

SCIENCE

7 October 1966

Vol. 154, No. 3745

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

DEVONIAN BRACHIOPOD

Instrument Issue

A Noble Approach to an Old Problem

Edison was first.

He converted heat to electricity in a vacuum tube back in '83. But there was a barrier. We're knocking it down.

In a gas-filled thermionic tube, electrons can be boiled off of an emitter and directed to a collector, giving current flow. But only briefly. Then a cloud of electrons forms in the path . . . a space charge inhibiting further flow.

One way to get rid of this barrier is to neutralize it with positive ions, charged atoms of some gas. Many experimenters use vaporized cesium. But its atoms impede electron flow, requiring close interelectrode spacing. So GM Research physicists chose some of the noble gases—argon, neon, and xenon. They offer less impedance.

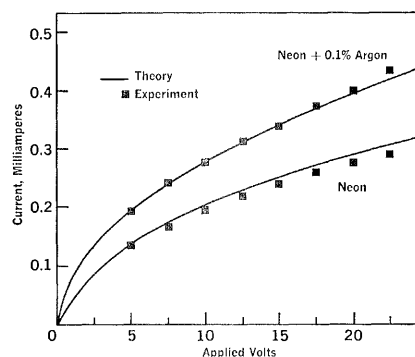
Our experimental emitter is a mixture of fissionable material and good electron-emitting material. Exposed to a neutron barrage in a reactor, the emitter gets hot from its own nuclear fission, sending electrons toward the collector. This same fission produces fragments that bombard the noble gas, generating ions to counteract the space charge.

We have developed a theory to predict the ion generation rate and have experimental data that backs it up. We think we understand why and how things happen.

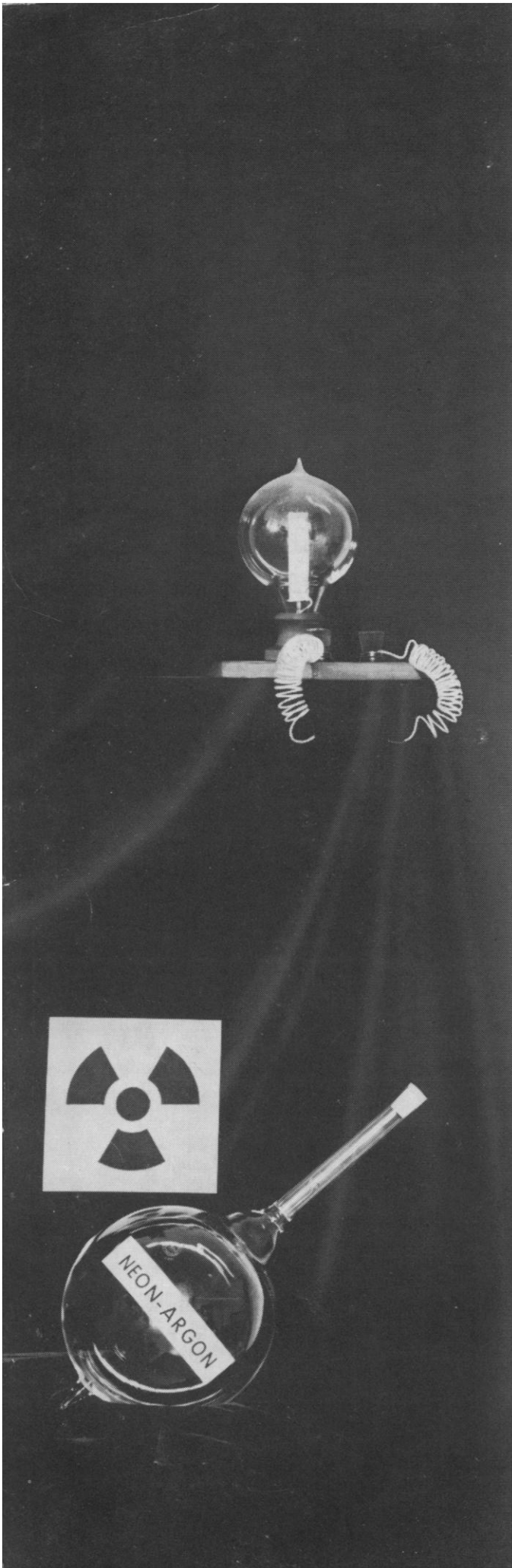
General Motors is in the energy conversion business. The direct conversion of heat to electricity, with a device having no moving parts, interests us.

General Motors Research Laboratories

Warren, Michigan



Characteristics of tubes filled with gases ionized by fission fragments. Resulting current is a function of ion generation rate, which is increased greatly (from 1.8 to 2.6×10^{16} ions per cm^3 per sec) by small addition of argon.





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Side by side on the same marble table, a Mettler B-6 analytical balance and an M-5 microbalance are in virtually continuous use in the coal chemistry laboratory. Here some of the raw materials used in Bethlehem's blast furnaces are tested to achieve the best blend for the most economical production of high-quality steels.

Precise and rapid analytical information is essential to proper blending. Coal for coking may come from Pennsylvania, West Virginia, or Kentucky; carbon content may vary from 75 to 90%. Each batch of coal poses its own individual problems.

The B-6 is used in proximate analysis to establish the direction for carrying out ultimate analysis. The microbalance is used for weighing absorption tubes in the ultimate carbon-hydrogen analysis, picking up weight differences in the microgram range. Together, they provide Bethlehem with a broad range of information in the shortest time possible.

In addition to raw materials analysis, Bethlehem's Research group also works with experimental materials as part of other research projects. Some of the carbonization and coke testing methods developed here, particularly those dealing with coal in the plastic temperature range, have been widely adopted throughout the steel industry.

More than 100 Mettler balances are found throughout the facilities of the huge Homer Research Laboratories, helping to make best use of the raw materials available, ultimately permitting Bethlehem to make better steel.

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7 October 1966

Vol. 154, No. 3745

SCIENCE

LETTERS: Lake Tahoe: Measured for Pollution: *E. S. Deevey, Jr.*; Medicine for the Poor in Denver: *G. Arnstein; D. L. Cowen; P. Booth*; Population Stabilization: *David B. Van Vleck*; Tenure in 1897: *W. R. Murchie*; New Quarks for Physics: *D. E. Laird*; Support the Theoretical Thinkers!: *R. W. Lewis*; A Tax-Saving Spin Off: *S. T. Martin*; Touché: *H. Churchill* 68

EDITORIAL Coping with the Information Explosion 75

ARTICLES Automation of Steroid Analysis: *I. E. Bush* 77

Direct photometric scanning of thin-media chromatograms can be both accurate and very rapid.

The Semiconductor Revolution in Nuclear Radiation Counting:
J. M. Hollander and I. Perlman 84

Applications of nuclear radiation have entered a new era with the advent of germanium and silicon counters.

Detection and Measurement of Pesticide Residues: *D. J. Lisk* 93

Gas chromatographs with selective detectors have streamlined analysis.

Zonal Centrifuges and Other Separation Systems: *N. G. Anderson* 103

New methods are being developed at Oak Ridge for fractionating human cells.

Image Tubes in Astronomy: *W. A. Baum* 112

Restoration of Photographs by Neutron Activation: *E. Ostroff* 119

A remnant trace of image silver and relative freedom from halogens and other silver are required.

Detection of Relativistic Particles: *L. C. L. Yuan* 124

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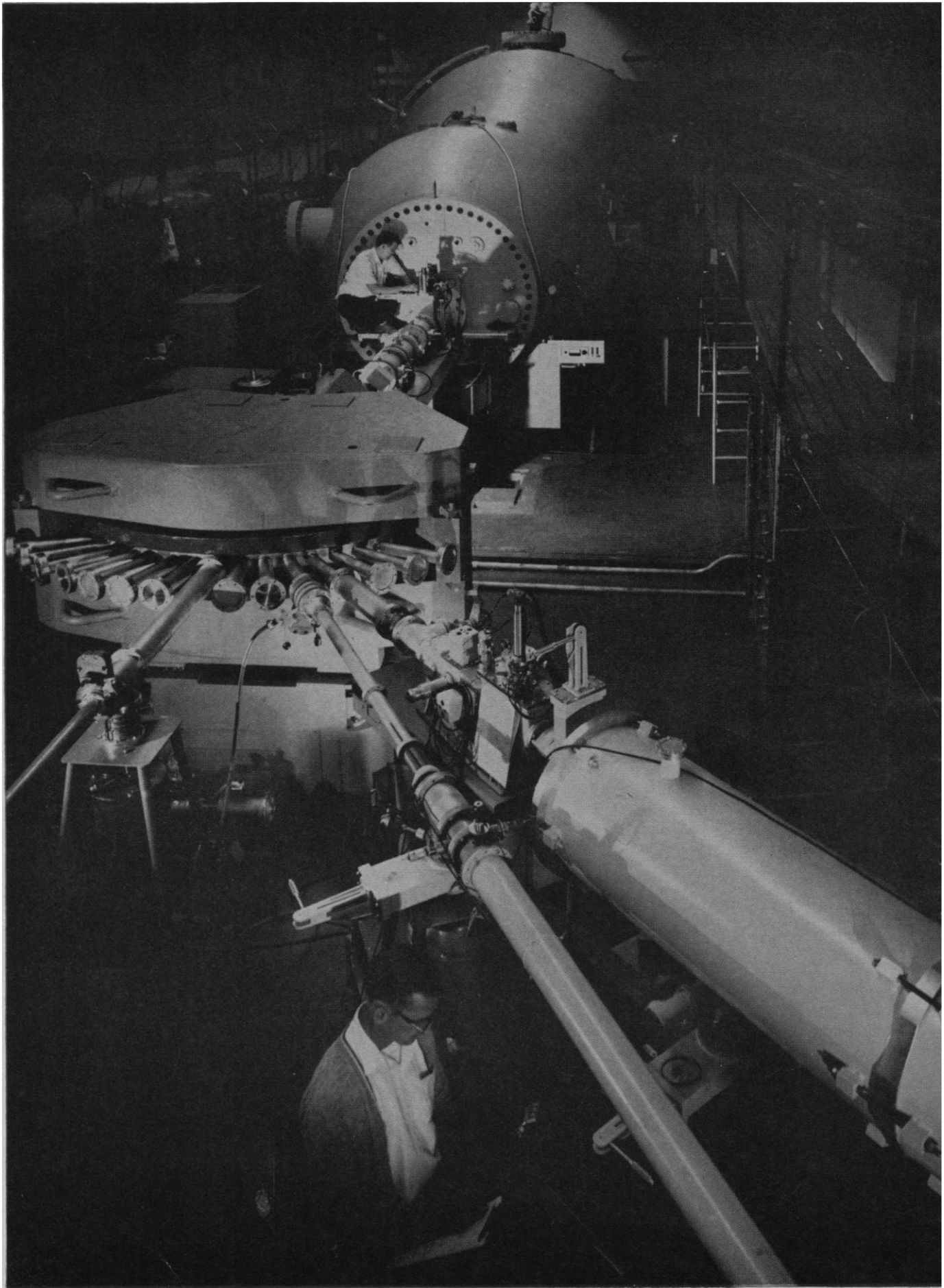
NEWS AND COMMENT	The Smale Case—Jitters at NSF and Berkeley; Scientists-Astronauts—Applicants Sought; Grand Canyon Dams—Interior To Review Alternatives; Kennedy School—Promoting Public Service	130
BOOK REVIEWS	Science as a Social System: <i>N. Kaplan</i>	139
	<i>The Electron Microprobe</i> , reviewed by <i>H. Yakowitz</i> ; other reviews by <i>D. A. Skoog</i> , <i>C. E. Miller</i> , <i>E. H. Cordes</i> , <i>P. A. Wilks, Jr.</i> ; New Books; Reprints; Conferences and Symposium Reports	141
REPORTS	A Braille-Reading Machine: <i>A. P. Grunwald</i>	144
	Turbulent Gas Chromatography: <i>J. C. Giddings</i> , <i>W. A. Manwaring</i> , <i>M. N. Myers</i> ..	146
	Silicone Rubber: A New Diffusion Property Useful for General Anesthesia: <i>J. Folkman</i> , <i>D. M. Long, Jr.</i> , <i>R. Rosenbaum</i>	148
	Oxygen Consumption of a Flying Bird: <i>V. A. Tucker</i>	150
	A Disulfide-Linked Collagenous Protein of Nematocyst Capsules: <i>R. Blanquet</i> and <i>H. M. Lenhoff</i>	152
	Pholidostrophiid Brachiopods: Origin of the Nacreous Luster: <i>K. M. Towe</i> and <i>C. W. Harper, Jr.</i>	153
	Sterilization by Electrohydraulic Treatment: <i>M. Allen</i> and <i>K. Soike</i>	155
	Disinhibition of Visually Masked Stimuli: <i>D. N. Robinson</i>	157
	Grizzly Bear Skull: Site of a Find near Lake Simcoe: <i>W. M. Tovell</i> and <i>R. E. Deane</i>	158
	Technical Comments: Random Light and Wheel Running: <i>C. Heckrotte</i> ; <i>D. L. Holmquest</i> , <i>K. Retiene</i> , <i>H. S. Lipscomb</i>	158

WALTER ORR ROBERTS STHELSTAN F. SPILHAUS	H. BURR STEINBACH JOHN A. WHEELER	PAUL E. KLOPSTEG Treasurer	DAEL WOLFLE Executive Officer
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COVER

The shell of the Devonian brachiopod, *Pholidostrophia nacre* (Hall), has a layered, crossed, lamellar structure. The calcite needles in each layer commonly indent one another and produce a surface that is an optical diffraction grating; hence the shell has a pseudonacreous luster ($\times$ approximately 710). See page 153. [K. M. Towe and C. W. Harper, Jr., Smithsonian Institution]

The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.



MP Tandem Test Facility at High Voltage Engineering Corporation.

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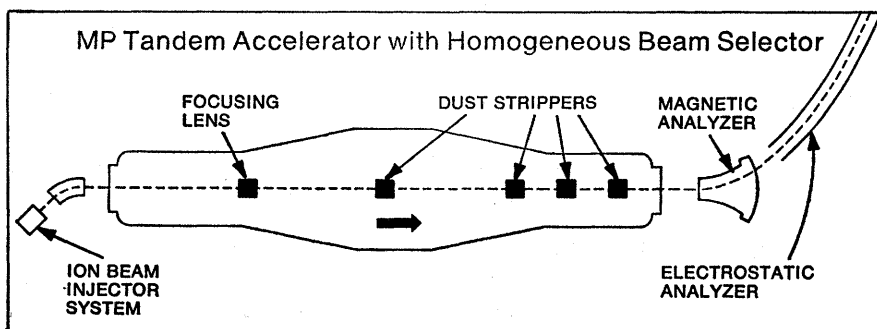
higher than ever before possible.

- A new beam-analyzing system, composed of magnetic and electrostatic components to provide researchers with a homogeneous beam of ions of known mass, energy, and charge.

New developments like these are typical examples of progress in ac-

celerator capabilities from HVEC, recognized leader in particle accelerator and related technologies. For additional information and technical literature on tandem accelerators write to:

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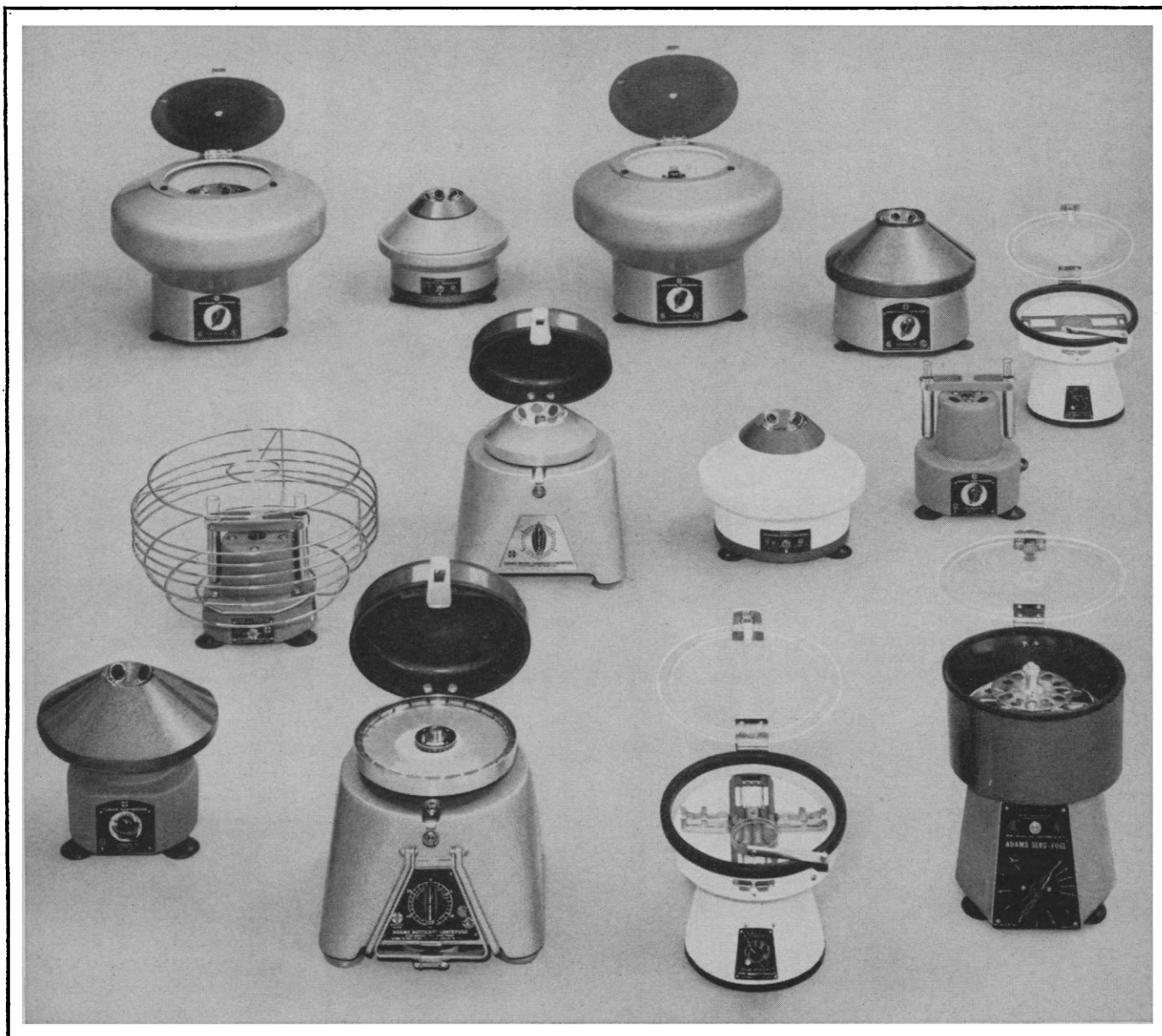
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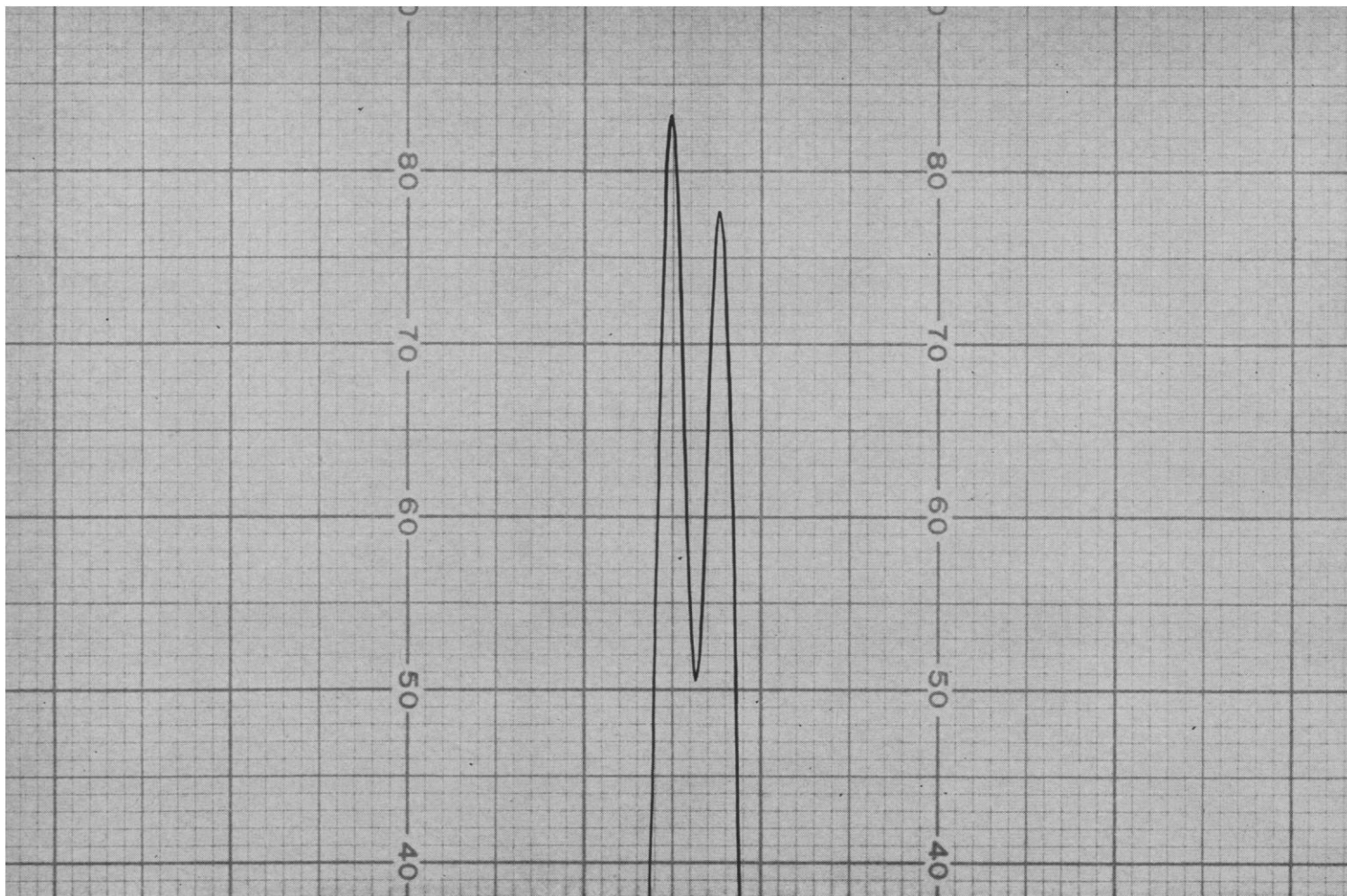
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You're looking at an impossibility

It goes without saying that the Zeiss Spectrophotometer PMQ II (185 $m\mu$ -2500 $m\mu$ range) has greater resolving power than any other single prism instrument. The "impossible" proof is at the top of this page.

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ANALOG MONOLOGUE

On Means for Modelling, Measuring, Manipulating, & Much Else

INTENTIONALLY-NONLINEAR ELECTRONIC CIRCUITS

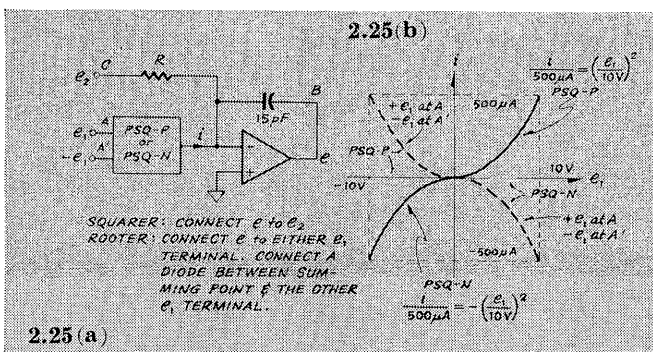
Imagine, for a moment, that your mathematical training had ended somewhere in the first year of Algebra, before you had mastered anything more complicated than a first-order linear equation. Imagine also that you had no knowledge of trigonometry, logarithms, or exponentials. Would such mathematical innocence hamper your present work?

Probably it would — unless your role is supervisory, speculative, or purely empirical. And even then, would you be able to discuss and evaluate the work of others, without a grasp of the everyday mathematical language in which they thought, wrote, and spoke? Of course not.

So it is with electronic measurement and data manipulation . . . for what is measurement, but a form of understanding? (. . . to paraphrase Lord Kelvin.) If the circuits one uses are limited to the handful that are linear in response (useful and powerful as they are), the range of measurement and data processing one can perform with them is correspondingly limited. Fortunately, we need not accept such a crippling restriction; hundreds of practical nonlinear circuits already exist, having been devised and perfected for use in the Analog Computing realm.

The kind of nonlinearity we mean is a deliberate, precisely-controlled relationship in a circuit — for example, a logarithmic input/output response — and *not* the unintentional, unavoidable, and undesired deviation of a nominally-linear circuit from perfect linearity . . . an imperfection to be avoided or minimized by careful design. Useful nonlinearity may be as natural to a circuit as is a linear response, and $y = A(x + B)^2$ may be reproduced with almost as great fidelity as $y = A(x + B)$.

The circuit below, one of more than 200 in the Philbrick *Applications Manual*, shows how the function Ax^2 may be embodied, using an Operational Amplifier and a Quadratic Transconductor. It also indicates the almost trivial circuit change required for square root computations.



Nonlinear circuits are neither as simple conceptually nor as economical as linear adders or voltage-to-current transducers — but, thanks to the creative efforts of workers in many fields, *they are just as easy to use*. Standard hardware, in the form of nonlinear feedback-network packages, is available for the generation of almost any conventional nonlinear higher-order response, whether or not it can be described by a simple equation.

Table 1 indicates (but by no means covers) the range and variety of useful nonlinear functions and operations that may be constructed with standard Philbrick Amplifiers and Transconductors.

Exponential and Root Functions
Multiplication and Division
Linearization of Transducer Outputs
Trigonometric Functions
Coordinate Transformations
Vector Resolution and Composition
Logarithmic Compression and Expansion
True RMS Computation

Table 1

Table 2 lists the most popular of our Transconductors.

(P)PL1	Dual Logarithmic Transconductor(diode or transdiode)
(P)PL2	Quadruple Logarithmic Transconductor (transdiode)
(P)PL3	Quadruple Logarithmic Transconductor (diode)
PPL4	Logarithmic Transconductor temperature compensated
SPL4	Logarithmic Transconductor temperature compensated (built-in control)
SPL4A	Logarithmic Transconductor — temperature compensated (built-in control and amplifier)
SPLR	Log-Ratio Transconductor
SPLRA	Log-Ratio Transconductor (built-in amplifier)
SPLOG	Logarithmic Transconductor
PSQ	Quadratic Transconductor
SPSIN	Sinusoidal Transconductor
SPCOS	Sinusoidal Transconductor
SPFX	Arbitrary Function Fitter (adjustable)

Note: All standard designs, except (P)PL3 are available in either negative or positive polarity.

Table 2

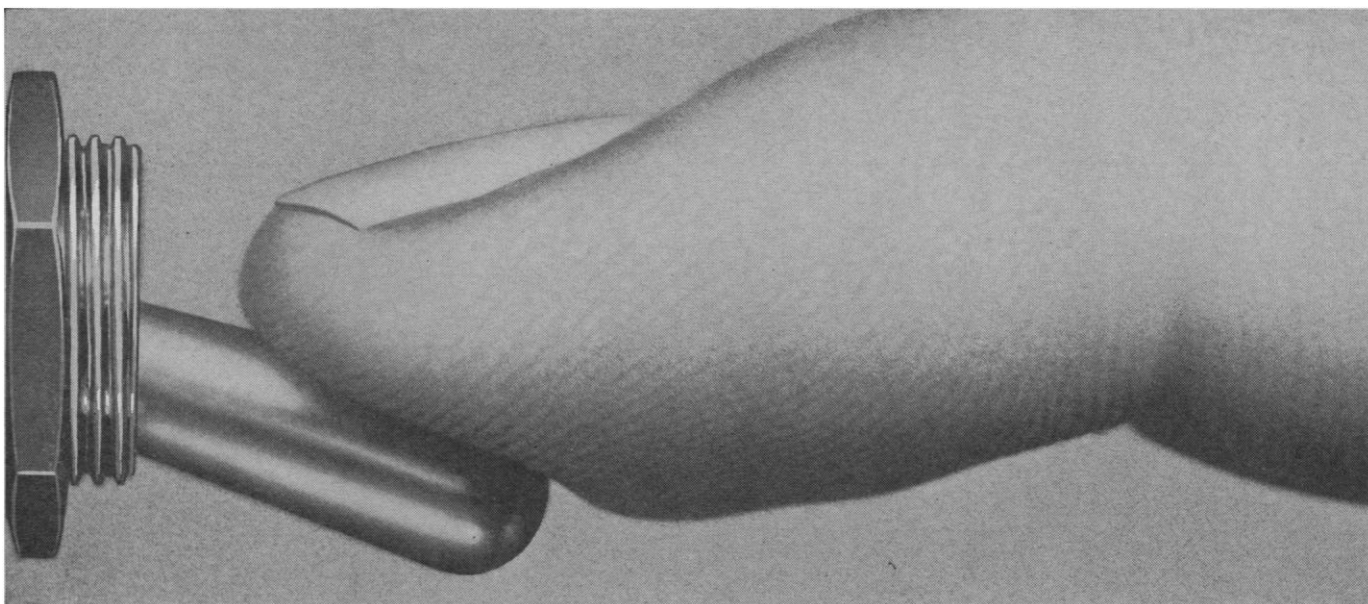
Perhaps this space has been barely sufficient to communicate to you the power of nonlinear instrument circuits. If so, it only serves to underscore our underlying thesis — that the uses of electronic analog technology deserve far greater exposition, and hence appreciation, than they now enjoy . . . despite their many conquests.

