15 February 1980 • Vol. 207 • No. 4432 $1.50

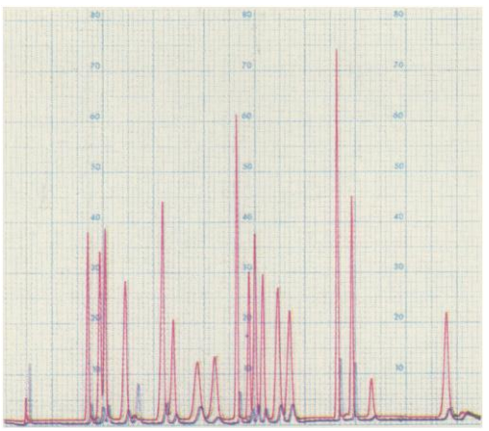
# SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

# The sensible analyzer

The 119CL is the sensible amino acid analyzer that gives you fast, accurate results with simple programming and automatic operation—all at moderate cost. Beckman representatives install your analyzer, then thoroughly train you on your own instrument. Illustrated guides show you how to set up various runs. And the proven components of the Model 119CL assure you of reliable operation.

From a performance standpoint, the 119CL comes close to analyzers costing twice as much. For instance, its sensitivity of 0.5 nanomole means accurate analysis of very small samples. Solid-trace recordings are linear with concentration for easy quantitation. Fast run times



give complete single-column hydrolyzate analyses in only 1½ hours (see chromatogram) and single-column physiological separations in only 4½ hours—times which include regeneration and equilibration. And, if you want to eliminate tedious manual calculations entirely, just add the companion Model 126 Data System.

Send for literature on the sensible 119CI : the best-selling analyzer in the world. Ask for SB-428 from Spinco Division, Beckman Instruments, Inc., 1117 California Ave., Palo Alto, CA 94304.


**BECKMAN®**

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ISSN 0036-8075

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# SCIENCE





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# AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





**COVER**

Male, black-chinned hummingbird (*Archilochus alexandri*) feeding at *Penstemon barbatus* at a site in the Chiricahua Mountains, Arizona. This tubular corolla, with the recurved lip to eliminate a landing place for insects, is adapted to attract hummingbirds. Although many hummingbird-pollinated flowers are red, the birds must learn to associate red with nectar sources. Moreover, the birds' vision extends into the near ultraviolet, and they can be taught to associate food with any color. See page 786. [T. H. Goldsmith, Yale University, New Haven, Connecticut]

# Scientists and engineers find computer systems powerful tools and control.

## Why?

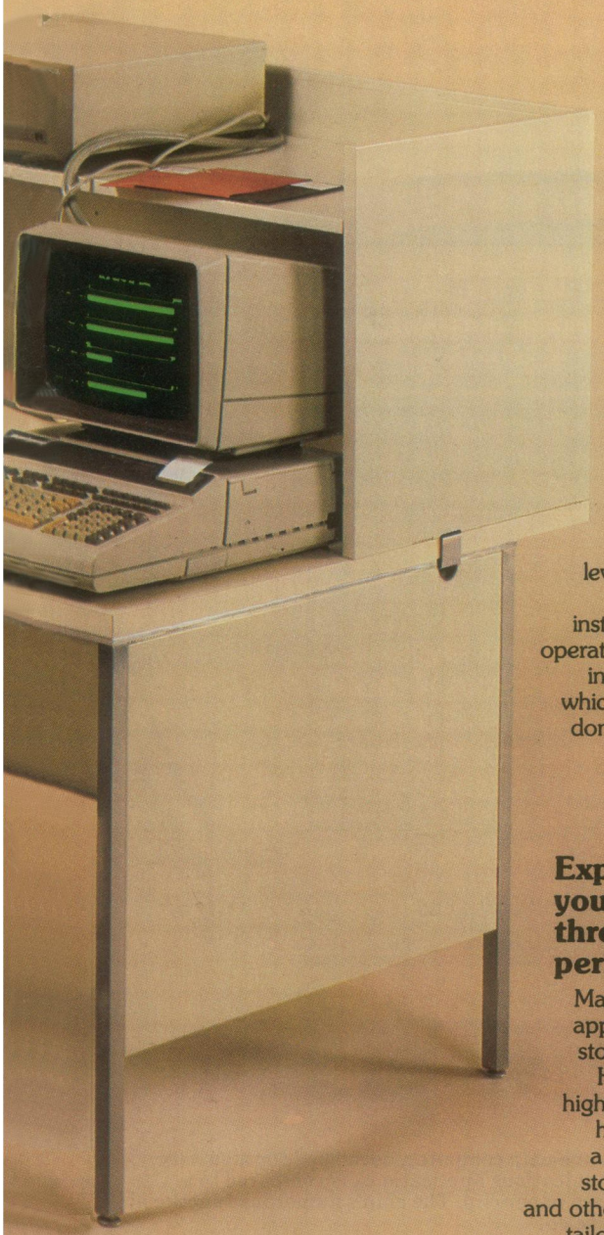
*Interfacing power.* Today's Hewlett-Packard desktop computer systems have such high performance interfacing features as direct memory access (DMA), vectored priority interrupt (up to 15 levels) and Enhanced BASIC and HPL programming languages. One model gives you up to 449K bytes of fully usable memory; another offers assembly language. Implementing your data acquisition and control system is as simple as choosing from one of four interface protocols on plug-in cards: HP-IB, Bit-Parallel, BCD or RS-232-C.

*Days, instead of weeks.* You can unpack a system and have it up and running on a production line, or in the lab in about one-third of the time you'd expect. Days, instead of weeks or even months.

*From lab to production line.* Once it's up, your test and control system can move with ease from one environment to another with no hardware or operating system changes. This kind of flexibility, coupled with the power and sophistication of today's models, makes an HP desktop computer the logical choice for your data acquisition and control needs.

*Friendly.* Together with the power to handle your big data acquisition and control problems, today's systems retain the reliability and ease of use that have always characterized HP desktop computers.

# today's desktop for data acquisition



DESIGNED FOR HP-IB SYSTEMS

## HP-IB: Not just a standard, but a decade of experience.

HP-IB is much more than just HP's implementation of IEEE Standard 488-78. It reaches beyond IEEE-488-78 to cover the operational area as well as the mechanical, electrical and functional specifications. For example, HP-IB systems incorporate a built-in, high level I/O language that saves you the time and expense of writing instrument drivers and configuring operating systems. It means powerful interfacing through a system in which a lot of the work has been done for you.

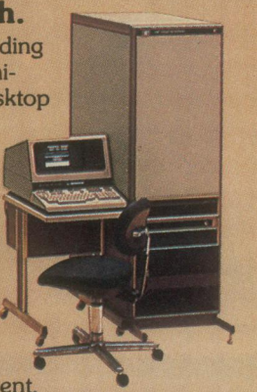
## Expand your system through HP peripherals.

Many data acquisition and control applications require external mass storage for large volumes of data. HP mass storage media include high speed flexible discs capable of handling data at burst rates and a selection of fixed discs offering storage up to 120M bytes. These and other input and output peripherals tailored for HP desktop computers allow you to configure the system that meets your needs today and accommodates future growth, as well.

## A wide selection.

We build a broad range of desktop computers, with one just right for your data acquisition and control application. From the low cost HP 9815 through the HP 9825, the standard for HP-IB controllers; the HP System 35 with BASIC and assembly language; and the HP System 45B with advanced graphics capability, every HP desktop computer has superior interfacing characteristics in terms of human engineering, ease of use and power.

## A growth path.



HP can meet expanding needs with communication links from desktop computers to HP 1000 series computers. For multi-user, multi tasking problems, HP 1000 systems offer a range of compatible RTE operating systems with software options for data base management, factory data collection and graphics.

**For more information.** Call 800-821-3777, extension 137, toll-free day or night (Alaska and Hawaii included). In Missouri, call 800-892-7655, extension 137. Or write 3404 E. Harmony Road, Fort Collins, Colorado 80525.

**For a demonstration.** Call the HP regional office nearest you: East 201/265-5000; West 213/970-7500; Midwest 312/255-9800; South 404/955-1500; Canada 416/678-9430.

