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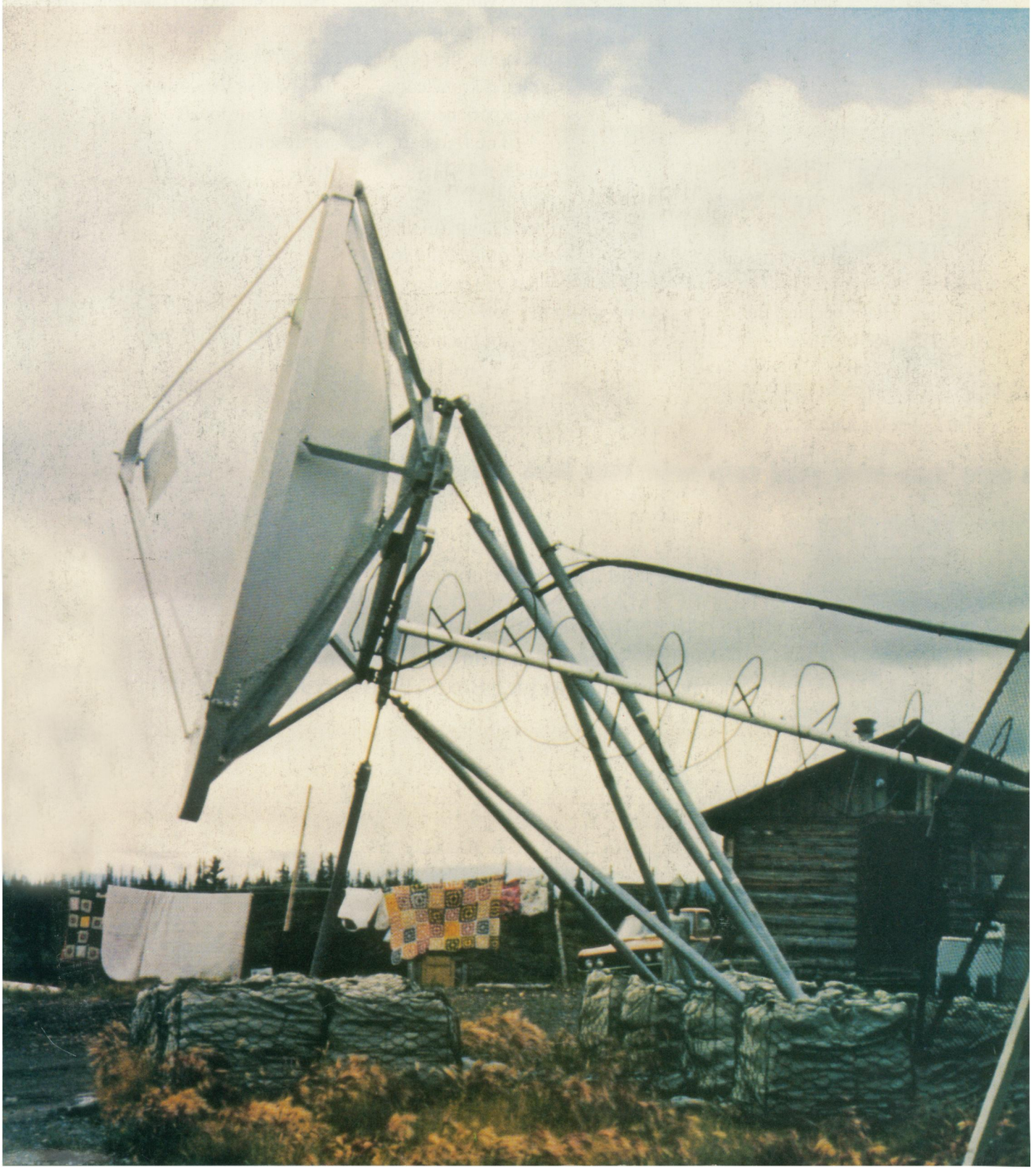

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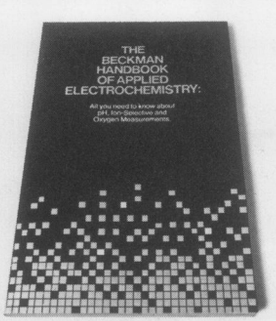