You can start today to put more mathematical versatility into your measurements and data processing. Send for our free literature package MBA 2. Better (and faster) yet — call your nearest Philbrick Field Engineer. He'll give you the straight story on nonlinearity. Or write to Philbrick Researches, Inc., 25-S Allied Drive at Route 128, Dedham, Massachusetts. Phone (617) 329-1600.

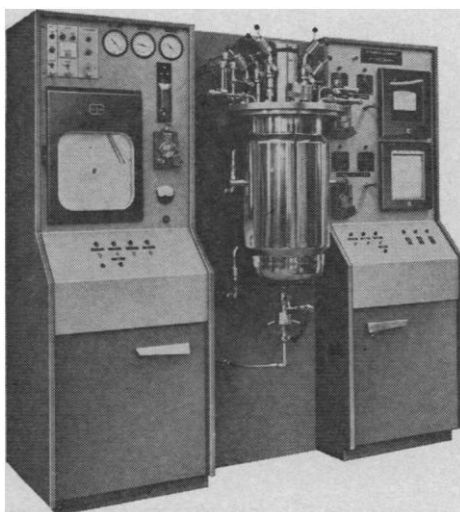
*A Transconductor is an active or passive network of which the short-circuit output current is a specific, accurately known, often non-linear function of the input voltage.



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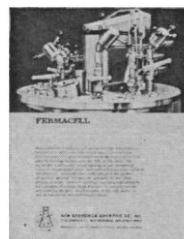
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6445-WO5. Micro Carbon-Hydrogen Analyzer, Thomas. as above described, complete with supply of absorption tubes, sample capsules, absorbents, materials for packing combustion tube, calculator, etc. For 115 volts, 60 cycles, a.c.

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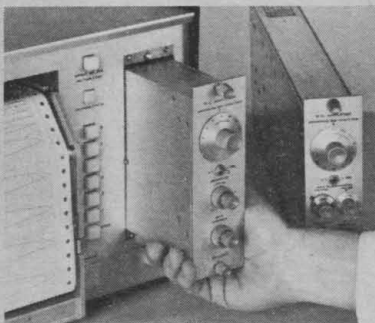
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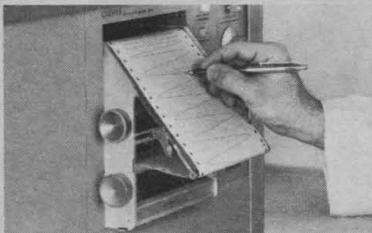
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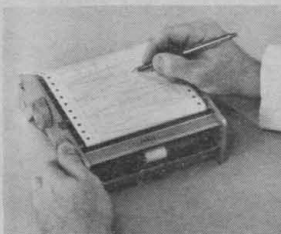
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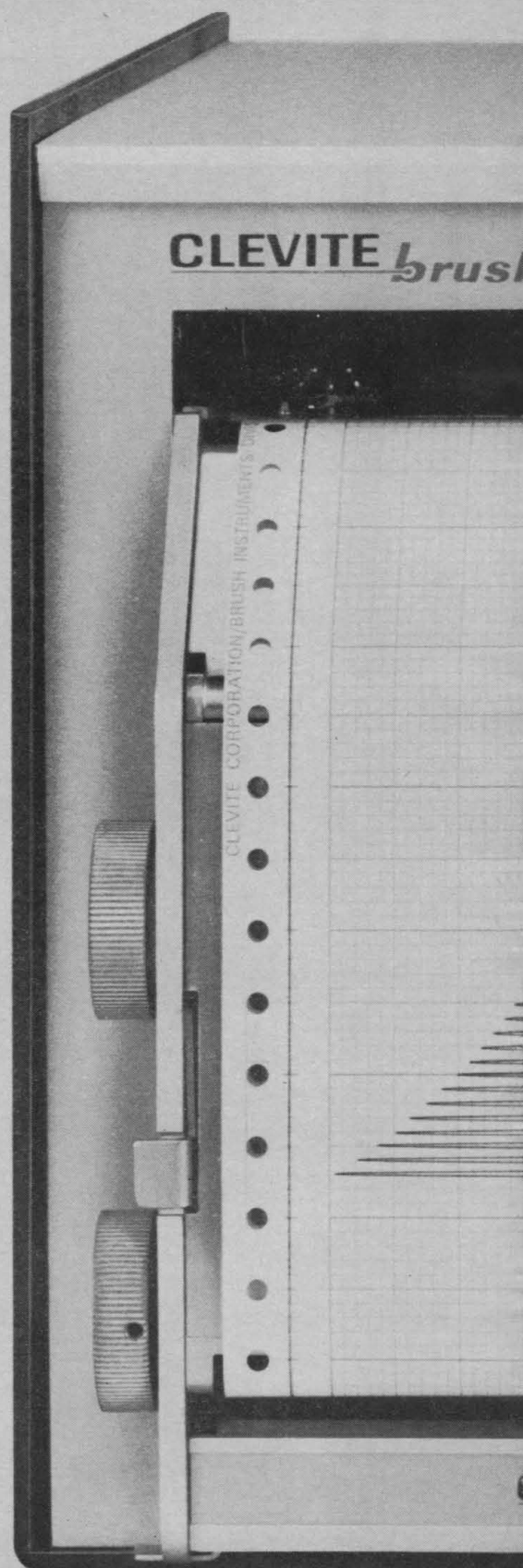
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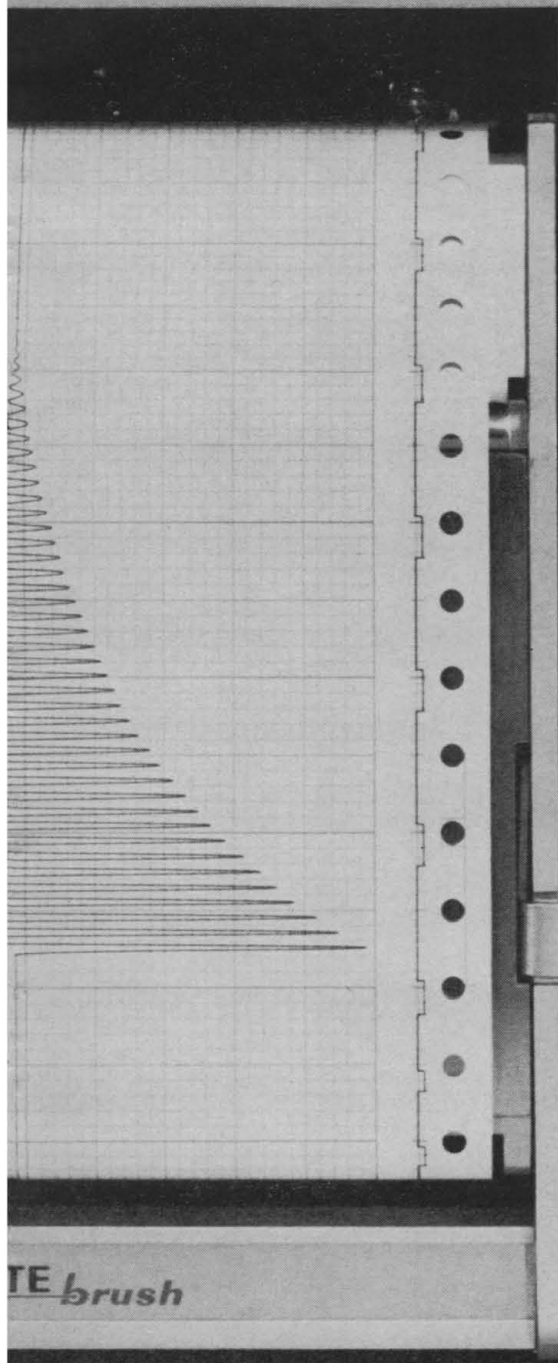
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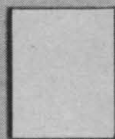
☐ chart speed
inches/sec

☐ inches/min

☐ 5
☐ 2
☐ 1
☐ .5
☐ .2
☐ .1
☐ stop

paper
F
E

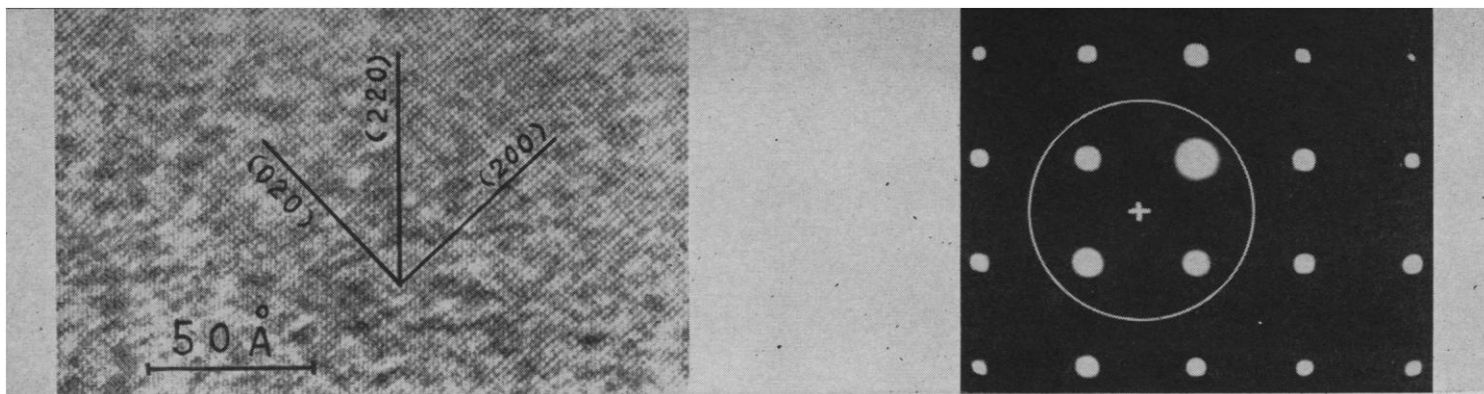
power



interlock
warning



The Brush Mark 250
First recorder for perfectionists



Electron micrograph and diffraction pattern taken on the HU-11C showing the crossed lattice images of the (200) planes of gold. The (020) and (200) planes = 2.04 Angstroms. The (220) plane = 1.44 Angstroms. All important factors such as contamination, stage drift, astigmatism and aberrations must be negligible to achieve this ultra-high resolution. The HU-11C was operated at an accelerating voltage of 100 KV and an electron optical magnification of 270,000 X. The illumination was tilted until the three reflections showed nearly equal intensity in the diffraction pattern; then the micrograph was taken.

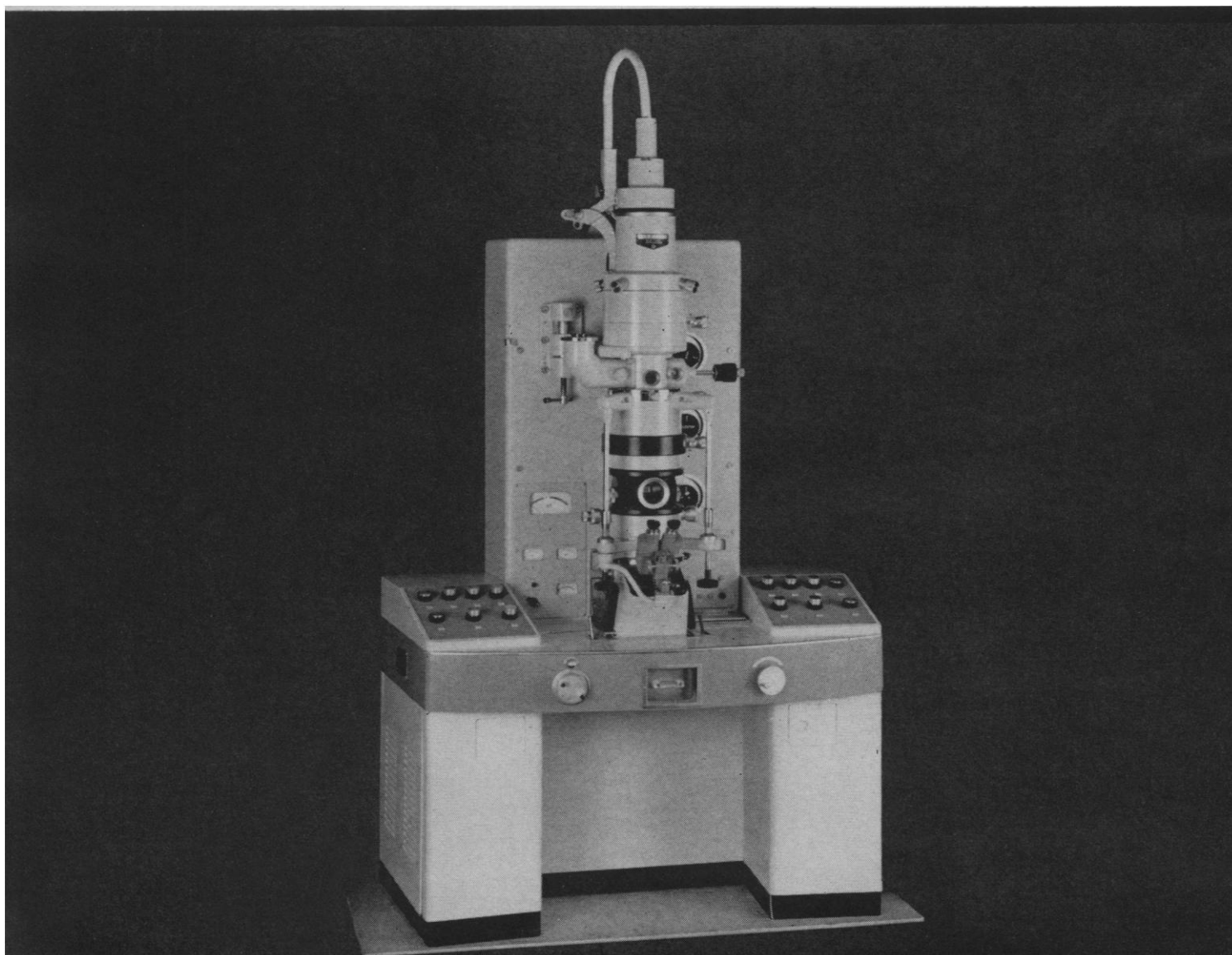
FROM HITACHI PERKIN-ELMER

THE HU-11C: LEADER IN A NEW GENERATION OF ELECTRON MICROSCOPES

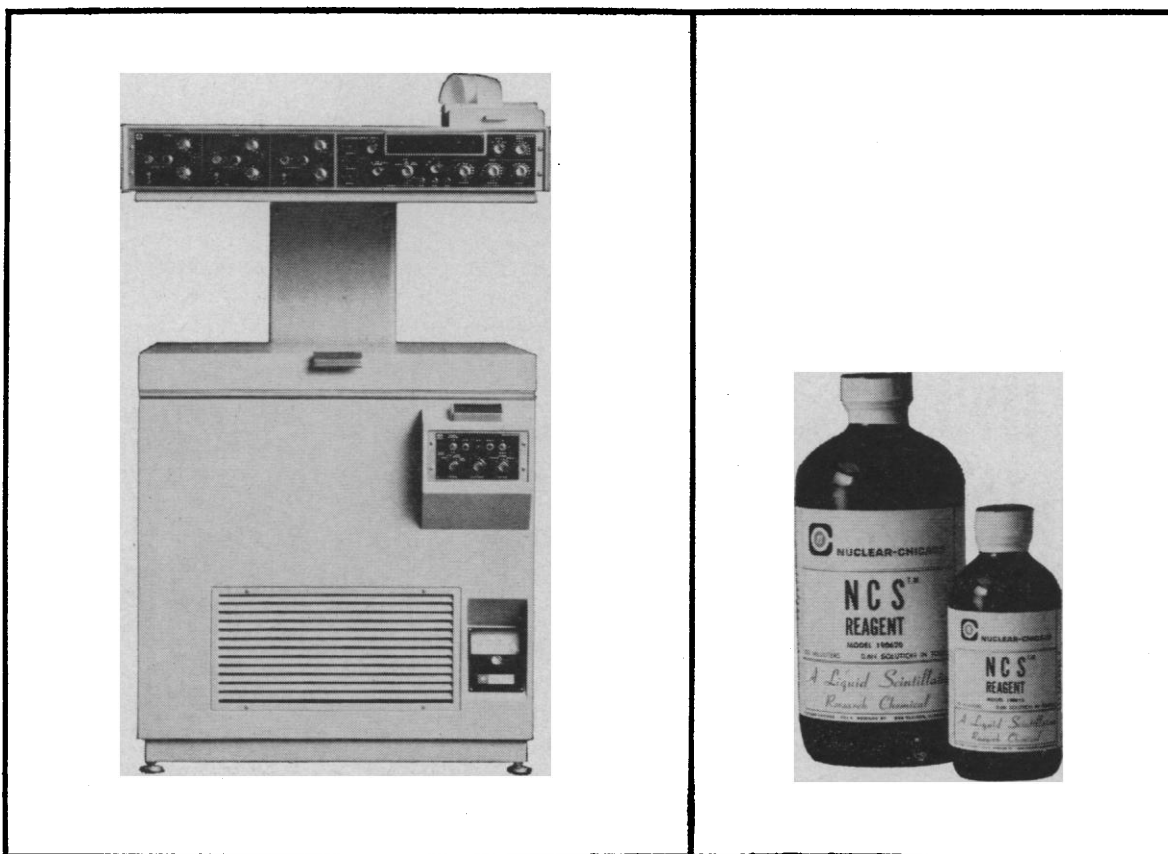
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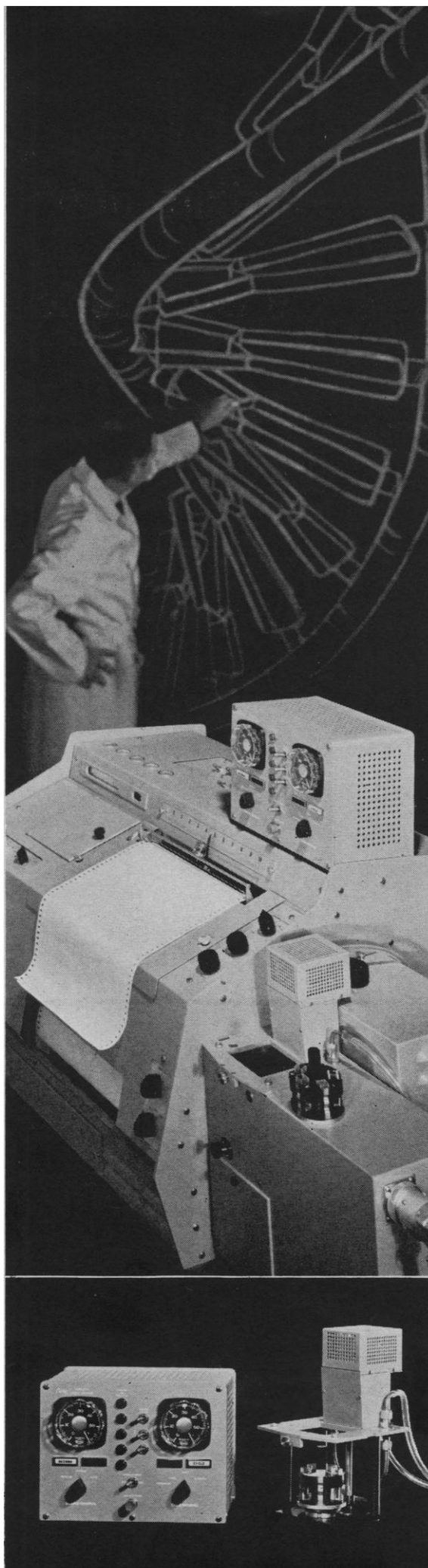
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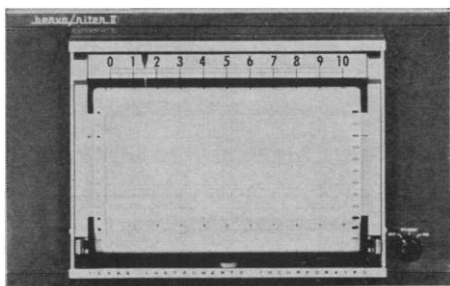
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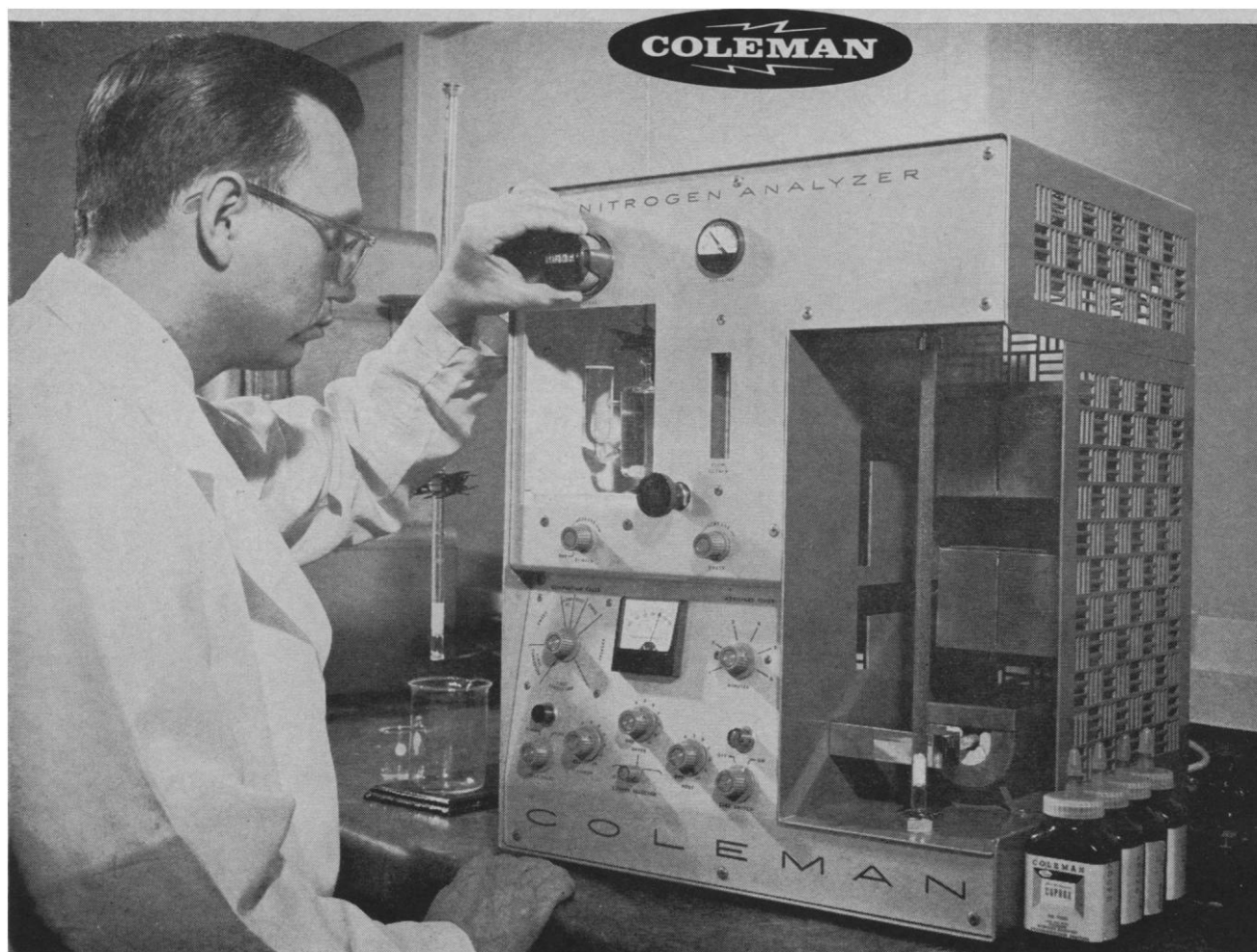
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** Chevron Research Company is the research arm of Standard Oil of California. Results of the work are reported in "Automatic Dumas Nitrogen Analysis of Lubricating Oils and Additives," by Farley, Guffy and Winkler, ANALYTICAL CHEMISTRY, Vol. 36, Page 1061, May 1964. Reprints and product literature are available from Coleman Instruments Corporation.*

