a built-in stream splitting device. This is an option on the 121.

10. There are 2 water baths in the 6AH design. There's 1 in the 121.



11. The 6AH consumes 2/3 less ninhydrin reagent than the 121.

12. The 6AH is teamed up with a JEOL integrator. The 121 is matched with an Infotronics model. The service is no match at all.

13. Our 6AH has 2 buffer pumps. Their 121 has 2, as well. Obviously it's a draw.

$. The 6AH . . . . . $17,900.
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This impartial analysis* was brought to you by the people with more information on the 6AH Amino Acid Analyzer. The Automated Analyzer Division, JEOL, 235 Birchwood Ave., Cranford, N.J. 07016. Tel. (201) 272-8820.

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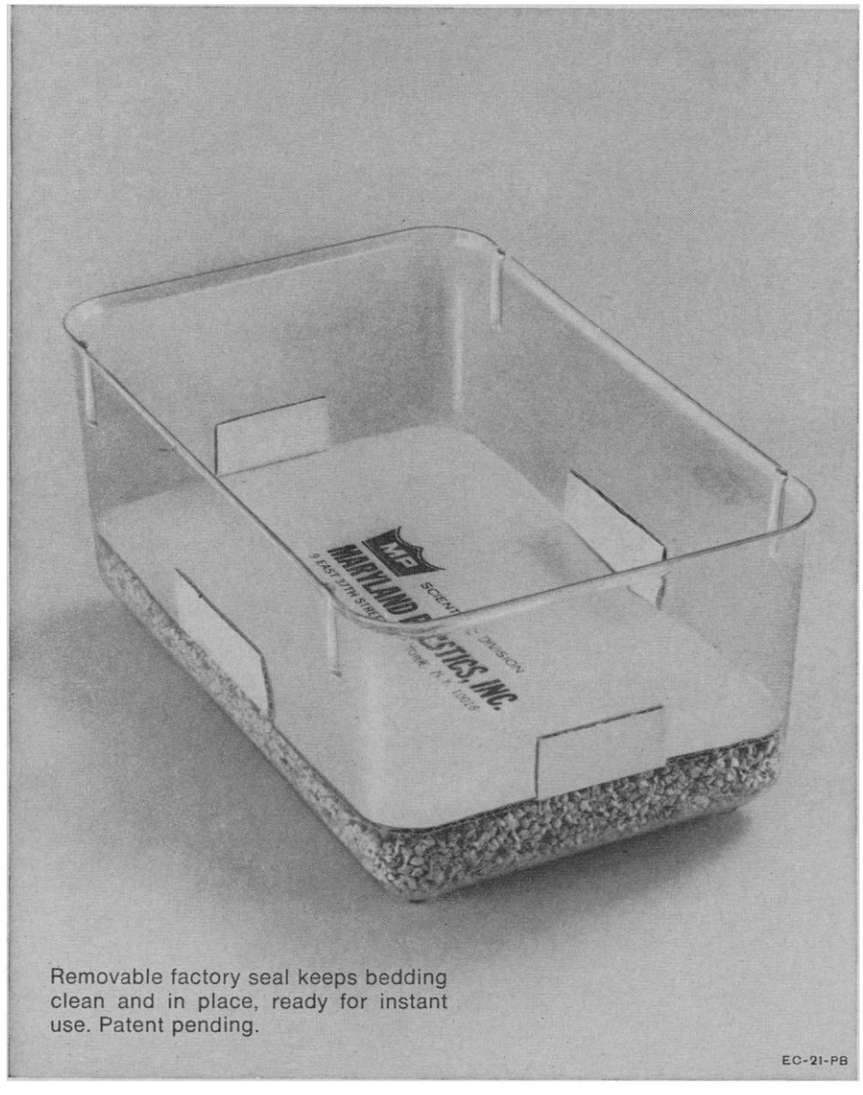

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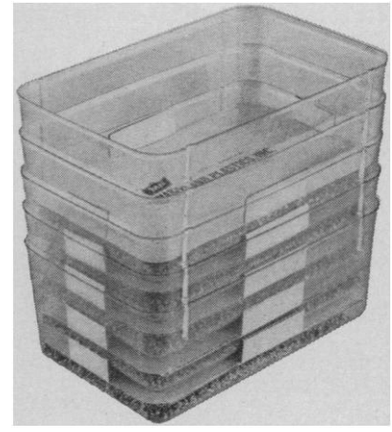
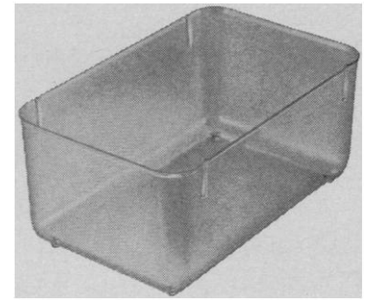


Econo Pre-bedded Cages with the unique factory seal require minimal storage space when nested. Part No. E-0214.



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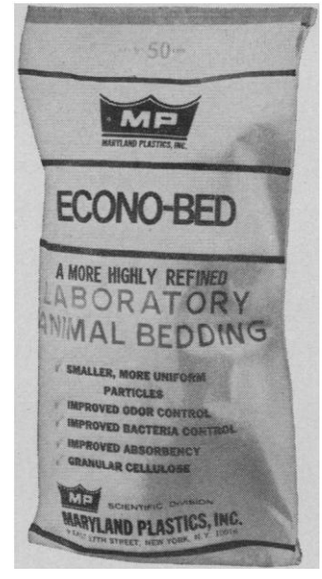