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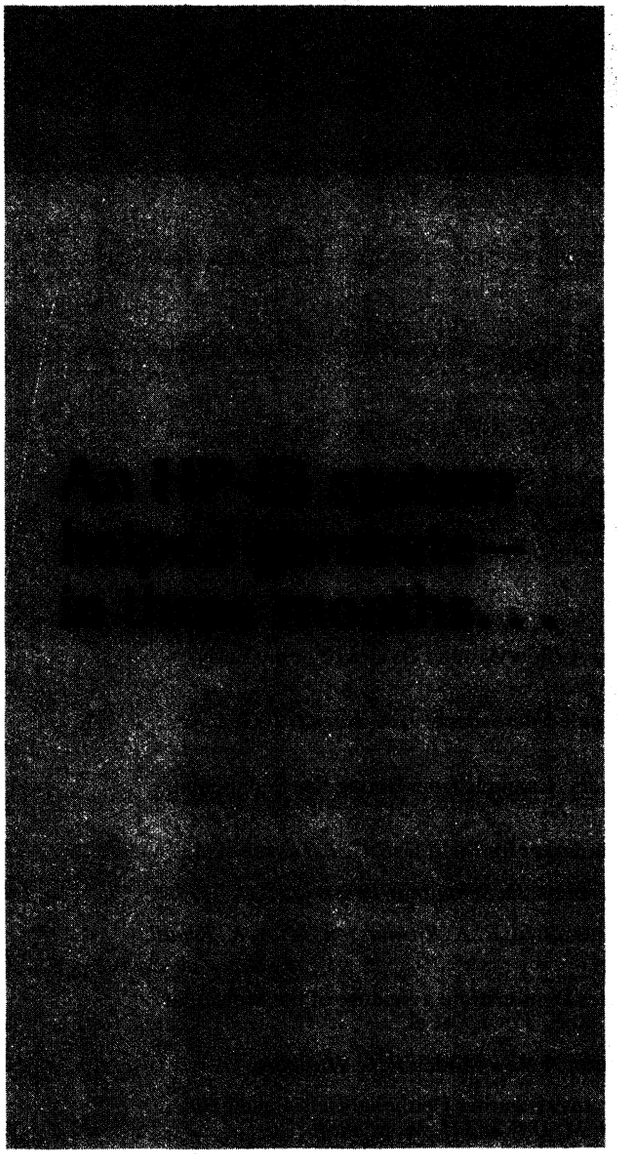
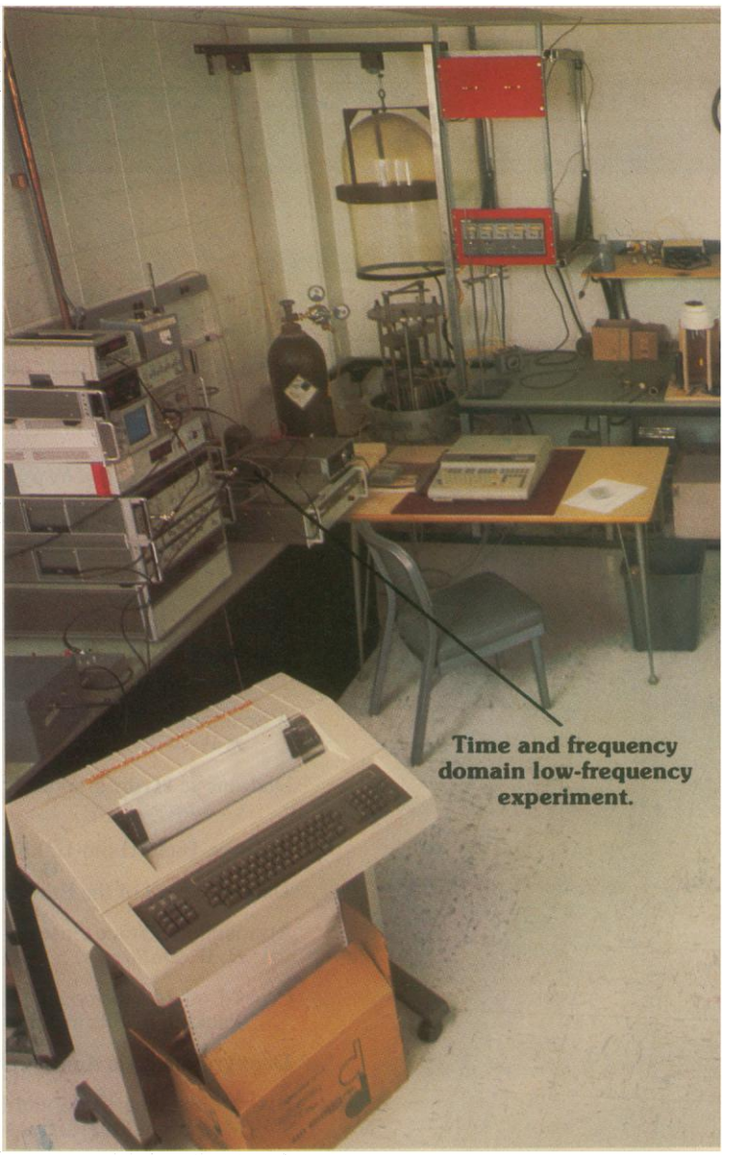
COVER

Satellite earth stations located in Arctic Village, Alaska. The earth station on the left was installed by Alascom, Inc., and the State of Alaska. It is capable of providing both telephone and television service. The earth station on the right was used in connection with the NASA ATS-1 satellite in a demonstration of very high frequency (VHF) satellite communications. See page 241. [Craig Mishler, University of Alaska, Anchorage]





Time and frequency domain low-frequency experiment.

For Colorado State University's Department of Electrical Engineering, contracts and grants are a hectic game. The competition is stiff, funds must be utilized to the maximum, and contracts unfailingly completed on time.

Professor Joel DuBow, head of the Department's Energy and Materials Group, recommended the use of an HP-IB system for experimental programs involving fossil fuels, because "we have enough problems understanding the measurements without having to worry about interfacing. By using HP-IB compatible instruments and computers, we were able to get right to the data analysis, without first having to do research on research."

Processing the unseen.