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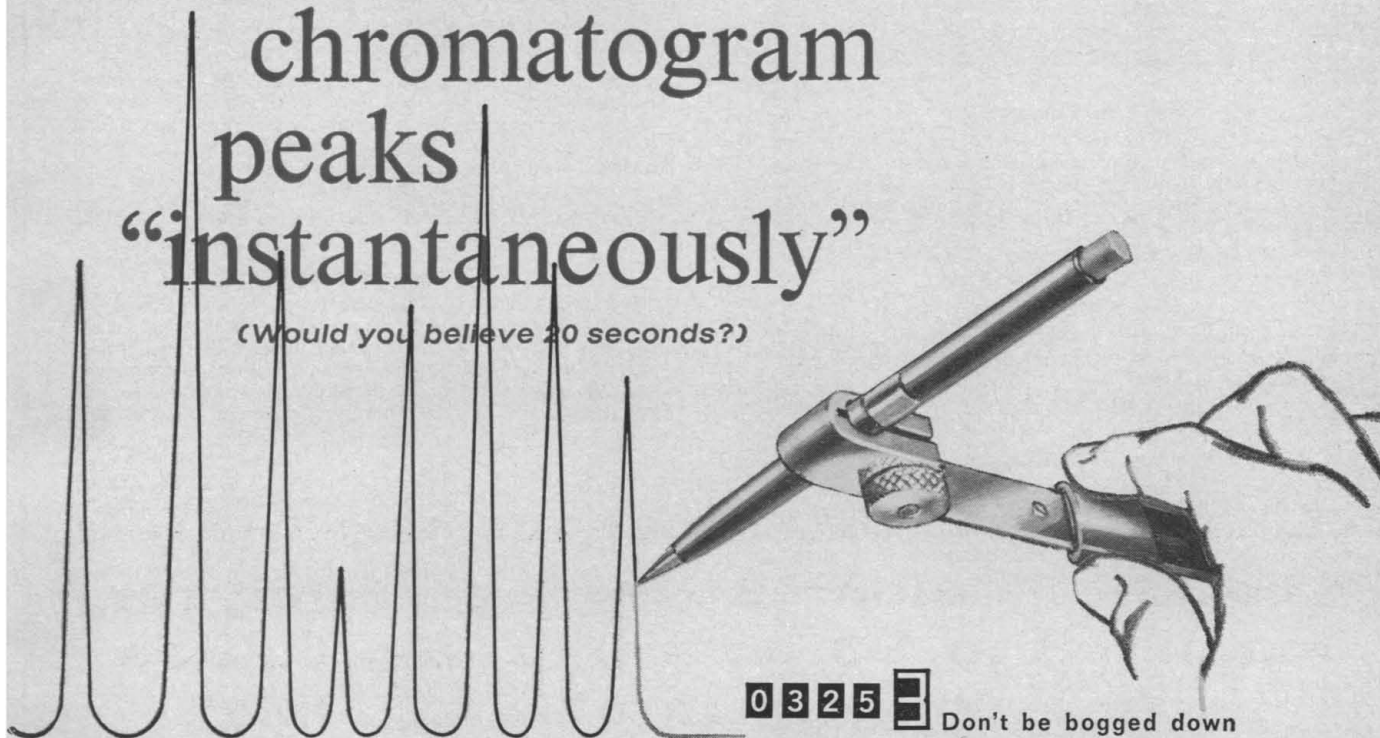
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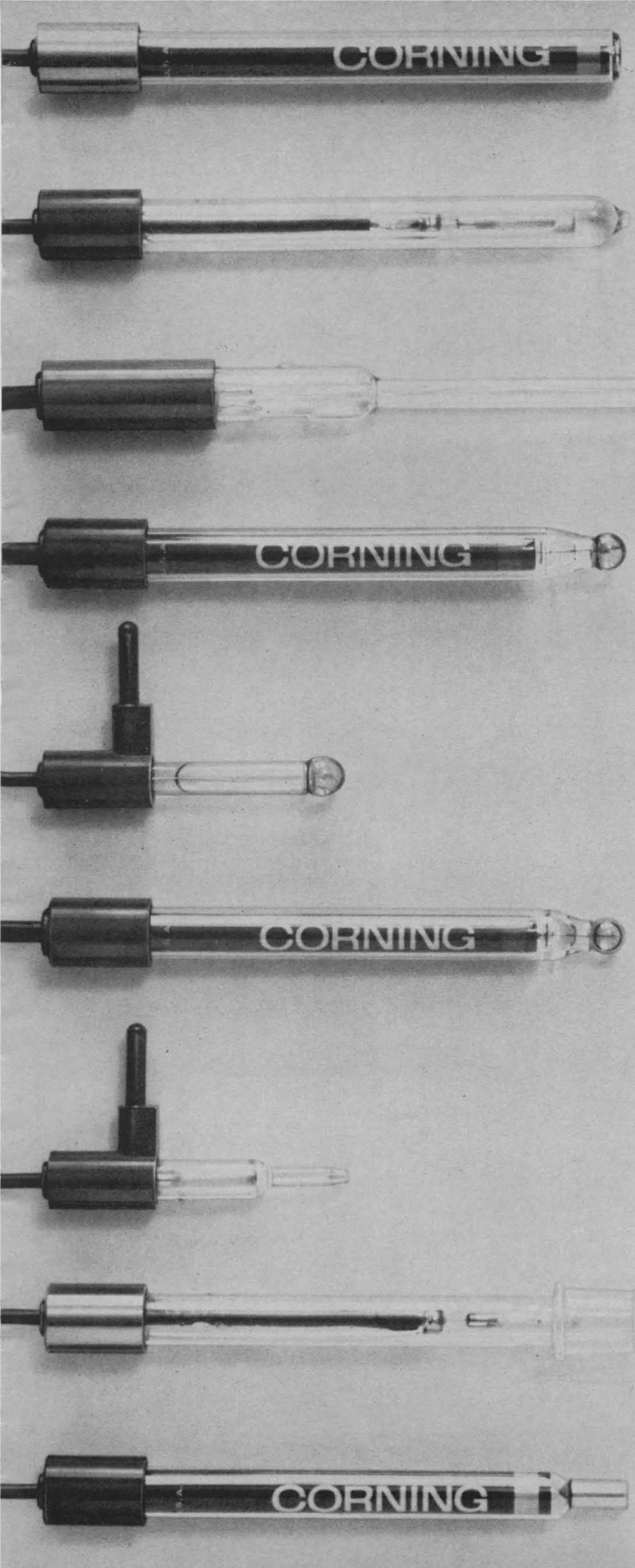
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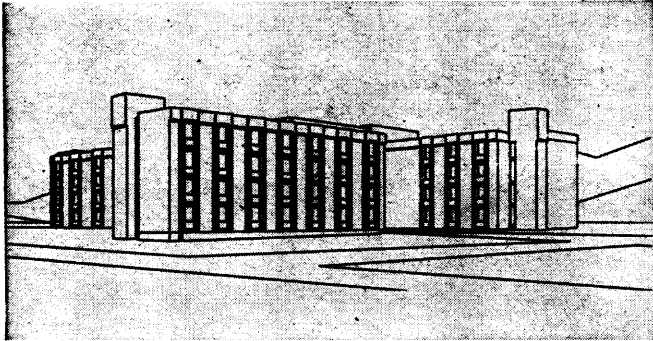
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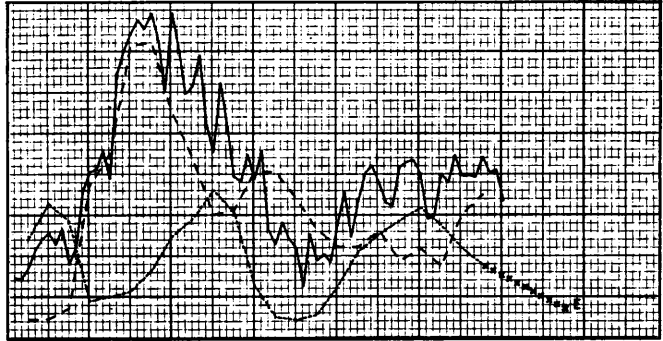
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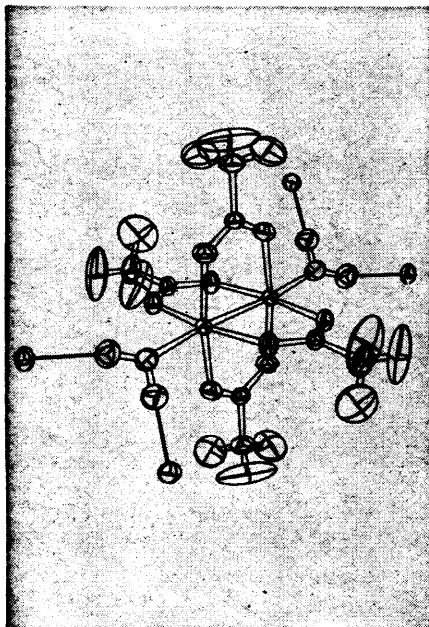
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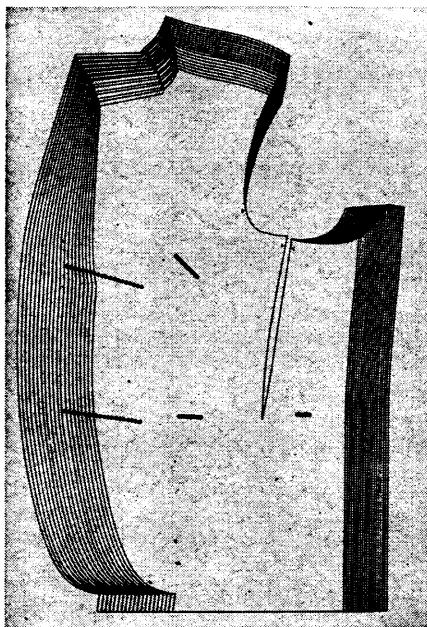
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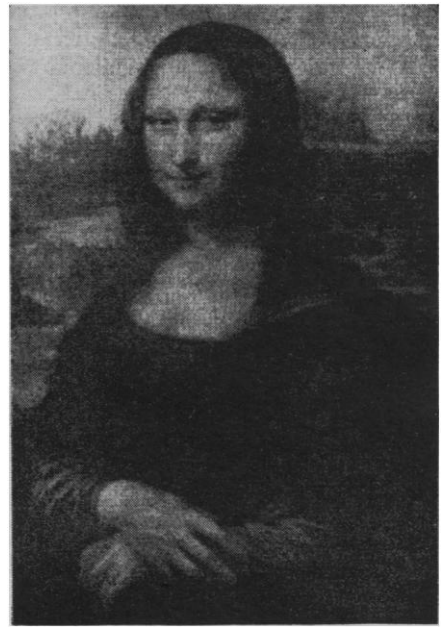
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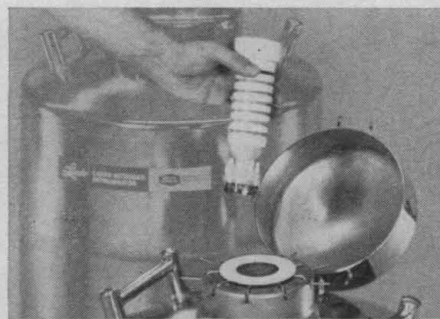
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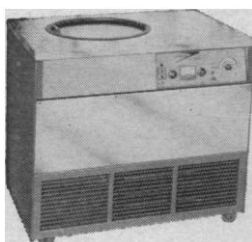
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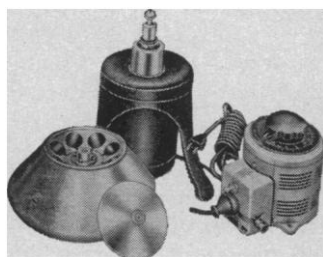
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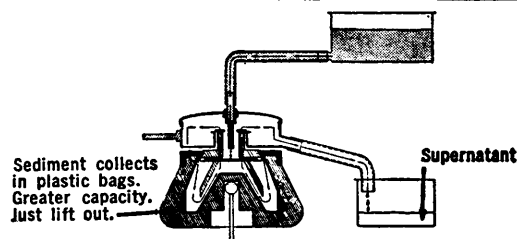
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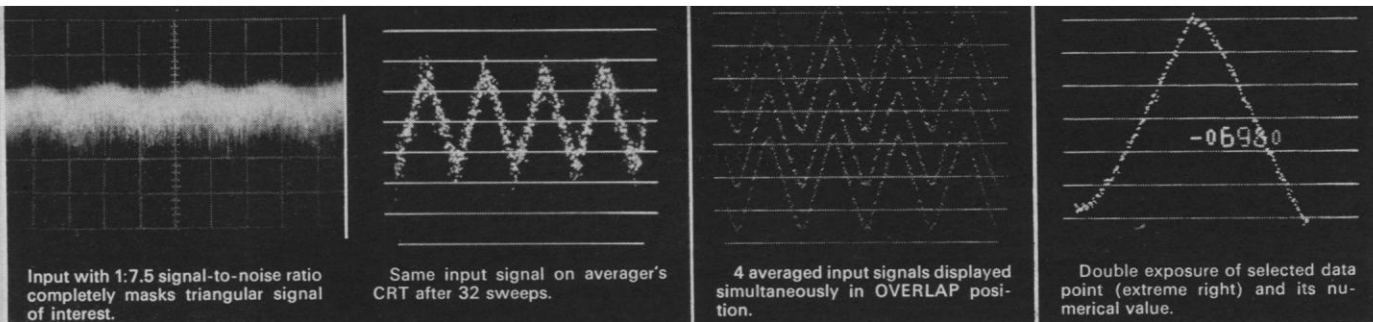
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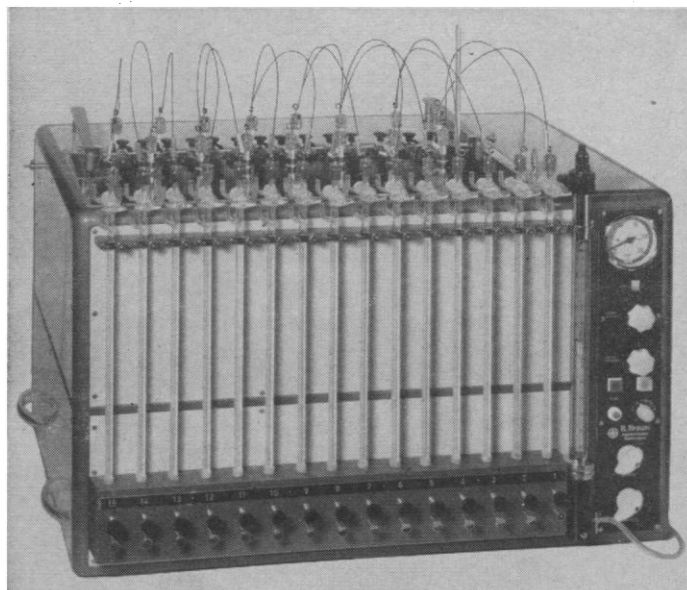
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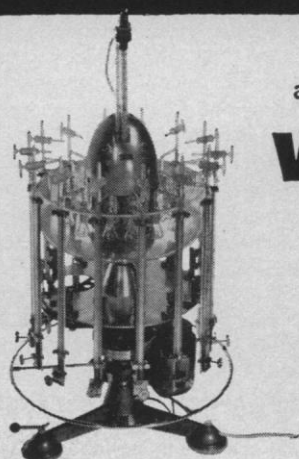
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The **extraordinary** features of many other brands are the **ordinary** in UNITRON Microscopes. Complete optical and mechanical accessories are standard equipment, rather than hidden extras "at slight additional cost". Coated optics are second to none. Original designs provide easy operation, versatility, lab-proven ruggedness and guaranteed performance. All of these are just routine, normal advantages that customers have learned to expect when they specify UNITRON Microscopes — **plus** attractive prices which are so easy on your budget.

UNITRON MEANS MORE MICROSCOPE for the MONEY. Leading labs throughout the world know this. It's the reason, really, why "UNITRON Microscopes are seen in the best of circles". But why take our word? It's easy to prove for yourself, the advantages and value that UNITRON can offer you. Borrow any model (or models) for a free 10 day trial in your own lab. No cost . . . no obligation to buy . . . not even any shipping charges. Why not use the coupon to ask for a free trial, the chance to try before you decide whether or not to purchase. Or, ask us to send a catalog that will give you full details.

- ☐ Please send UNITRON'S Microscope Catalog. 4-Z
☐ I accept (without cost or obligation) your invitation to try UNITRON Model _____ for 10 days.

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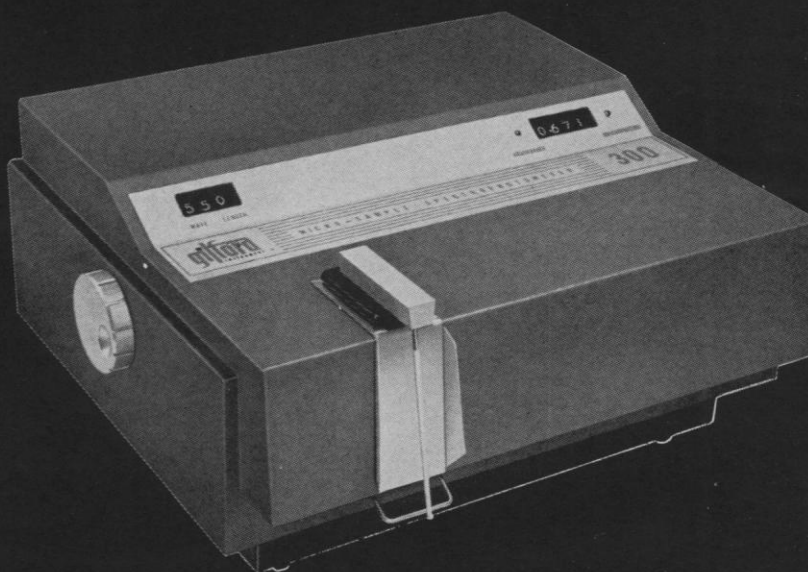
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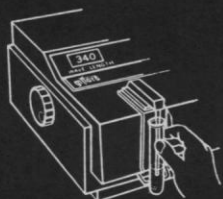
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340 to 700 mμ**



SIMPLIFIED SAMPLING



**DIRECT READOUT IN
ABSORBANCE OR
CONCENTRATION**

...with the Gilford Model 300 MICRO-SAMPLE SPECTROPHOTOMETER

This instrument maintains a usable resolution of 0.001 absorbance unit over its entire measurement span of 0.000 to 2.000 A units. Its long term stability is better than 0.005 A per hour, requiring only occasional zero setting on a reference. And it combines this uncommon performance with explicitly simple operation.

The automatic time-impulse sampling system draws in less than 0.5 ml per sample with no handling of cuvettes or pouring of fluids. Touch a bar, and in a few seconds you flush out the previous sample, then introduce the next. The absorbance value appears immediately on the four-digit numerical indicator. Or, after a single calibration setting, you get direct readings of concentration in any convenient units.

Technicians find the compact Model 300 especially easy to use and maintain. Yet, here is a true spectrophotometer with research accuracy and flexibility, filling a realistic need in busy laboratories.

The remarkable sensitivity and stability of the Model 300 is a product of a unique electronic circuit, sophisticated optical and mechanical design and close tolerance manufacturing.

For special applications there are accessories for continuous flow arrangements, use of standard cuvettes and chart recording of absorbance data.

As vital diagnostic and research techniques improve, measurements often require new orders of sensitivity, precision and speed. The Gilford Model 300 is clearly ahead of this trend.

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**INSTRUMENTATION FOR
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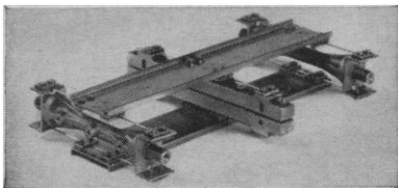
All the finest analytical balances used to have knife edges

until the EA-1

It used to be that the finest analytical balances were of knife-edge construction. (As a matter of fact, The Torsion Balance Company's own Christian Becker Division has made top-quality balances of this type since 1836 and still makes the world's best two-pan knife-edge balances.) But now Torsion, manufacturer of more precision balances than any other company in the world, has found a way to build a balance in the analytical range that eliminates the disadvantages of knife edges—and offers several other desirable features as well:

1 Longer accuracy thanks to friction-free torsion construction

In conventional analytical balances of knife-edge construction, in time the fulcrums become dull or are affected by abrasive or corrosive atmospheres—and initial sensitivity and accuracy suffer. The new Torbal EA-1 is constructed on the unique, proven torsion design principle. In this design there is no move-



ment of parts over one another, hence no friction. Torsion balances retain their initial high sensitivity and accuracy as no other balance can—for 20 years and more!

2 Null Indicator makes accurate weighing easier

The new Torbal EA-1 replaces the conventional optical system with an electronic null indicator; balance beam is always restored to equilibrium position before weight is read. Possibilities of inaccuracies in weighing due to variations in deflection sensitivity (when knife edges become worn, dirty, or damaged) are completely eliminated.

3 Complete digital readout to 0.1 mg.—without vernier

Digital presentation of weight without the use of an optical system, micrometer or vernier gives better readability, accuracy and reproducibility.

Write today for a free 4-page  bulletin or a demonstration.

THE TORSION BALANCE COMPANY

Department S

Main Office and Factory: Clifton, New Jersey
Sales Offices: Birmingham, Ala., Chicago, Ill., Lynnfield, Mass., Pittsburgh, Pa., Richardson, Tex., San Mateo, Cal., Santa Ana, Cal.

Types 561A & RM 561A oscilloscopes

easily adapted to particular needs



Here's a Tektronix oscilloscope featuring operational simplicity and versatility through a new series of plug-in units. Presently, you can select from 17 amplifier units and 7 time-base units.

Knowing your application area, you select units to fit your needs. Some of the plug-in unit combinations available include those for low-level, differential, multi-trace, sampling, and spectrum analysis applications. Plug-in units offer capabilities from 100 $\mu\text{V}/\text{cm}$ deflection factor (3A3) and 15 MHz bandwidth (3A5) to 0.5 $\mu\text{sec}/\text{cm}$ sweep rate (3B1, 3B3) and sweep-delay applications (3B1, 3B2, 3B3).

With any combination of plug-ins including the same type amplifier units in both channels for X-Y displays — this oscilloscope provides you with no-parallax displays for accurate reliable measurements.

features

crt with an internal graticule and controllable edge lighting • regulated power supplies • regulated dc heater supply • Z-axis input • 3.5-kV accelerating potential • amplitude calibrator • and operation from 105 V to 125 V or 210 V to 250 V. (The Type 561A operates from 50-400 Hz and the Type RM561A operates from 50-60 Hz.)

Type 561A Oscilloscope \$500

Plug-ins Illustrated:

Type 3A74 Four-Trace
Unit \$590
(4 identical channels, bandwidth DC-to-2 MHz, deflection factor 20 mV/cm to 10 V/cm)

Type 2B67 Time-Base
Unit \$210
(Sweep range 1 $\mu\text{s}/\text{cm}$ to 5 s/cm, 5X magnifier, single sweep, flexible triggering facilities)

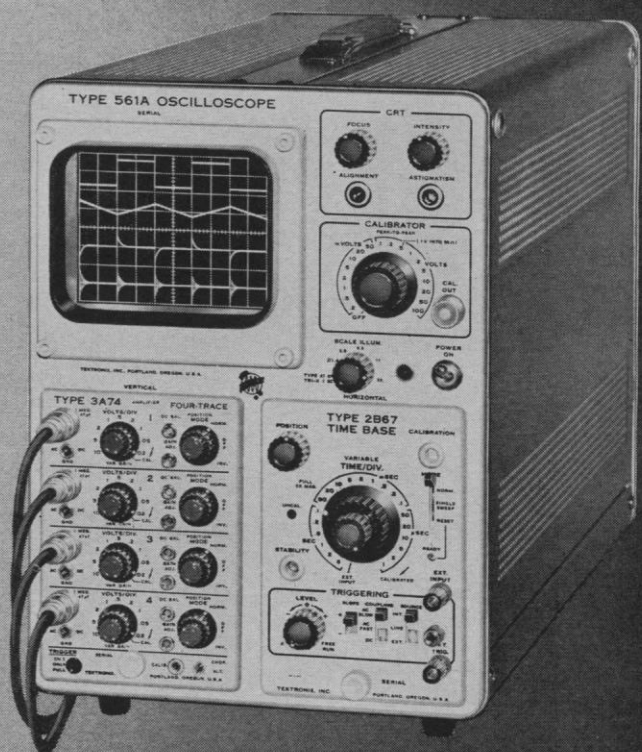
Type RM561A
(7" rack height) . . . \$550

Plug-ins illustrated:

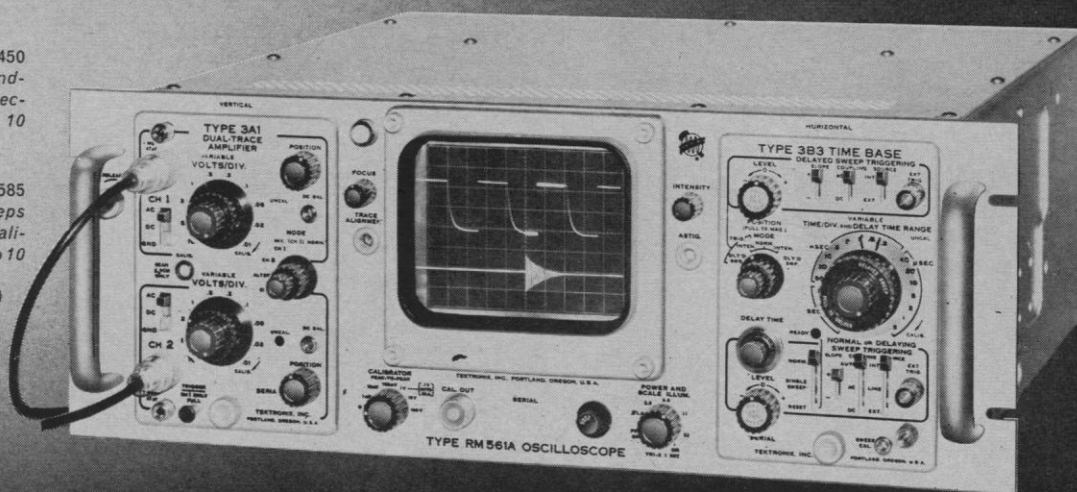
Type 3A1 Dual-Trace
Unit \$450
(2 identical channels, bandwidth DC-to-10 MHz, deflection factor 10 mV/cm to 10 V/cm)

Type 3B3 Time-Base
Unit \$585
(Normal and delayed sweeps 0.5 $\mu\text{s}/\text{cm}$ to 1 sec/cm, calibrated sweep delay 0.5 μs to 10 sec, single sweep, flexible triggering facilities)

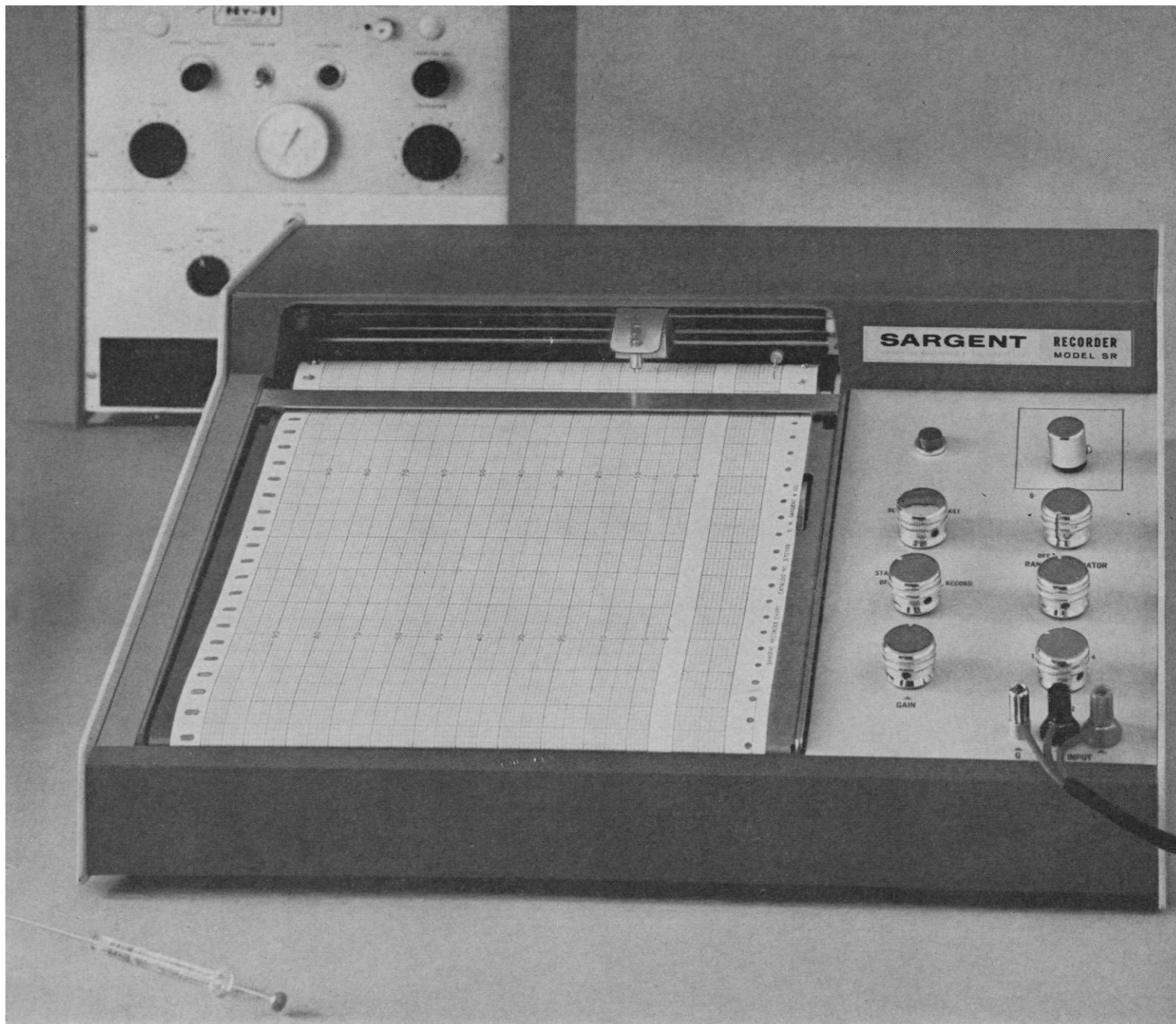
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Tektronix, Inc.



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The MODEL

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■ Connect directly to all Gas Chromatographs,
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■ Two Models to choose from —
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S-610

READ ALL ABOUT THESE RECORDERS IN BOOKLET SR-GC-2

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S/P TekTimers (TM)

tell time backwards so you don't have to figure ahead

The S/P TekTimers show the time *remaining* instead of the time elapsed. And they show it in large, clear figures that can be read across the room. When the time is up, the adjustable buzzer alarm signals above busy laboratory background noises. The TekTimer is available in two models that may be set in minute segments up to 999 minutes (over 16 hours). The standard model, shown at the right, is designed for routine timed procedures. The S/P TekTimer S, shown above, is also a time switch with the added capability of automatically turning equipment of less than 1700 watts on or off at a preset time. Attractive bronze colored metal case. One year warranty. 115 volts, 60 cycles AC.

No. C6490—S/P TekTimer Interval Timer. **\$25.00**
4½" d x 4½" w x 4¼" h, with cord and 3-wire plug.

No. C6492—S/P TekTimer S. **\$37.50**
4½" d x 5¾" w x 4¼" h, with cord and 3-wire plug.



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Designing an atmospheric system for physical chemistry, nuclear research, aerospace projects or metallurgy turns into an expensive game called "Nuts, Bolts and Gaskets." Pestiferous minutiae eat up costly technical man hours.

If you spend your time on it, it's a waste.

At Blickman we have a vast library of already designed components. They exist . . . engineered, built, tested and ready for your job.