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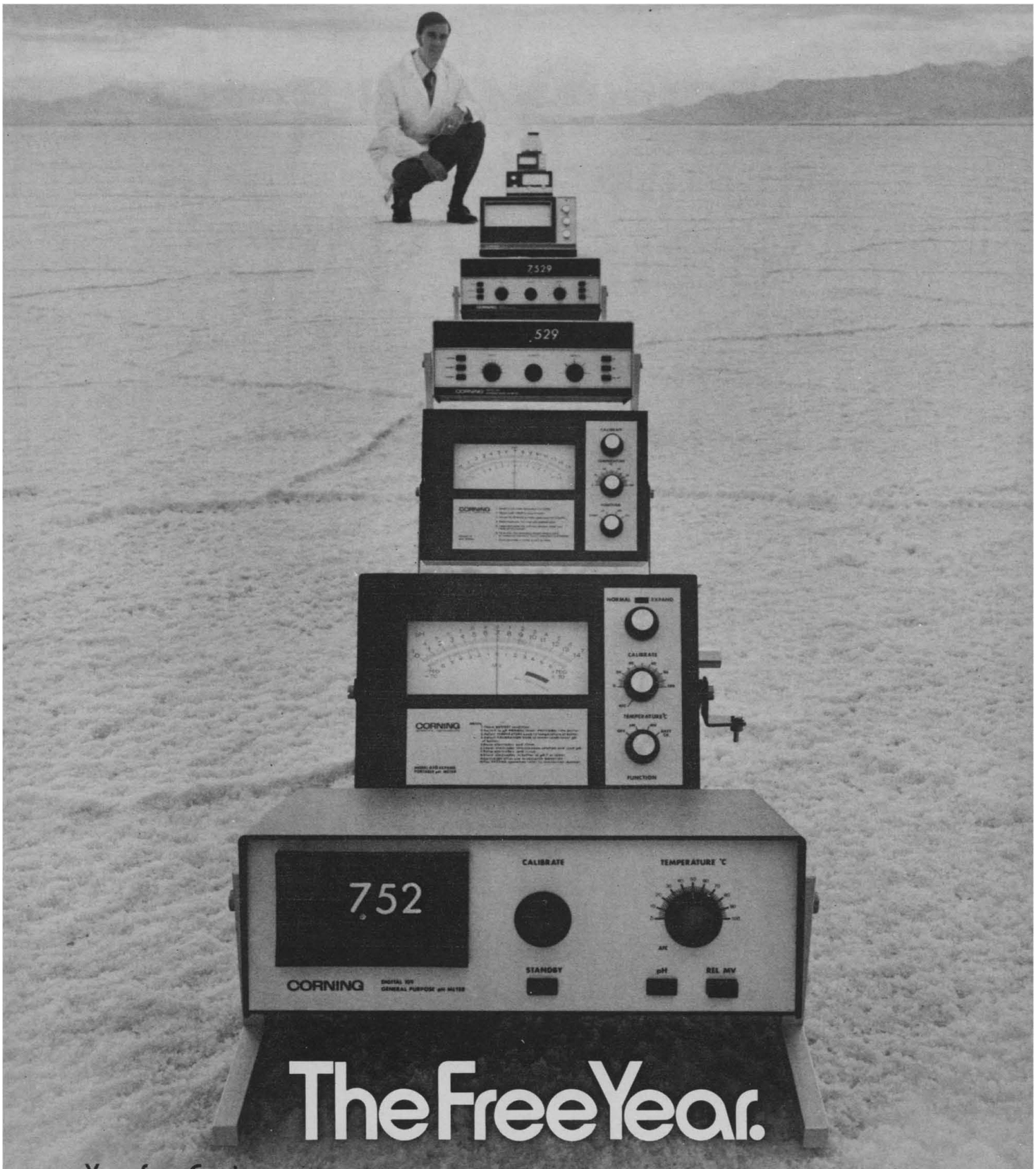

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Nuclear magnetic resonance (NMR) spectroscopy has made significant contributions in structural and conformational studies of complex organic molecules, natural products, steroids, proteins, medicinals, drug metabolites, and other biomolecules. However, obtaining spectra like those of adenosine-5'-triphosphate (ATP) shown on these pages, has been so formidable a task that it was seldom attempted. Now, Varian's XL-100, NV-14, HA-100, HR-220 and HR-300 NMR Spectrometers with Fourier transform accessories make these studies possible on a routine basis. The greatly increased sensitivity and speed of analysis lets you work with smaller samples than previously possible; lets you measure compounds that you couldn't measure before; improves capability for NMR measurements of less sensitive nuclei such as ^{13}C, ^{14}N, ^{15}N, ^{17}O, ^{31}P, and others; and lets you make direct measurement of time-dependent NMR phenomena.

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The adjacent three spectra of three different nuclei in ATP were all obtained with a Varian XL-100 NMR Spectrometer with Fourier transform accessory.

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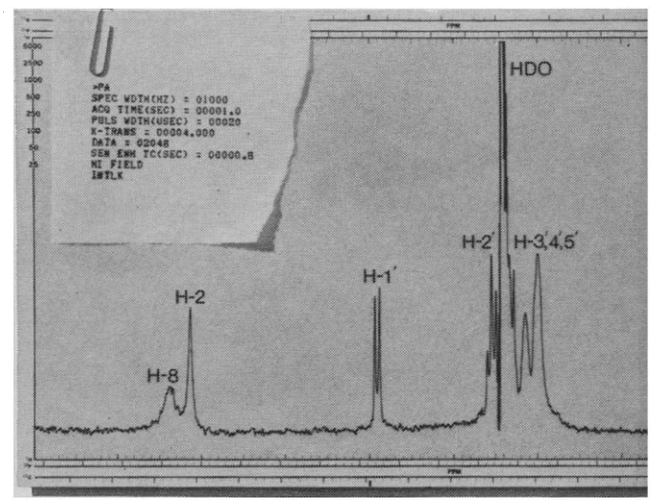
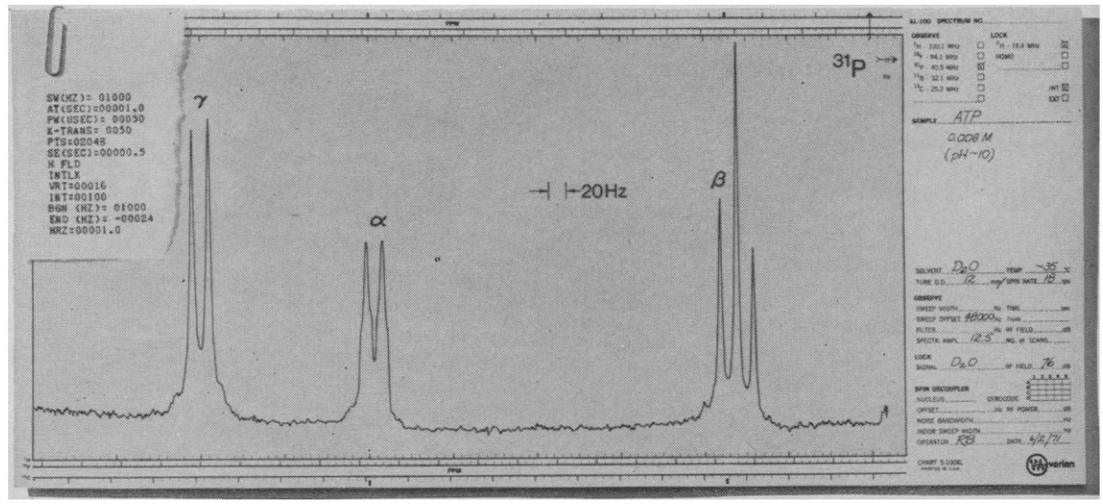
^{13}C The natural abundance ^{13}C spectrum was obtained using 400 pulses at 0.8-second intervals. The peaks are assigned following Dorman and Roberts.[1] Of particular interest are the doublets due to C-4' and C-5' arising from spin-spin coupling of these carbon atoms to the α-phosphorus, characteristic of all 5'-nucleotides. The ribose carbon atoms all fall between 66 and 89 ppm* and are almost independent of pH, while the adenine carbons, with the exception of C-5, fall between 143 and 151 ppm and are strongly pH dependent. The 118.8 ppm shift of C-5 reflects the markedly higher electron density at this position. From the pH dependence it is tempting to conclude that protonation is favored at N-9, but this is not consistent with the proton NMR pH dependence. Further studies over a range of concentrations and with related molecules might be expected to clarify this point and to throw further light on the structure of dimers and polymers formed by parallel stacking of nucleic acid bases.