409/12

HEWLETT PACKARD

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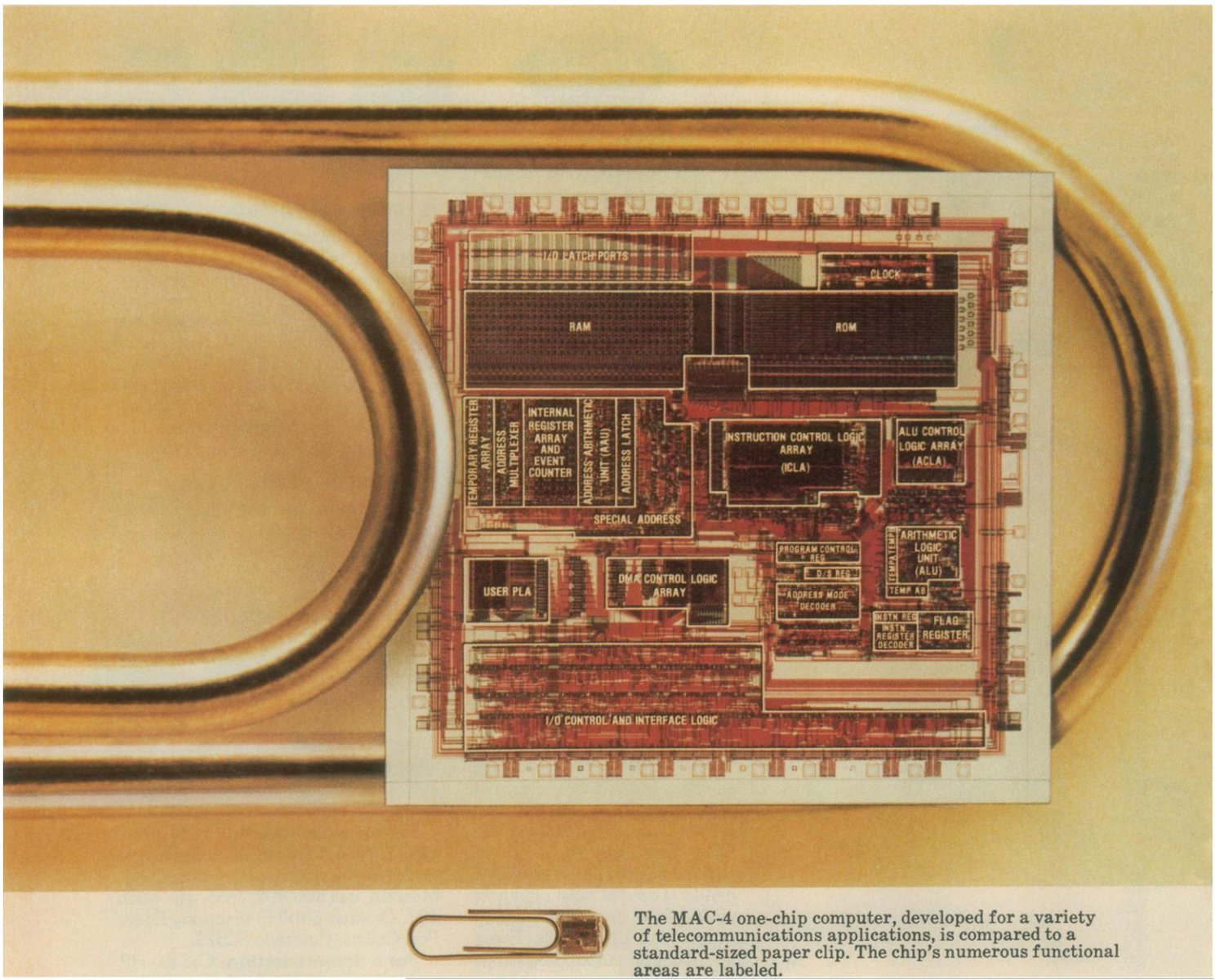
# The one-chip computer: offspring of the transistor




The MAC-4 one-chip computer, developed for a variety of telecommunications applications, is compared to a standard-sized paper clip. The chip's numerous functional areas are labeled.

One of the transistor's latest descendants is the Bell System's 30,000-element MAC-4 "computer-on-a-chip." It's another in a long line of microelectronic developments that have come from Bell Laboratories.

The MAC-4 is so efficient that a program written on it takes 25 percent less storage space than that required by most other microcomputers. Its assembler language, C, also developed at Bell Labs, has features that make MAC-4 easier to program, debug and maintain. And the MAC-4 can handle anything from nibbles to bytes to words with its 4-, 8-, 12-, and 16-bit operations capacity.

Like other one-chip computers, the MAC-4 has sufficient memory to support its varied tasks—3000 nibbles of read-only memory and 200 nibbles of random access memory coupled to 34 input/output ports.

Fabricated with the latest CMOS technology, the MAC-4 needs little power. Thus it is well matched to a variety of telecommunications applications.

### It started with the transistor

MAC-4 is just one current example of the many microelectronic devices to come from Bell Labs since we started the solid-state revolution with the invention of the transistor in 1947.

Over the past three decades, our advances in materials, processing, and devices have been vital to solid-state technology. These include:

- The Junction Transistor
- Crystal Pulling
- Zone Refining
- Field-Effect Transistor
- Diffusion
- Solar Cell
- Oxide Masking
- Thermocompression Bonding
- Photolithography
- Epitaxial Film Process
- Magnetic Bubble Memory
- Charge-Coupled Device
- Semiconductor Heterostructure Laser Used in Lightwave Communications
- Electron-Beam Exposure System

### Today and tomorrow

Today, we continue to make important contributions to solid-state technology. For example, we've developed a rugged 65,536-bit RAM that can tolerate processing faults. Corrections can be made on the chip itself, so we can get more usable chips out of each manufacturing batch—and thus lower unit costs.

In materials processing, we've developed a technique for precisely controlling the growth of successive atomic layers of single crystal materials. This "molecular beam epitaxy" process is finding increasing use within Bell Labs and elsewhere in the electronics industry. We've used it to fabricate a device that permits us to double the speed of electrons by channeling them into crystal layers where they meet less resistance.

Other advances, in X-ray lithography and new resist materials, for example, promise to help place more elements on microelectronic devices and thus enhance their ability to perform important tasks.

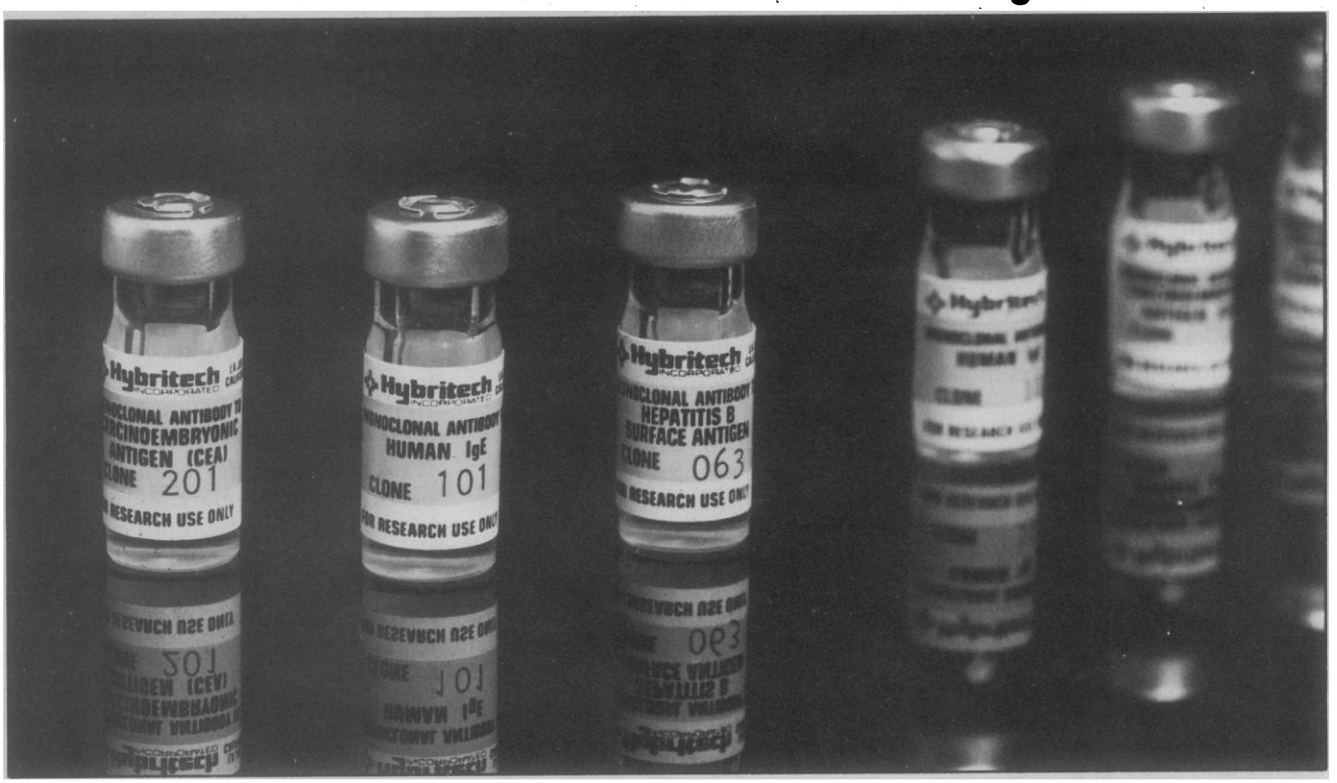
As the solid-state revolution continues, these and other developments from Bell Labs will play an important part in it. What's important to us is the promise these advances offer for new telecommunications products and services. Like the transistor, MAC-4 and its solid-state relatives will find more and more applications in the nationwide telecommunications network.

*For further information, or to inquire about employment opportunities, write: Bell Laboratories, Room 3C-303, 600 Mountain Avenue, Murray Hill, N.J. 07974.*


**From Science: Service**

# Now Available!

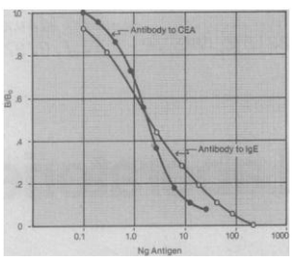
## Monoclonal Antibodies to *Human* CEA and IgE.




Monoclonal antibodies are no longer a research novelty—they are a research necessity! Increasingly, technical advances and innovations based on immunochemical techniques are incorporating hybridoma-produced antibodies. And the exceptional specificities of these monoclonal antibodies are opening up whole new possibilities for medical diagnosis, immunotherapy, and affinity chromatography.

Recently, Hybritech announced the availability of a system of monoclonal antibodies to the hepatitis B surface antigen. Now we have two new families of monoclonal antibodies for use in the areas of tumor-associated antigens and serum proteins. The first commercially available monoclonal antibodies to *human* Carcinoembryonic Antigens (CEA) and *human* Immunoglobulin E (IgE) are ready for delivery![1]

Hybritech antibodies to CEA offer precise, specific probes for illuminating and characterizing an antigen that is the center of intense research... and intense controversy. For development of new assay techniques, Hybritech's excellent antibody affinities permit quantitation well below 1 ng. For research into tumor location with radioactively labeled antibody and external scintigraphy, monoclonality is of demonstrated value[2] And projects aimed at demonstrating immuno-suppression of tumors or at developing antibody-linked toxins should benefit immediately from the availability of highly purified monoclonal antibodies to CEA.