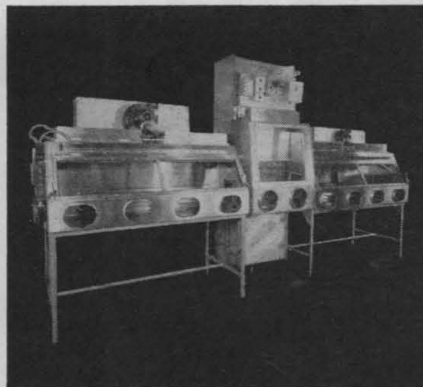
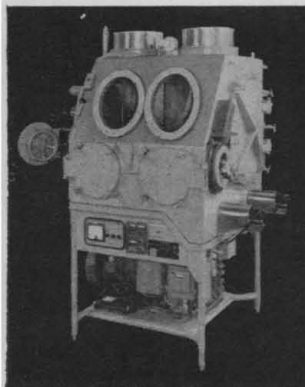
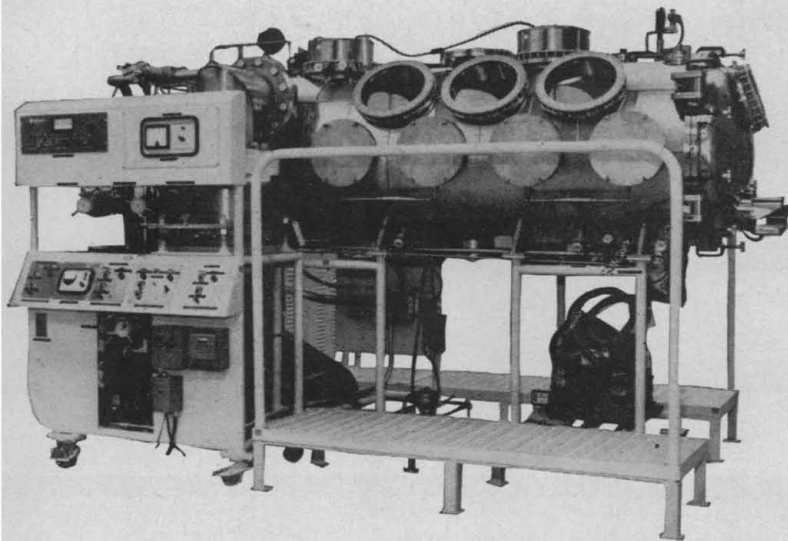
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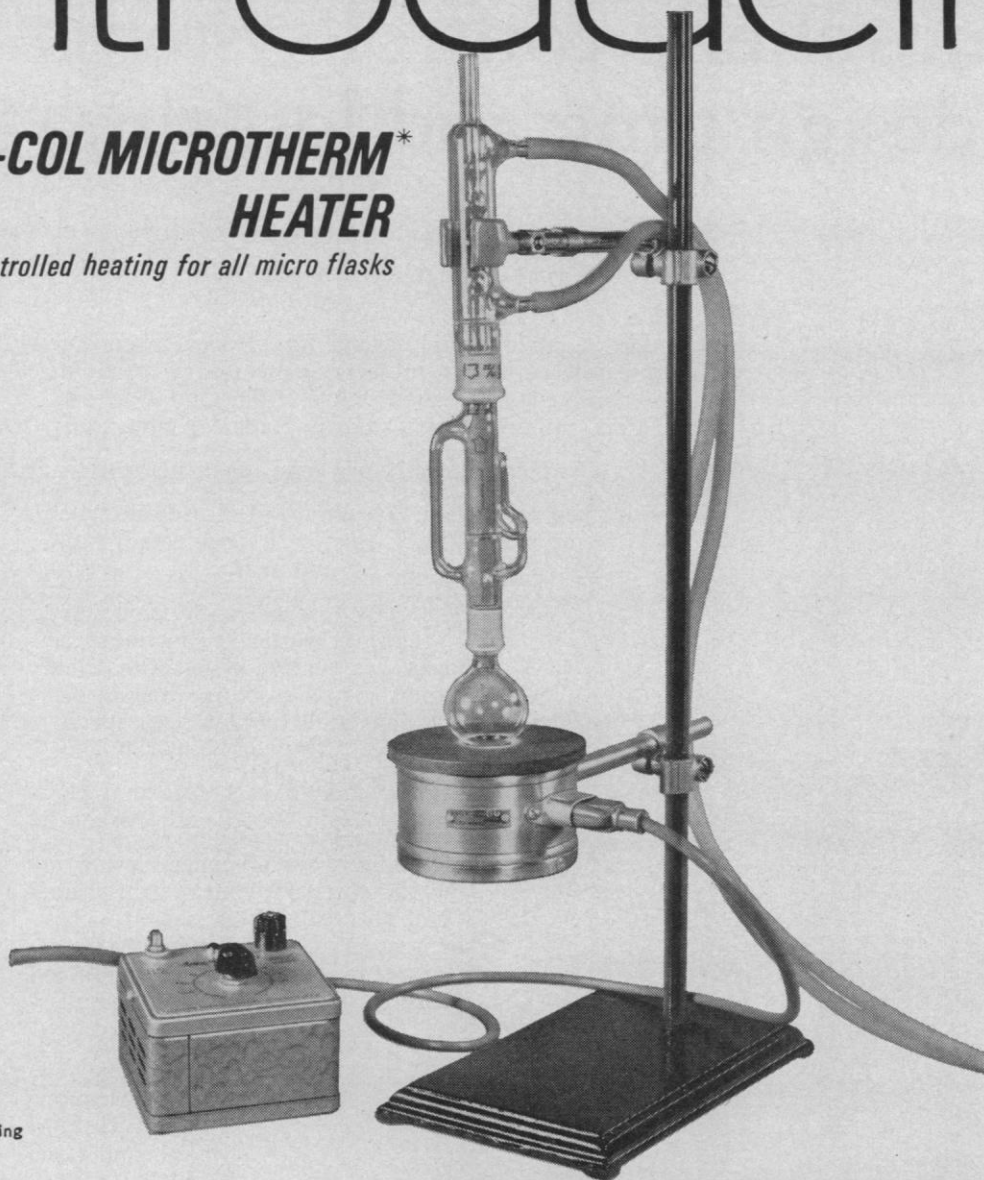
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GLAS-COL MICROTHERM* **HEATER**

-safe, controlled heating for all micro flasks



*Patents Pending

You can distill virtually to the last drop . . . without superheating the bare flask wall above liquid level.

The new Glas-Col Microtherm heater will fit any micro flask, sizes up to 50 ml, spherical or pear shape. Area of heat input less than 0.4 square inches, yet provides ample heat for most micro distillations.

Simple construction—a hot well, formed from a small inconel tube, flared for snug flask fit. It is the nearest practical approach to the ideal of a point source of heat at bottom center of flask.

Microtherm heater rated 60 watts, 115 volts. Furnished with a 3-wire, 3-foot long cord. Can be used with variable transformer. Additional data on request.

GLAS-COL **HEATING MANTLES**

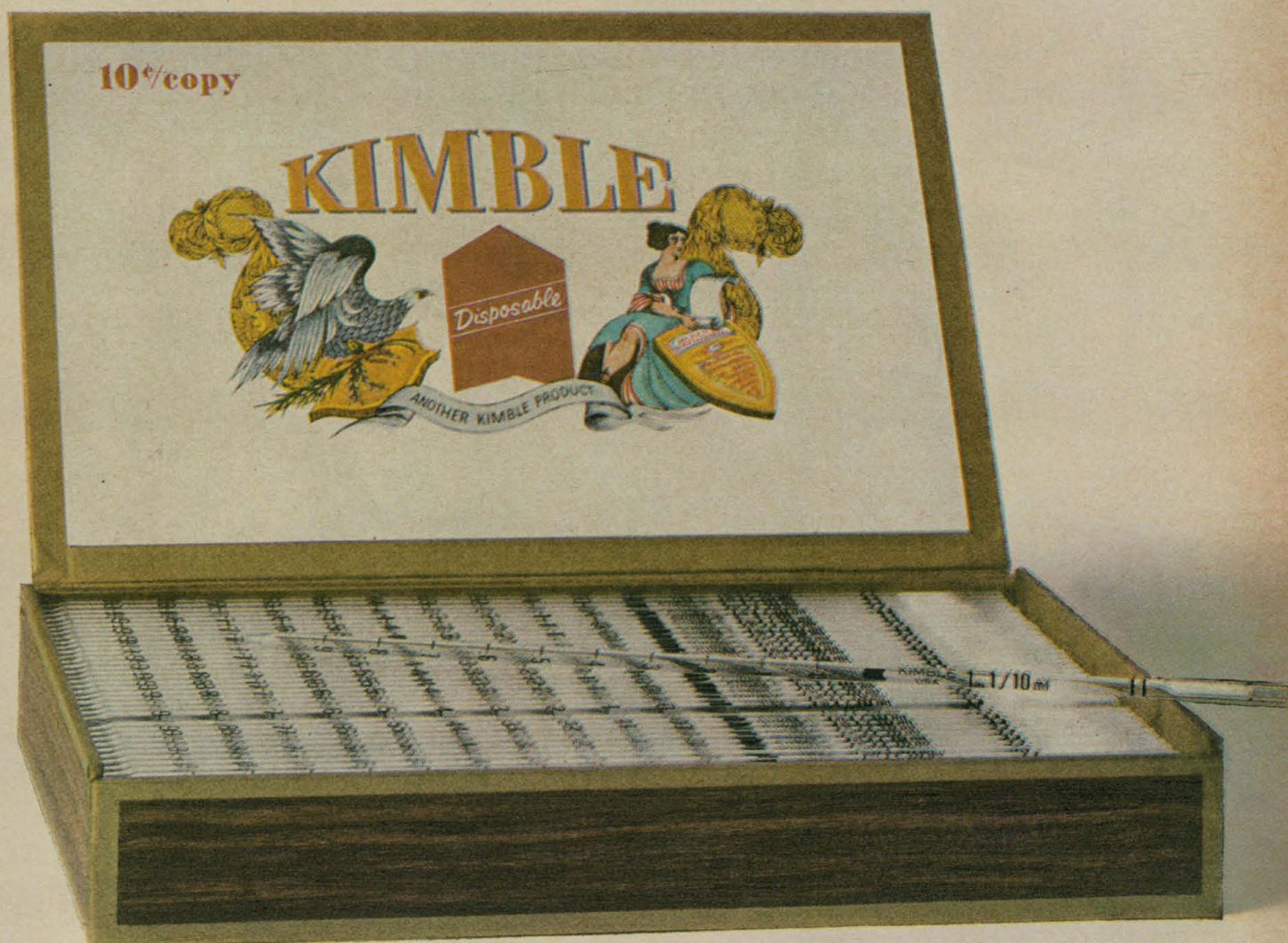
Glas-Col Apparatus Company • Dept. SC, 711 Hulman Street, Terre Haute, Ind. 47802
Specialists in solving unusual heating problems

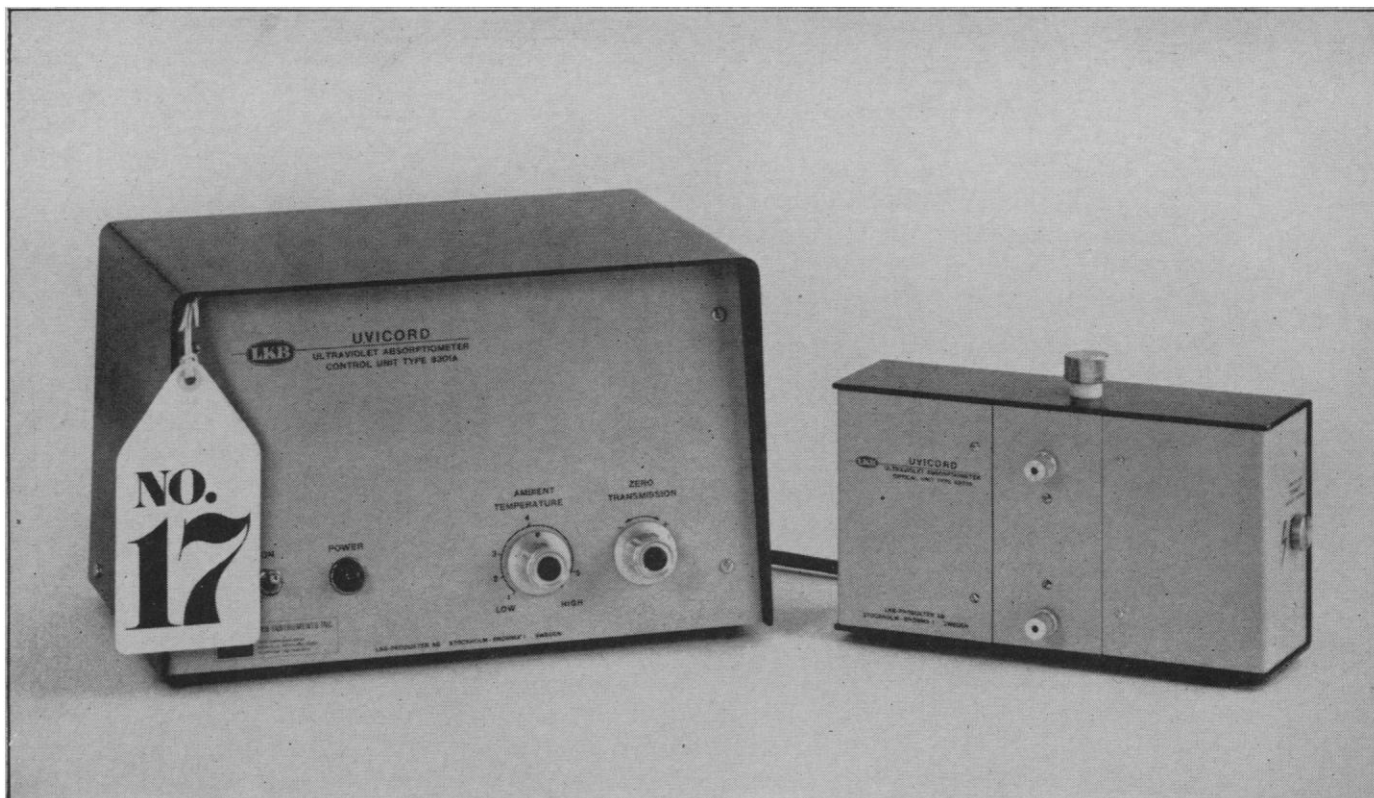
What this country needs is a good 10-cent pipet!

Could a 10-cent pipet do the same job as a conventional pipet? This new Kimble *disposable* pipet can...for even less than a dime! Made of fine borosilicate glass, it's clean, cotton-plugged, sterile, ready to use. Features a rugged, uniform tip for consistent delivery. Same accuracy as a regular pipet: $\pm 2\%$. The right length for handling ease; the right price for disposable convenience, and new packaging for added utility. Compare! Write for your complimentary sample and complete information. Address below, c/o Marketing Services Department.

OWENS-ILLINOIS

maker of Kimble Products
Toledo, Ohio 43601





**There are at least 16 UV monitors already available
(and one of them is even ours).
Whatever possessed us to develop number 17?**

Unbounded optimism. That, and the rather firm conviction that it was now time for a first-rate, fully quantitative flow analyzer for monitoring UV absorption at either 254 or 280 m μ .

This new analyzer, the Uvicord II, is now available as a particularly useful tool for continuous measurement of the UV absorption of electrophoretic or chromatographic effluents containing fractions which absorb at 254 or 280 m μ . And it is especially suited for cold room use because: (1) the light source compartment is insulated and has its own built-in heating coil, and (2) the control unit *and/or* recorder can be physically separated from the detector unit, thanks to a very long cable. (One of several advantages of a *separate* recorder.)

The primary source of the 254 m μ in the Uvicord II is a stable, long-lived, low-pressure mercury lamp. But then getting the desired 280 m μ was quite

another matter and proved to be somewhat of a strain on the aforementioned unbounded optimism. The eventual elegant exclusive solution: the 254 m μ from the mercury lamp is used to excite a transparent rod which has been specially activated to fluoresce strongly. This rod then emits UV in a relatively narrow peak with a maximum at 280 m μ . Unwanted radiation is eliminated by using black glass and selective interference filters. This latter interference filter was also developed by us and provides unique assurance of getting the essentially monochromatic light needed for quantitative measurements.

What is the possibility of harming UV-sensitive materials with the Uvicord II? It's unlikely. The *maximum* UV dose to which a sample can be exposed is a negligible 10⁻¹¹ Einstein/min, equivalent to 0.09 μ W.

Then we should probably also tell you

that this instrument has a well-designed detector unit, that the very small measuring cells have good flow properties and are easy to get to, and that the circuitry is simple, straightforward and dependable. All true. Or, that the Uvicord II is compatible with our entire line of chromatographic devices, fraction collectors, and recorders. The Uvicord II takes its place comfortably in our complete systems (whose individual units are all LKB-designed and built), or, alternatively, can perform as a versatile UV analyzer when coupled to other equipment. Incidentally, the Uvicord II follows the Uvicord I but doesn't necessarily displace it. You might keep the Uvicord I in mind if your need is solely for 254 m μ ; it's still very viable.

(So now there are at least 17 UV monitors, and two of them are ours.) For complete specifications on the Uvicord II, ask for bulletin 8300S10.



LKB INSTRUMENTS, INC., 12221 Parklawn Drive, Rockville, Maryland 20852
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Why no derating?



Derating of ultracentrifuge rotors is a necessity brought about by the development of progressive metal fatigue as a consequence of long-continued or repeated stressing under extremely high centrifugal forces. This is usually expressed as successive limitations in permissible top speeds.

A key factor in derating is the original strength of the rotor which is largely determined by the nature of the material used, manufacturing processes and design.

IEC ultracentrifuge aluminum and titanium rotors represent a technological breakthrough in which optimum design was achieved through computer techniques. Our manufacturing processes involve advanced forging

techniques, stress relieving, specialized alloys, and custom developed machinery.

As a result, IEC rotors withstand repeated stressing over such a protracted period without impairment, derating is eliminated as a factor to consider in use. That's why we say, **no derating**. You buy one of each type you need and that's it. Many years and thousands of use-cycles later, you can still run these rotors at their top rated speed. Just keep them free from corrosion — IEC guarantees them unconditionally without time limit.

No derating. One more significant reason why, if you work anywhere in the ultracentrifuge spectrum you should be prepared to change basic thinking about equipment. Send for brochures on Models B-35 and B-60.

INTERNATIONAL  EQUIPMENT CO.

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“Low-level counting”

You can now buy the instruments that experts developed for their own demanding research.

An assemblage of experts doing research in low-level counting techniques needed (but could not find) instruments that met their exacting requirements. So, as you just might surmise, they solved their problems over the years by developing several rather distinctive low-level counters — *not* to develop instrumentation for the sake of developing instrumentation (or even for the sake of selling it), but only as functional, reliable means to ends. And then, inevitably, as they used this equipment in their own research programs, they de-bugged it. Result: user-designed, user-perfected, user-seasoned, low-level counters which can do what no existing instruments can do. Now as other workers see these counters working in our laboratories, we get, with increasing frequency, requests for duplicate copies. Accordingly, we are now making these counters available (not reluctantly, it should be noted) to others with similarly exacting requirements. For the specifics, read on.

Precise measurement of low-energy beta emitters.

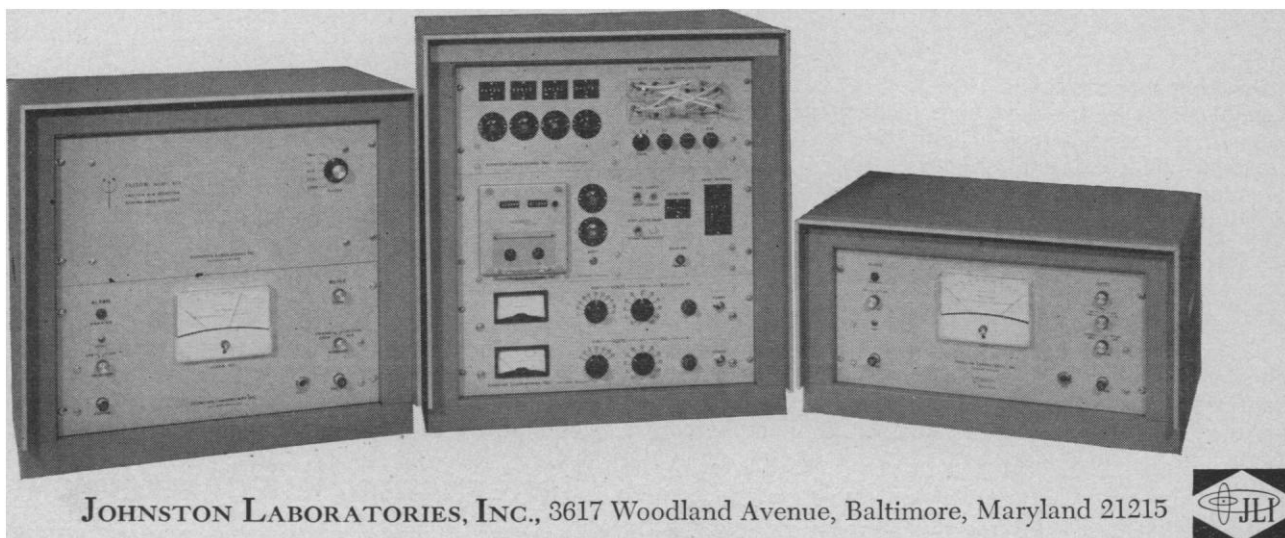
The Beta-Logic Gas Counting System was specifically designed for carbon-14 age-dating, natural tritium and low-level tracer analysis. The system utilizes proportional internal gas counting. A three-channel pulse charge analyzer provides data on the energy distribution of counts and allows simultaneous measurement and correction for contaminant activities such as H^3 and Rn in C^{14} samples. A two-channel printer records the number of counts for each of the preset time periods, which repeat automatically. Four independent scalars accumulate during each run. The energy analyses are accomplished through the use of computer-type logic circuitry.

This is an ideal system for serious work requiring maximum counting efficiency and low-background levels for utmost sensitivity. For complete data: request bulletin GC-10.

Tritium air and gamma area monitors.

Johnston Laboratories has perfected two instruments for tritium air and gamma area monitoring: the Model 755B Triton, and the more sensitive model 855 Triton. The Model 755B Triton accurately monitors airborne beta-emitting radioisotopes such as H^3 , C^{14} , and Kr^{85} or, alternatively, ambient low-level gamma radiation. The design of this instrument eliminates the errors usually associated with tritium air monitors and provides a new high level of accuracy and reliability. Its exceptional stability and sensitivity also permit analytical applications when incorporated into the closed atmospheric circuits of controlled environmental experiments. The 755B Triton may also be used as a low-level gamma monitor with much higher sensitivity than most gamma survey meters. For much more information: request bulletin 755B.

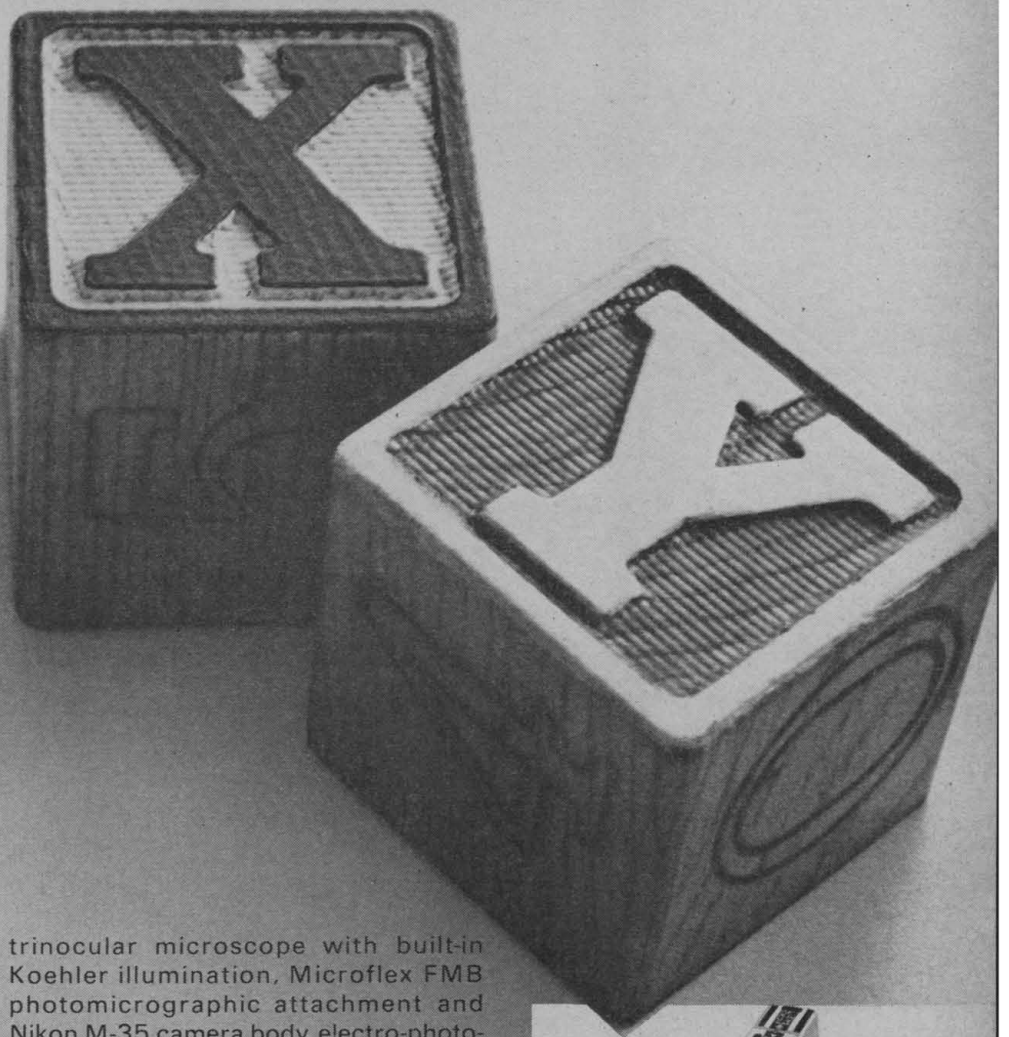
The Model 855 Triton, more sensitive than its progenitor above, is ideal where the measurement of extremely small amounts of gaseous radioactive contamination is a necessity. This instrument is particularly suited for monitoring the maximum permissible concentration of tritium in air ($5\mu C/M^3$) since the sensitivity is $10\mu C/M^3$ full scale. It can also serve to measure other beta emitters and is a very sensitive gamma area monitor too ($.05\text{ mr/hr.}$ full scale). Ask for bulletin 855 for complete data.



JOHNSTON LABORATORIES, INC., 3617 Woodland Avenue, Baltimore, Maryland 21215



Karyotyping as easy as:



It's tough enough to catch a good metaphase, break a cell, and hold the chromosomes intact. But even then you're only half way home.

You still have to photograph the specimen, process the negative, and make the enlargement before you can even begin to get down to the real business at hand — the analysis.

In organizing the Nikon Chromosome Photomicrographic Outfit, we didn't presume to simplify the preparative aspects of the technique, though we may have taken some of the uncertainty out of the interpretation. Essentially we reduced the photographic procedure to a simple, standardized routine.

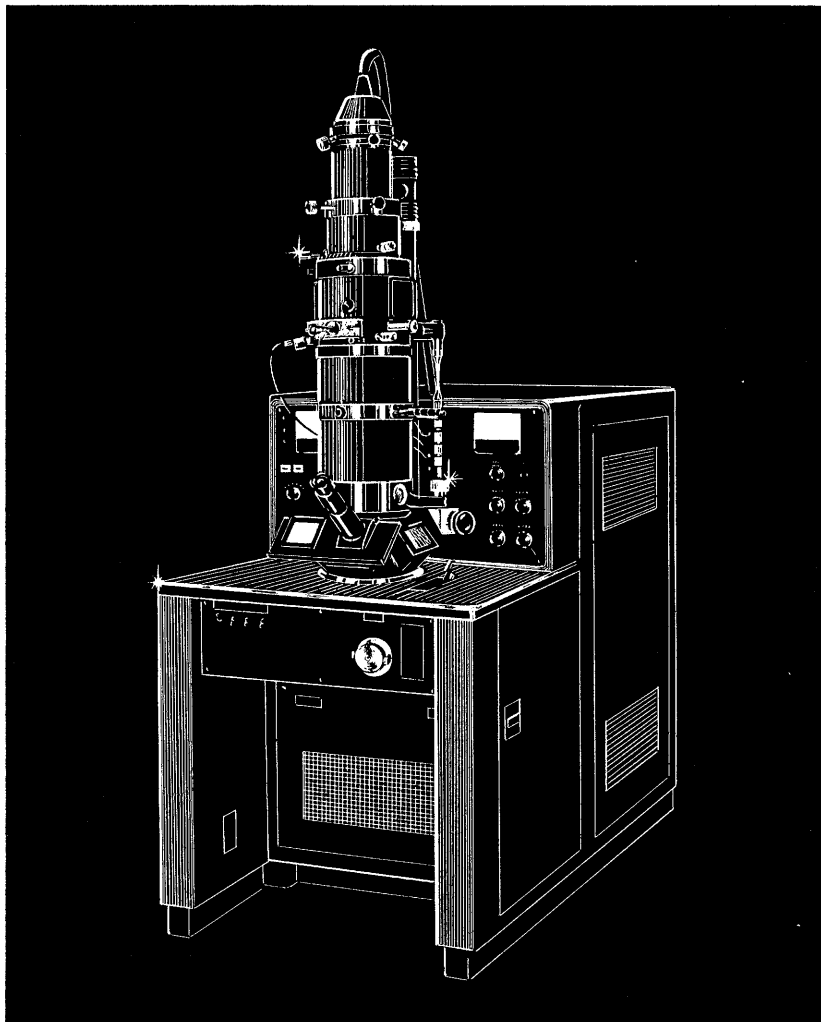
The Nikon Chromosome Photomicrographic Outfit is as complete as you could want it to be. All the necessary equipment is included: Nikon SUR-Ke

trinocular microscope with built-in Koehler illumination, Microflex FMB photomicrographic attachment and Nikon M-35 camera body, electro-photometer for exposure determination, daylight film-processing tank, Durst enlarger with lens, Fotorite rapid processor for enlargements, and other accessories.