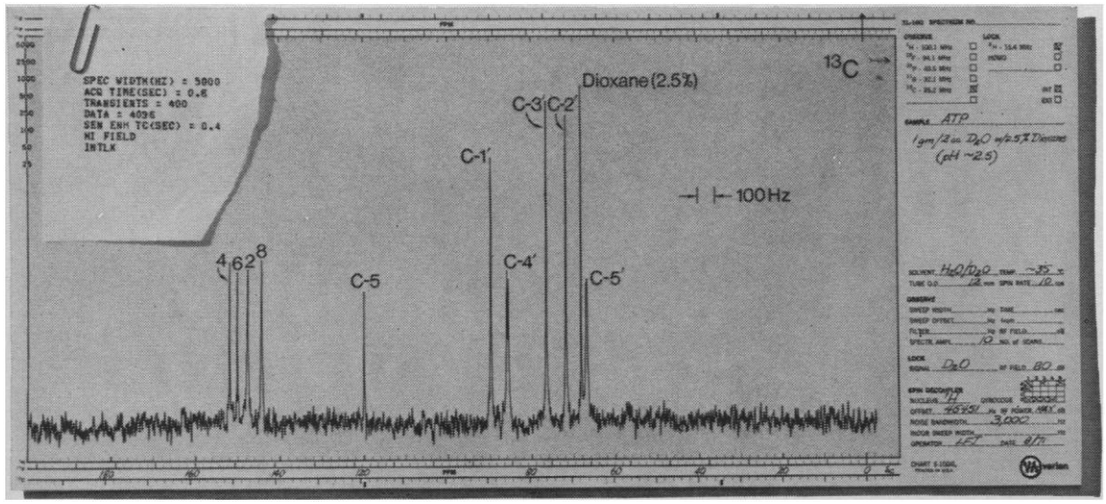
1) Dorman, D.E. and Roberts, J.D., Proc. Nat. Acad. Sci. **65**, 19-26 (1970).

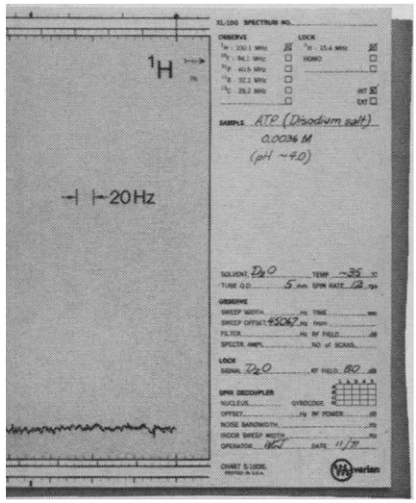
*relative to TMS, using dioxane = 67.4 ppm





transform NMR systems complex molecules routine.

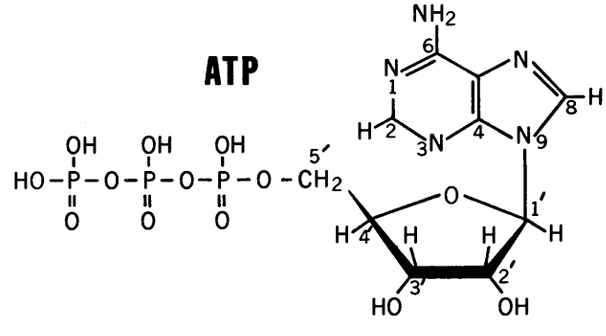




^1H The ^1H spectrum of 0.0036 M ATP at left required 4000 pulses of 1.0-second intervals, yet clearly shows the signals from individual protons on the ribose and adenine rings. The unique shift of H-1′ arises from C-1′ being bonded to both O and N. Spin-spin coupling to H-2′ splits this resonance into a doublet. Tentative assignments for H-2 and H-8 were made by Jardetsky and Jardetsky[2] from studies of adenine and adenosine, and the pH dependence of these peaks was measured. It was found that H-2 is much more shifted to lower field in going from high to low pH than either H-8 or H-1′, and this was interpreted as indicative of protonation of the pyrimidine portion of the ring rather than the imidazole nitrogens. The apparent discrepancy between the conclusions drawn from the ^1H and ^{13}C NMR spectra of ATP regarding the site of protonation poses an interesting problem which could lead to a better understanding of ^{13}C chemical shifts in aromatic molecules and to a more precise determination of which nitrogen is most susceptible to protonation. A further interesting problem is raised by the marked difference in breadth of the H-2 and H-8 resonances. Broadening of H-8 could arise from any dynamic process which would affect the chemical shift of H-8, such as protonation and dissociation, forming or breaking hydrogen bonds, or hindered internal molecular motion. Fourier transform spectroscopy would permit systematic studies of the effect of concentration and pH in these dilute solutions.

2) Jardetsky, C.D. and Jardetsky, O., J. Am. Chem. Soc. **82**, 222 (1960).

^{31}P The ^{31}P spectrum illustrates the speed with which an interpretable spectrum can be obtained from a dilute solution, using the Fourier transform technique. Only 500 pulses at 1.0-second intervals were required. The spin-spin coupling between the ^{31}P nuclei makes the assignment of the spectrum straightforward, since the β-phosphorus is coupled to both α and γ and is therefore a triplet. The α and γ peaks are both doublets, but long-range couplings to the 5′ and 4′ protons result in further splitting of the peaks. Cohn and Hughes[3] report that the α and γ peaks coincide until the last proton ionizes, whereupon the γ peak moves to lower fields following the titration curve. They also report[4] that Mg^{++}, Zn^{++}, and Ca^{++} complex with the β and γ phosphate groups as determined from the ^{13}P shifts as a function of ion concentration. On the other hand, Cu^{++} was found to complex solely with the α and β phosphate groups as deduced from line broadening at 5×10^{-5}M for the paramagnetic Cu^{++} ions.