**Representative Saturation Analysis (90 μl reaction volumes)**

Our monoclonal antibodies to human IgE also offer significant advantages. Antibody affinities in excess of $10^{10}$ liters/mole translate into superior assay sensitivities, with quantitation down to 0.1 ng and detection to 60 pg. The antibodies are specific for the $Fc_\varepsilon$ portion of the IgE molecule, with no detectable cross-reactivity to other immunoglobulin classes.

Because of the diversity of research applications for Hybritech monoclonal antibodies, we have developed a unique process for purification and lyophilization that optimizes their incorporation into immunochemical systems. Now you can purchase pure, homogeneous antibodies with rigorous affinity specifications.

So contact Hybritech today for more information about immediate delivery of monoclonal antibodies to human CEA and IgE. Ask about our technical bulletins too. The Hybritech family of monoclonal antibodies is *growing*. And they are a research necessity!


**Hybritech** INCORPORATED

2945 Science Park Road • La Jolla, CA 92037 • (714) 455-6700

1. At the present time, Hybritech antibodies are not designed or intended for either diagnostic or therapeutic use. The products are therefore labeled and made available FOR RESEARCH USE ONLY.

2. See B. Ballou et al: "Tumor location detected with radioactively labeled monoclonal antibody and external scintigraphy"; *Science*, Nov. 1979; Vol. 206. pp. 844.



Circle No. 161 on Readers' Service Card

# *Would you pay twice as much for the family protection you need when you could get the same coverage at half the cost?*

***Not likely,*** if you realized you were eligible for low-cost individual life insurance from Teachers Insurance and Annuity Association! The brief cost comparison chart below illustrates why it pays to shop for life insurance, and the magnitude of your TIAA cost advantage. Check to see how much less owners of TIAA 5-Year Renewable Term policies pay than persons similarly insured by the country's biggest insurers—companies that sell one third of the policies purchased by Americans each year.

**COMPARISON OF TIAA WITH THE 10 LARGEST U.S. INSURANCE COMPANIES**
**20 Year Average Annual Costs* for $50,000 5-Year Renewable Term Policies**

| | Policies Issued to Men | | | Policies Issued to Women | | |
|---|---|---|---|---|---|---|
| | Aged 25 | Aged 35 | Aged 45 | Aged 25 | Aged 35 | Aged 45 |
| **TIAA** | **$ 91.00** | **$189.50** | **$445.00** | **$ 73.00** | **$126.00** | **$281.50** |
| Aetna Life | 214.50 | 344.00 | 793.50 | 209.00 | 295.50 | 629.50 |
| Conn. General | NOT ISSUED | | | | NOT ISSUED | |
| Equitable | 183.00 | 334.00 | 747.00 | 154.50 | 275.50 | 585.00 |
| John Hancock | 203.50 | 326.00 | 723.50 | 193.50 | 291.50 | 637.50 |
| Mass. Mutual | 182.50 | 310.50 | 732.50 | 171.50 | 286.50 | 697.00 |
| Metropolitan | 119.00 | 225.50 | 584.50 | 103.50 | 177.50 | 469.00 |
| New York Life | 171.50 | 290.00 | 624.00 | 156.00 | 236.50 | 465.00 |
| Northwestern Mutual | 154.00 | 277.00 | 628.50 | 137.00 | 242.50 | 545.00 |
| Prudential | 150.50 | 239.00 | 552.00 | 130.00 | 179.50 | 336.00 |
| Travelers | 198.50 | 352.50 | 801.00 | 181.50 | 275.50 | 589.50 |
| **Mean Cost, Largest Companies** | **$175.22** | **$299.83** | **$687.39** | **$159.61** | **$251.17** | **$550.39** |
| % Greater than TIAA | 93% | 58% | 54% | 119% | 99% | 96% |

*Based on published 1979 premium rates and dividend scales (dividends not guaranteed), adjusted for interest (5%) to recognize the time value of money. (Sources: Diamond Life Bulletins, Best's Flitcraft Compend)

The figures speak for themselves: For example, the mean cost for $50,000 5-Year Renewable Term policies issued by these insurers to men aged 35 is 58% higher than the same coverage with TIAA; and for 35 year old women it's 99% higher. Whether you choose 5-Year Renewable Term or some other plan, TIAA insurance is the best buy for you because you are a member of the academic and research community. To learn how you can give your family the most new protection for the least money just get in touch with TIAA!

## *Mail Coupon or Call Collect*

For more information, just return the coupon at right or, for immediate assistance, call the TIAA Life Insurance Advisory Center—collect—(212) 490-9000. An insurance counselor will discuss your personal life insurance needs, help you select the plan and amount of coverage that's right for you and your family, and send details for you to study at home. TIAA employs no sales agents and no one will call upon you as a result of your inquiry.

***Eligibility*** to apply for life insurance from Teachers Insurance and Annuity Association is limited to employees of colleges, universities, private schools and certain other nonprofit educational or research institutions. The employee's spouse is also eligible provided more than half of the combined earned income of husband and wife is from a qualifying institution.

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Life Insurance Advisory Center SP8002K2
Teachers Insurance and Annuity Association
730 Third Avenue, New York, NY 10017

Please mail me the TIAA Life Insurance Guide and personal illustrations for the policies indicated below. I understand that no one will call upon me as a result of my inquiry.

☐ Decreasing Term ☐ 5-Year Renewable Term ☐ Whole Life

(Please print)

Name _____

Job Title _____ Birthdate _____

Home Address _____

City _____ State _____ Zip _____

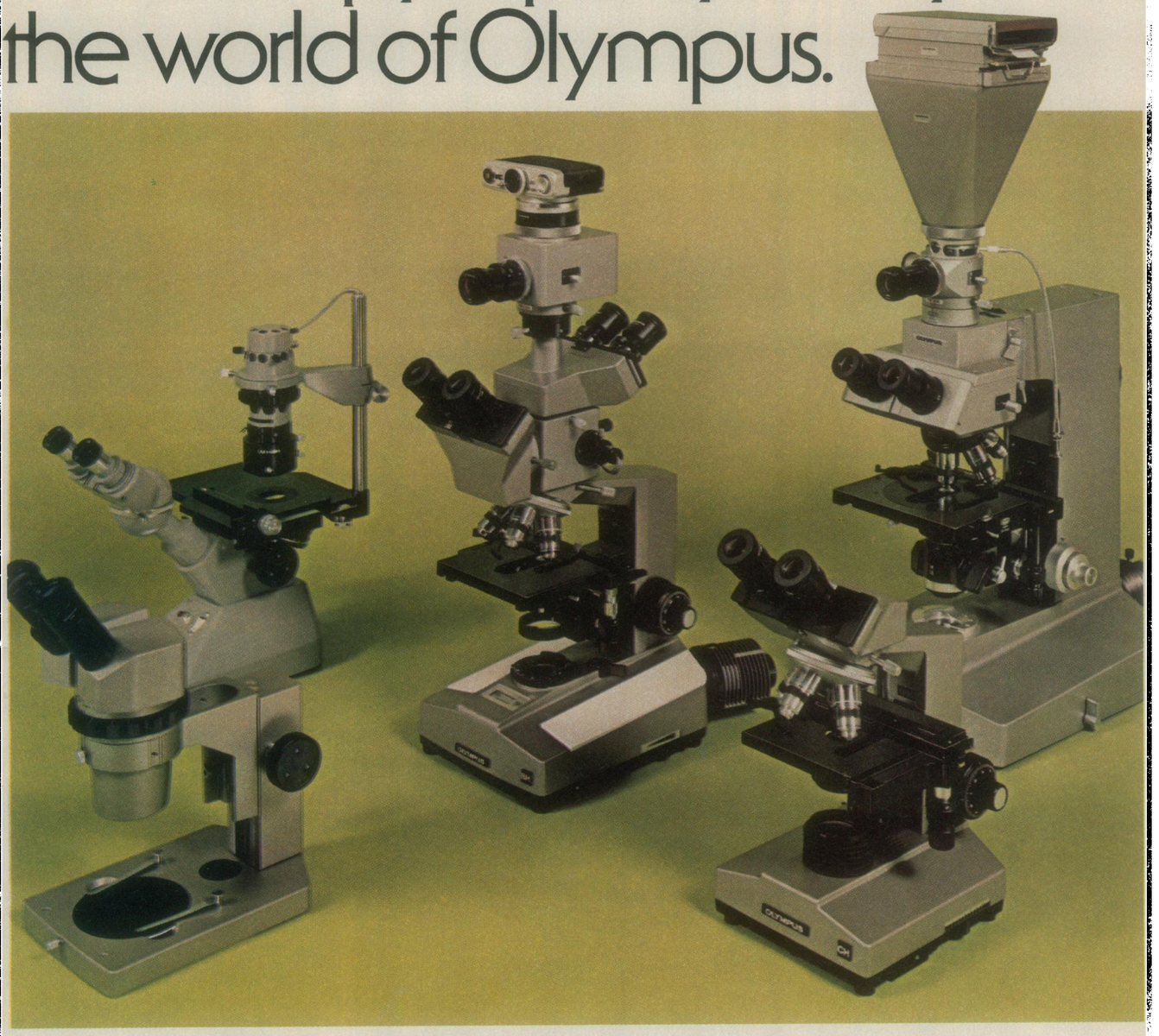
Phone #s ( ) _____ ( ) _____
Home Office

Your nonprofit educational or scientific employer (college, university, private school, etc.) _____

If your spouse is also eligible according to the rules printed at left, please provide:

Spouse's name _____ Birthdate _____

# If your requirement is superior microscopy, open your eyes to the world of Olympus.



In the forefront of scientific discovery, the Olympus name has become synonomous with quality and performance. This is best exemplified by the Olympus Microscopes, offered in a wide variety of models with sophisticated system components.

Whatever your specific microscopy needs, Olympus produces the instruments providing incredible accuracy, unsurpassed versatility and remarkable functionality and economy.