The outfit also includes a starter set of Karyotype forms, a Difco culture kit and a complete manual of instructions. No darkroom is required.

The Nikon Chromosome Outfit has so simplified the photographic procedure, it can be entrusted to any competent technician, leaving the cytogeneticist free to devote his time to the microscopy and the analysis. For complete details write to Nikon Inc., Instrument Division Garden City, N.Y. 11533 Subsidiary of Ehrenreich Photo-Optical Industries, Inc.

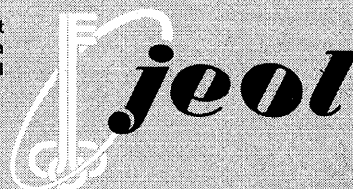




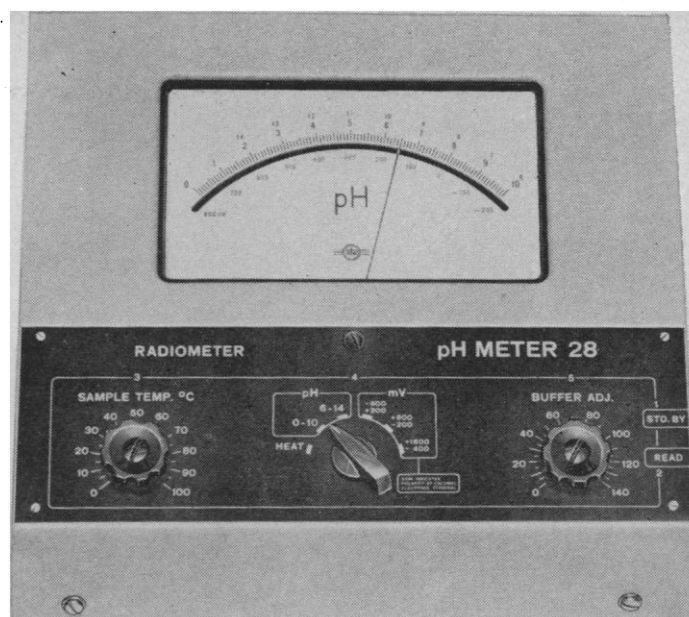
The JEM-T7 Electron Microscope for biological applications

... resolution — $10\text{\AA}$... continuous magnification — 400X to
 80,000X without change of pole piece ... high contrast, wide angle
 for low magnification work ... accelerating voltage — 60kv
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 automatic exposure system ... priced at \$23,228 (duty free).

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 Branch offices at Atlanta, Chicago and Montreal



pH Measurement



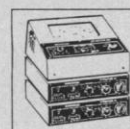
Teamwork: The basis of Radiometer systems for measuring and controlling pH.

The pH meter above is a Model 28, ready to measure pH accurately and dependably. It is typical of the several fine Radiometer models from which the one best meeting your particular requirements can be selected. The Titrators below are designed to team up with the pH meter either singly or in pairs.



One of these economically priced model 11s adds the facility to perform all types of end-point titrations automatically, or to control pH in one direction.

Two of them provide control to maintain a constant pH regardless of which way the pH is changing.



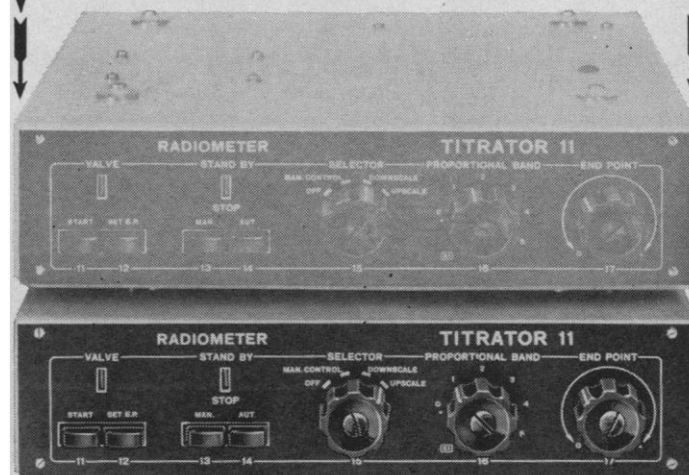
The variety of delivery systems and recording facilities available provides for even more potent combinations. Write for more detailed information on how to put a Radiometer team to work for you.

THE LONDON COMPANY

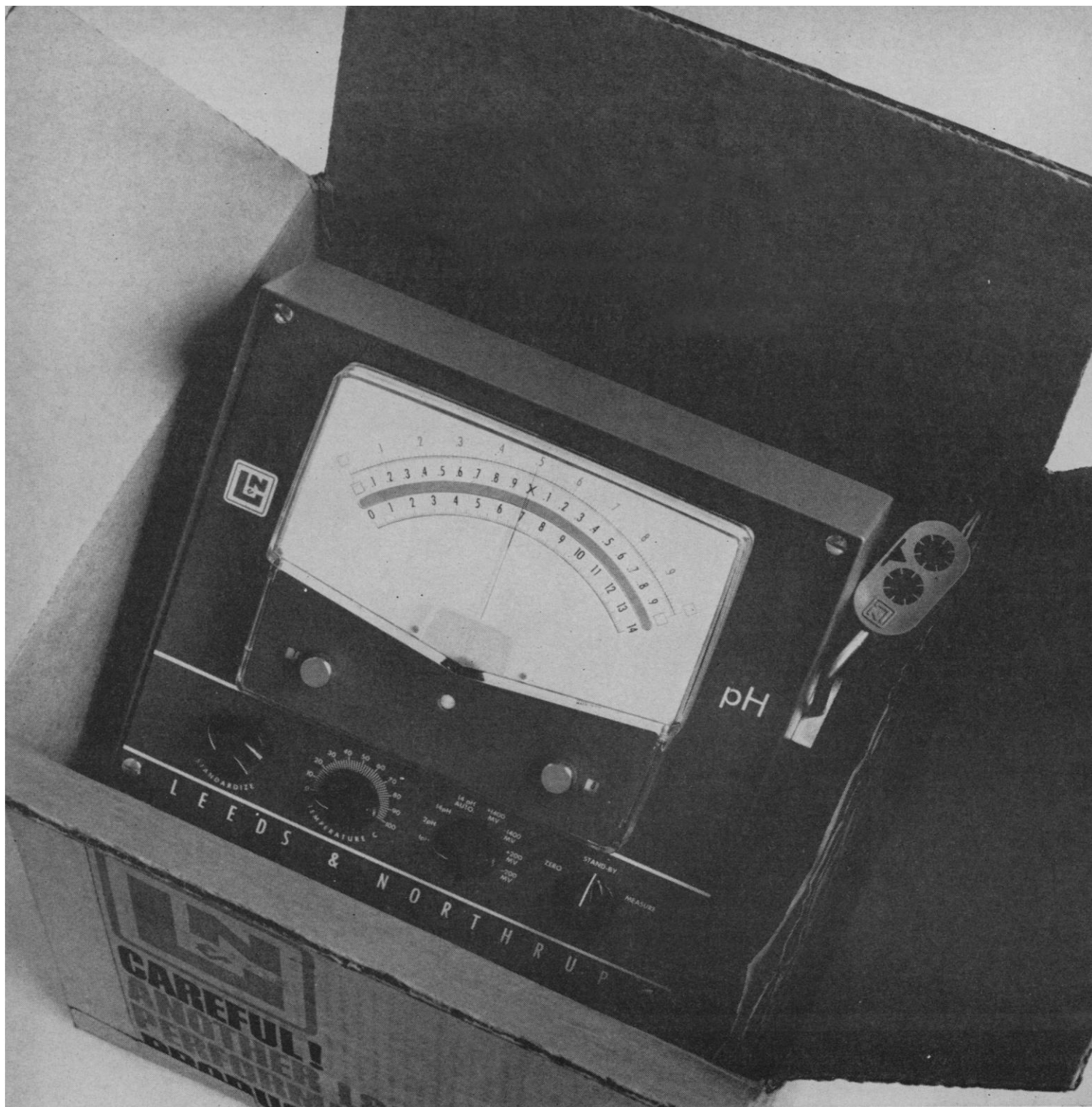
811 SHARON DRIVE, WESTLAKE, OHIO

RADIOMETER  **COPENHAGEN**

In Canada: Bach-Simpson Limited, Box 2484, London



pH Control



Do you need reproducibility to 0.002 pH? Our new meter delivers it.

It's far and away the most sensitive device in L&N's entire pH family... the 7407-A2 pH meter... designed specifically for laboratory and clinical research and diagnostic use (flexible enough for general-purpose applications too).

Not only does it give you direct-reading to $\pm 1/1000$ pH on the one-pH span, it also has these capabilities...

- 2-pH span, direct-reading
- 0 to 14 pH range
- ± 200 -mv spans, direct-reading
- 0 to ± 1400 mv ranges
- Manual temperature compensation on 1, 2, and 14 pH range

- Automatic temperature compensation on 14 pH range

The one-pH span provides the added readability required in such critical measurements as pH of blood and body fluids, where minute changes are highly significant. The two-pH span minimizes range-changing and simplifies checking against buffers. The 0 to 14 pH range and millivolt spans and ranges provide the additional flexibility to meet general-purpose requirements.

And like the other A-2 Series meters, the 7407 also features a photoconductive chopper, feedback-stabilized amplifier,

hand-wiring, highly-responsive meter with taut-band suspension and 7" scale, Karl Fischer circuitry, and output terminals for recorder display.

For full details on this or any of the A-2 Series meters, and the name of the laboratory pH dealer nearest you, write to: Leeds & Northrup Co., 4926 Stenton Avenue, Philadelphia, Pa. 19144.



LEEDS & NORTHRUP
Philadelphia 44 • Pioneers in Precision



Disinfect, Deodorize and Clean animal cages with Mikro-Spray as easily as you now hose them down!

A unique device for the in-place cleaning of animal cages and animal rooms, the MIKRO-SPRAY system injects detergent germicides into your waterline at a rate exactly proportional to the flow of water.

Any surface or object that can be washed with water can be cleaned, disinfected and deodorized with the MIKRO-SPRAY just as easily and far more effectively. In fact, MIKRO-SPRAY hooks right into your existing waterline system. It is available in both wall-hung and portable models, which dispense one of two powerful detergent germicides (whichever one is best suited for your needs) in a rate exactly proportional to your flow of water. And gives you your safest, most sanitary, in-place cage cleaning ever, with no mopping or rinsing needed!

The first of these two detergent germicides, MIKRO-QUAT, is a quaternary ammonium detergent germicide. Completely harmless to animals, it disinfects and deodorizes for a full twenty-four hours. It is recommended for normal in-place cage cleaning requirements.

The second, MIKRO KLENE, is an iodophor detergent germicide that gives you the ultimate in disinfection results. It is recommended for use in cages where ani-

mals are being used for experimentation with dangerous infectious diseases and a fast, positive bacterial kill is required. Like MIKRO-QUAT, it is completely harmless to animals.

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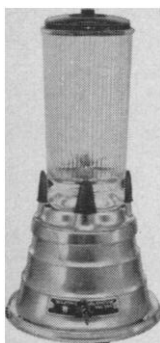
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GIANT!

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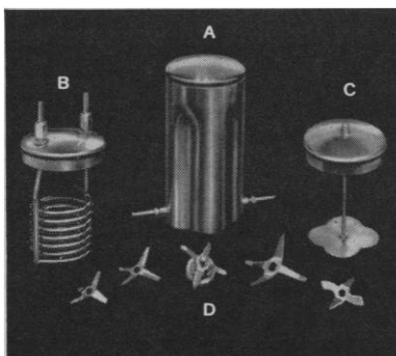
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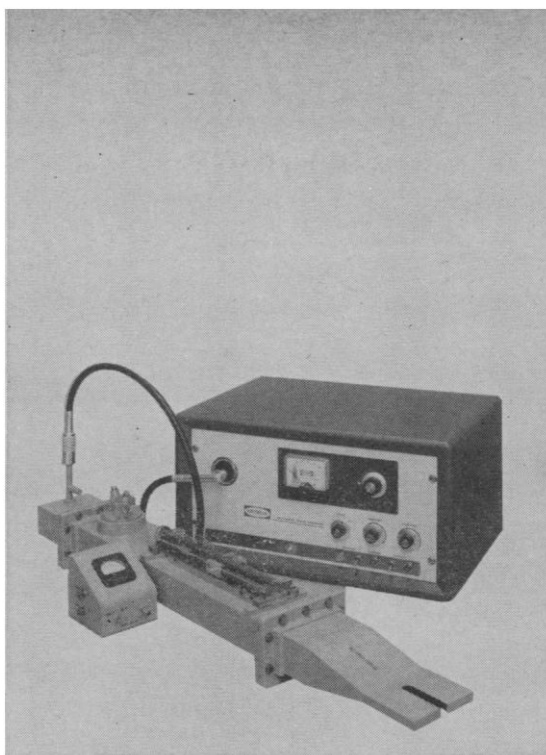
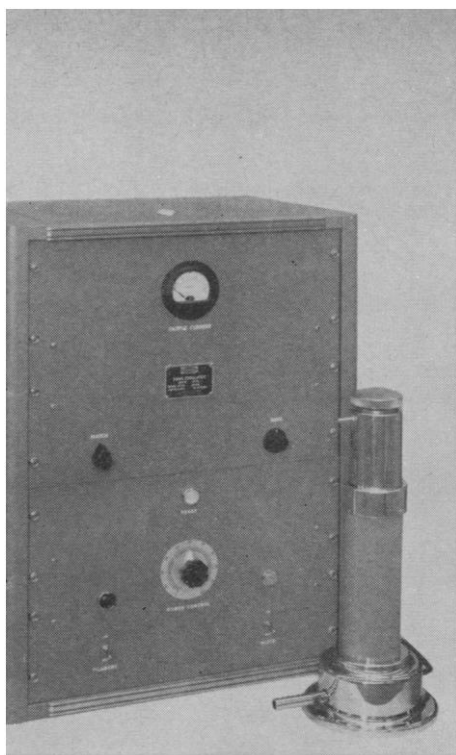


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Applications include: Bacterial and cellular disruption, dispersion and homogenization, free radical research, spectroscopy and interferometry.

Model DF 101 sonic oscillator is a low frequency magnetostriction unit designed for the rapid duplication of physiochemical reactions in laboratories. The unit may be used in a wide variety of industrial and laboratory research projects such as studying the effects of sonic energy on liquids, living organisms, mixtures and chemical solutions. Power output (driver to stand) is 250 watts, 1.2 amperes. Frequency is 10 KC (nominal). Power requirements are 110 @ 50-60 cycles, 750 w. Recommended capacity is 50 cc however the stand will contain up to 165 cc.

Model PGM-10X2 microwave generator and its accessories are designed for the production of free radicals and the excitation of electrodeless discharge lamps in the fields of spectroscopy, raman spectroscopy and interferometry. Specifications: Power input—105-130 v @ 60 cycles, 385 watts. Power output—85 watts CW power at 2450 ± 25 MHz and/or variable pulse rate between 100—5000 Hz and duty cycle variable between 1% and 80%. The chosen operating frequency minimizes cleanup accumulation on the walls of the electrodeless lamps.

The Model PGM-100 microwave generator fills the need for higher power. Specifications: Standard JAN waveguide RG 104/U • Maximum CW power output 800 watts • Fixed frequency, 2450 ± 25 MHz • Modulation in the order of 10% or 120 Hz pulsed. The power output is constant through normal line fluctuations and variations of magnetron impedance with load and life. The unit contains a filter network that can be switched into the magnetron plate supply to provide a microwave power output with modulation of about 10% in the detected rf envelope.

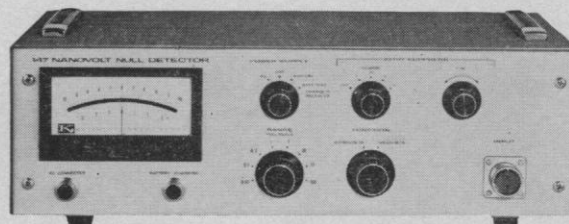
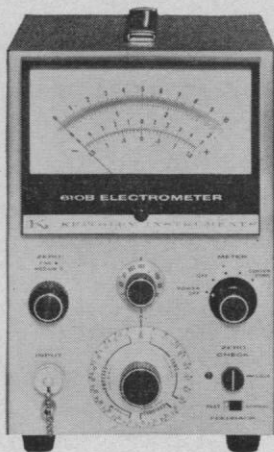
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RAYTHEON

AC AMPLIFIERS PICOAMMETERS ELECTROMETERS HIGH VOLTAGE SUPPLIES MICROVOLTMETERS NANO VOLTMETERS MEGOHMMETERS CURRENT SOURCES NANOVOLT SOURCES AC VOLTMETERS AC/DC AND DC DIFFERENTIAL VOLTMETERS DC VOLTMETERS KEITHLEY MEANS INSTRUMENTS NANO DETECTORS OPERATING AMPLIFIERS NANO AMMETERS CURRENT SOURCES MEGOHMME TERS HIGH VOLTAGE SUPPLIES MICROVOLTMETERS NANOVOLT SOURCES AC VOLTMETERS AC/DC AND

ELECTROMETERS AND PICOAMMETERS

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Holding nanovolt and microvolt level signals is easier when you count on Keithley's line of low noise, highly stable instruments. Most have built-in zero suppression, too! The Models 148 Nanovoltmeter and 147 Nanovolt Null Detector operate by line or battery power. Sensitivities range from the 148's 10 nV or 147's 30 nV, to 100 mV. The low cost 153 measures from .2 μ V to 1000 volts, with high ac rejection. For lower cost and proven performance, with sub-microvolt resolution, you can count on both our 150A and 149.

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ac AMPLIFIERS

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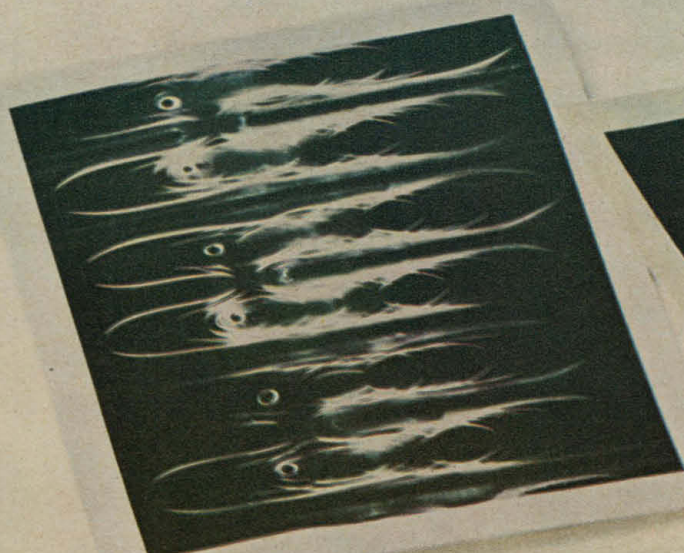


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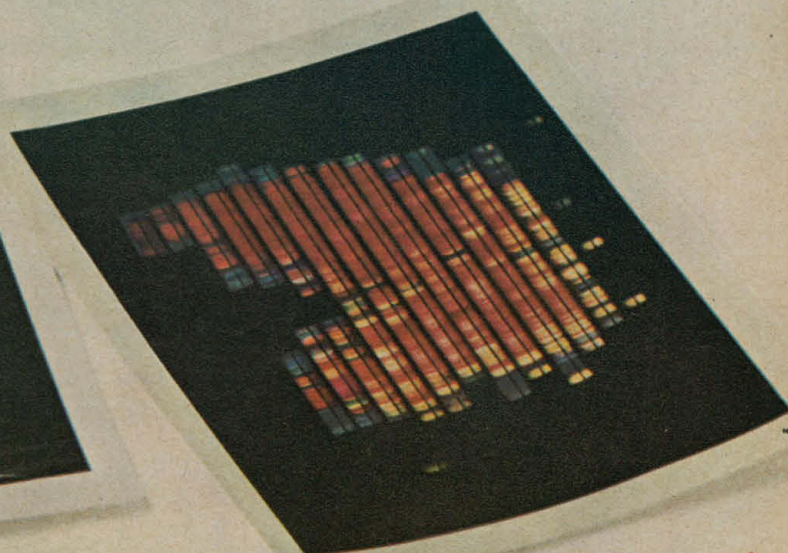
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Spin Labels for Biomolecules

EXAMPLE: "Tagged" molecules by chemical reaction with stable spin systems.

Most materials of biological and chemical interest do not contain an unpaired electron spin (in their ground states) and are not useful for EPR studies. Many of these materials can be studied with EPR methods by either oxidizing or reducing them. Recently, a more general method has been developed by McConnell *et al.*^{1,2,3} who have "tagged" molecules by chemical reaction with stable spin systems, somewhat in analogy to customary fluorescence labeling. All tagging or labeling methods are useful in determining the mere presence or absence of the tagged compound. In addition, spin labeling offers several intrinsic advantages over other methods: The EPR technique has very high sensitivity; the spin label provides a microprobe for examination of the local environment; and the motion of the tagged species affects the observed spectrum.

As an example, the reversible change of Bovine Serum Albumin (BSA) as the pH is lowered was studied by spin labeling methods. The molecule BSA was reacted chemically with a spin label, which in this case was a stable nitroxide molecule similar to that shown in Figure 1. In a pure solution of the spin label, three sharp well resolved hyperfine lines are observed, arising from coupling to the nitrogen nucleus ($I=1$). The lines are sharp because rapid

motion in solution averaged the anisotropic hyperfine interactions. The spectrum of spin labeled BSA is shown in Figure 2. McConnell *et al.* have shown that this spectrum arises from spin labels bound in two different environments of the BSA molecule, one site where considerable motion of the nitroxide radical is permitted giving rise to 3 narrow lines, and one site where the spin label is more tightly bound to the BSA molecule and an anisotropically broadened spectrum is obtained. Here the spin label presumably is bound to a region of restricted access in the BSA molecule.

As the pH is lowered, the BSA molecule is uncoiled in such a manner that the broad anisotropic portion of the spectrum arising from the tightly bound spin labels decreases in intensity. At the same time the intensity of the 3 narrow hyperfine lines arising from more freely moving spin labels increases. Figure 3 shows the pH dependency for the process, which is envisaged as an opening up of the protein BSA.

Spin labels are currently being considered for other applications such as kinetic rate determinations and study of the environments close to reaction sites, e.g. enzymes.

1. Stone, Buckman, Nordio, McConnell, Proc. Nat'l. Acad. Sci. 54, 1010, (1965);
2. Griffith and McConnell, Proc. Nat'l. Acad. Sci. 55, 8, (1966);
3. Lawrence, Berliner and McConnell, Proc. Nat'l. Acad. Sci. 55, 708, (1966).

Fig. 1

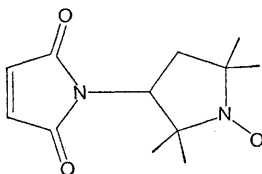


Fig. 2

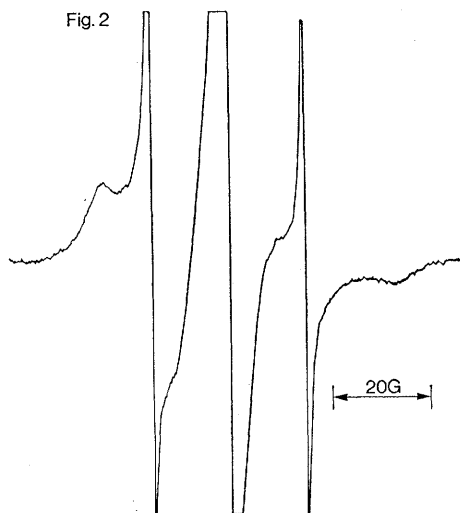
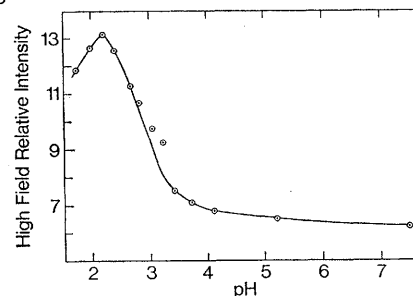


Fig. 3



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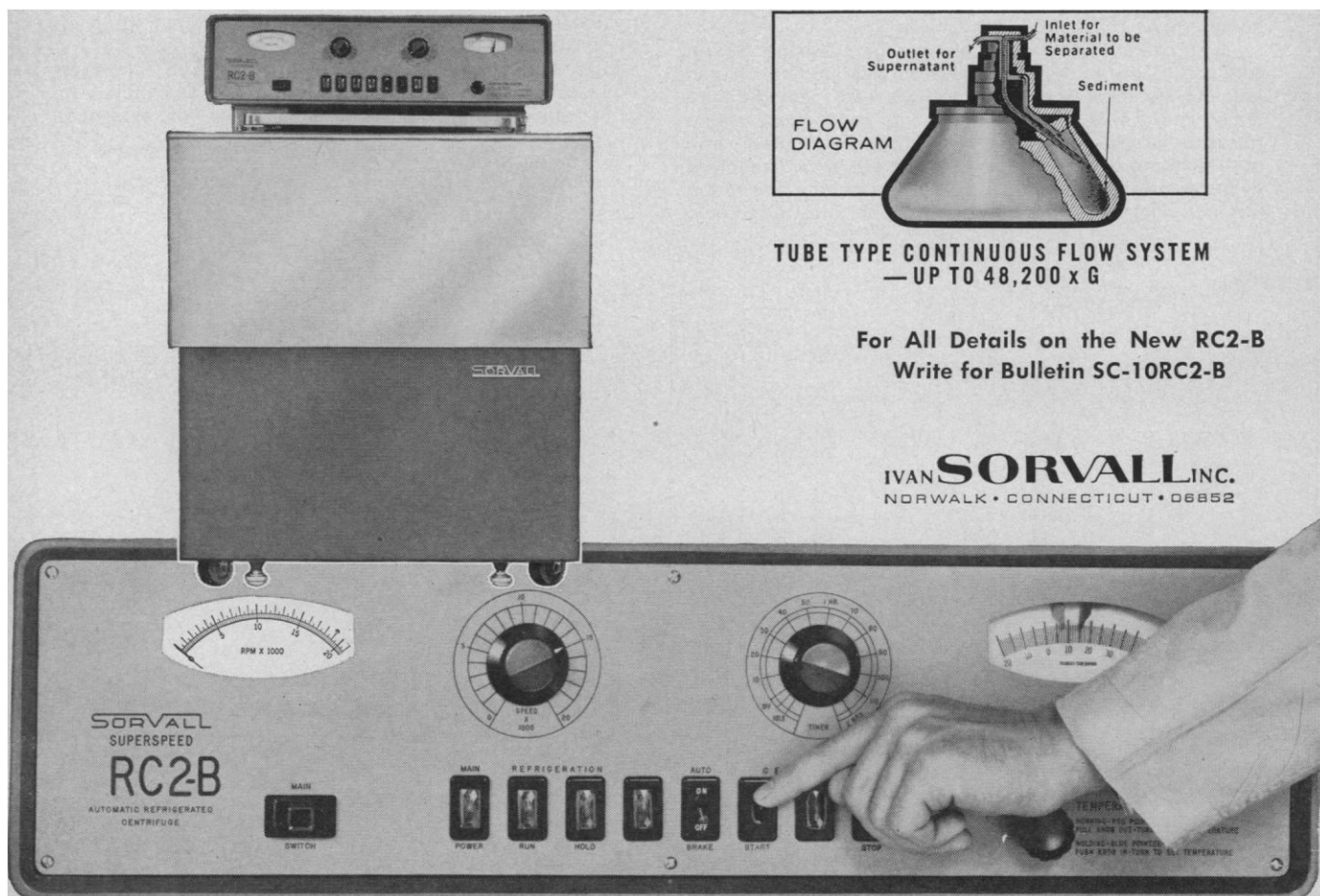
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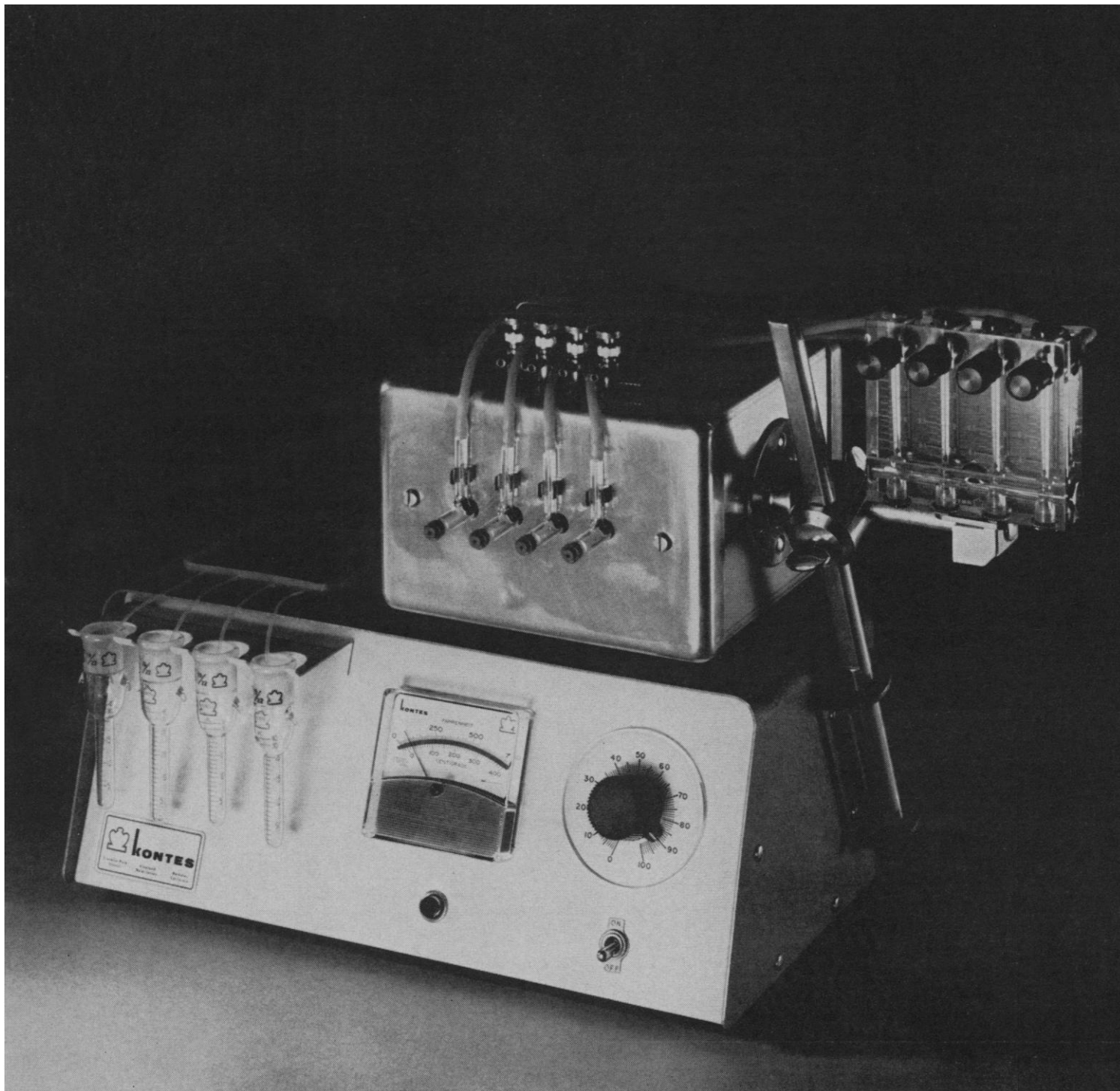
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*Patent pending
**Reference J. O. A. C., Vol. 48, Dec. 1965, "A Sweep Co-Distillation Clean-up Method for Organophosphate Pesticides", by R. W. Storherr & R. R. Watts. © Trademark of Du Pont