3,4) Cohn, M. and Hughes, T.R. Jr., J. Biol. Chem. **237**, 176-181 (1962); **235**, 3250-3 (1960).

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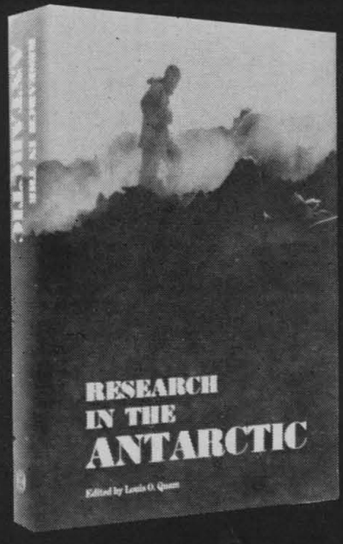

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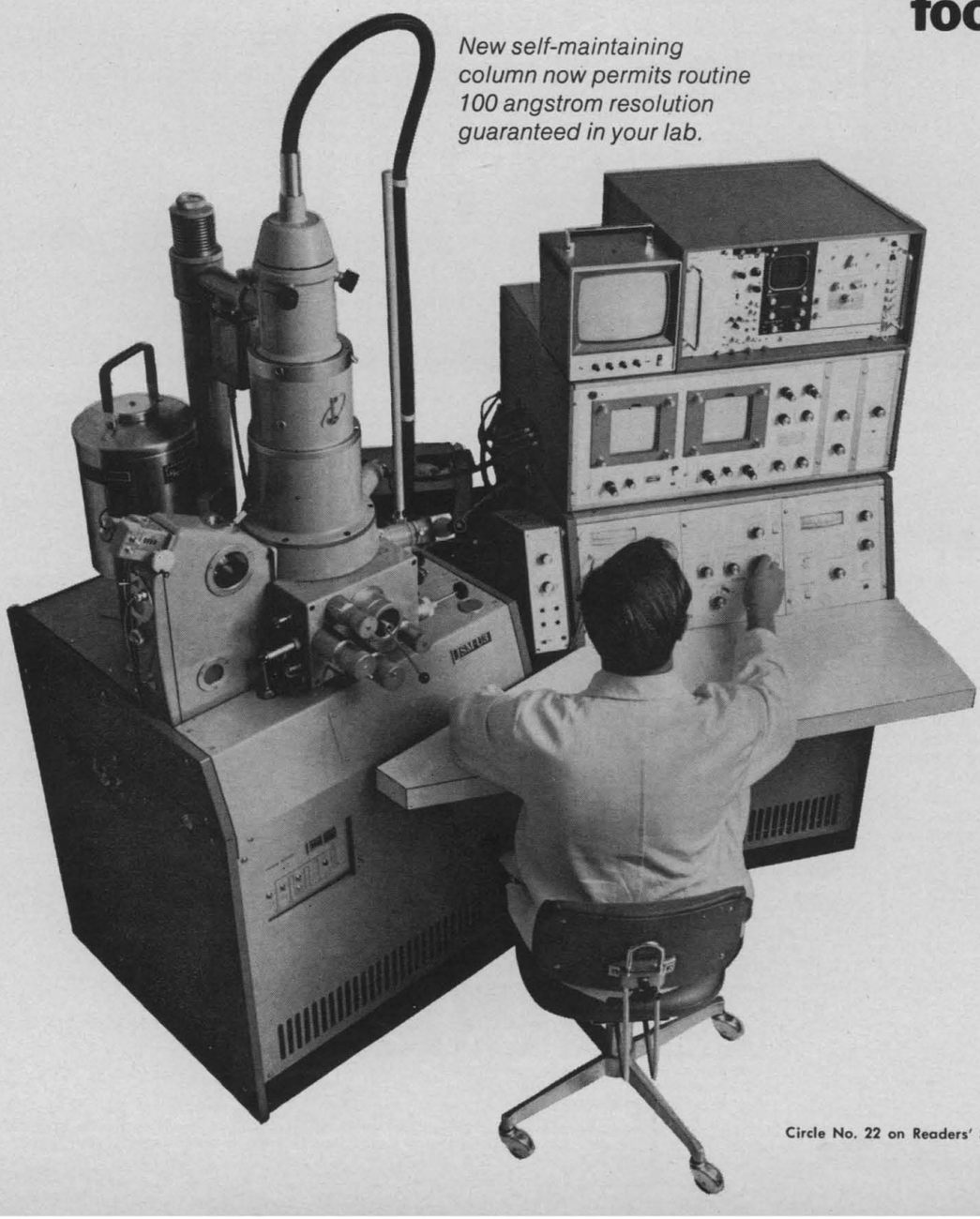

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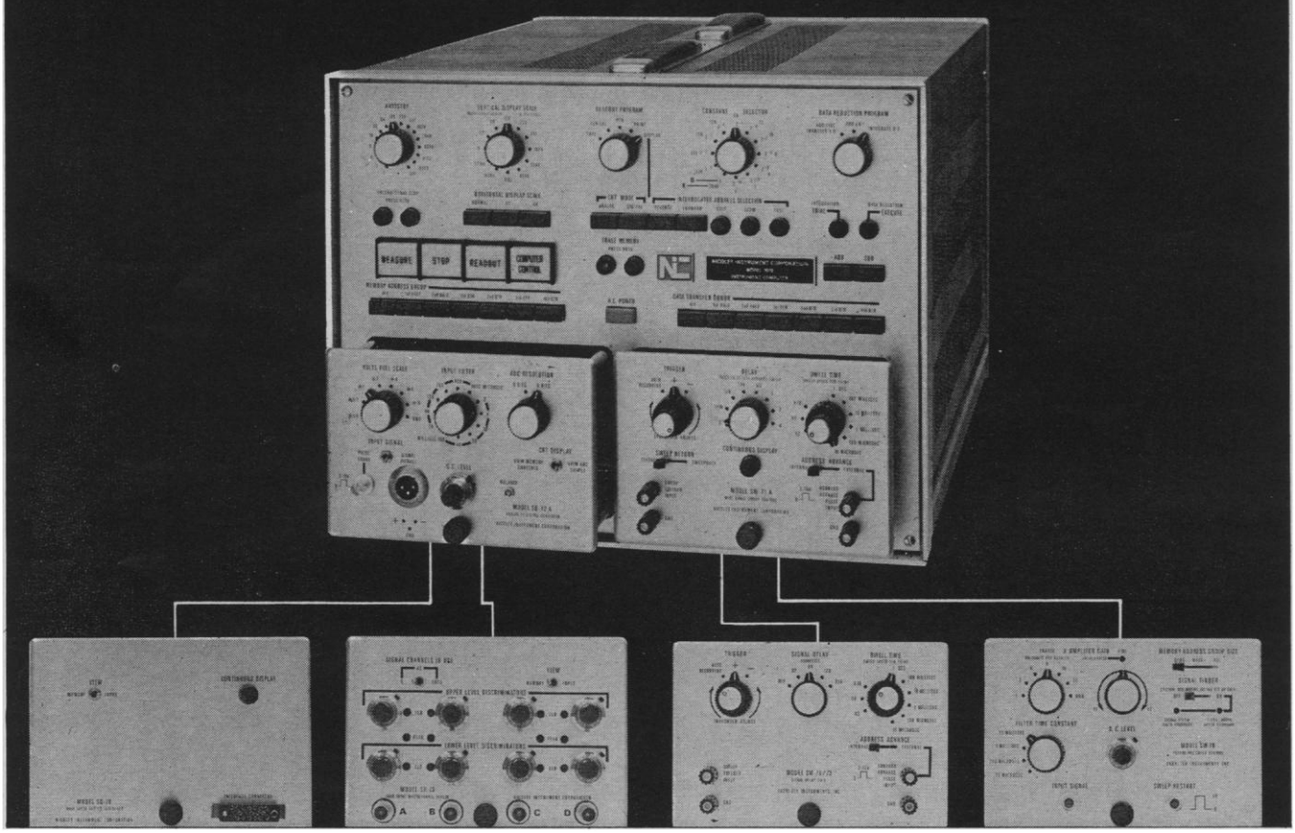