For detailed literature on Olympus Microscopes and Photomicrographic equipment ideally suited to your requirements, write Dept. R, Olympus Corporation of America/PID, 4 Nevada Drive, New Hyde Park, N.Y. 11042, stating your needs. Or for a demonstration, see your Yellow Pages for the Olympus Sales & Service Network, ready to serve you.

OLYMPUS

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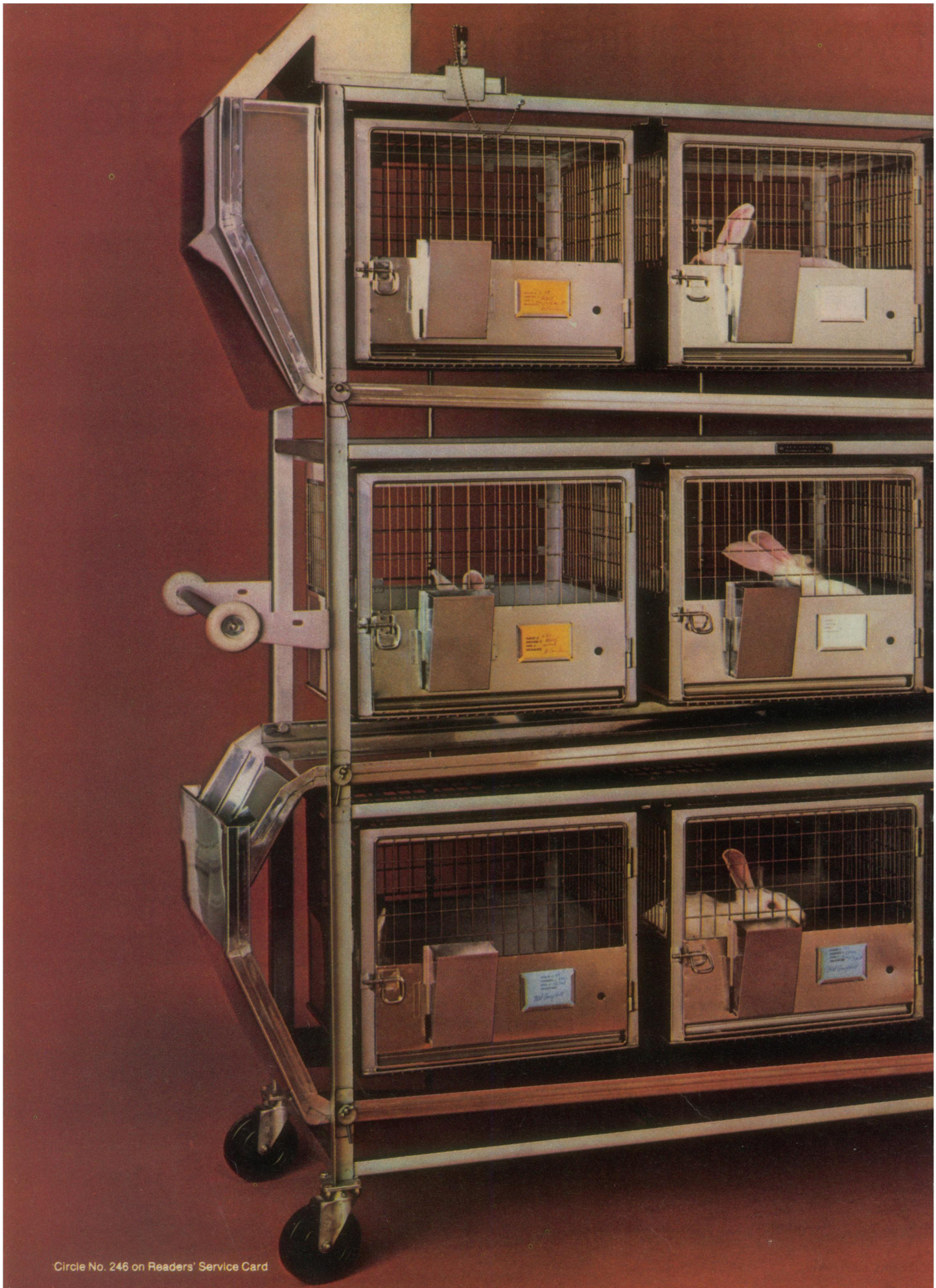


Circle No. 246 on Readers' Service Card

# This Auto-Flush™ system can substantially reduce the costs of housing your laboratory animals.

## Consider:

### Custodial care reduced

Automatic periodic flushing reduces the need for caretaker maintenance and is especially useful for weekends and holidays.

### Eliminates bedding materials

As a major supplier of laboratory animal bedding materials (Absorbi-Dri™ and Pine-Dri™) we regret to announce that this Auto-Flush system requires absolutely *no* bedding.

### Bonuses

Auto-Flush also minimizes airborne litter dust, room odors, excrement fermentation.

### Note

Auto-Flush systems are available for housing rabbits and smaller rodents.

### Please write or call for details

Lab Products Inc., 365 West Passaic St.
Rochelle Park, New Jersey 07662
Phone: 201/843-4600

**lab products inc**
a bioMedic company



LP 79-1431

# Lanier introduces the No Problem™ typewriter for your technical typing.

Want to get your typing back faster than ever before? **NO PROBLEM**

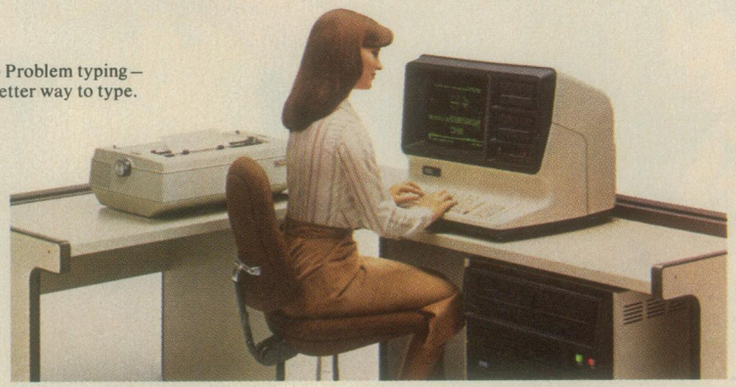
Want to type Greek and math symbols right on the screen? **NO PROBLEM**

Want to type and edit multi-level equations with typewriter simplicity? **NO PROBLEM**

Want to add line drawings and charts to the page? **NO PROBLEM**

Most typewriters—even many of the latest electronic models—are limited to basic typing.

But the Lanier No Problem Electronic Typewriter is multi-use, with extraordinary powers for technical and scientific typing.



No Problem typing—a better way to type.

**The No Problem concept**

To begin with, the No Problem typewriter speeds up the typing of your proposals, manuals, and reports like no ordinary typewriter can.

It eliminates typing rough drafts on paper. Pages are prepared on a TV-like screen instead.

Changes and corrections are made right on the screen. So no whiteouts. No retyping. No false starts. Whole paragraphs can be moved with the touch of a few keys.

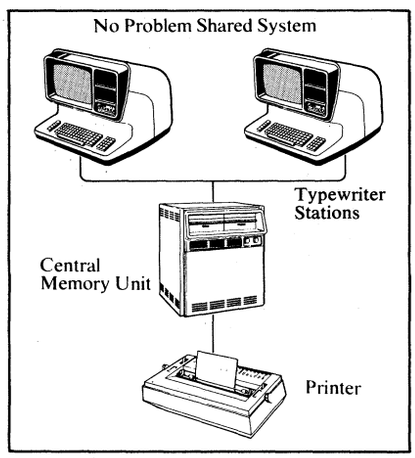
Letter quality printing is done at up to 540 words per minute.

With the No Problem typewriter, one typist can now do work as fast as 3 or 4 people using ordinary electric typewriters.

Plus, the basic intelligence for the No Problem typewriter is contained on No Problem Smart Discs.™ So future functions and improvements can be added with new Smart Discs as they are developed.

## One typewriter or a shared system

The No Problem Shared System™ offers you even greater typing capabilities.




The No Problem Shared System™ adds new capabilities to the already versatile No Problem concept.

The heart of the system is the Central Memory Unit. It can store up to 30,000 pages, giving you lower storage costs per page, and eliminating the need for typists to handle numerous discs.

You can start with one or two typewriter stations connected to the Central Memory Unit, and add typewriter stations or printers as your needs increase.

There is also an attractive economic factor in sharing printers and other equipment.

## Advanced features

Consider the old method of incorporating complex mathematical equations into your copy: leave the space blank, then hand letter them in after the page was typed. Or, you could run to the photocopier, then "cut and paste."

With the No Problem Shared System, you can incorporate *and edit* virtually any equation you may encounter—*right on the screen.* It will display *256 different characters,* including Greek and math symbols.

Line drawings can be constructed on the No Problem screen, too.

The No Problem Shared System automatically selects left, right or center page position for numbers, and chapter names on even and odd pages. Repagination automatically updates section numbers to accommodate your additions and deletions.

Advanced editing automatically positions footnotes on the proper page.

And the printing of the No Problem Shared System approaches typeset quality and flexibility. Proportional and bold printing, to fit any format or width, is easily done. Even in two typestyles and two colors on the same page at the same time.

Most of all, the No Problem Shared System can improve your cost/performance ratio dramatically with its increased workpower.

## Modular design protects your investment

You can add Shared System typewriter stations, standalone No Problem typewriters, printers and Smart Discs to your office at will.

So your investment will *continue* to be a money-making problem solver as long as you own the equipment.

## The No Problem demonstration

Your Lanier representative won't waste your time with a memorized sales pitch.

We would rather show you how No Problem typing can solve *your* problems.

Send us this coupon and we'll call immediately to set up an appointment. Or call toll free **(800) 241-1706.**

Except in Alaska or Hawaii. In Georgia, call collect (404) 321-1244.