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 Price: \$140/10 μ c \$600/50 μ c \$1080/0.1mc

Guanosine-C¹⁴ (u.l.) 5'-Monophosphate

Form: Diammonium Salt
 NEC-354 Sp. Act. > 200 mc/mM
 Price: \$55/10 μ c \$200/50 μ c \$400/0.1mc

Guanosine-C¹⁴ (u.l.) 5'-Triphosphate

Form: Tetralithium Salt
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 Price: \$55/10 μ c \$225/50 μ c \$450/0.1mc

Orotidine-carboxyl-C¹⁴ 5'-Monophosphate

Form: Triammonium Salt
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 Price: \$100/10 μ c \$400/50 μ c \$720/0.1mc

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Form: Diammonium Salt
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 Price: \$60/10 μ c \$250/50 μ c \$475/0.1mc

Thymidine-2-C¹⁴ 5'-Triphosphate

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Uridine Diphosphate Galactose-C¹⁴ (galactose-C¹⁴ u.l.)

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NEC-414 Sp. Act. 100-200 mc/mM
 Price: \$110/10 μ c \$400/50 μ c \$720/0.1mc

Uridine-2-C¹⁴ 5'-Monophosphate

Form: Diammonium Salt
 NEC-404 Sp. Act. 20-30 mc/mM
 Price: \$40/10 μ c \$150/50 μ c \$300/0.1mc

Uridine-C¹⁴ (u.l.) 5'-Monophosphate

Form: Diammonium Salt
 NEC-369 Sp. Act. > 200 mc/mM
 Price: \$55/10 μ c \$200/50 μ c \$400/0.1mc

Uridine-2-C¹⁴ 5'-Triphosphate

Form: Tetralithium Salt
 NEC-430 Sp. Act. 20-30 mc/mM
 Price: \$50/10 μ c \$200/50 μ c \$400/0.1mc

Uridine-C¹⁴ (u.l.) 5'-Triphosphate

Form: Tetralithium Salt
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 Price: \$55/10 μ c \$225/50 μ c \$450/0.1mc

Fall 1966 Listings. Technical Data supplied upon request.



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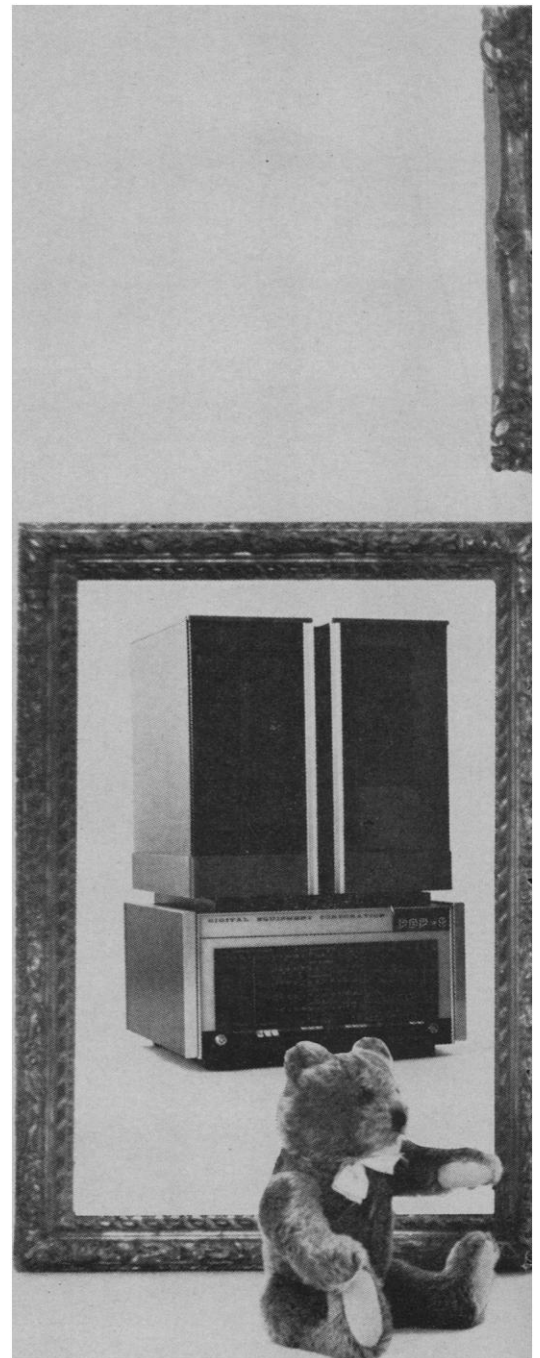
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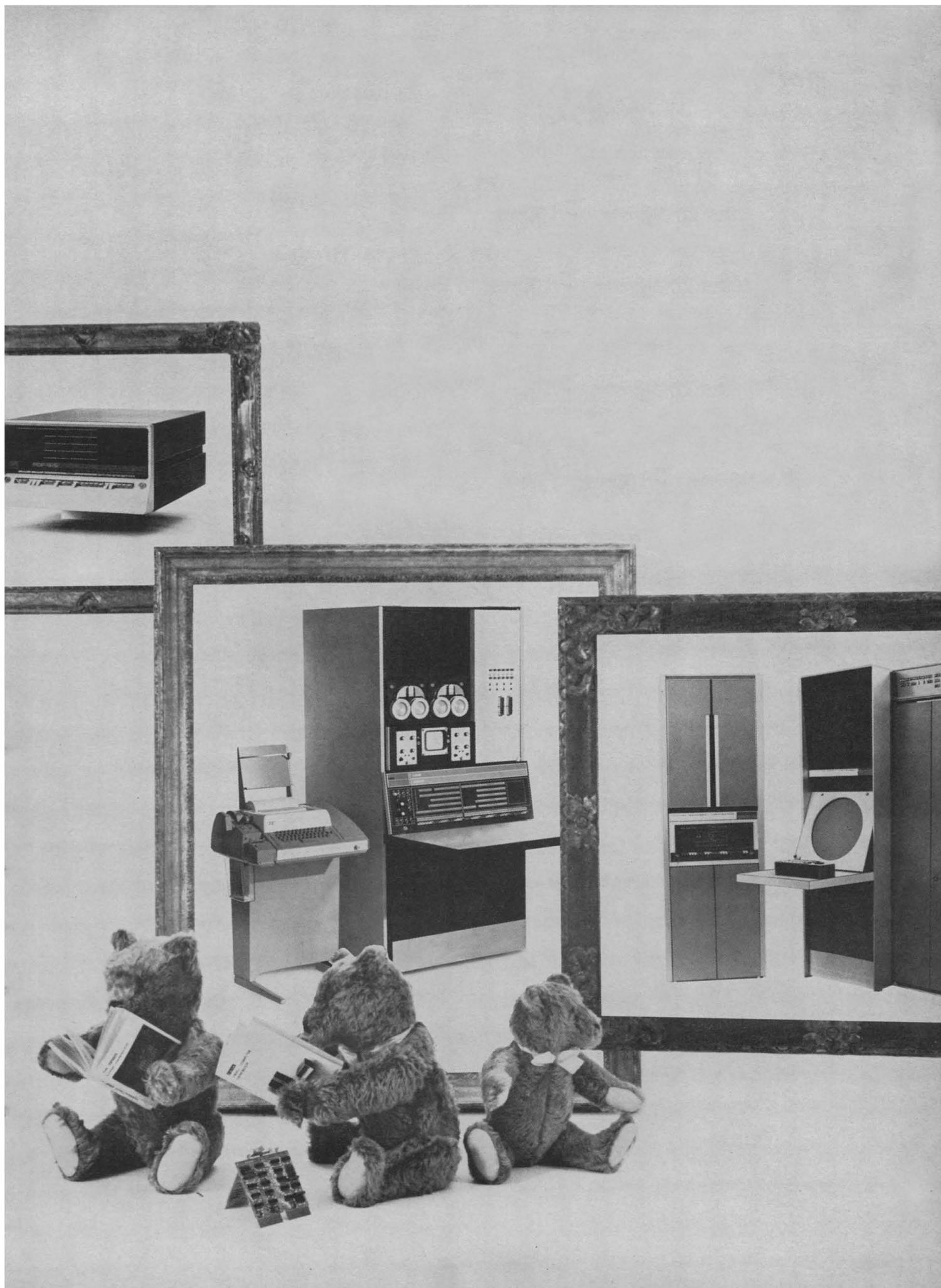
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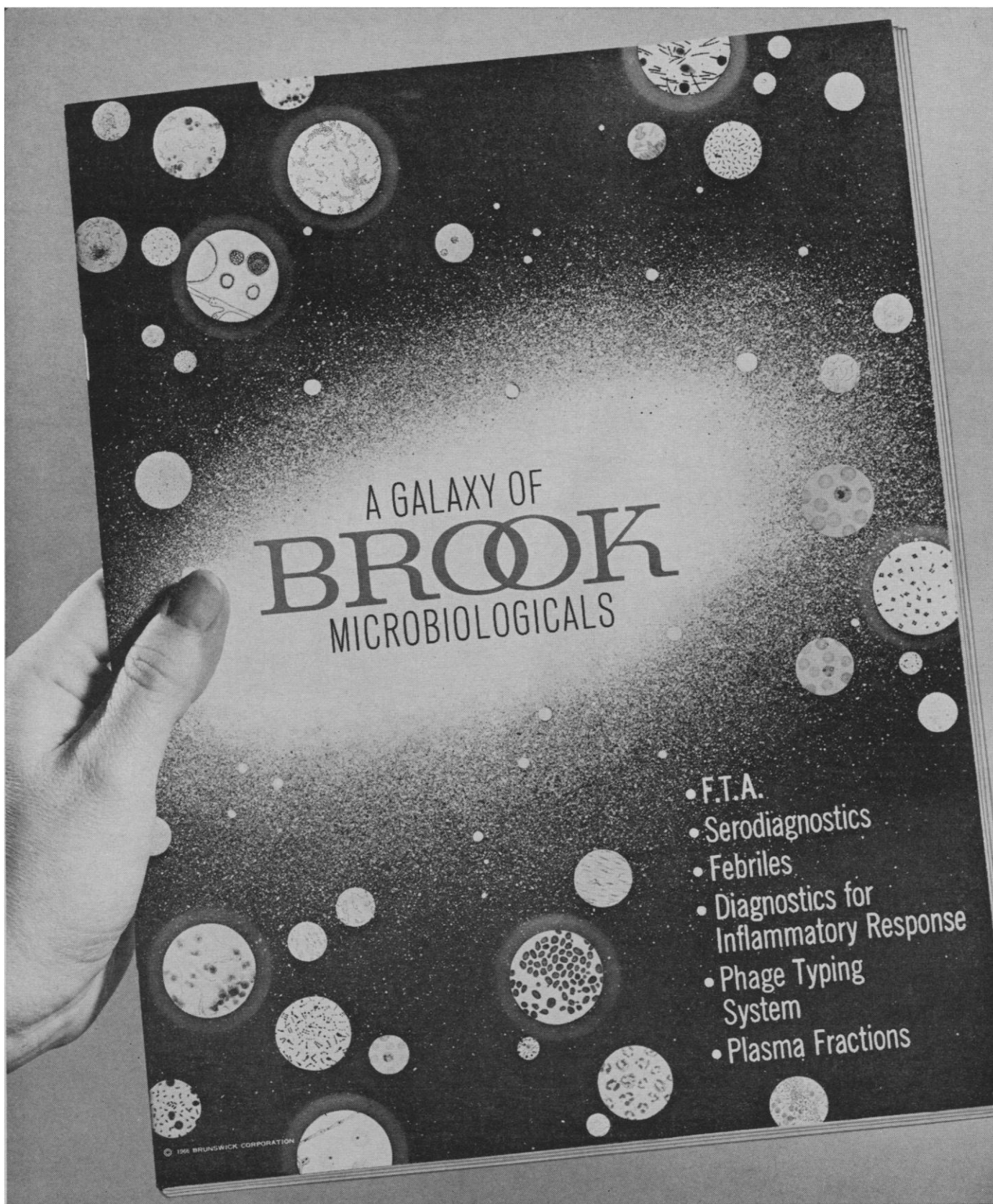
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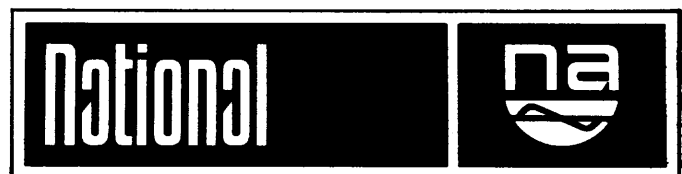
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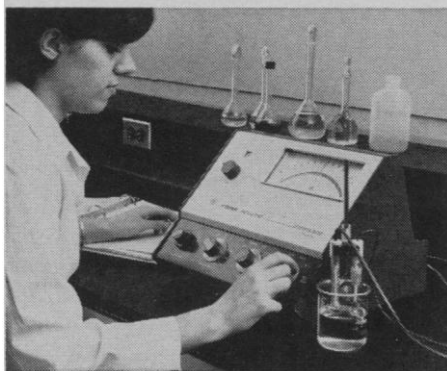
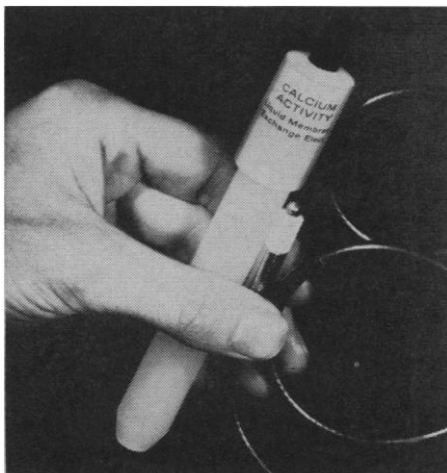
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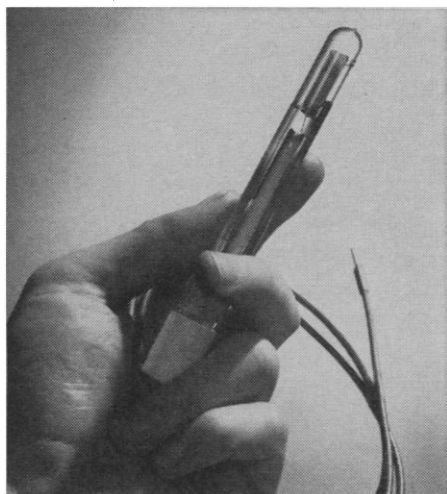
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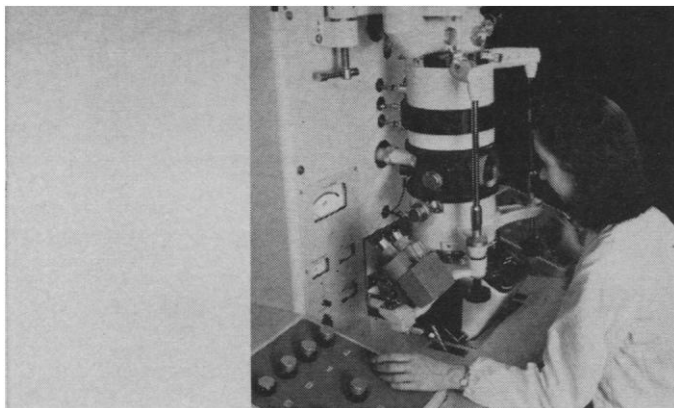
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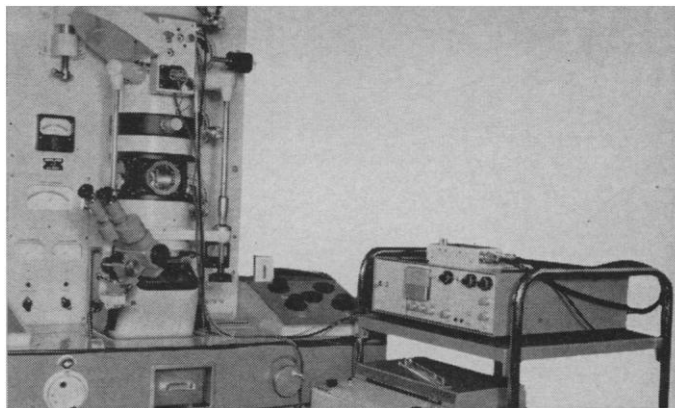
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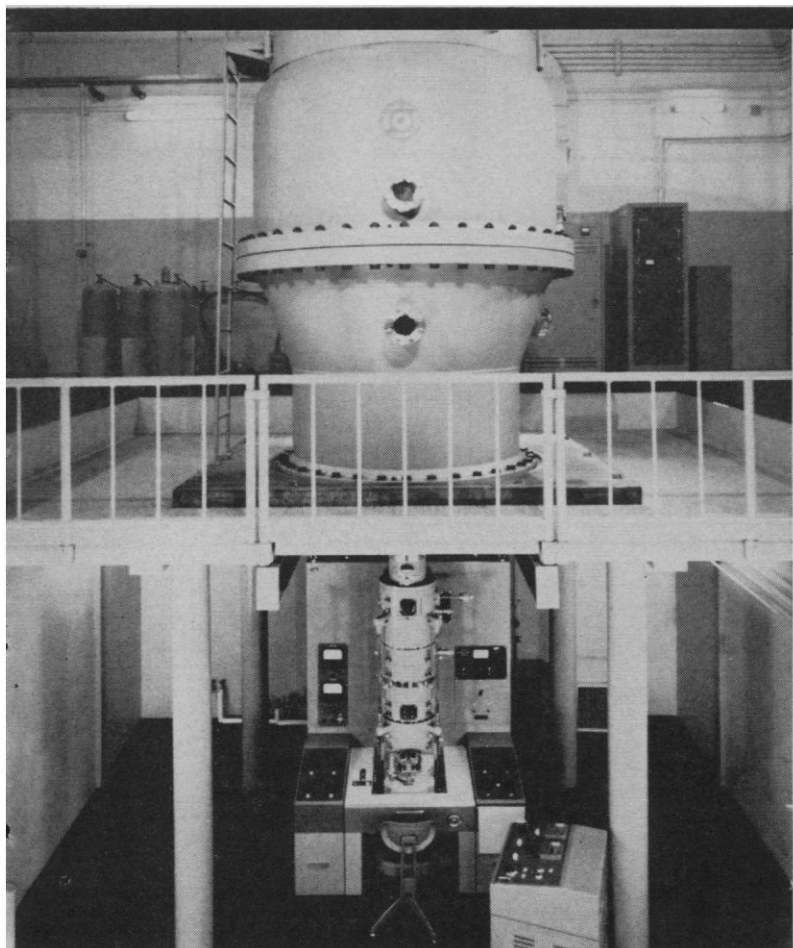
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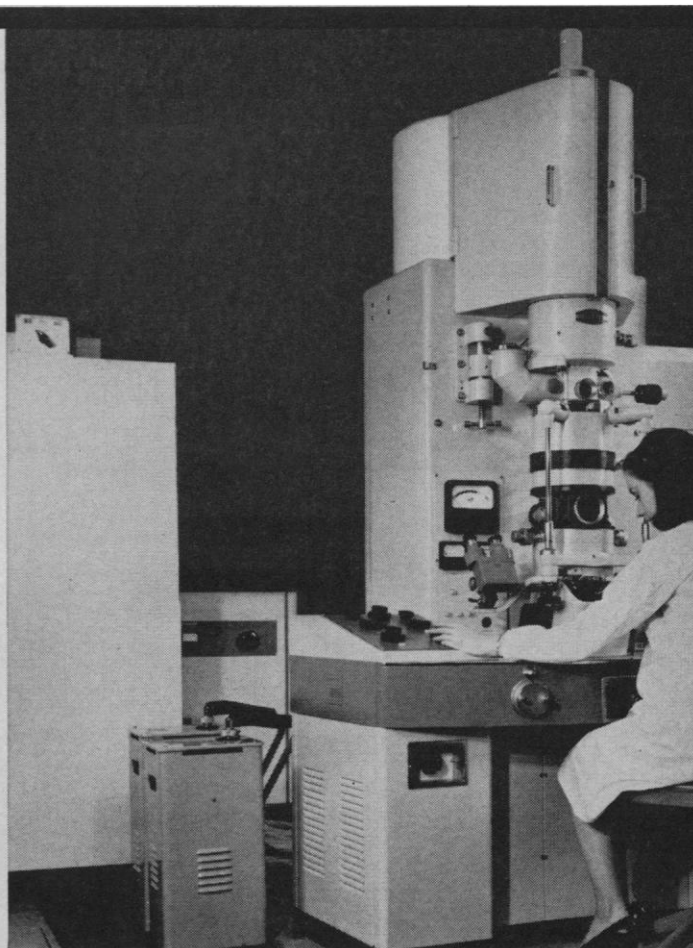
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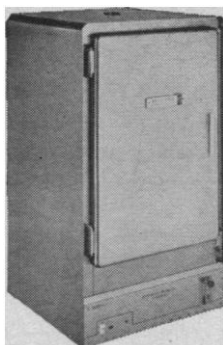


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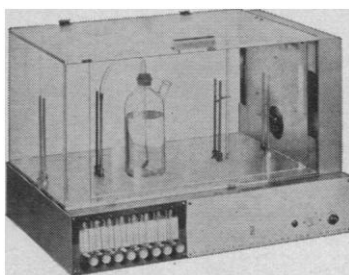