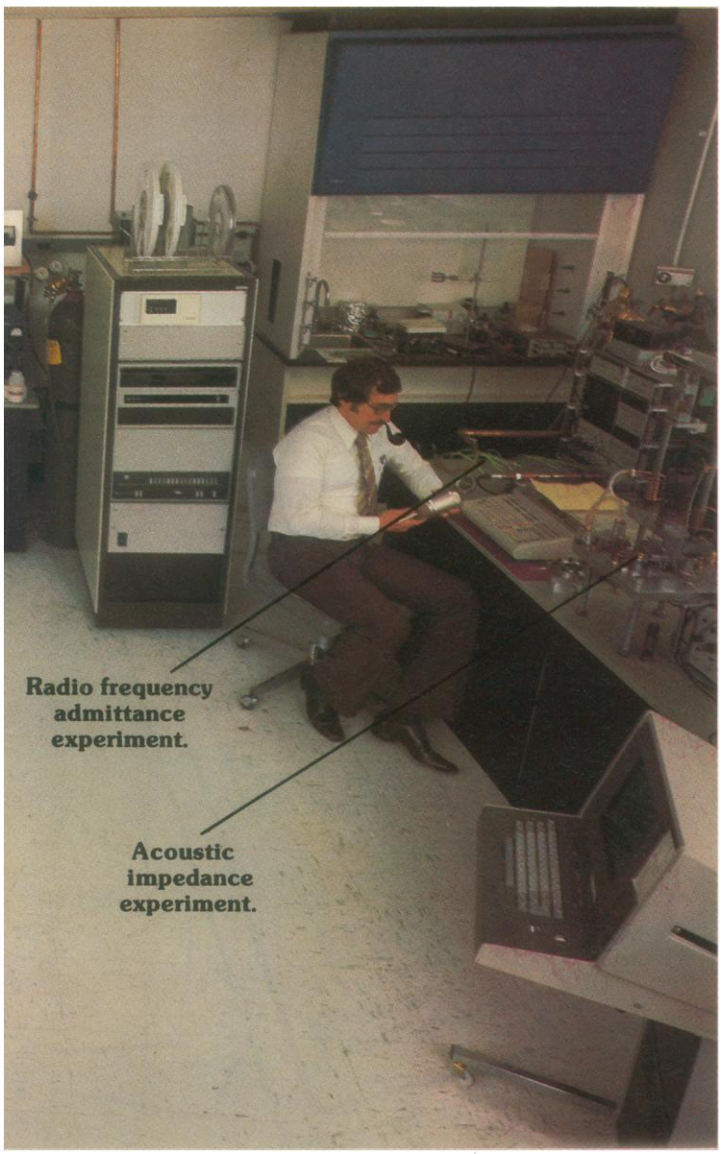
The in situ oil shale processing, now considered the most promising oil extraction technique, utilizes underground processing. Since the material cannot be seen, it is critical that the process be monitored and diagnosed accurately. CSU's HP-IB system has permitted Professor DuBow and his colleagues to devise — and test — conceptual schemes for accomplishing this. For example, when oil shale is heated, it goes through three structural changes: from an "as is" state to a transition zone, to a retorting zone, and, finally, to a combustion zone. By using the HP-IB system to monitor temperature coefficients of the shale properties, Prof. DuBow has been able to delineate the location of these zone boundaries. Process engineers can then use this data to detect the position and velocity of these reaction zones, and to determine the shape of each zone. In turn, this tells them whether or not the desired process is being followed. If not, corrective action can be immediately taken.

A hierarchy of machines.

Another reason why Prof. DuBow chose HP-IB is because of the flexibility provided. "We use three HP 9825s, in conjunction with an HP 1000," Prof. DuBow says. "That way, we end up with a hierarchy of machines. The 9825s have the capacity to analyze most of our data, while the HP 1000, with floppy disc drive, is faster for graphics and hard copy output. The HP 1000 also gives us the ability to store data permanently, and to compare new data against data that was generated six months ago. On the other hand, if the 1000 is busy, the 9825s can provide us with a lot of our essential data. And, since software is compatible, if one 9825 is unavailable the other two can keep the lab running."

Flexibility for data quantity and quality.

In short, this HP-IB system made it possible for CSU engineers to assemble a system configuration quickly, so they could begin looking at data months faster than might have been possible had conventional components been used. It also permits them to analyze oil shale samples faster and obtain more data from the tests. In fact, in one three-month period, CSU has generated more oil shale test data than had ever before existed in published form.



more oil shale test data than had ever before been published.

"Not a new adventure every time."
Professor DuBow's HP-IB system now represents an investment in excess of $250,000, and includes the computers, a low frequency network analyzer, a differential thermal analyzer, printer, four-pen plotter, five disc drives, tape drive, measurement process controller, terminals, and ten other HP instruments. "With HP," Prof. DuBow reports, "I can modify, upgrade or expand the system as our needs change; I have a system where I can hook up specialized and expensive analytical instruments (such as an HP GCMS) rapidly and not have a new adventure every time. Aid from HP people was crucial at certain times. In fact, if it hadn't been for them, the whole program might have failed. One of their applications engineers was especially helpful not only in the interfacing, but his intimate knowledge of the instrument system helped us design our experiment to get the data we wanted accurately."

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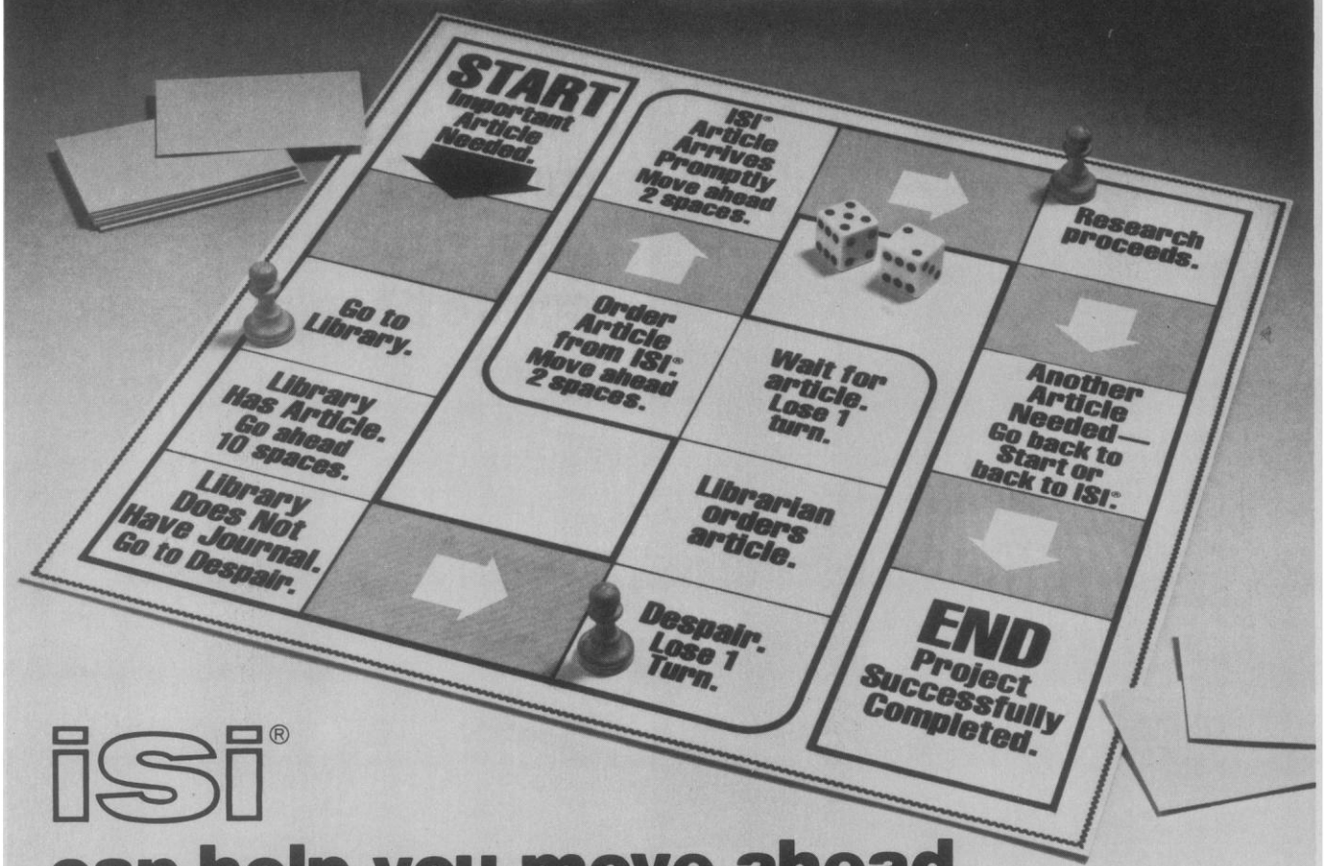