# The No Problem Electronic Typewriter from LANIER®

LANIER BUSINESS PRODUCTS, INC.

***It does more than just type.***

Want to see Lanier No Problem typing in action? NO PROBLEM.

Send us the information below and a Lanier representative will call for an appointment.

Name_____ Title_____

Phone_____

Best Time To Call_____

Firm Name_____

Address_____ County_____

City_____ State_____ Zip_____

What kind of typing or word processing system are you using now?_____

**Lanier Business Products, Inc.**
**1700 Chantilly Dr. NE, Atlanta, GA 30324**



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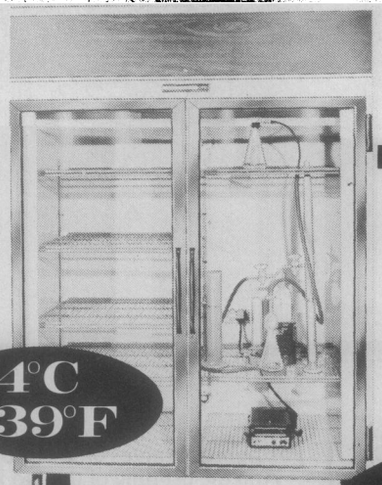


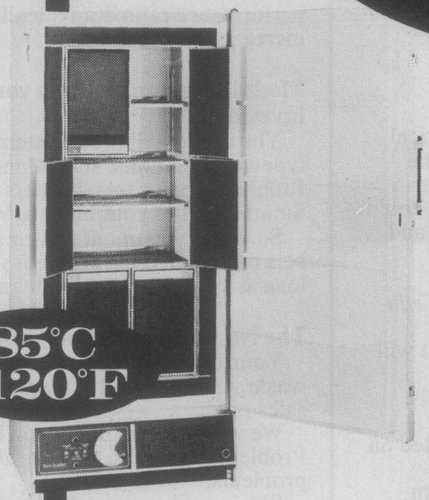
Model UC-50-RG-CH
CHROMATOGRAPHY
REFRIGERATOR

4°C
39°F

Model UC-26-F-FMS
FLAMMABLE
MATERIAL STORAGE
FREEZER

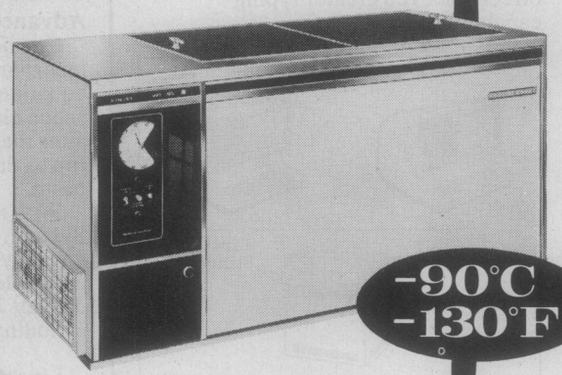
-32°C
-25°F

Dependable
Kelvinator
Economical



Model UC-122
UPRIGHT
FREEZER

-85°C
-120°F



-90°C
-130°F

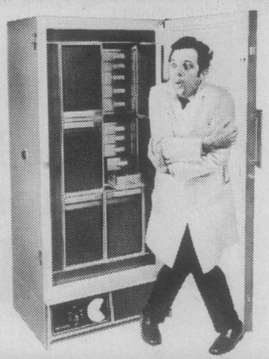
Model UC-522
CHEST TYPE
FREEZER

# Storage Ideas From Kelvinator Ultra Cold

We know what you need in the way of cold so we've designed our units to make you happy. Single and double door models for chromatography, Flammable Material Storage, quick freezing. And upright and chest models from -76°C. to -90°C. for Ultra Cold testing and research.

We sell Ultra Cold. Hair-cracking cold. Send for detailed information on our complete line of cabinets.

Kelvinator will give you the best "Cold" you ever had.



For complete information on the full Kelvinator line, contact T.M. LeClair, Sales Coordinator, Scientific and Industrial Sales. Phone; (414) 682-0156 or TWX: (910) 260-3507 TODAY!

**Kelvinator**

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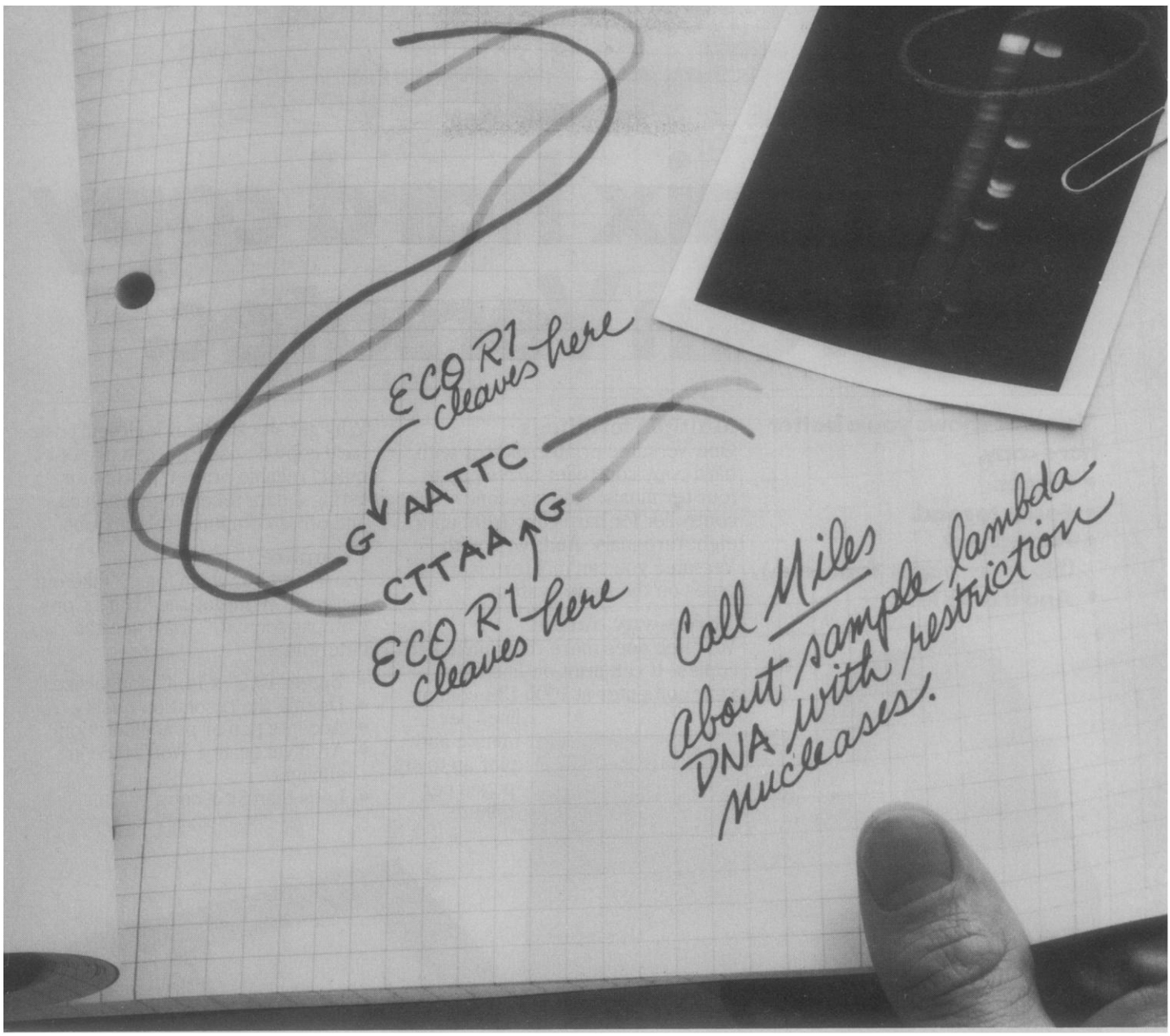


# Happy Endings.

Your DNA research should have a happy ending. That's why Miles has developed enzymes that cleave and splice DNA easily and accurately.