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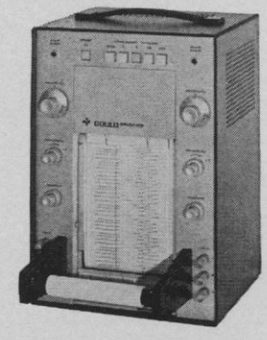

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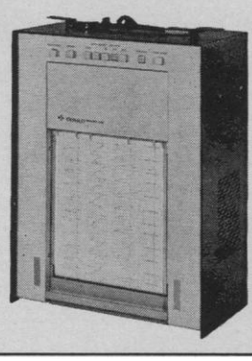

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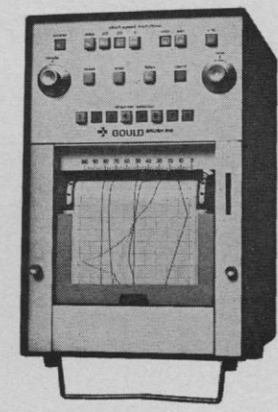

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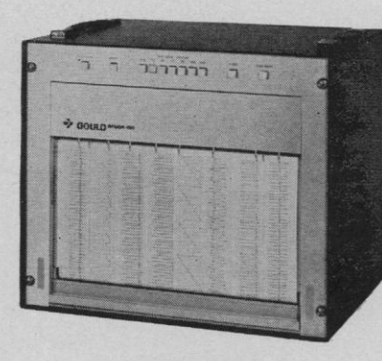

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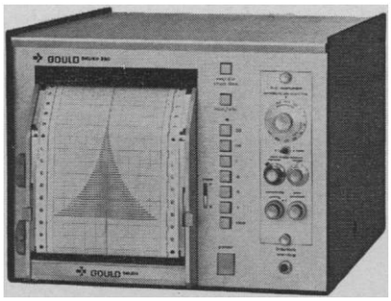

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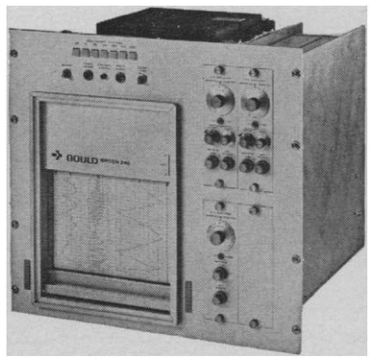

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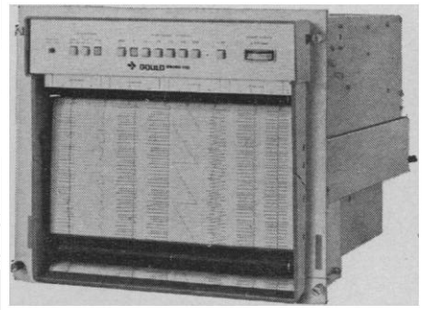

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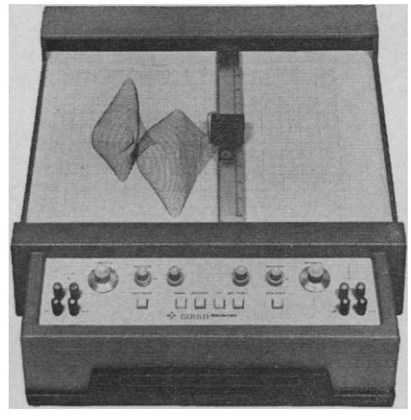