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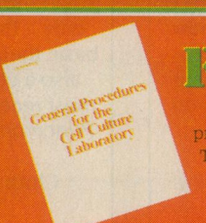

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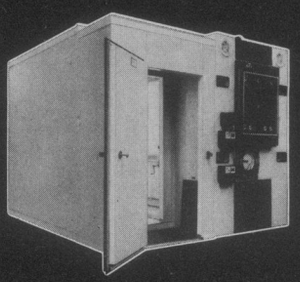

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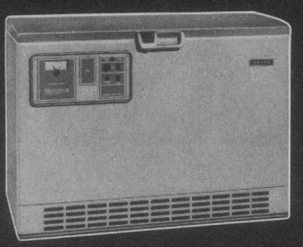

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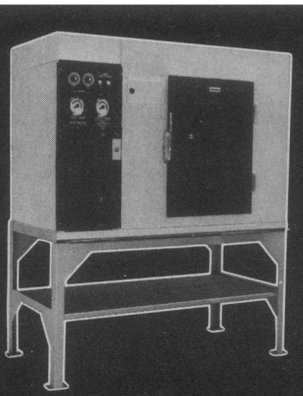

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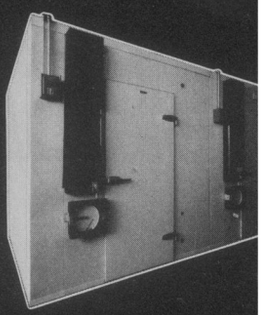

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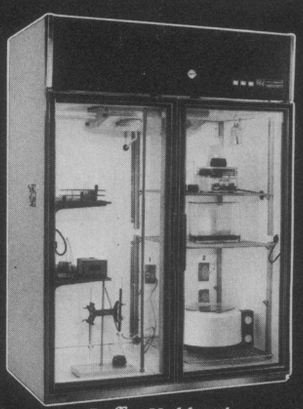

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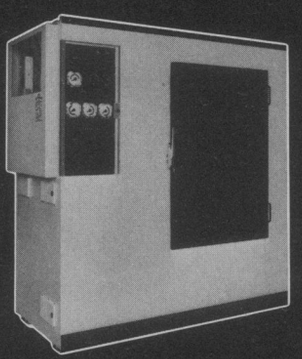

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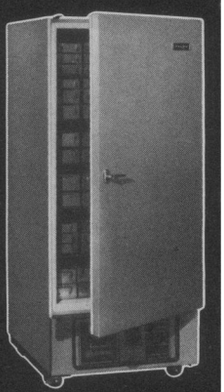

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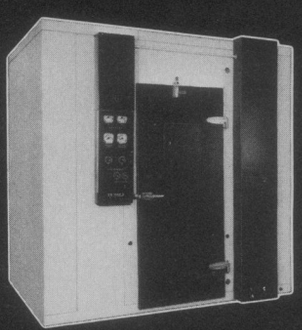

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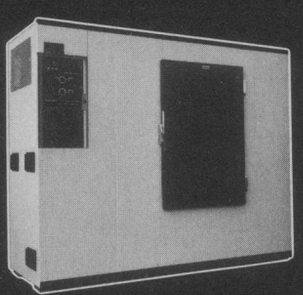

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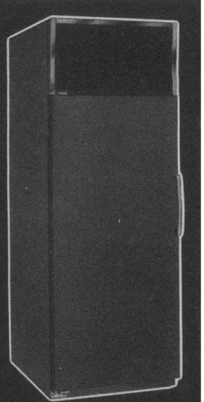

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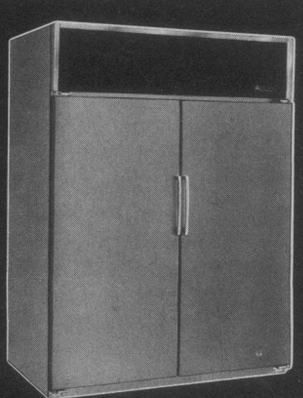

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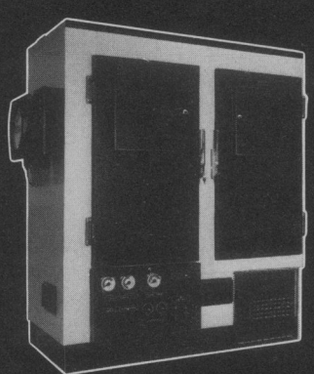