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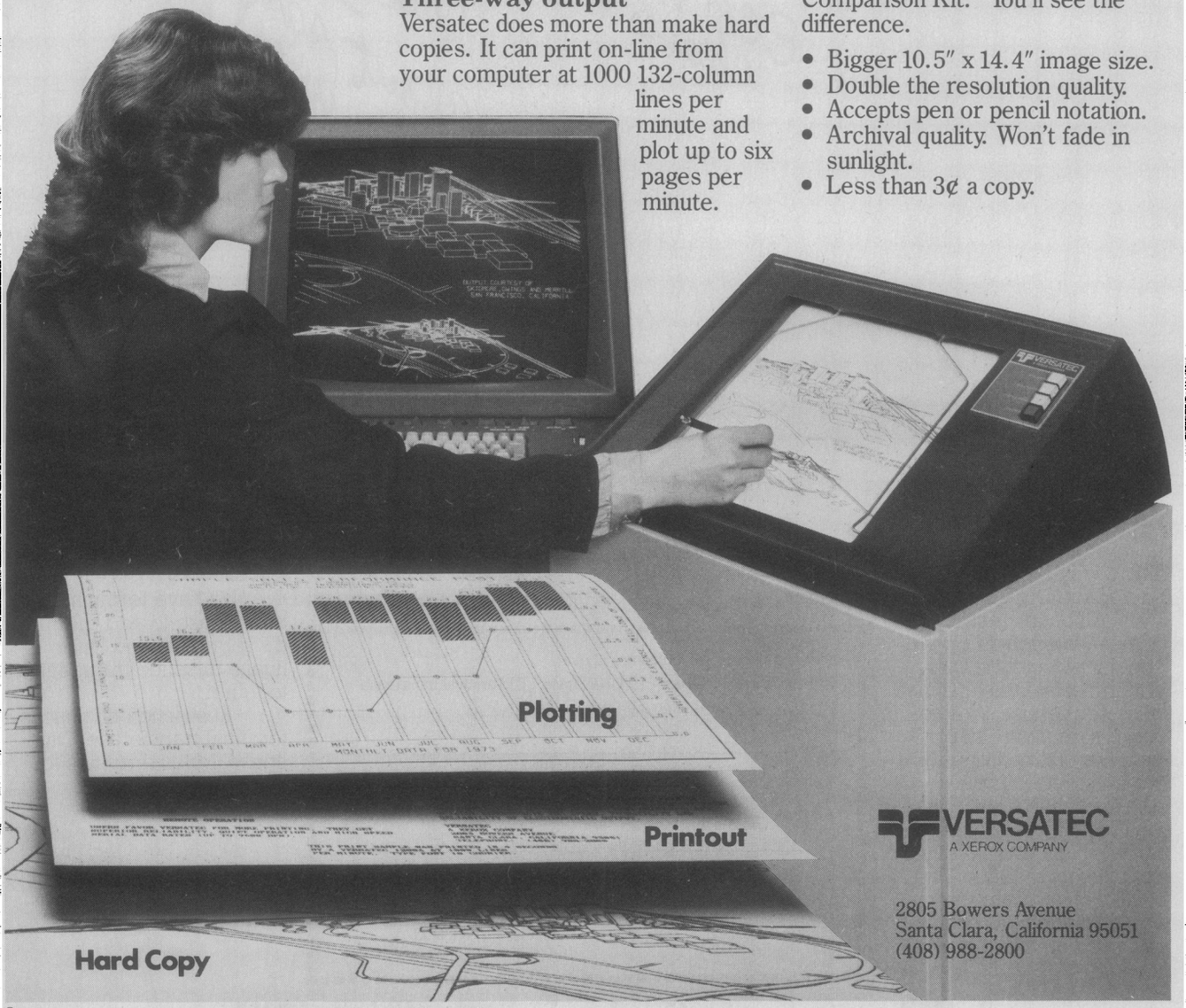


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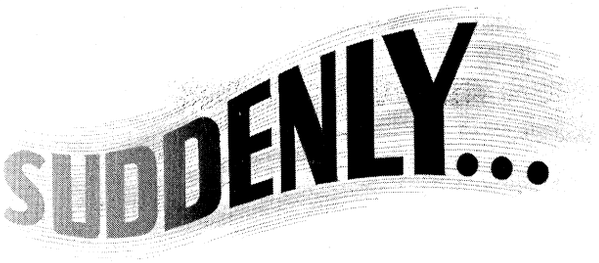


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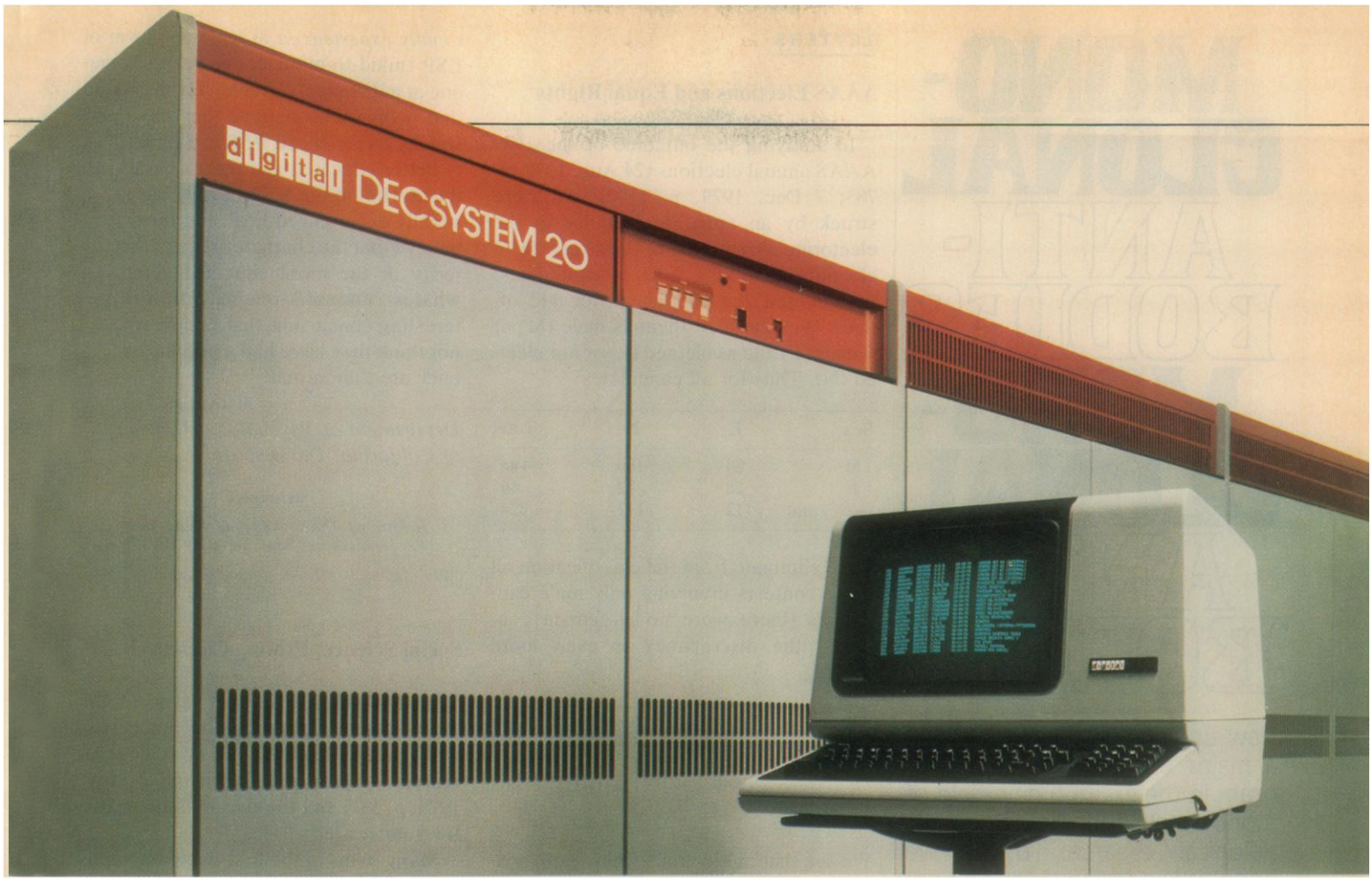


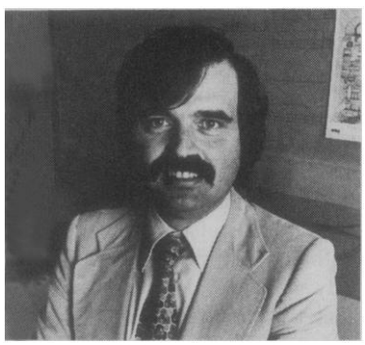

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## LETTERS

### AAAS Elections and Equal Rights

In studying the outcome of the 1979 AAAS annual elections (24 Aug. 1979, p. 783; 7 Dec. 1979, p. 1170), we were struck by an apparent inequity in the electorate's treatment of the sexes. In 73 elections involving 2 to 16 candidates, we counted 224 candidates for 112 offices. We classified them as male (M) or female (F) and as elected (E) or not elected (N). Thus for all candidates:

| Sex | E | N | Total |
|---|---|---|---|
| M | 84 | 100 | 184 |
| F | 28 | 12 | 40 |
| Total | 112 | 112 | 224 |

If we eliminate from the classification all those contests involving only male candidates (there were no all-female contests), the discrepancy is even more striking.

| Sex | E | N | Total |
|---|---|---|---|
| M | 28 | 44 | 72 |
| F | 28 | 12 | 40 |
| Total | 56 | 56 | 112 |

We see that in elections where both sexes were represented, 39 percent of the male candidates won, while in contrast 70 percent of the female candidates won.

If we reject as untenable the theory that the electorate is swayed by such an irrelevant characteristic as sex, this suggests that the nominating committees are applying more exacting standards to female candidates.

Or vice versa.

STEPHEN M. STIGLER
VIRGINIA L. STIGLER
*5816 South Blackstone Avenue, Chicago, Illinois 60637*

### Is the Paranormal "Normal"?

Nicholas Wade (News and Comment, 4 Jan., p. 41) writes of Wagner and Monnett's conclusion that American college professors have much more positive attitudes toward extrasensory perception (ESP) than does the American population in general. They report that 15 percent think ESP is scientifically established and 50 percent think it is a likely possibility. It is more likely, however, that college professors are simply typical Americans. In a representative survey of the American population, conducted in 1973, Greeley (*1*) found that 58 percent of the population believed they had *personally experienced* at least one form of ESP (mind-to-mind contact with someone at a distance). Greeley further found that people who believe they have personally experienced ESP are significantly better educated and more liberal than those who do not believe they have personally experienced ESP. For those who believe that the characteristics of the majority or the more educated determine what is "normal," one may draw the interesting conclusion that people who do not think they have had a psychic experience are "abnormal!"

CHARLES T. TART
*Department of Psychology, University of California, Davis 95616*

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### Social Science: Ethics of Research

I am writing to correct some of the more blatant errors in Constance Holden's article "Ethics in social science research" (News and Comment, 2 Nov. 1979, p. 537) and to raise an issue or two for your readers.

Many items in the first two paragraphs of Holden's article are not accurate. In addition to those mentioned in the letter from Horowitz (30 Nov. 1979, p. 1022) and in the erratum in the same issue, I note the following errors. My research on impersonal sex acts in public restrooms was conducted not "in 1969" but from 1965 to 1968. Observations of these acts were made in dozens of public rest facilities rather than "in a public bathroom." My study was not "designed to cast light on society's treatment of homosexuals," noble as such a purpose might be, but to investigate a covert and highly stigmatized form of behavior engaged in by men who claim a *range* of sexual orientations and life-styles.