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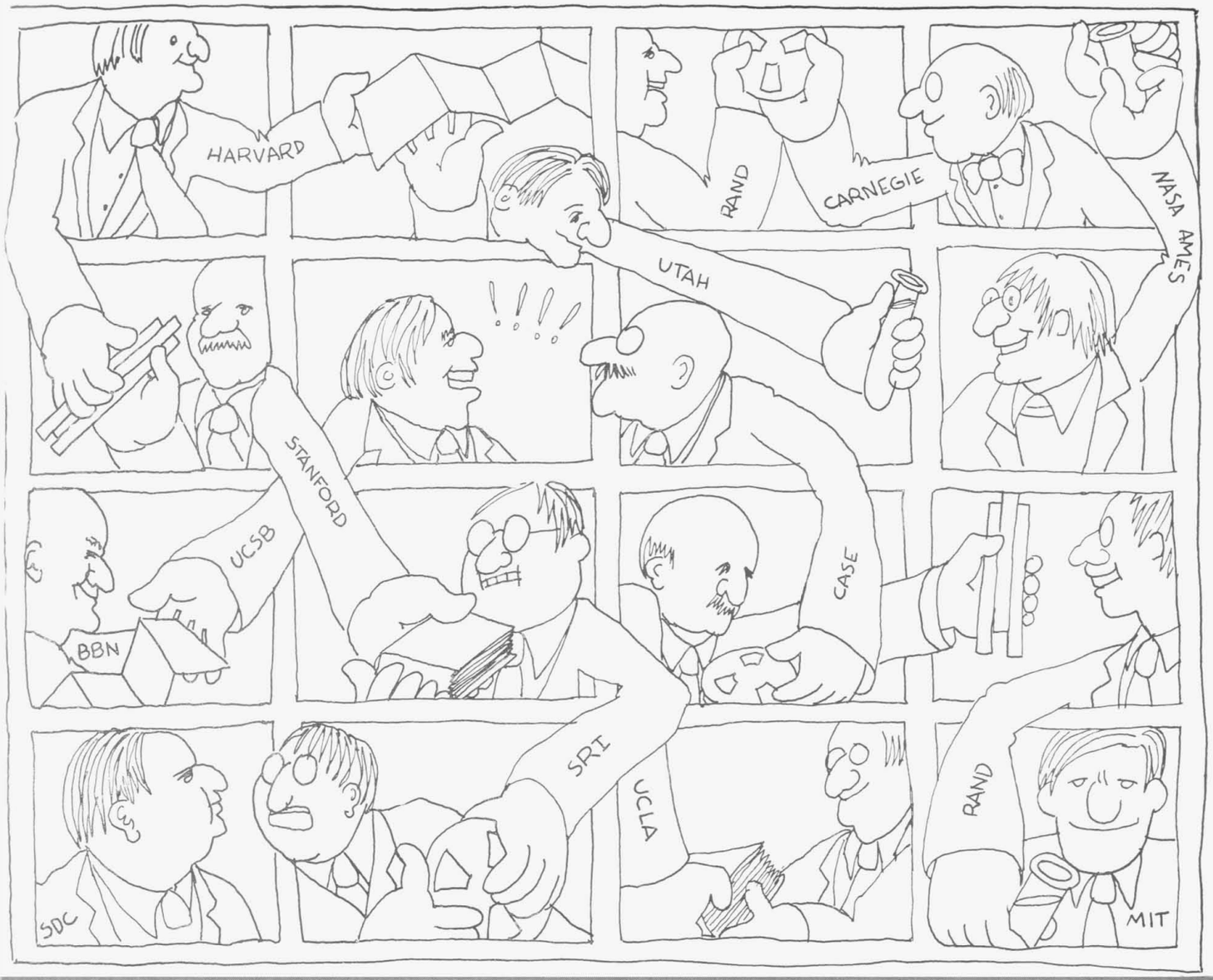

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Turkey Anatomy

In his sarcastic letter (24 Sept., p. 1191) concerning the publication by the Atomic Energy Commission of the *Atlas of the Domestic Turkey* (Meleagris gallopavo): *Myology and Osteology* by E. B. Harvey *et al.*, Abrahamson's major complaint appears to be against the utilization of appropriated funds to support a study which, in his opinion, has no place in the work of the AEC. The implication in the letter that the study was underwritten in its entirety by the AEC is highly misleading. In a portion of the preface to the atlas which Abrahamson chose to ignore, the authors clearly indicated that the research was financed by private contributions and by small grants from agencies not affiliated with the AEC, and that only the "final steps necessary to the publication" and the actual costs of publication were absorbed by the AEC.

Perhaps the greater question, however, is the validity of Abrahamson's complaint that poultry anatomy studies do not belong within the AEC's "mission." That irradiation produces pathological effects is axiomatic. Pathological conditions—in any animal—can be recognized only by comparison with the "normal" conditions. The intended function of the atlas was to describe the "normal" condition of the domestic turkey. It is important, for economic reasons, to understand the effects of radiation on domestic and wild animal populations. The first step in any such study is to ascertain the normal condition, including the range of variation and the naturally occurring abnormalities. This information is, in our opinion, not yet available in sufficient detail for any species of domesticated birds to provide the foundation for investigation of radiation effects.

The growth and development of the poultry industry is economically important not only in this country but in developing countries. In one of his quips Abrahamson refers to the "nearly 100 million domestic turkeys" produced annually to provide food for the American consumer. What he does not mention is the economic loss that results because large numbers of these birds never reach the processors owing to pathological conditions about which little is known.

The utilization of domestic fowl in AEC research is not new; the reader can be referred to the bibliographies given in studies by Quisenberry and Atkinson (*1*) and Lucas and Denington (*2*), in which effects of body irradiation on reproductive performance and blood composition in domestic chickens were studied.

Abrahamson's comments constitute a specious review of the atlas. Since the volume has not received regular treatment in the book review section of *Science*, Abrahamson's comments are the only ones on the work which many readers of *Science* will see. It is poor taste to select such a work as a vehicle for a humorous exercise or for the purpose of emphasizing a personal disagreement with the policies of a particular agency. When such disagreement exists, it would seem proper to us that the target for complaint should be the policy and not, as in this instance, the research which was thought to be the result of that policy.

ROBERT D. KLEMM
Avian Anatomy Investigations,
Agricultural Research Service,
U.S. Department of Agriculture,
East Lansing, Michigan 48823

WALTER J. BOCK
Department of Biological Sciences,
Columbia University,
New York 10027

References

1. J. H. Quisenberry and R. L. Atkinson, *Poultry Sci.* **35**, 1327 (1956).
2. A. M. Lucas and E. M. Denington, *ibid.* **36**, 1290 (1957).

Newton, the Politician

In his illuminating article "Reflections on the decline of science in America and on some of its causes" (2 July, p. 27) Arnold Thackray makes a slip when he writes of Isaac Newton's "movement from Cambridge professor . . . to minor state functionary." Presumably he is thinking of Newton's tenure as Warden of the Mint; although not generally realized, this was an instance of a scientist making a political contribution of great importance.

Macaulay deals fully with the matter in chapters 21 and 22 of his *History of England* (*1*). "The silver coin, which was then the standard coin of the realm, was in a state at which the boldest and most enlightened statesmen stood aghast." Continual clipping of minute pieces of silver from the irregular edges of the hammered coins greatly reduced their weight. "At length in the

autumn of 1695 it could hardly be said that the country possessed, for practical purposes, any measure of the value of commodities. . . . On a market day, the clamours, the reproaches, the taunts, the curses, were incessant. . . . Never had there been an occasion which more urgently required both practical and speculative abilities." These abilities were displayed in the plans to overcome the crisis that were formulated by the politicians Somers and Montague and the philosophers Locke and Newton.

The old currency was recalled and replaced with new currency; the then novel process of milling the coins' edges was used. Until the new coins were issued, commerce was forced to creep along largely by credit and barter. At that juncture, Montague appointed Newton to be Warden of the Mint, an office that had previously been a sinecure. Under Newton's vigorous leadership, coin production leaped to almost ten times what the old officers of the Mint had considered an excellent level. During this time, Newton wrote that he did not love to be "teased by foreigners about mathematical things, or to be thought by our own people to be trifling away my time about them, when I am about the King's business."