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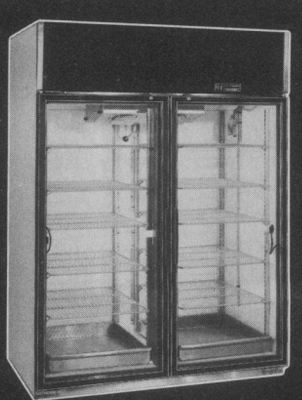

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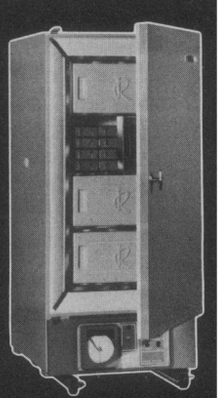

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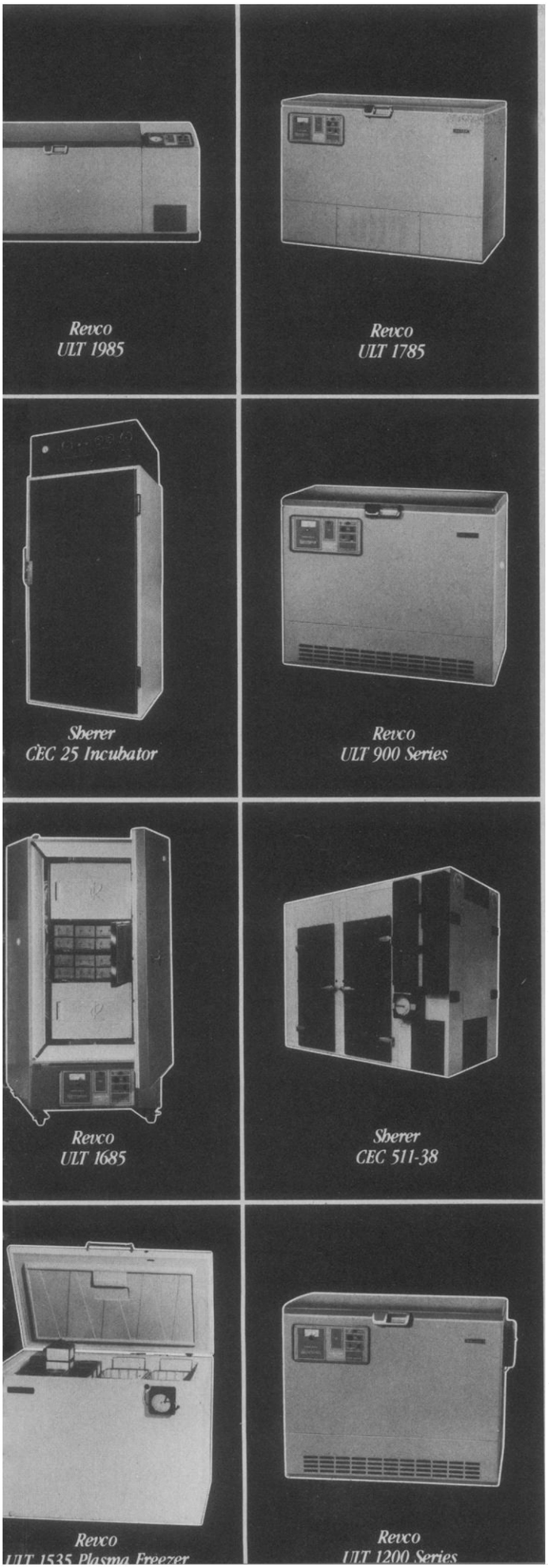

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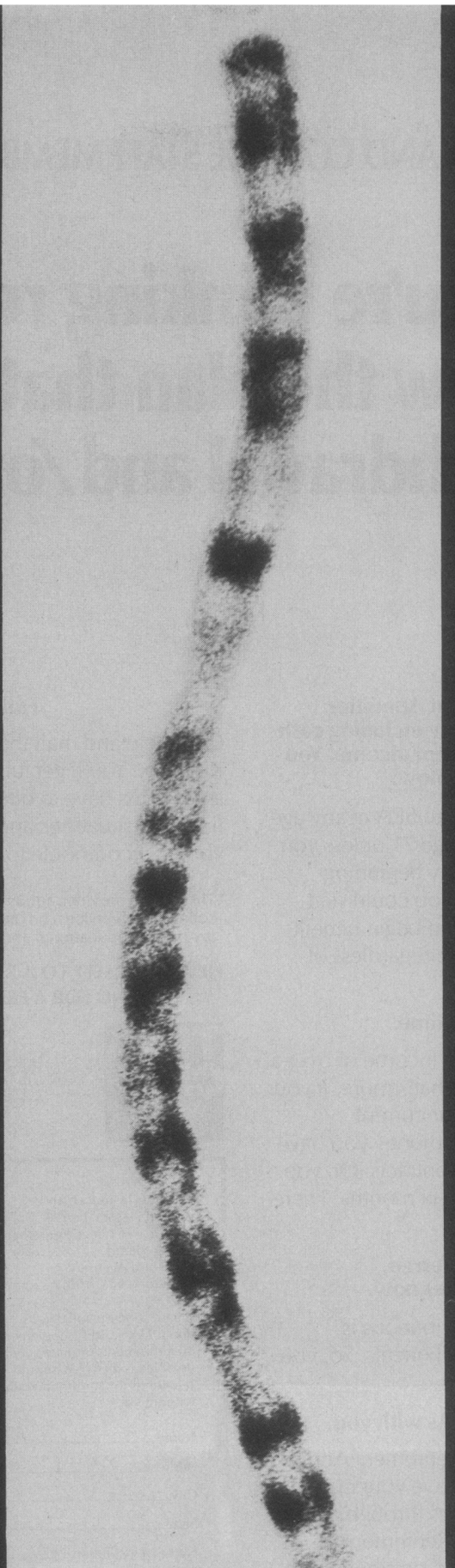