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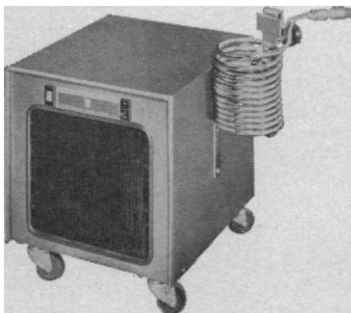
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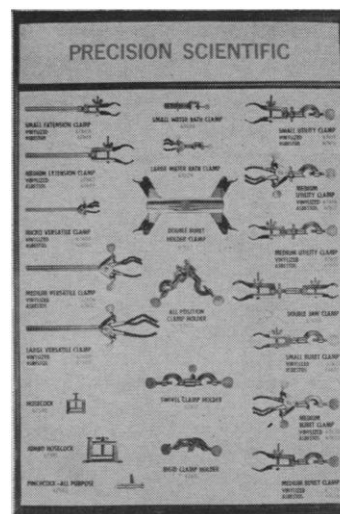
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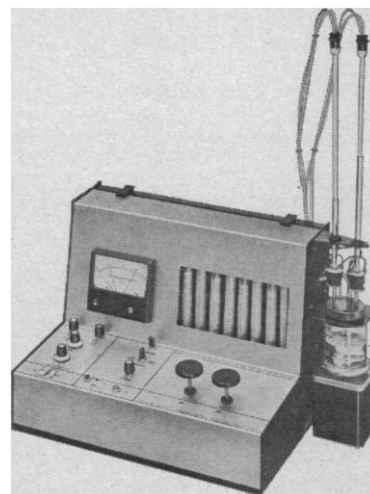
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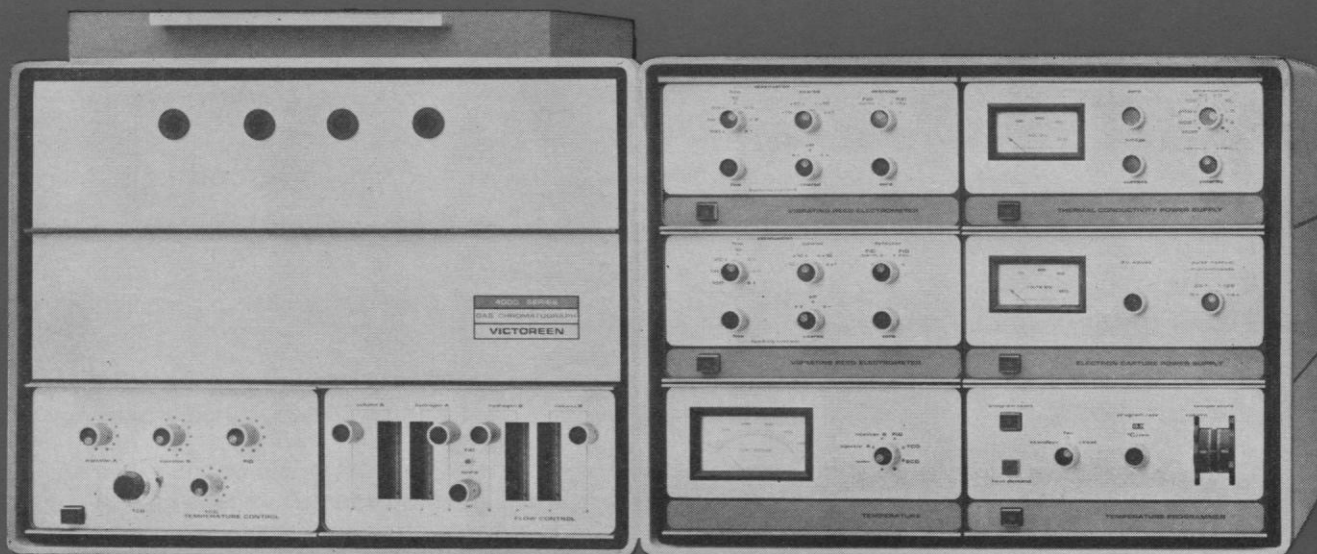
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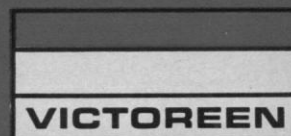
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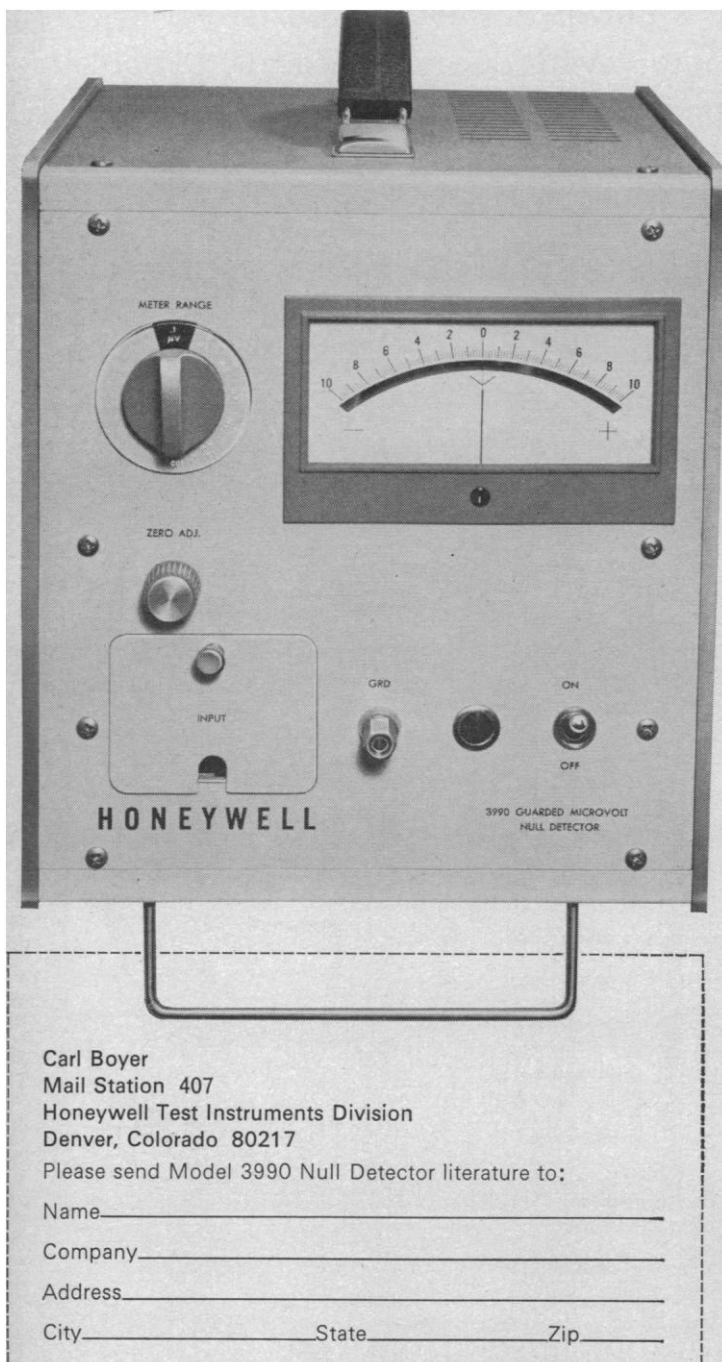
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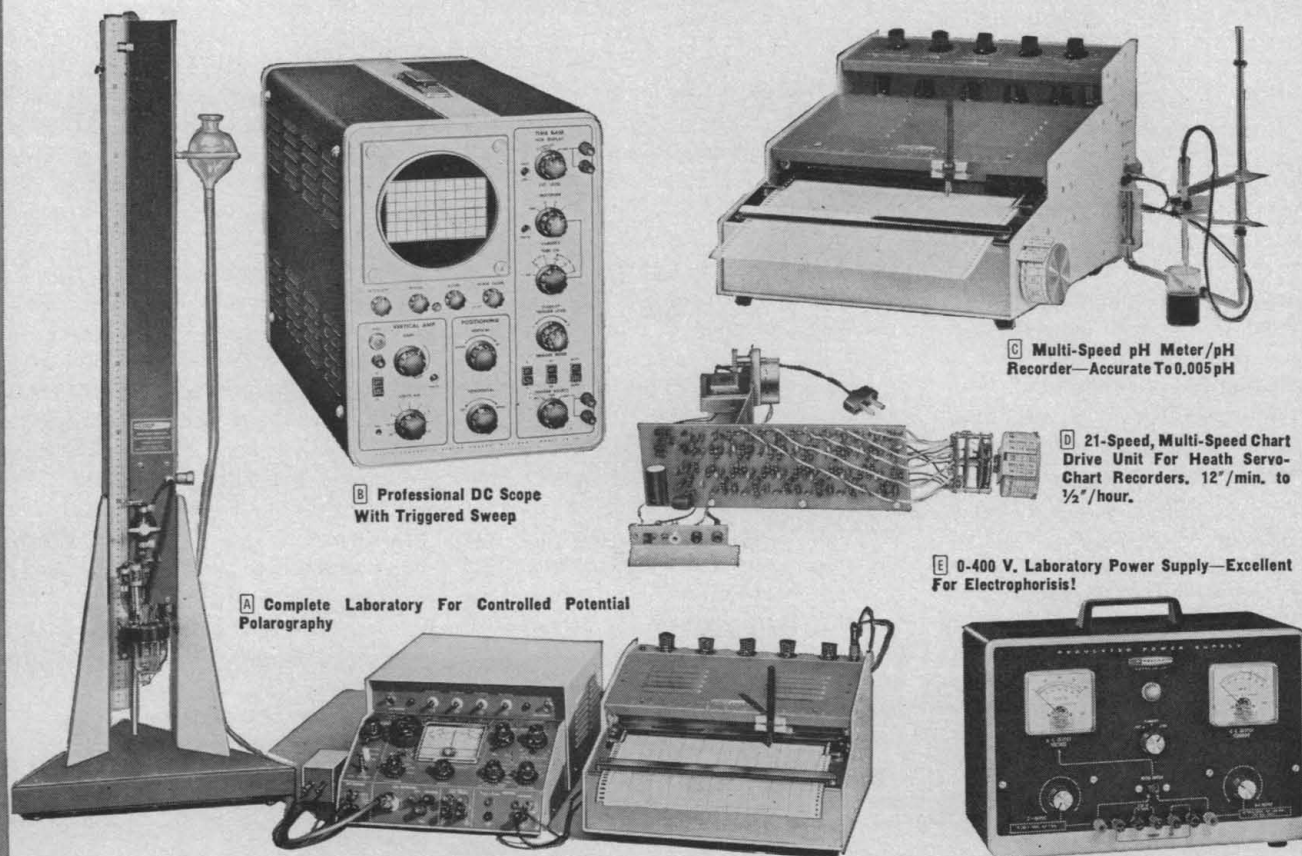
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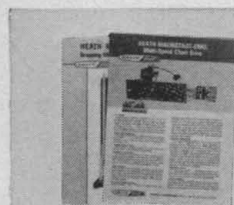
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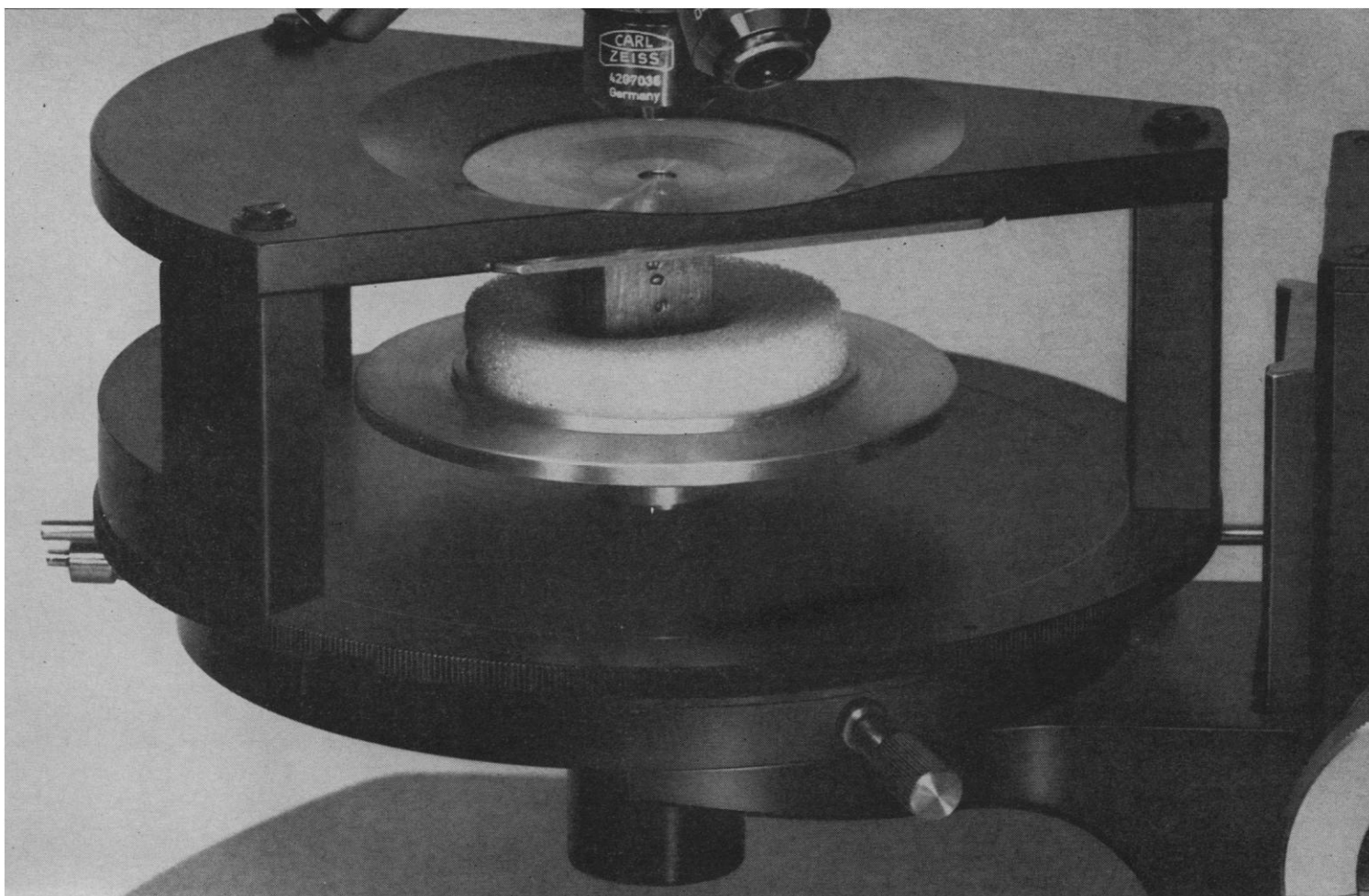
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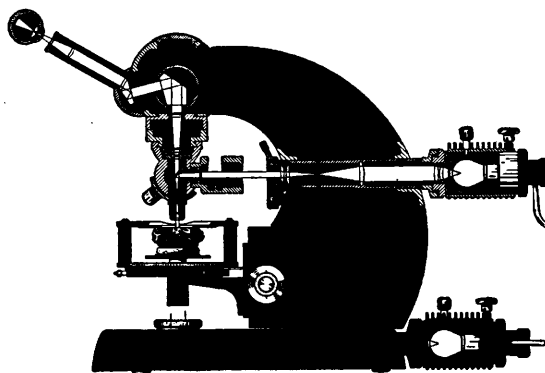
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The article appears to praise the center. Yet, the care given at the center is described as being no better than that at Denver General Hospital, which, by insinuation, is poor. Or as stated, "neither much better nor much worse than most municipal hospitals."

In the future I would suggest that all relevant sources of information be sought before writing such an article. Visiting Denver General Hospital and discussing the subject with the manager of health and hospitals would have afforded the writer the opportunity to ascertain more of the facts.

DAVID L. COWEN

*Department of Health and Hospitals,
West Sixth Avenue and Cherokee
Street, Denver 4, Colorado*

Langer's article strikes me as one of the more perceptive analyses of the importance of local health service programs in the current OEO-sponsored antipoverty programs. Its discussion of the center's impact on the scope, quality, and tone of health services made available to an urban minority group, of its impact on political and professional interest groups, and of its utilization of a combination of nonprofessional and professional personnel, among other points, made the article extremely useful for our classes in social welfare policy.

PHILIP BOOTH

*School of Social Work,
University of Michigan,
Ann Arbor 48104*

Population Stabilization

John Walsh's discussion of the food-population balance (News and Comment, 13 May, p. 896) again emphasized the overwhelming need for controlling world population. Wars and famine are but two examples of world problems that are intensified by population pressures. A 1965 Gallup Poll indicated that only 60 percent of Americans regard overpopulation as a major world problem. The Office of Economic Opportunity is reluctant to support progressive family planning programs because of possible negative public response. Therein lies the role and obligation of the scientific community: to learn about and to teach the need for population stabilization.

The combined efforts of the biologist, chemist, mathematician, physicist, geologist and meteorologist could

greatly improve community understanding of overpopulation and its consequences. One lecture, or part of a lecture, each semester by each *Science* reader would help shape the political atmosphere that is essential before our government can launch an international program. High school and university students would quickly grasp the seriousness of the situation when confronted with the demographic facts. Though birth control has been commonly considered a personal matter for each individual and his family, this will be less true in the future. Some people believe that a massive international program of family planning methods would corrupt youth. This does not follow. The seeds of morality are planted elsewhere and do not depend on the availability or denial of information for their nourishment. The point is that citizens of every nation must learn about the international consequences of unchecked population increases, and have a knowledge of basic family planning methods. In thirty years, Vietnam, Korea, and Cuba will be incidents in history books, but with a population twice that of the present one, the world may be in interminable chaos.

DAVID B. VAN VLECK

*Department of Biology, University of
Miami, Coral Gables, Florida 33124*

Tenure in 1897

Occasionally, it is almost a relief to look back, perhaps three score years and ten, to find a few real problems existed in those older days as well as today. The following postcard, addressed to the late Frank Smith, then an assistant professor at the University of Illinois, may underscore one such worry about the future:

My dear Smith: I was much pleased to receive your paper on the Oligochaeta yesterday. It rejoices one to realize how you are prospering. I can hardly help but envy you such a good solid place. Zoologists are getting terribly frequent nowadays and it makes me speculate about the future. However, I am having a fine time now. I am expecting to go down to Naples before long, to stay till the middle of July.

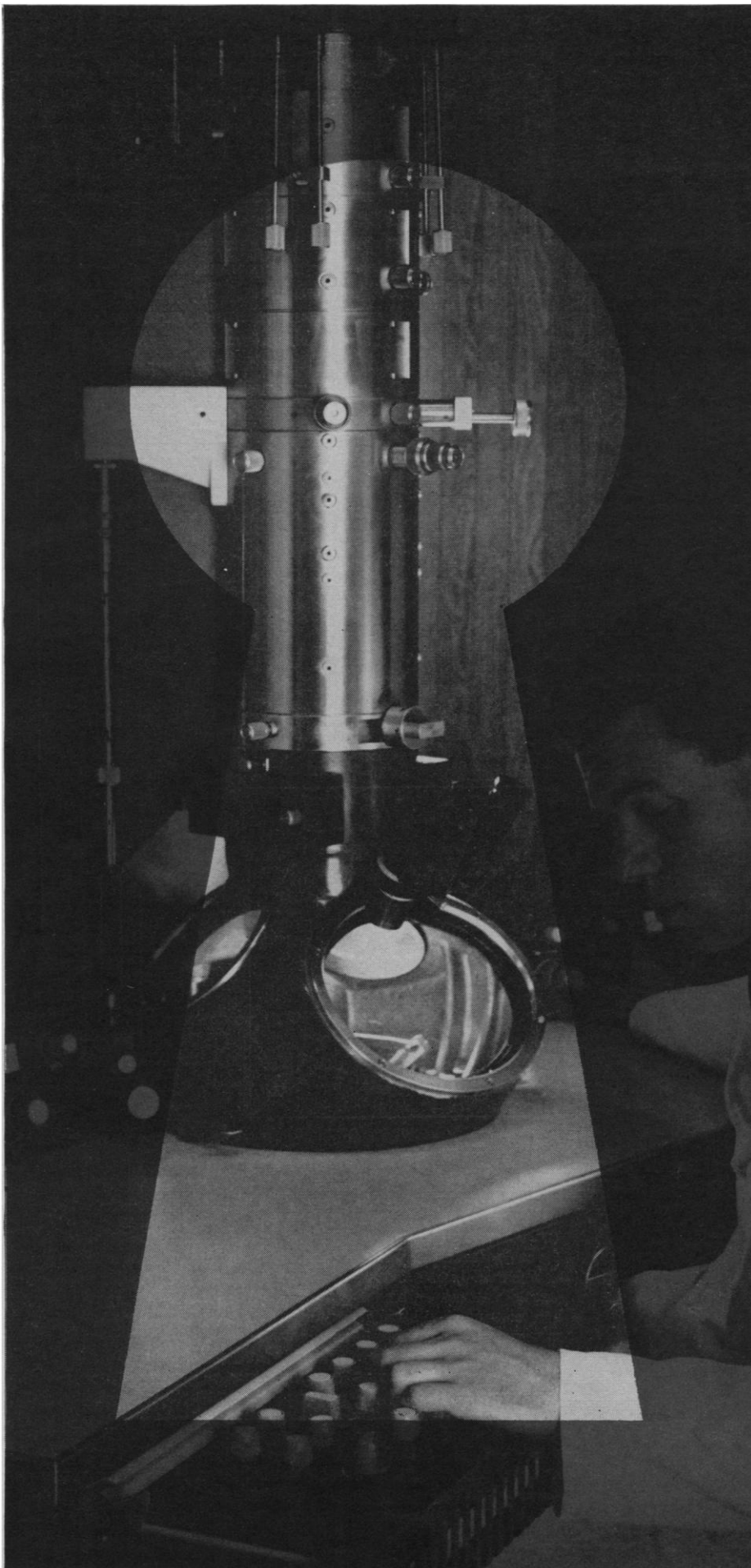
Yours,

H. S. Jennings

Jena, Germany
February 22, 1897

WILLIAM R. MURCHIE

*Department of Biology, University of
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New Quarks for Physics

Thanks to Willy Ley for pointing out (Letters, 22 July) that "quark" is German for "a somewhat gluey cottage cheese" (or even trash or rubbish). Long ago Goethe foresaw the need for this word when he wrote the prologue to *Faust*. Mephistopheles, sojourning in heaven, cynically describes man's insatiable curiosity and concludes: "*In jeden Quark begräbt er seine Nase.*" (He sticks his nose in every quark.)

The German and Faustian origin of *quark* is obviously so much more appropriate, despite the slander, that McMillan and Murray Gell-Mann may wish to reconsider the origin of the physicists' quark!

DAVID E. LAIRD

Physics Department,
Cincinnati Country Day School,
6905 Given Road, Ohio 45243

Support the Theoretical Thinkers!

Regarding Greenberg's article (News and Comment, 24 June, p. 1724) on "Basic research: the political tides are shifting" . . . the old category of "basic" ("fundamental," "pure") research is not good because it means different things to different persons. Really there are two kinds of so-called basic science that must be considered—inscribed (trivial, limited)—and theoretical. Inscribed science is simple fact-finding science without any direct thoughts about established theories or without any new set of postulates in mind that might ultimately become a theory. When I try to learn the nutrient conditions that cause the tips of fungus filaments to lyse, I am engaged in inscribed (trivial) science because my thinking has not related the facts to established theory or to a new set of postulates that might develop into a theory. This kind of basic (inscribed, trivial) science is often on the same intellectual level as applied science. It is fascinating work because it satisfies one kind of curiosity. But this kind of nonapplied research should not be confused with truly theoretical work like that which produced the 1:1:1 hypothesis, the operon hypothesis (both of which should now be called theories), or the like.

Of the different kinds of science, theoretical science is the kind that should receive unstinted financial sup-

port because theories give us command of knowledge whether we choose to use the knowledge in practical applications or in the advancement of science. A quick review of the history of physics, chemistry, or biology will support this contention.

Within theoretical science are those men whose genius and drive permit them to build the frameworks of new incipient theories, new postulational-deductive systems. But who, in politics or in science, has the wit to recognize these men while they are in the early stages of formulating their ideas? Probably only a few other scientists and these men are seldom in a position to grant financial support. The greatest problem in the support of science is not whether you support basic or applied science, but rather, how do you support truly theoretical work?

RALPH W. LEWIS

Department of Natural Science,
Michigan State University, Lansing

A Tax-Saving Spin Off

In his contribution to contemporary etymology, Hines (Letters, 12 Aug.) deals successfully with the origins of *A-OK* and *blast off*, but fails with *spin off*, which he suspects is a NASA substitution for *fallout*.

I hasten to inform you that *spin off* has long meant a specific legal corporate fission process, followed when it is desirable to make two corporations out of one. It solves a genuine problem created by the capital gains tax. Some of the assets of the original corporation are *spun off* to the new. If a capital gains tax were assessed, that would be fallout from the fission.

STUART T. MARTIN

P.O. Box 608, Burlington, Vermont

Touché

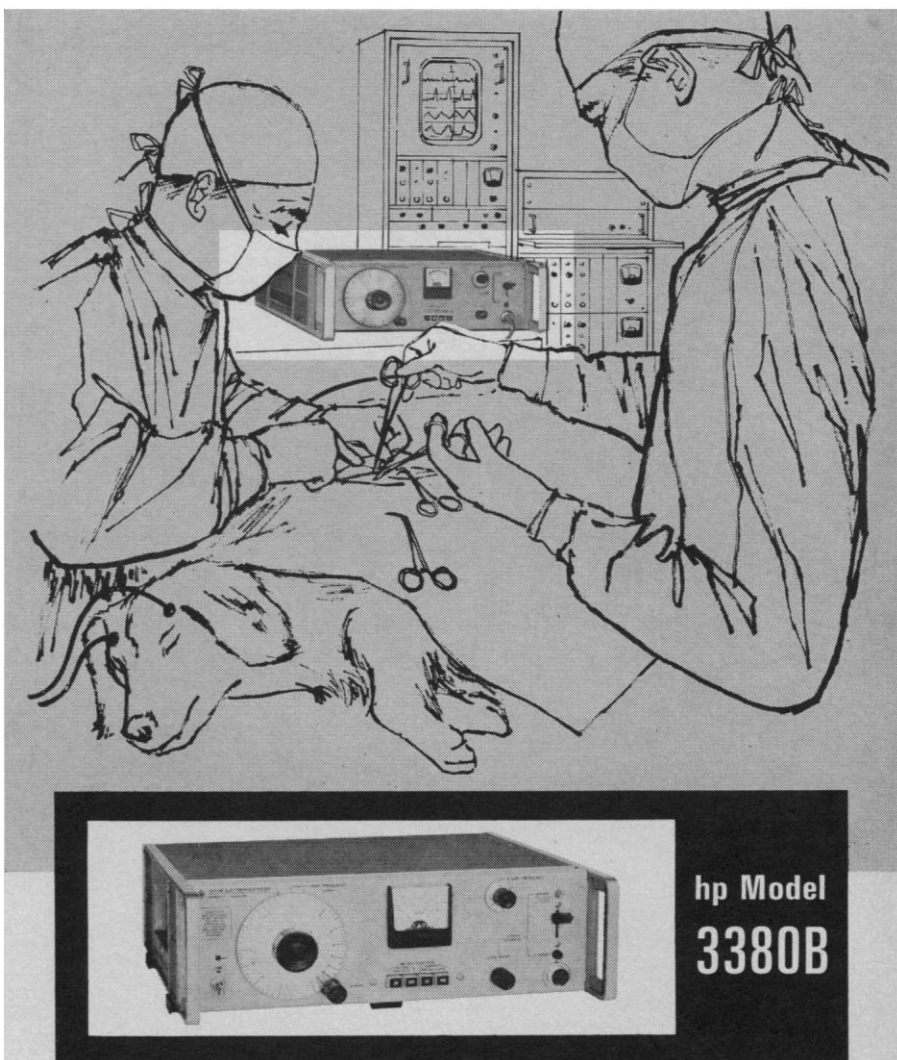
Non-nonwalking is something I enjoy, but only because I've had a college education. Otherwise, I would like plain walking.

In the same way, "nonincongruity" (Cover, 1 July) can be reduced to "congruity," a term respectable enough to be accepted in dictionaries. "Nonincongruity" seems to be a low character who has been justly ignored by lexicographers.

HELEN CHURCHILL

Hollins College, Virginia

7 OCTOBER 1966



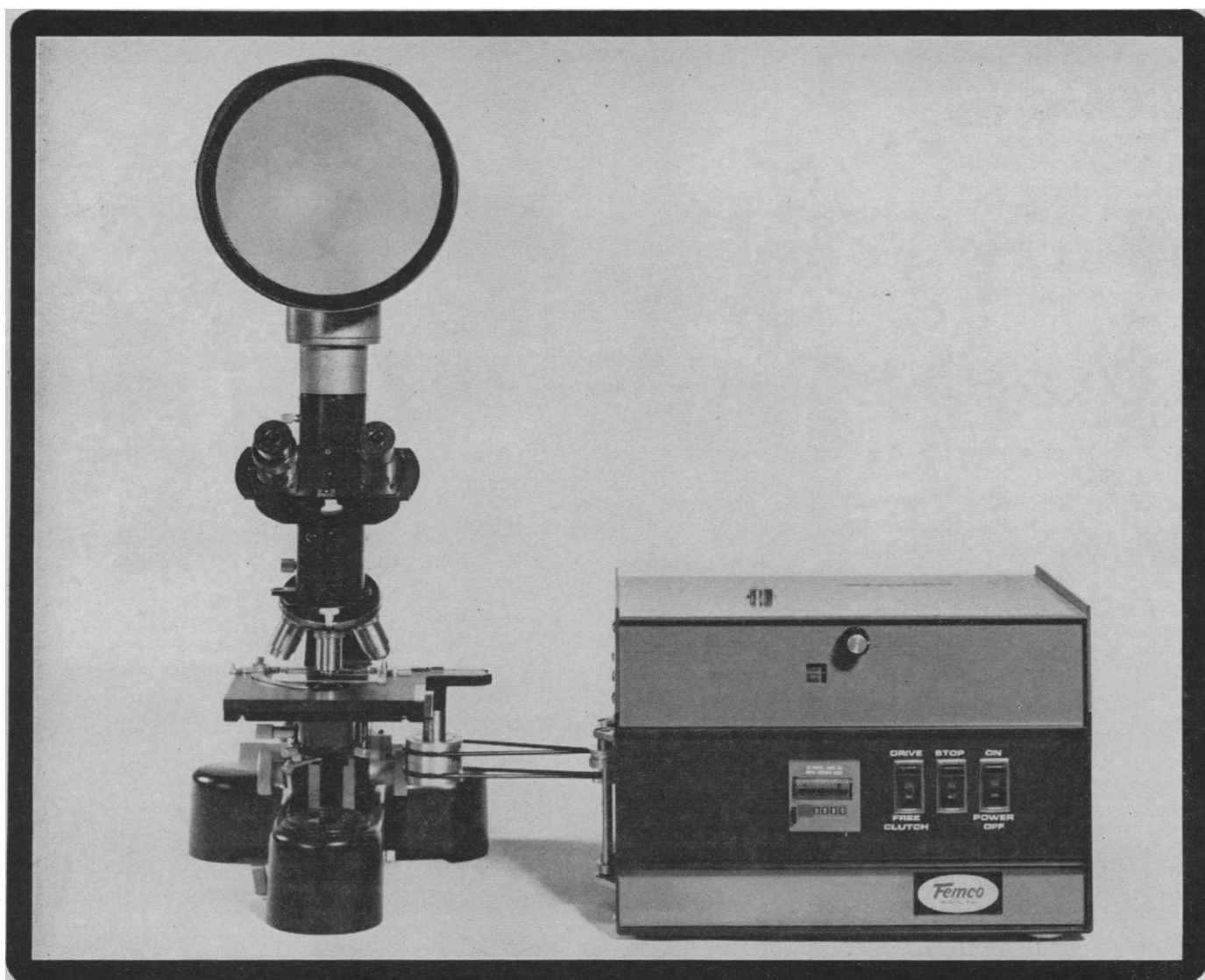
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Coping with the Information Explosion

There is divergent opinion concerning the seriousness of the information explosion. Many research workers minimize the importance of the problem. Established investigators find that most of their needs for information are met through participation in invisible colleges and scanning of the relatively few journals in which material of interest to them usually appears. Instead of spending time on more or less fruitless search among a vast number of journals, they gamble that their proposed research will not closely duplicate existing work. Usually their judgment is correct.