I did fill the role of a "watchqueen" to alert the participants to approaching intruders, although the purpose of performing those duties was to facilitate observing sexual behavior in a natural setting in the least obtrusive way possible. Rather than "lying" to the Department of Motor Vehicles (as the article's indictment reads) in order to trace license numbers of potential respondents, I misrepresented myself to the local campus police as engaging in "market research" for the purpose of protecting my respondents. The implication that I "then joined a public health survey team" in order to deceive my "subjects" is a distortion.

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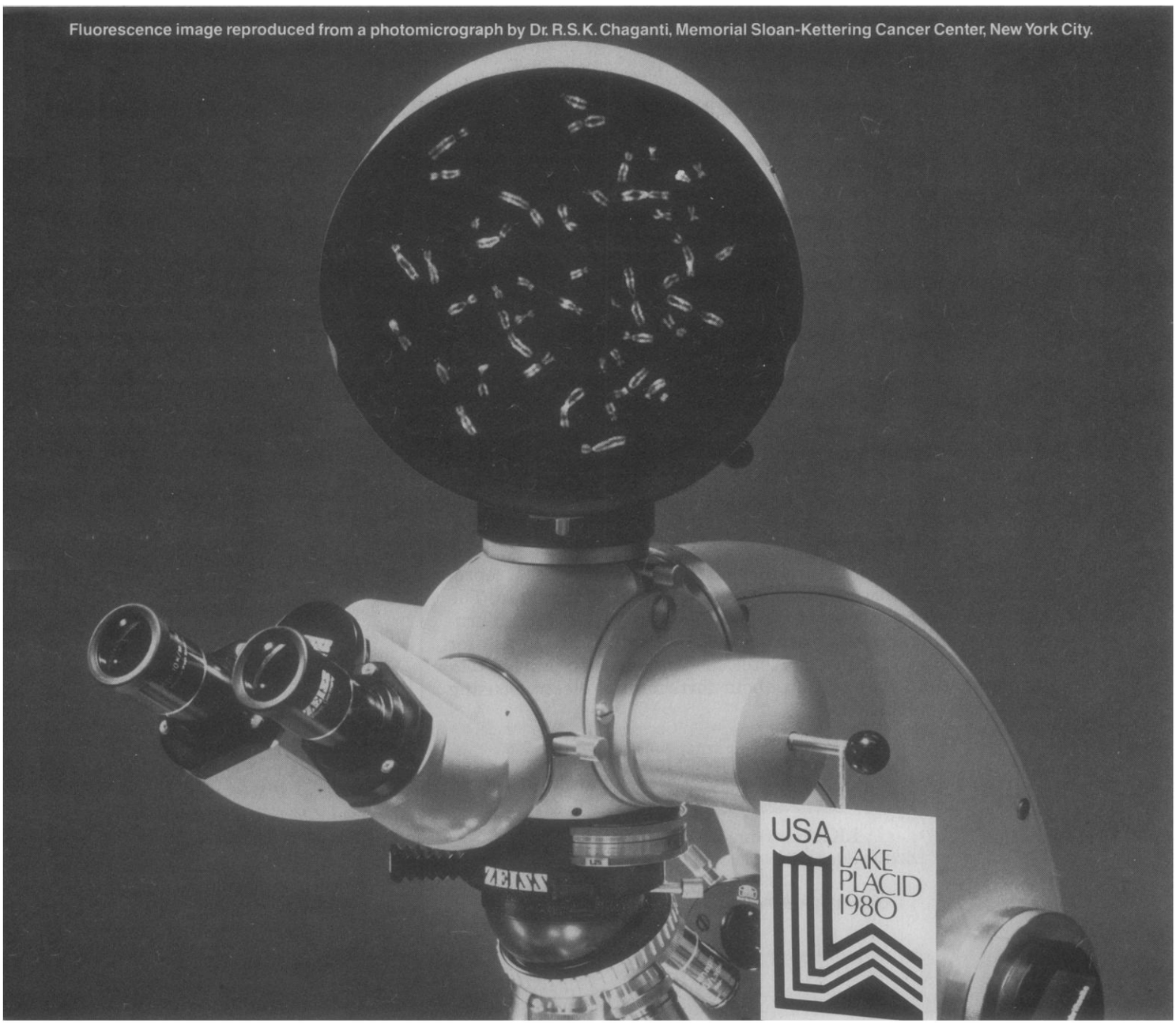

Holden may be correct in noting that *Tearoom Trade* "has become a classic in the fast-growing field of ethics in social science research, where it is commonly cited as a crass violation of subjects' rights." What she does not report, however, is that the book won the C. Wright Mills Award of the Society for the Study of Social Problems in 1970 as "the outstanding work on a social issue."

It is disturbing to learn for the first time, from a journal article, of a 2-day conference that apparently featured discussion of my work. Are the distortions of fact perhaps the result of misrepresentations made in materials presented at that conference, to which I had no access?

Innumerable commentators have arraigned my dissertation research on charges comparable to those cited by Holden. Who, on the other hand, has mentioned the following points about the tearoom study?

1) Not one of my 100 respondents has ever reported suffering harm as a result of my research.

2) Many of my respondents (both those who were fully informed about the research and other, "deceived" men who later read the book), not to mention hundreds of other "tearoom participants," have expressed appreciation for ways they have benefited from the study.

3) The moral entrepreneurs fail to note that, in the mid-1960's, the sociologists had no Code of Ethics mentioning the need for "informed consent." The issue was never raised in my graduate studies, and I had never thought about that as a matter of concern. As Holden grants, I "was scrupulous about guarding the confidentiality" of my respondents. That was all anyone knew about the ethics of research in those days.

4) In the revised (1975) edition of *Tearoom Trade*, I added a 57-page "Retrospect" on ethical issues, including a complete reprinting of the major critical publications available at that time.

Do my critics offer me a comparable platform? Have those affluent foundations that foster the work and careers of the Ayatollahs of Research Ethics ever considered the possibility of allowing those of us assumed to be guilty to enter into dialogue with our accusers?


LAUD HUMPHREYS
*Department of Sociology, Pitzer College, Claremont Colleges, Claremont, California 91711*


The letter from Horowitz, aside from its self-serving bromides, objects to the fact that an author who was "mentioned repeatedly" at a social science confer-

ence was not invited to attend. Well, who was to know in advance that the author would be mentioned repeatedly?

Nowhere does this well-known gatekeeper-editor, Horowitz, commend Holden for her brilliant article, which makes clear what is generally obscured by the social science jargon of our time.

BEN RUSSAK
*Crane, Russak & Company, Inc.,*
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## Power-Line Radiation

Thorne and Tsurutani (Reports, 25 May 1979, p. 839) address some important questions regarding power-line radiation (PLR) in the magnetosphere, a subject that has become a topic of intense research in recent years (*1-3*). Although Thorne and Tsurutani accept the existence of PLR in the magnetosphere, they conclude that it is unimportant in comparison to naturally occurring waves. We believe that their conclusion, based on analysis of a limited amount of data, is premature and that it is important to further investigate this man-made perturbation of the space environment out to a distance many times the radius of the earth.

It has been clearly demonstrated that PLR can trigger emissions that strongly interact with trapped energetic particles in the magnetosphere (*2*). However because of limitations in signal detection and processing techniques that have been employed to date, it is not *always* possible to determine conclusively whether a given emission is triggered or is generated spontaneously. For this reason, it is not possible at present to make a quantitative comparison between PLR effects and natural effects.

The main argument of Thorne and Tsurutani is based on the fact that their data on ELF (extremely low frequency) chorus collected by the Orbiting Geophysical Observatory (OGO) do not show significant variations at different longitudes that could be attributed to PLR. This is contrary to earlier results based on ELF and very low frequency data collected by OGO-3 (*3*). This discrepancy is not too surprising in view of the fact that the two relatively small data sets were acquired by different instruments covering different frequency ranges and were analyzed differently. Without getting into detailed technical arguments, we simply wish to make a fundamental point concerning their data —that the absence of evidence should not be used as evidence for absence.

There are undoubtedly waves of entirely natural origin that are important for magnetospheric dynamics. However, their importance cannot be used as evidence against the importance of PLR unless it is supported by a quantitative comparison. Such a comparison will require improved techniques for identifying PLR and PLR-triggered emissions. Fortunately progress can be and is being made in that direction. For example, since the report by Thorne and Tsurutani, direct evidence of PLR has been found in the deep magnetosphere in data from ISEE-1 and GEOS satellites (*4*). Theoretical and experimental studies of PLR sources are under way or are being planned by a number of research teams around the world (*5*).

It will be some time before we fully understand PLR effects and their importance, vis-à-vis natural phenomena, but there is certainly no basis at present to dismiss PLR as unimportant.

C. G. PARK
R. A. HELLIWELL
*Radioscience Laboratory, Stanford, University, Stanford, California 94305*

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5. The PLR intensities near power lines have been recently measured by R. Barr in New Zealand and T. Yoshino in Japan, both of whom used ground-based as well as balloon and rocketborne instruments. Yoshino and his colleagues plan to make more measurements using balloons, rockets, and satellites. The University of Manitoba, Stanford University, and the Sandia Corporation plan to make balloon measurements in Manitoba, Canada, in collaboration with the Manitoba Hydro.

Park and Helliwell disagree with portions of our *Science* report, particularly our conclusion that the stimulated generation of magnetospheric chorus by PLR is unimportant in comparison to naturally occurring waves. We argue that our conclusion remains valid. There is no conclusive evidence of any dependence of outer zone chorus on geographical longitude. Claims of such evidence (*1*) are based on erroneous statistical arguments (*2*). Furthermore, such a dependence would not be expected because chorus occurs on magnetic field lines that intercept the polar regions of the earth, well away from high-density population centers. As we stated in our report, PLR would also be strongly damp-

ed as it propagates from the earth into the magnetosphere. Arguments concerning the dependence of chorus starting frequency on PLR frequency are contradictory (*2, 3*), and only further independent research will resolve the problem. Arguments concerning weekday dependence of chorus occurrence are also controversial. Ground-based evidence indicates a reduction of chorus occurrence on Sundays (*4*), but the validity of this work is currently being challenged (*5*). The only magnetospheric study done to date (*6*) shows no evidence of such an effect.