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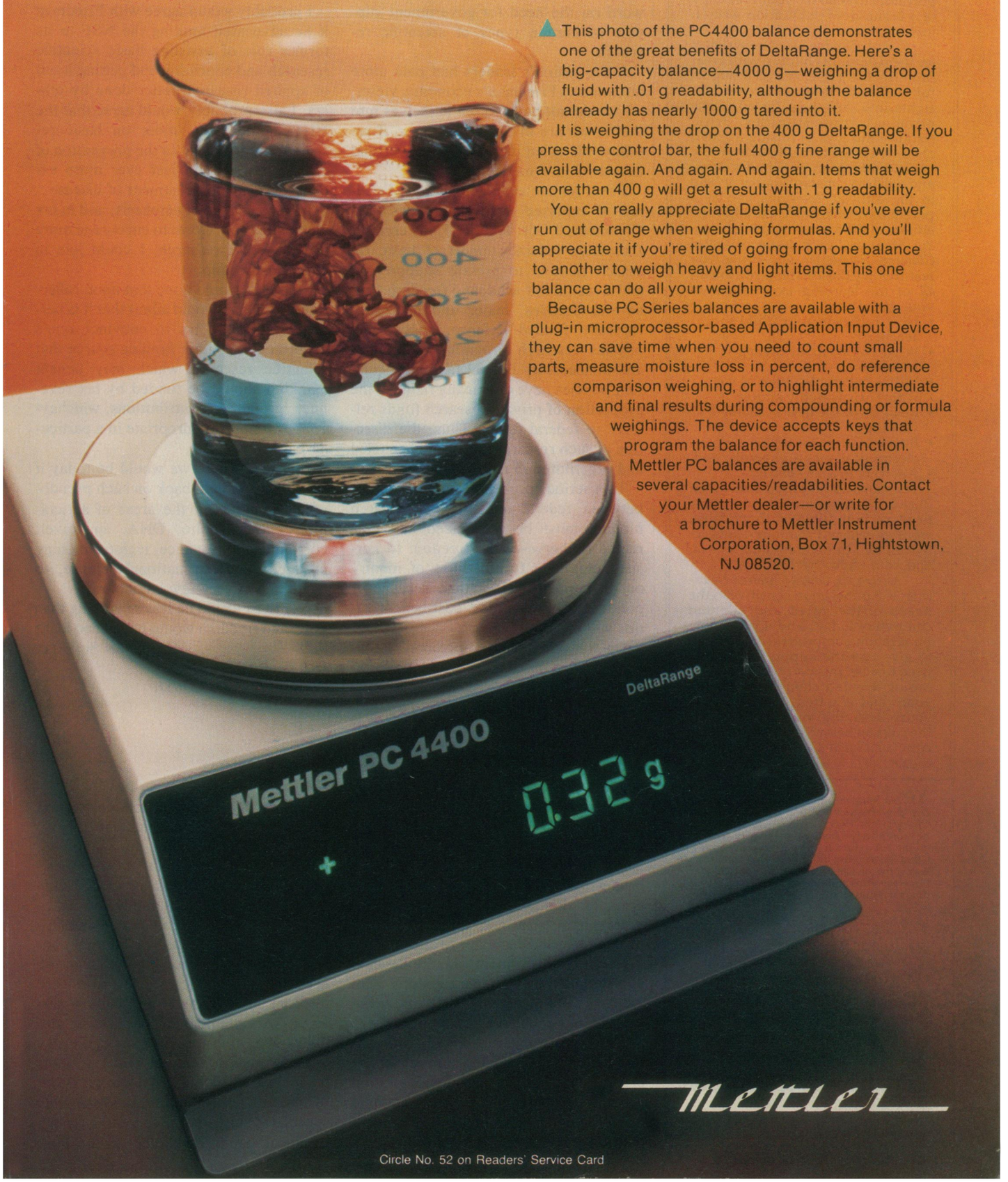

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LETTERS

The Federal Government's Role in Basic Research

Recent and widely publicized remarks by economist and Nobel laureate Milton Friedman must *not* be taken as the last word on the need for government support of certain types of scientific research.

If the nation's leaders had paid more attention to Friedman's economic views, we would not have gotten ourselves into the fix we are in today; however, if we follow his scientific advice we will find ourselves in even deeper trouble.

First, let me point out where Friedman's reported analysis (News and Comment, 3 Oct. 1980, p. 33) is correct: Excessive federal support of basic research relative to private support can and does inhibit academic freedom. For several decades, major and necessary federally funded defense, space, and physics research programs and major and unnecessary federal tax and regulatory policies have drastically reduced the proportion of private research funds relative to federal funds. Thus, the direction of such research has been channeled and prostituted in many instances.

This serious problem of the imbalance between federal and private research funding must be recognized and corrected. Otherwise, the freedom to pursue potentially fruitful lines of inquiry out of curiosity rather than because of politics or bureaucratic cost-benefit ratios will disappear.

On the other hand, Friedman's solution to this imbalance would be catastrophic to the future of the country, its economy, and freedom itself. To advocate the abolishment of the National Science Foundation (NSF), the National Institutes of Health (NIH), and federal support of higher education is like treating brain tumors with a guillotine.

The present difficulty with the government's role in basic research is that we have confused what the government's proper role should be. First of all, government should encourage private investment in basic and applied research through tax and regulatory reform.

Second, government should develop appropriate research partnerships with industry and academia such as those existing in agriculture and aeronautics.

Third, government should provide tailored encouragement and support for the private development and demonstration of new technologies where national needs demand more rapid development than current economic forces will allow.

Finally, government must fund those costly research and development programs, such as in nuclear fusion, space, defense, and global environment, which are obviously necessary but far beyond the risk-taking potential of the private sector under any foreseeable economic and regulatory conditions.

I probably would agree with Friedman if he advocated limiting the NSF to its former role of assisting basic scientific research and education and getting it out of applied research better done by others. I also probably would agree that the NIH should focus more on basic research that may lead to the prevention of disease rather than just ever more expensive means of treatment of disease.