Perhaps there is a lesson for our times in this cooperation between politicians and intellectuals to solve a pressing social problem.

LEE A. SEGEL

Department of Applied Mathematics, Weizmann Institute of Science, Rehovot, Israel

Reference

1. T. B. Macaulay, *History of England* (Dent, London, 1966).

Information Systems

Although John H. Schneider (23 July, p. 300) makes some valid points in his article on selective dissemination of information (SDI) systems, particularly when he points out that scientists should be encouraged to use the process more, I feel that he has unfairly downgraded the usefulness of keyboard searching.

I am a subscriber to an SDI system that matches titles of journal articles against a keyword profile. When I took the output of the last year and subjected it to the sort of analysis that Schneider used, I received 1314 references on information science (at least as broad a topic as cancer research), of which 54 percent would fall into his "very useful" or "definite" use categories. Therefore, in the same amount of time (12 months) I received approximately the same number of references (1314) as his subjects (1386), with exactly the same percentage of usefulness, using a keyword search of titles of articles. Schneider's conclusion, that classification indexing is (in some way) better than keyword indexing, is thus open to question.

The cost involved, the time needed, and the professional expertise required both to create the hierarchical classifications and to index articles make the system proposed by Schneider impractical, except perhaps for narrow disciplines. The adoption of this system on a large scale would result in a sizable delay in the appearance of articles on the SDI tape services and an increase in the cost of such services, perhaps greater than the $200 per year target figure Schneider suggests.

R. M. MCMULLEN

Communication Data and Library Services, Canada Department of Communications, Ottawa, Ontario

McMullen's position as chief of Communications Data and Library Services probably requires that he maintain a broad overview of the entire information field. This may explain why he found 709 out of 1314 references on information science to be either "very useful" or of "definite" use. I regret that my study did not include such omnivorous users of information. Instead, the participants in my test situation were the principal investigators of research grants who were working on very narrow, specific fields of research. The purpose of my experiment was to exactly identify these research areas as categories in a classification so that each scientist could be matched precisely with documents useful to his specific research effort. Under these circumstances, I believe the criteria for ranking "usefulness" by the participants in my study were much more selective than those used by McMullen, and a comparison of his personal experience with the results I presented has little validity.

At no point in my article did I make a blanket statement that "classification indexing is better than keyword indexing." Instead, I tried to present the advantages and disadvantages of both types of systems. Clearly an SDI system based on automated indexing of key-

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words in the titles of articles is much cheaper and requires less time and less professional input than a system based on classification indexing. If low cost and speed are the prime considerations, then keyword systems such as the one McMullen is using are undeniably excellent. However, if intellectual indexing is used, then the advantages of classifications (particularly in terms of precise indexing of intact concepts, use of obvious generic-specific relations between items of information, and ease of retrieval) should be considered by those who are interested in developing information systems with a higher level of performance than that of keyword systems.

JOHN H. SCHNEIDER
National Cancer Institute, National Institutes of Health, Bethesda, Maryland 20014

Particle Accelerator Application

In his article "Relevance of particle accelerators to national goals" (6 Aug., p. 490), Louis Rosen lists ways in which accelerators have been applied to the study of radiation damage processes in fast breeder reactors. We would like to call attention to another recent application of this type.

In fast breeder reactors, a significant reduction in reactor efficiency is caused by the swelling of the stainless steel cladding of fuel elements. This swelling is due to the intense fast-neutron bombardment that produces a high density of small voids inside the steel. In the light of the national objective to construct a demonstration breeder reactor by 1980, it has been necessary to mount a large research effort to study systematically the void-swelling phenomena and to develop low-swelling alloys. This work is being expedited by the use of accelerators to simulate neutron-damage effects by ion bombardment. Because heavy ions have a high cross section for producing atomic displacement, it is possible to build up, relatively quickly, a region of intense radiation damage; the structure of this damage is similar to that observed in reactor irradiations. Further, the examination of samples is facilitated by their lack of residual radioactivity.

At Argonne, if a beam of 2-μÅ Ni+ ions from the 4-Mv Dynamitron accelerator is used, a 1-year irradiation in Experimental Breeder Reactor-II

may be simulated in 3 hours. The saving in research dollars and the flexibility afforded by this technique in the development and screening of material for breeder-reactor and fusion-reactor applications are self-evident.