Previous discussions of PLR effects on chorus have generally ignored the wealth of published articles on energetic, outer zone electrons (*7*), magnetospheric substorms (*8*), and chorus, together indicating a natural generation of chorus. Space physicists have shown that intense fluxes of energetic (1 to 100 kiloelectron volts) electrons are injected into the near-midnight outer magnetosphere during the onset of substorms (*7, 9*). The electron fluxes are above the "stably trapped limit" (*10*) and generate chorus via the loss-cone instability, the "free energy" of the electrons going into wave (chorus) energy. The waves in turn interact with the electrons, scattering them such that they are lost into the upper ionosphere, giving rise to the polar x-ray aurora (*8, 11*). It has recently been confirmed that chorus is associated with substorm events and occurs at the same geomagnetic latitude and local time as the detected electron precipitation (*12*). Chorus has been shown to be localized close to the equatorial plane (*12*), where it is expected to be generated via a loss-cone instability. Examination of the energetic electron velocity versus magnetic field (pitch angle) distribution during chorus events shows that the electrons have the expected loss-cone distribution (*13*). Thus, the existing literature is adequate to explain the majority of chorus and its effect on the outer radiation belt electrons via natural causes.

Park and Helliwell (*14*) argue that PLR may act as an embryonic emission that stimulates the growth of chorus and subsequently induces the electron precipitation. However, they agree (*15*) that the electron flux must be high to provide the free energy for wave growth, thus a magnetospheric substorm must be in progress. The only consequential effect of PLR is to "force" the chorus growth and electron precipitation to occur over high-power consumption areas. However, even evidence for this is nonexistent; rather, within statistical uncertainty, chorus appears to occur at all geographic

longitudes with equal probability (*1*, *2*).

We do not dispute the existance of PLR or PLR-triggered emissions especially in locations where there is adequate wave ducting (at latitudes less than 60°), allowing PLR field-aligned wave propagation to the equatorial region of the magnetosphere where unstable wave growth can occur. However, at magnetic latitudes above 60°, where chorus is principally detected (*16*), both the wave ducting and population centers are generally absent.

From the evidence and arguments presented in our report, we cannot rule out the possibility of minor PLR effects on chorus. We do show, however, that there is a general lack of evidence for significant PLR effects on outer-zone chorus. Until more positive evidence becomes available, we feel that it is best to remain with the well-established model for natural generation of outer-zone magnetospheric chorus.

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RICHARD M. THORNE
*Department of Atmospheric Sciences, University of California, Los Angeles 90024*

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15 February 1980, Volume 207, Number 4432 **SCIENCE**



# General Sarnoff and Generic Research

General David Sarnoff is reputed to have said that 50 percent of invention is knowing what to invent. At one of his talks specifying what needed inventing, he is supposed to have remarked to the listening RCA researchers, "I've done my 50 percent, now it's your turn!" There is much of this philosophy in former Secretary of Transportation Brock Adams's proposal asking for the "reinvention of the automobile." To accomplish this feat, he proposed a $100 million a year generic research program financed jointly by industry and government, and performed in academic laboratories specifically established for the task.

Such targeted, or generic, research can be productive when the state of knowledge is ripe, but more often targeting represents wishful thinking. Yet bills have been introduced by Senator Adlai Stevenson and Congressman George Brown to implement the idea of generic research centers which would conduct fundamental and interdisciplinary research on topics thought to be relevant to desired applications, among them automotive transportation. The President's message on industrial innovation contains similar initiatives. The State of the Union message mentions a 10-year, $1 billion proposal for research on automotive fuel efficiency, a program presumably related to the Administration's Cooperative Automotive Research Program (CARP), son of Adams's idea.

These proposals represent an overt attempt to steer commercial technology into what are seen as "desirable" paths. Indeed, if one examines industrial research closely, it is hardly distinguishable from generic research. Industrial laboratories typically focus on interdisciplinary areas that underlie the objectives of the firm. This has long been the operational mode of great industrial laboratories, although their managements do not usually go as far as General Sarnoff in demanding specific inventions.

Is it feasible for government to use the industrial, interdisciplinary paradigm to augment ongoing industrial research? Not significantly. To be successful, industrial research must be part of a larger whole, which incorporates development, often involving highly organized project work; engineering design, including means for manufacturing and quality control; securing financial support; and marketing the result in accord with consumer preferences. There is no reliable technique for connecting generic research done in academic or independent centers to this larger whole. Another difficulty is the mismatch in timing between the demands of the patron and the maturation of research institutions. It has taken decades for the Bell and IBM laboratories to achieve their preeminent state. Patience and resolve over at least a decade are required. Government cannot have that staying power because of changing political, social, and economic factors.

Nevertheless, there may be a few cases where federally inspired generic research could be productive. But these instances will be overwhelmed by the number of failures. The minimum requirement for generic research to be successful is that it have enthusiastic industrial involvement, fine leadership and management, and excellent research people. Such a conjunction will be rare. CARP and other massive proposals do not recognize these requirements. Neither does that of the American Council of Education for 10 to 15 federally funded, university-based research centers.

Even modest beginnings in these directions would be dangerous if they substitute for effective federal programs to encourage more fundamental industrial research and closer academic-industrial research relations. It is dangerous, too, if it diverts academic researchers from their disciplinary research toward specific problem solving where they have limited competence. Unfortunately, these are the likely outcomes unless generic research proposals become part of a larger effort to encourage innovative research in places of excellence where there is effective coupling to development, manufacturing, finance, and marketing.—EDWARD E. DAVID, JR., *President, Exxon Research and Engineering Company, Florham Park, New Jersey 07932*

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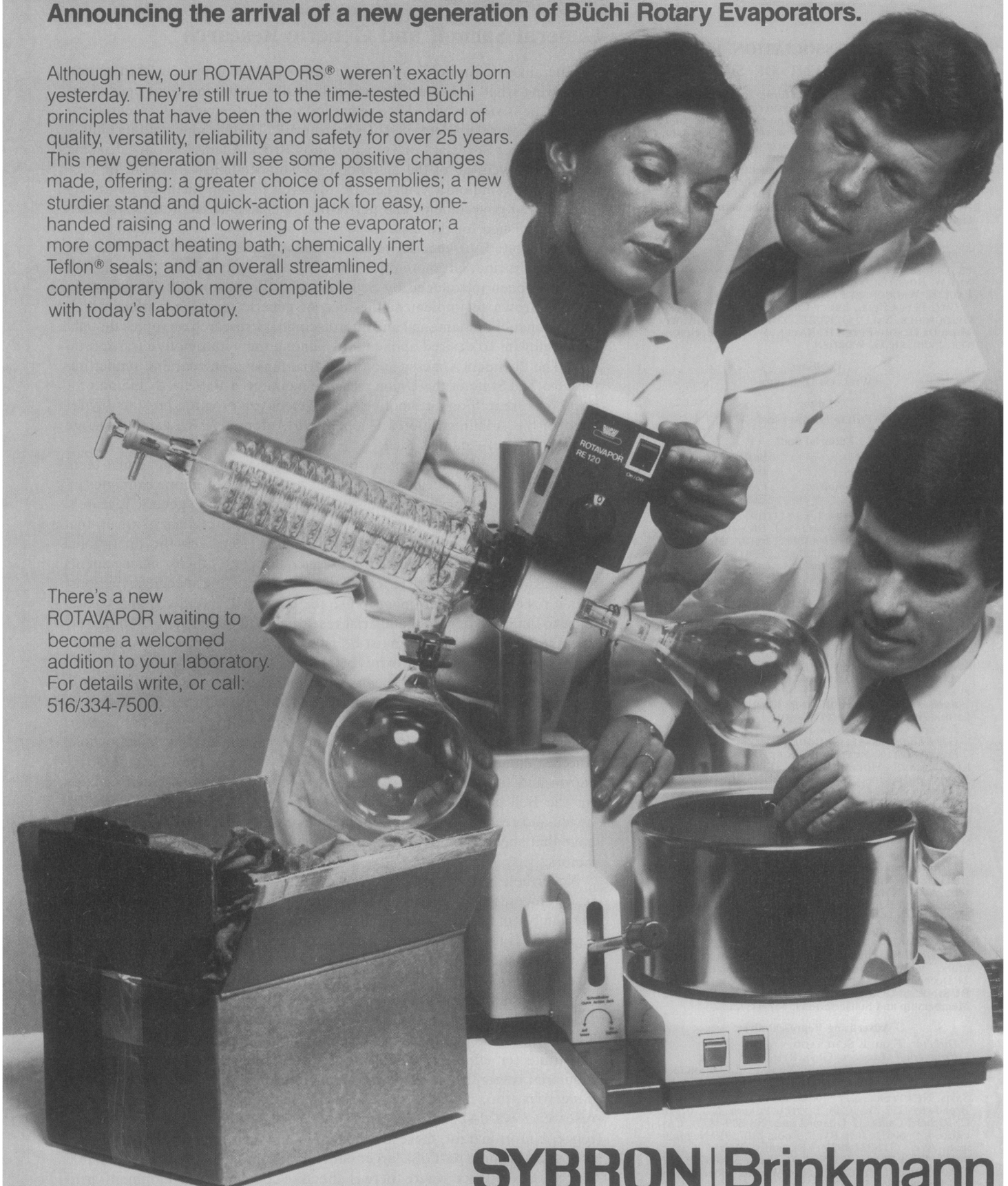


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