In such change of emphasis, and in tax and regulatory reform to encourage more private-sector research, I could join in enthusiastic support.

Finally, I would hope that upon reflection, Friedman would admit that it is perfectly ethical to try to convince one's government or other funding source that scientific research which may benefit mankind should be funded by tax revenues, profits, or contributions, whichever appears most appropriate in a particular case.

Consider where we would be today if scientists had held back on such pseudo-ethical grounds in the areas of agriculture, energy, polio, DNA, air travel, communications, space, high-technology products, and our national defense, to name only a very few examples.

Our lives would be less rewarding than now, and freedom would have been lost.

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Teletext Systems

William J. Broad's article on teletext standards (News and Comment, 7 Nov. 1980, p. 611) attributes to one of us, H.M.S., the conclusion that the enthusiasm of some networks for closed captioning was probably motivated by a desire to "waste" potential communications capacity. In quite a different context, where we were emphasizing the need for systematic policies to ensure freedom and diversity in teletext services, we commented on possible motives. We did not then, nor did we ever, speculate that anyone's support for a closed captioning system grew out of anticompetitive motives. We merely speculated that a possible motive for the technical standards choice was to limit

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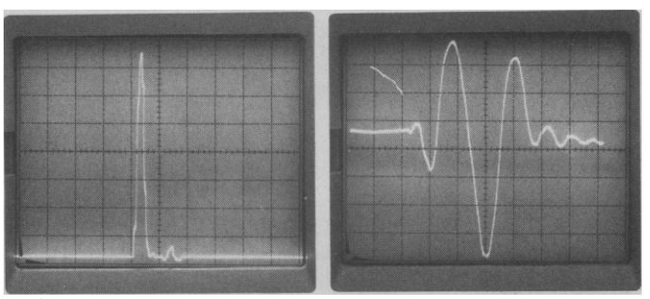

***At left, the 12-ns pulse** and leading edge information were captured with a Biomation Model 6500, sampling at 2-ns intervals. Each scope division represents 20 ns. **Signal at right** was captured by the precision Model 1010. Each division is 20 μs wide.*

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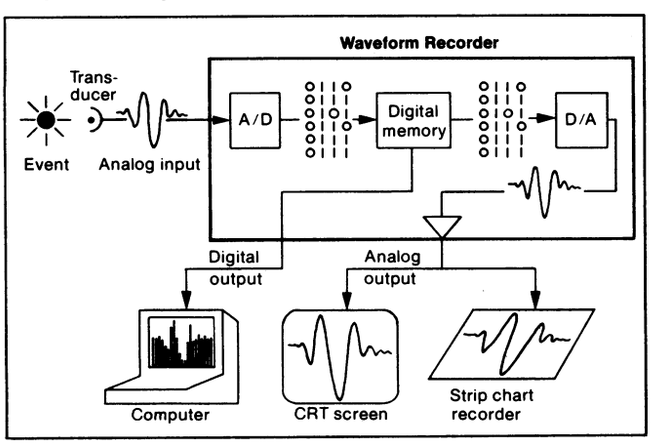

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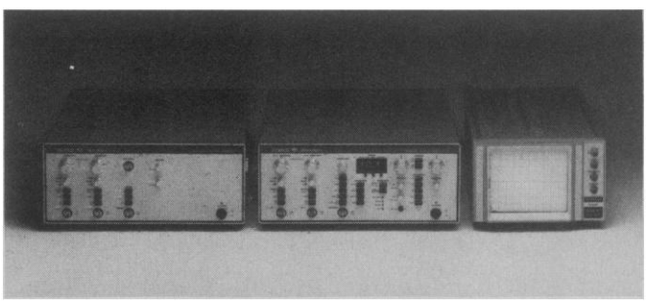

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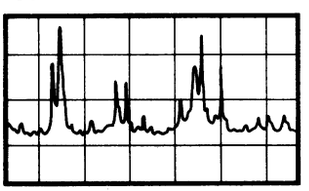
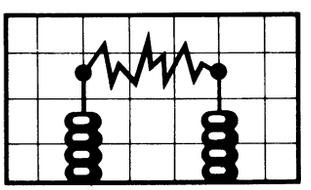
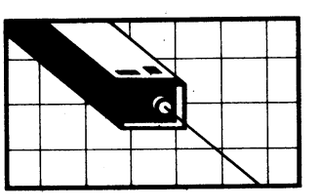


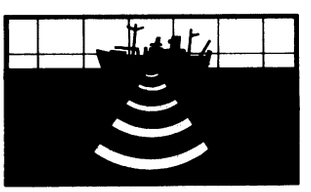
***KINETIC CHEMISTRY**—Mass spectroscopy/Fluorescence/Pulse radiolysis/Flash Photolysis/NMR/Stopped flow/T-jump*



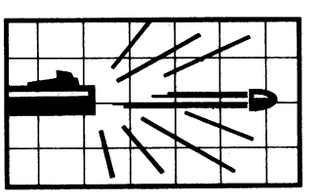
***ELECTRICAL/ELECTRONICS**—HV design & testing/Analog circuit design/Automated test systems/ Energy conversion/ Telecommunications*



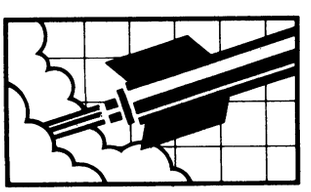
***LASERS**—Pulsed lasers/Laser fusion/Luminescence/Laser-plasma interactions/Laser communications/LIDAR*



***ULTRASONICS**—Sonar/ Acoustic emission/Body-scanners/UNDT*



***BALLISTICS**—Weapons research/Explosives testing/ Shock tube physics*



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16 January 1981, Volume 211, Number 4479 **SCIENCE**

Sex and Mathematics

On 12 December 1980, the President signed the National Science Foundation Authorization and Equal Opportunities in Science and Technology Act, which sets aside $30 million for projects designed to increase the participation of women and girls in science and to provide better opportunities for women scientists. Senator Edward Kennedy, the Senate Subcommittee on Health and Scientific Research, and a coalition of women scientists worked hard for over 3 years to get this law passed.