A. TAYLOR
K. MERKLE
Argonne National Laboratory, Argonne, Illinois 60439

Labeling of Blood-Typing Serums

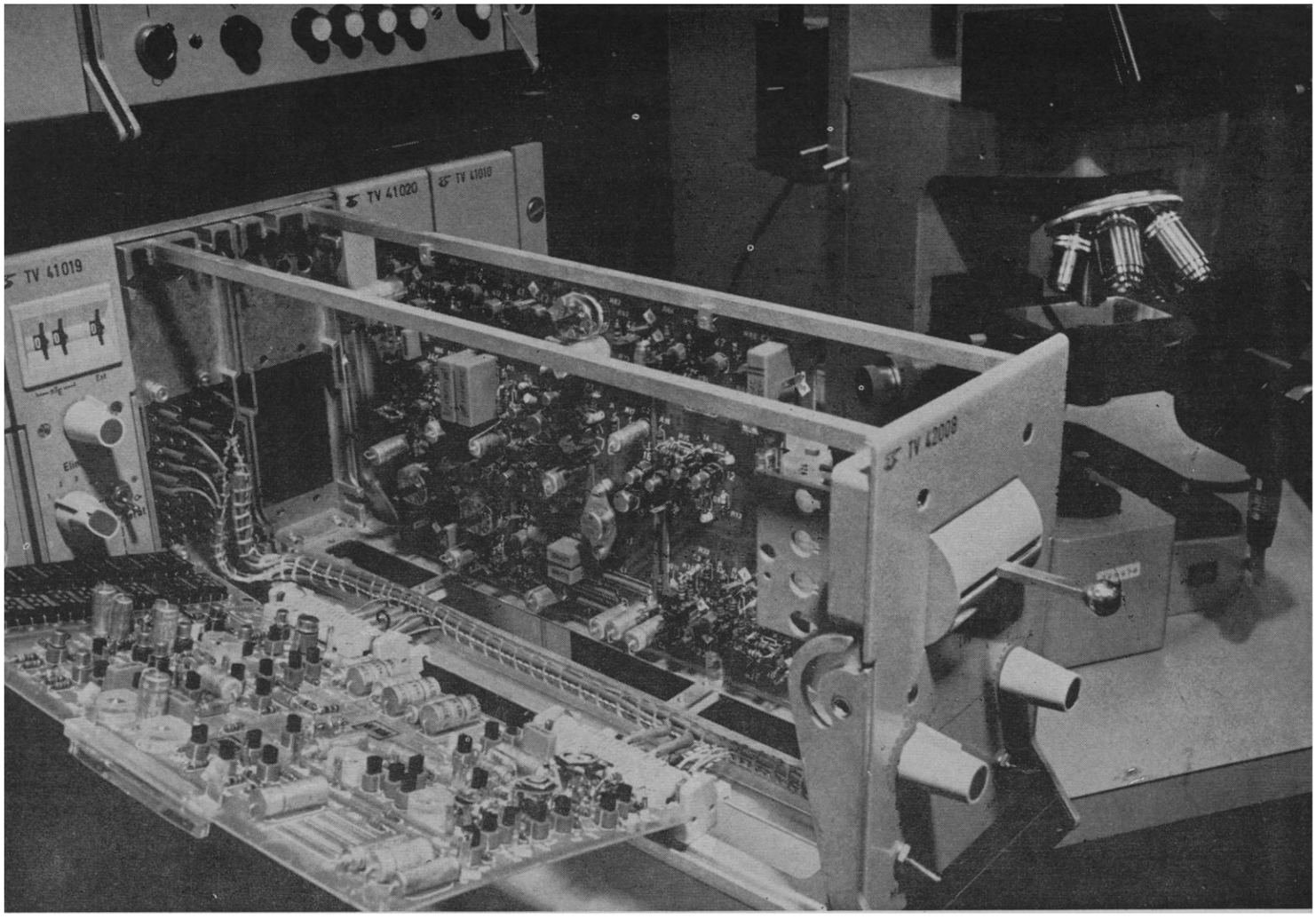
I heartily agree with the remarks made by Austern and by Ross (Letters, 9 July, p. 105) about the abuse of eponyms in scientific terminology, and I would like to point out one subtle method of getting workers in a field to use pseudoscientific terminology. The method is to print the terms to be popularized on the labels of scientific products. This method has proved highly successful in the case of the C-D-E coded notations for human Rh-Hr blood types. Blood bankers are constantly being confronted with labels on vials of blood-typing serums which carry these symbols, usually in parentheses after the correct scientific symbol. Because of the attractive simplicity of the C-D-E symbols, the worker often adopts the fallacious C-D-E symbols and ignores the correct Rh-Hr symbols, even though the Rh-Hr symbols are given priority on the label.

Manufacturers were required to place the C-D-E symbols on the labels of their Rh-Hr antiserums by the Division of Biologics Standards of the National Institutes of Health after a meeting on Rh-Hr nomenclature held more than 20 years ago. However, in the intervening decades tremendous advances (*1*) have been made in the knowledge and understanding of the Rh-Hr blood types. The labeling of Rh-Hr antiserums should be modernized to take these advances into account. Despite repeated requests to hold a meeting on the labeling of blood-typing serums, so that this matter can be brought up to date, the Division of Biologics Standards continues to adhere to its original regulations.

A. S. WIENER
Department of Forensic Medicine, New York University College of Medicine, New York 10016

Reference

1. A. S. Wiener, Ed., *Advances in Blood Groupings* (Grune & Stratton, New York, 1970), vol. 3, pp. 170–257.



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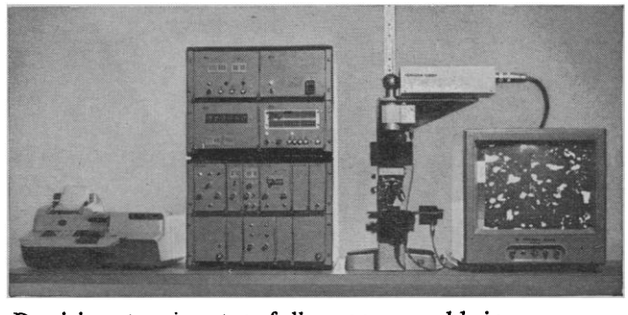

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21 January 1972, Volume 175, Number 4019 **SCIENCE**

Managing Technology by Performance

Virtually everyone now agrees that if Earth is to become and then remain a suitable habitat for mankind, living in harmony with nature, the management of technology to this end is required. There is much less unanimity on how to do it.

Many people are inclined to put their faith in the legal adversary process as a means for selecting among candidate technologies. This process results in the legal sanctification of one technology and condemnation of another, often confusing the severity of the restraint with effectiveness in solving the problem.

The consequence can be frustration of hopes for a viable environment with safe and healthful air, water, vehicles, products, food, homes, and workplaces for people. A popular conviction that science necessarily ill serves mankind might also follow.

Standards intended to ensure the achievement of specific social goals should, wherever possible, be based on performance criteria and not on design specifications. They should specify the problems to be solved and not the detailed prescription for solving them. But they must include valid quanitative means for determining whether the required performance has been achieved. The virtues of the performance approach are two.

1) By specifying the performance criteria in functional terms, the social purpose of the standard is clear, as is the level of performance required to achieve it. Everyone has an opportunity to evaluate the wisdom of the choices made and the value judgments implicit in them.

2) The scientist and engineer who are trying to meet the goal can search, with minimum restraint, for innovative solutions. The restraints on technology are limited to those that are actually relevant to social ends. Performance standards are also less likely to serve as obstacles to a fair, competitive marketplace, since they are less likely to protect established technologies against potentially more productive new ones.

Broad participation by all affected parties is essential in the selection of the strategy for solving a given problem and the choice of the level of performance to be required, for it is here that value judgments enter. But achieving a fair and effective regulatory process based on performance requires progress in a research task whose difficulty and importance are usually underestimated. While compliance with design requirements can be verified by inspection, compliance with performance-based standards can only be evaluated with very sophisticated tools.

It is frequently very difficult to devise test methods which exclude technologies that will not achieve the specified social need, yet which are free of prejudice and do not favor one technical solution over another. It is difficult to prescribe test methods than can withstand challenge by sophisticated lawyer-expert teams in court. Thus research in the field of physical measurement takes on a new dimension as an essential element of the rational systems approach to the management of technology by society.

The performance approach need not rest on the skills of physical scientists and engineers alone. The ideal would be to specify the performance goal in terms of social and biological effects. Psychophysics and other branches of biometrology, applied in conjunction with physical science and engineering, deserve a very exciting period of development. If the research community insists on the performance approach as an essential basis for rational regulation and provides sufficient research help to make it practical, science can be used to manage technology responsibly.—LEWIS M. BRANSCOMB, *director, National Bureau of Standards, Washington, D.C. 20234*

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