Among those active in this work were members of the Association for Women in Mathematics and the Joint Committee on Women in Mathematics. Due in large part to the work of these two groups, the past decade has seen evidence of progress in opportunities for women in mathematics. There have been two women vice-presidents of the American Mathematical Society (AMS); the Mathematical Association of America (MAA) has its first woman president; the number of women on mathematics faculties of universities has been rising slowly; women are giving invited talks at AMS and MAA meetings; and the percentage of doctoral degrees in mathematics awarded to women has risen from approximately 6 percent in 1970 to approximately 14 percent in the last 2 years.

The 12 December issue of this magazine reported a study* which showed that the mean Scholastic Aptitude Test (SAT) mathematics score of boys in the top 2 to 5 percent of a group of seventh graders was consistently higher than that of girls in the same group. On that basis the investigators hypothesized that sex differences in achievement in and attitudes toward mathematics result from superior male mathematical ability. There are at least two problems with this hypothesis. First, environmental and cultural factors have not been ruled out. Anyone who thinks that seventh graders are free from environmental influences can hardly be living in the real world. While the formal training of all students may be essentially the same, the issues of who helps with mathematics homework, of what sort of toys and games children are exposed to, of what the expectations of parents and teachers are, and of a multitude of other factors cannot lightly be set aside. Second, it is not clear that SAT mathematics scores are a good measure of inherent mathematical ability. In the *Harvard Educational Review*, August 1980, Rex Jackson of the Educational Testing Service wrote that "the developers of the SAT do not view it as a measure of fixed capacities," but instead, "The test is intended to measure aspects of developed ability." Certainly there is no evidence that SAT scores are good predictors of creative ability in mathematics. Not a single student identified by the study as mathematically precocious—boy or girl—has gone on to do graduate work in mathematics, although a number are in or have completed graduate school in other fields.

The study has, of course, attracted the attention of the press, which largely ignored the cautionary statements that the data were consistent with numerous alternative hypotheses. It is virtually impossible to undo the harm that the sensationalized coverage has done. The proponents of the Equal Opportunities in Science and Technology Act do not deserve to hear from those who have consistently opposed the legislation that it is a waste of money because women are genetically inferior when it comes to mathematics. More research may well be needed on whether girls respond differently than do boys to various stimuli in their learning of mathematics and whether different approaches to teaching might be effective. Certainly, more research is needed on how to identify and nurture the truly creative. More importantly, however, work is needed by everyone on changing the environmental factors which are barriers to the full realization of the potential of women and girls.—ALICE T. SCHAFER, *Professor of Mathematics, Wellesley College, Wellesley, Massachusetts 02181, and* MARY W. GRAY, *Professor and Chair, Department of Mathematics, Statistics and Computer Science, American University, Washington, D.C. 20016*†

*C. P. Benbow and J. C. Stanley, *Science*, 12 December 1980, p. 1262. †Dr. Schafer is retiring chairperson and Dr. Gray is incoming chairperson of the Joint Committee on Women in Mathematics of the AMS, MAA, National Council of Teachers of Mathematics, and Society for Industrial and Applied Mathematics.

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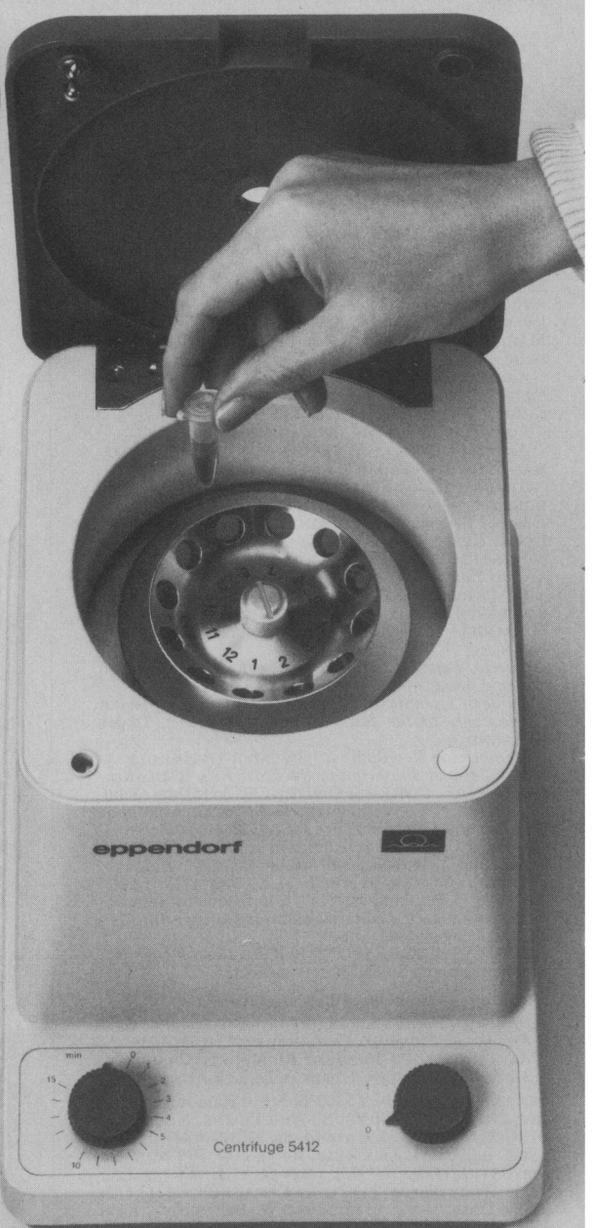

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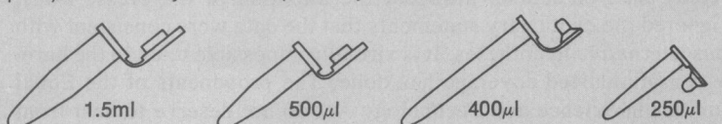

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