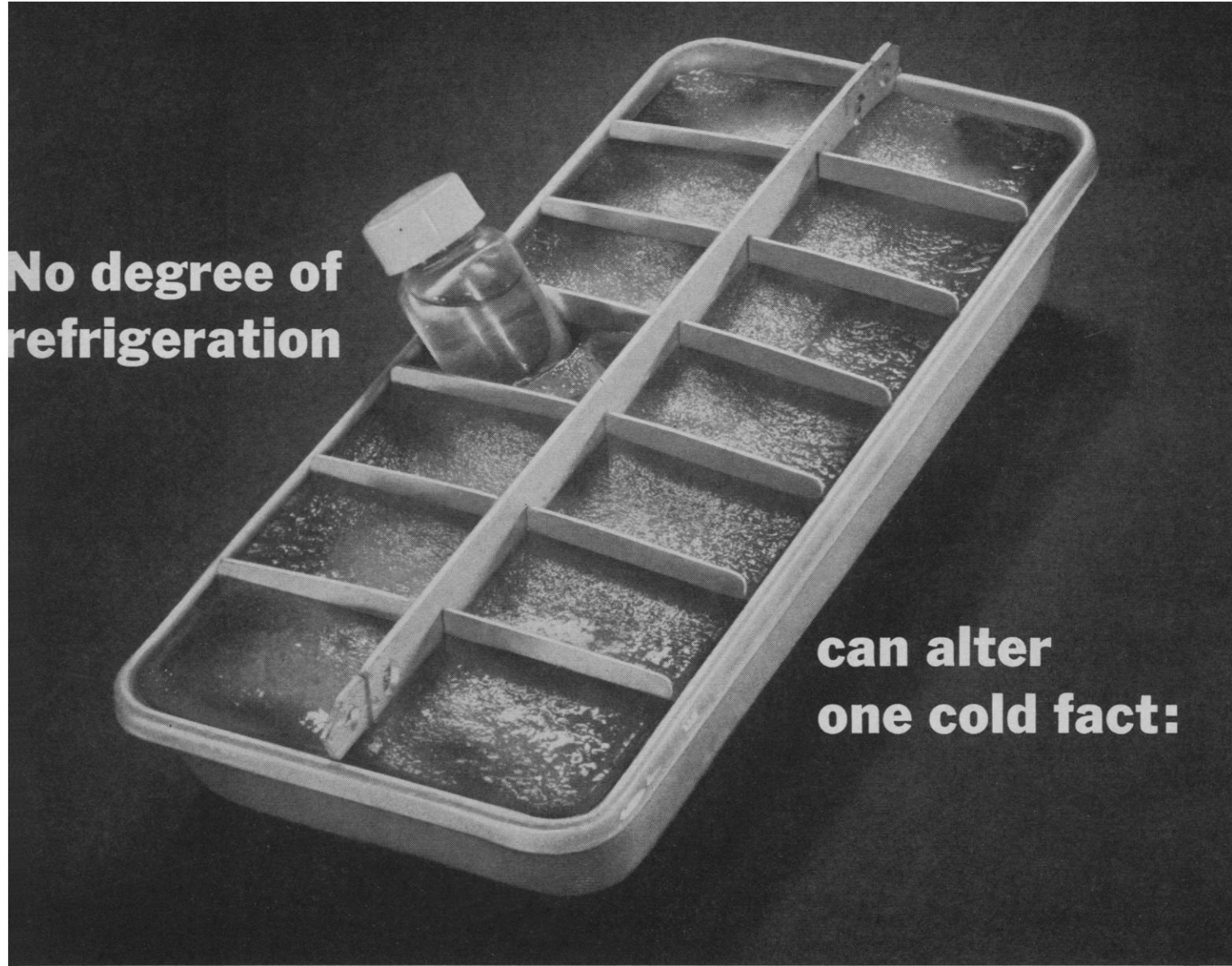
On the other hand, some administrators believe that we are failing to utilize much of the vast amount of information available in 50,000 scientific journals. Some politicians seem to have an almost pathologic fear that research may be unwittingly duplicated. As a result, they have been willing to support all kinds of attempts to make scientific and technical information more readily available. Currently the federal government annually devotes \$250 million to such efforts. This sum substantially exceeds the funds allocated for all research project grants supported by the National Science Foundation.

In spite of the divergence of opinions concerning the information explosion, scientists and politicians agree that quick, selective information retrieval and dissemination are desirable. Progress toward these goals is being made by scores of organizations. One of the most interesting approaches has been made by a commercial concern, the Institute for Scientific Information, of Philadelphia. The Institute has, on magnetic computer tape, comprehensive information concerning current scientific periodicals, and it has devised effective means of using this resource. The coverage includes more than 1500 of the world's leading scientific journals, which in a year print more than 300,000 articles and perhaps over 90 percent of those reporting significant advances. The information concerning each article includes title, author or authors, and literature cited. Associated with the 300,000 articles are more than 3.3 million citations, 576,000 authors, and titles containing 2.1 million words. Altogether there are almost 10 million stored index items pertaining to the articles. A particularly useful tool in a search for significant articles in a particular field is the Citation Index. Authors usually cite literature that they feel is particularly relevant to their work. To learn what is new in a field one merely asks the computer for a list of published items that contain citations to previous important articles in that field. The computer can also be asked to supply a list of articles written by authors known to be active in a given area. Words or combinations of words in the title can also serve to identify items of interest.

A complete Citation Index, available quarterly, is bulky and contains more material than the average scientist wants. The Institute has a service much better designed to meet the needs of individuals. It is called Automatic Subject Citation Alert (ASCA). This service provides a weekly list of articles that have appeared in any of the 1500 scientific journals and that meet citation, author, or other indexing criteria that the user has provided.

An interesting by-product of the Citation Index is a new method of evaluating scientific productivity. Instead of counting a man's reprints, one counts citations of his work by others. Already sociologists are examining the value of this new analytical tool. They note some limitations but find that a citation index is a valuable aid to management.

—PHILIP H. ABELSON



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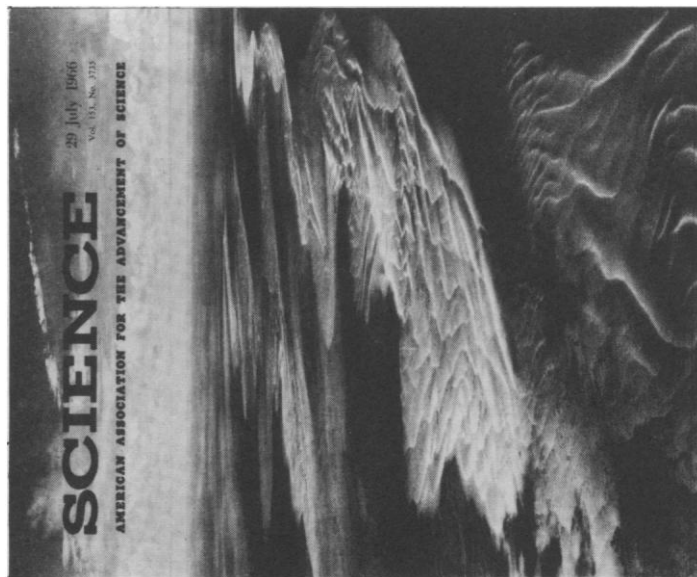
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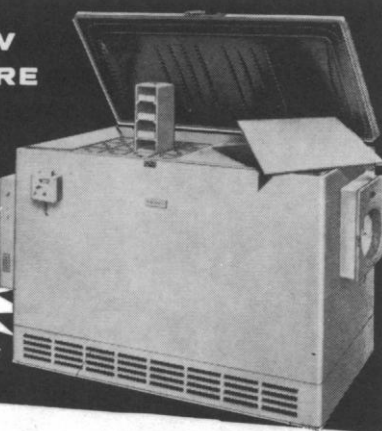
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Page	No.	Key	Page	No.	Key	Page	No.	Key
1	1	1	42	42	42	101	101	101
2	2	2	43	43	43	102	102	102
3	3	3	44	44	44	103	103	103
4	4	4	45	45	45	104	104	104
5	5	5	46	46	46	105	105	105
6	6	6	47	47	47	106	106	106
7	7	7	48	48	48	107	107	107
8	8	8	49	49	49	108	108	108
9	9	9	50	50	50	109	109	109
10	10	10	51	51	51	110	110	110
11	11	11	52	52	52	111	111	111
12	12	12	53	53	53	112	112	112
13	13	13	54	54	54	113	113	113
14	14	14	55	55	55	114	114	114
15	15	15	56	56	56	115	115	115
16	16	16	57	57	57	116	116	116
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18	18	18	59	59	59	118	118	118
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26	26	26	67	67	67	126	126	126
27	27	27	68	68	68	127	127	127
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162	162	162	203	203	203	262	262	262
163	163	163	204	204	204	263	263	263
164	164	164	205	205	205	264	264	264
165	165	165	206	206	206	265	265	265
166	166	166	207	207	207	266	266	266
167	167	167	208	208	208	267	267	267
168	168	168	209	209	209	268	268	268
169	169	169	210	210	210	269		

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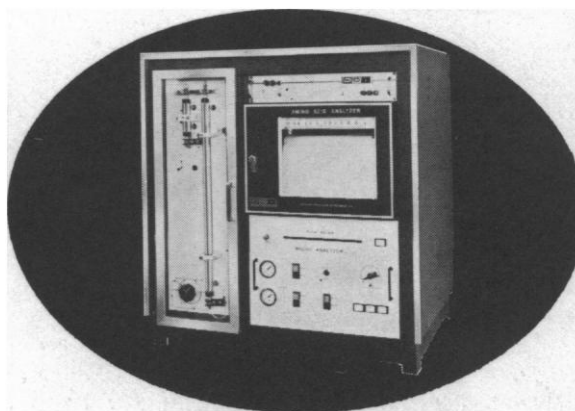
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NEW BOOKS

(Continued from page 143)

1. C. B. Smith. Pergamon, New York, 1966. 242 pp. Illus. Paper, \$4.50. The Commonwealth and International Library.

Applied Underwater Acoustics. D. G. Tucker and B. K. Gazey. Pergamon, New York, 1966. 260 pp. Illus. Paper, \$4.50. The Commonwealth and International Library.

Approximate Analysis of Randomly Excited Nonlinear Controls. Harold W. Smith. M.I.T. Press, Cambridge, Mass., 1966. 150 pp. Illus. \$7.50.

Atlas of Planetary Solar Climate. vol. 5. Clyde J. Bollinger. Bollinger Climatic Research Service, Norman, Okla., 1966. 112 pp. Illus. Paper.

Atomic Absorption Spectroscopy. James W. Robinson. Dekker, New York, 1966. 216 pp. Illus. \$9.75.

Atoms to Andromeda. S. T. Butler and H. Messel, Eds. Pergamon, New York, 1966. 301 pp. Illus. Paper, \$3.50. The Commonwealth and International Library. Fifteen lectures given at the 1966 Nuclear Research Foundation Summer Science School for High School Students.

Basic Chemistry: A Programmed Presentation. Stewart M. Brooks. Mosby, St. Louis, 1966. 145 pp. Illus. Paper, \$3.85.

Basic Matrix Analysis and Synthesis: With Applications to Electronic Engineering. G. Zelinger. Pergamon, New York, 1966. 244 pp. Illus. \$7.50.

Bituminous Materials: Asphalts, Tars, and Pitches. vol. 3, *Coal Tars and Pitches.* Arnold J. Hoiberg, Ed. Interscience (Wiley), New York, 1966. 603 pp. Illus. \$25. Fifteen papers.

Book of ASTM Standards: With Related Material. pt. 9, *Cement; Lime; Gypsum* (512 pp. \$9; members, \$6.30); pt. 16, *Structural Sandwich Constructions; Wood; Adhesives* (828 pp. \$14; members, \$9.80). American Soc. for Testing and Materials, Philadelphia, 1966. Illus.

Calculus. pt. 1. Edwin E. Moise. Addison-Wesley, Reading, Mass., 1966. 508 pp. Illus. \$8.95.

The Challenge of the Computer Utility. D. F. Parkhill. Addison-Wesley, Reading, Mass., 1966. 219 pp. Illus. \$7.95.

The Chemical Bond. J. J. Lagowski. Houghton Mifflin, Boston, 1966. 208 pp. Illus. Paper, \$2.95. Classic Researches in General Chemistry.

Chemical Data Book. G. H. Aylward and T. J. V. Findlay, Eds. Wiley, New York, ed. 2, 1966. 96 pp. Illus. Paper, \$2.95.

Chemical Kinetics in Homogeneous Systems. Mowbray Ritchie. Wiley, New York, 1966. 123 pp. Illus. Paper, \$2.95. University Chemical Texts.

Chemistry. John S. McAnally. Merrill, Columbus, Ohio, 1966. 120 pp. Illus. Paper, \$1.75; cloth, \$3.95. Merrill Physical Science Series.

The Chemistry of Cellulose and Wood. N. I. Nikitin. Translated from the Russian edition (Moscow, 1962) by J. Schmorak. Israel Program for Scientific Translations, Jerusalem; Davey, New York, 1966. 703 pp. Illus. \$26.50.

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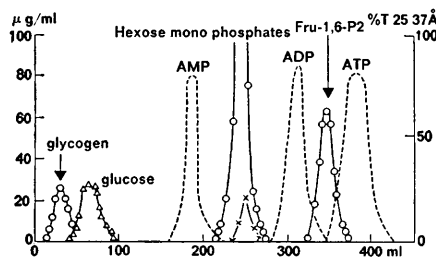
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liam L. Jolly. Prentice-Hall, Englewood Cliffs, N.J., 1966. 159 pp. Illus. Paper, \$2.50; cloth, \$5.50. Foundations of Modern Chemistry Series.

Circuits, Devices, and Systems. A first course in electrical engineering. Ralph J. Smith. Wiley, New York, 1966. 790 pp. Illus. \$11.95.

Classical Mechanics, Quantum Mechanics, Field Theory. Amnon Katz. Academic Press, New York, 1965. 217 pp. Illus. \$7.50. Pure and Applied Physics Series.

Coal Carbonization Products. Donald McNeil. Pergamon, New York, 1966. 171 pp. Illus. Paper, \$2.95. The Commonwealth and International Library.

Cold Cleaning with Halogenated Solvents. Prepared by Committee D-26 on Halogenated Organic Solvents. American Soc. for Testing and Materials, Philadelphia, 1966. 37 pp. Paper, \$2.75; members, \$1.95.

Colloid Chemistry. A. Sheludko. Translated from the second Russian edition (Moscow, 1960) by Express Translation Service. Elsevier, New York, 1966. 287 pp. Illus. \$14.50.

Complex Compounds of Uranium. I. I. Chernyaev, Ed. Translated from the Russian edition (Moscow, 1964) by L. Mandel. M. Govreen and IPST Staff, Translation Ed. Israel Program for Scientific Translations, Jerusalem; Davey, New York, 1966. 534 pp. Illus. \$21.50.

The Conceptual Development of Quantum Mechanics. Max Jammer. McGraw-Hill, New York, 1966. 413 pp. Illus. \$10.50. International Series in Pure and Applied Physics.

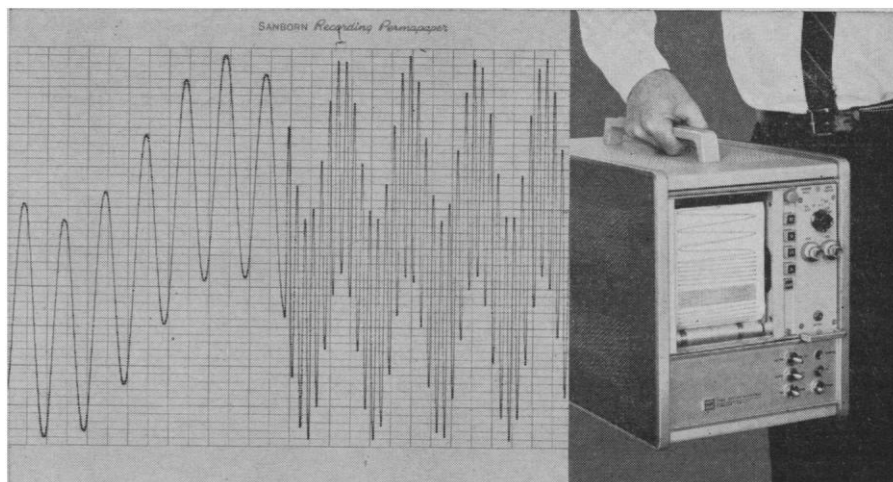
Copper-Catalytic Reactions. Ovanes Akopovich Chaltykian. Translated from the Russian edition (Erevan, 1963) by A. Eric Stubbs. Thomas Gray, Translation Ed. Consultants Bureau, New York, 1966. 78 pp. Illus. Paper, \$10.

Crystal Physics of Interaction Processes. Warren P. Mason. Academic Press, New York, 1966. 256 pp. Illus. \$14.95.

Crystallization Processes. N. N. Sirota, F. K. Gorskii, and V. M. Varikash, Ed. Translated from the Russian edition (Minsk, 1964) by Geoffrey D. Archard. Consultants Bureau, New York, 1966. 179 pp. Illus. Paper, \$22.50. Twenty-eight papers.

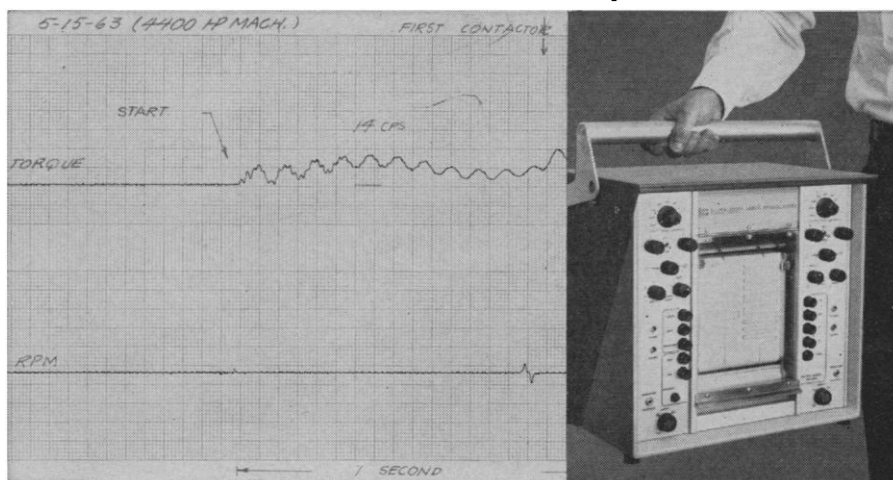
Deep Circulation, Central North Pacific Ocean: 1961, 1962, 1963. William D. Barbee. U.S. Department of Commerce, Washington, D.C., 1966 (order from Superintendent of Documents, Washington, D.C.). 112 pp. Illus. \$1.75.

Developments in Inorganic Nitrogen Chemistry. vol. 1, Charles B. Coburn, Ed. Elsevier, New York, 1966. 591 pp. Illus. \$32.50. Seven papers: "Bonding in nitrogen compounds" by Michael Green; "The inorganic azides" by A. D. Yoffe; "Developments in the inorganic chemistry of compounds containing the sulphur-nitrogen bond" by Margot Becke-Goehring and Ekkehard Fluck; "Nitrogen ligands" by W. P. Griffith; "Phosphorus-nitrogen compounds (*sans* cyclic phosphoronitrilic compounds) by Morris L. Nielsen; "Nitrogen compounds of boron, aluminum, gallium, indium and thallium" by John K. Ruff; and "Inorganic reactions in liquid ammonia" by G. W. A. Fowles.



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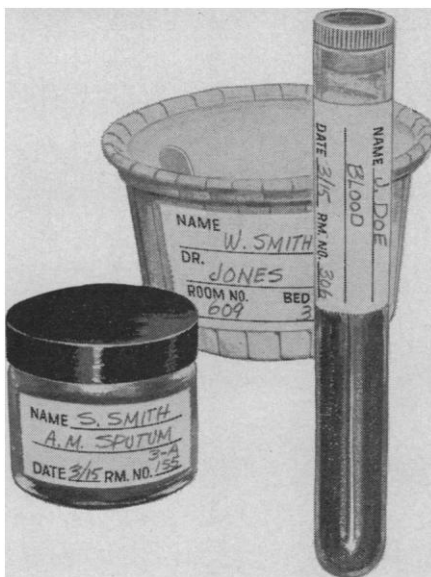
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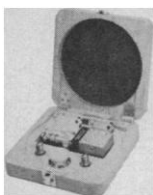
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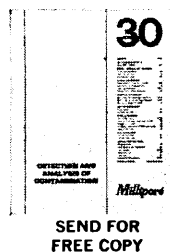
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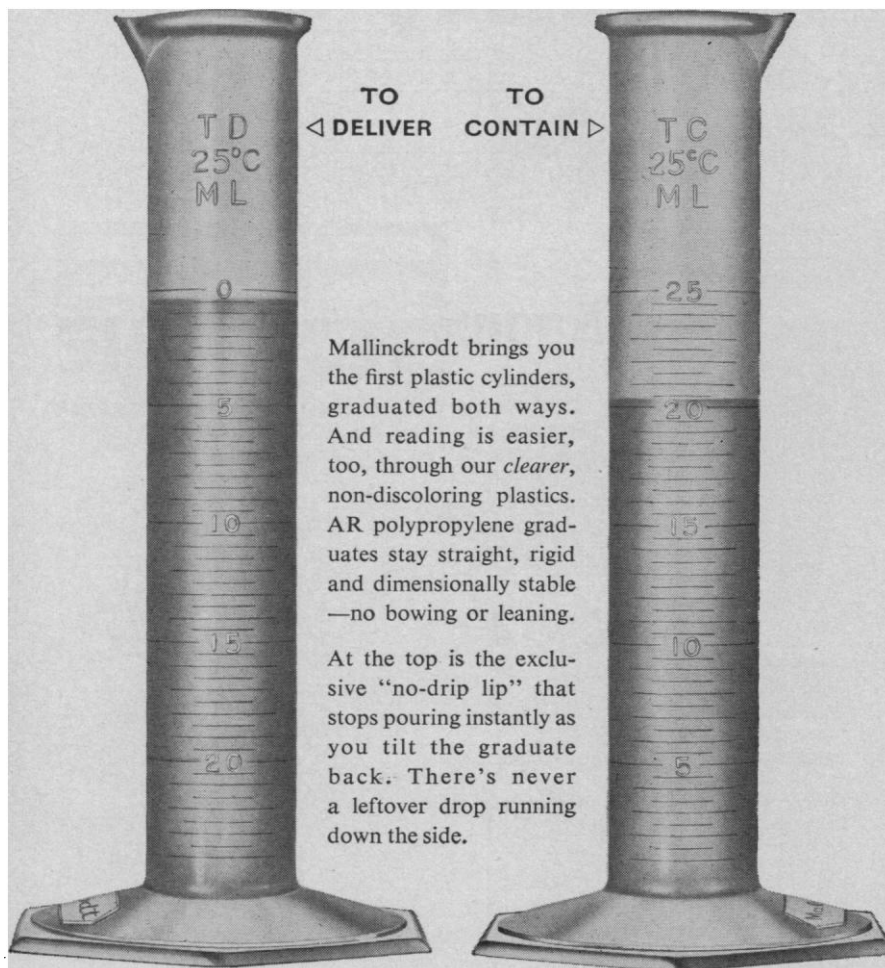
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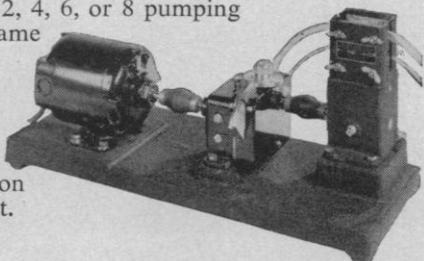
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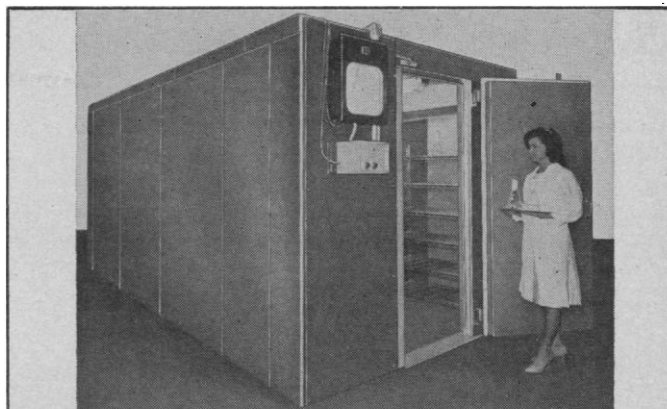
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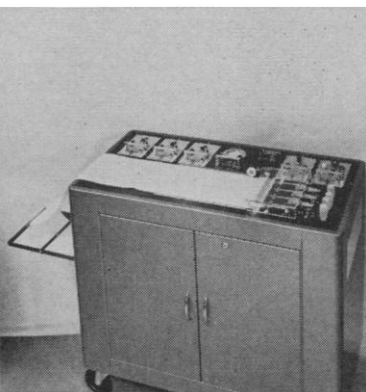
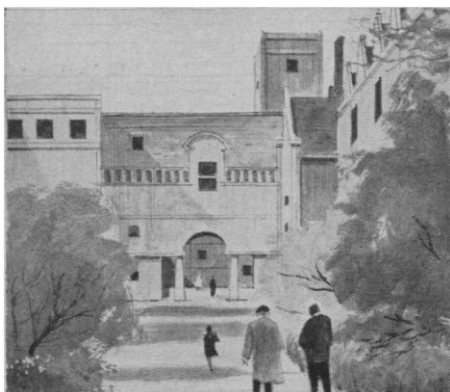


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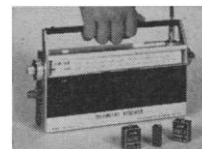
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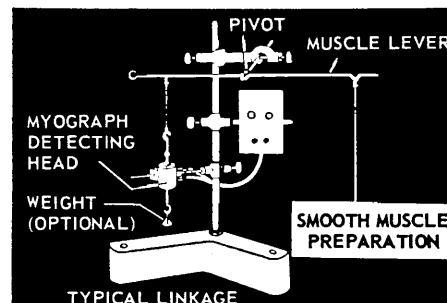
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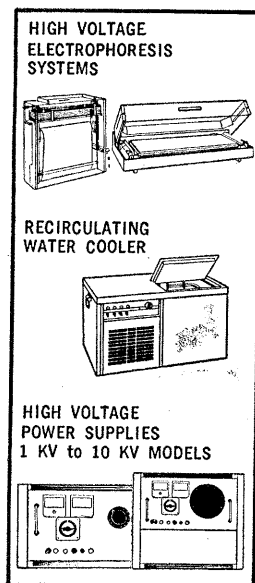
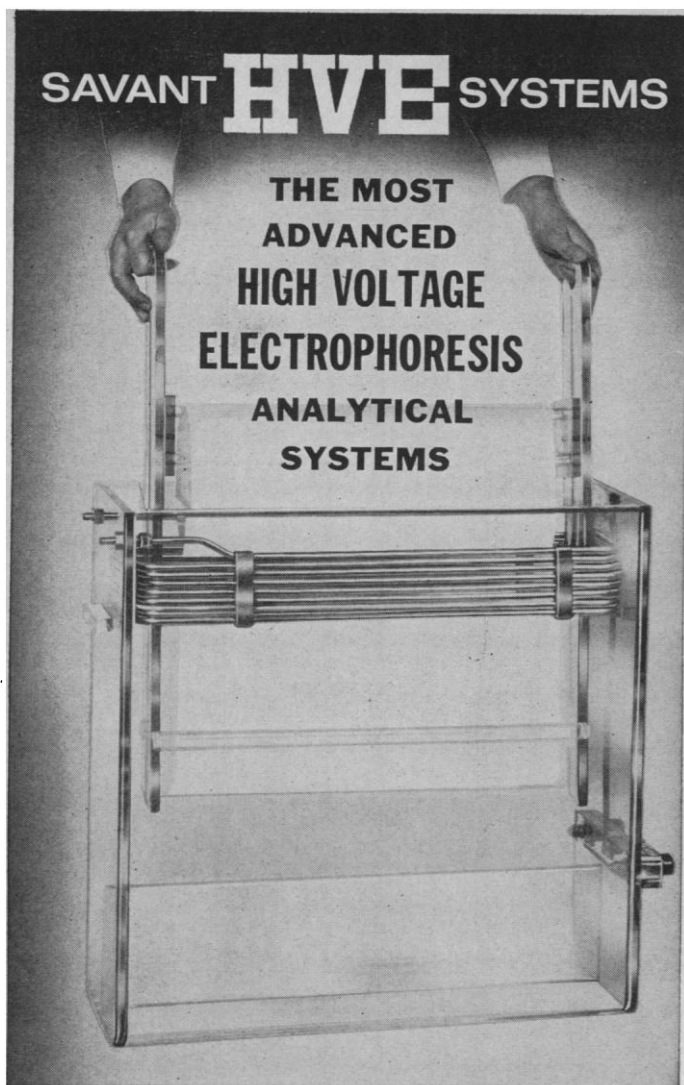
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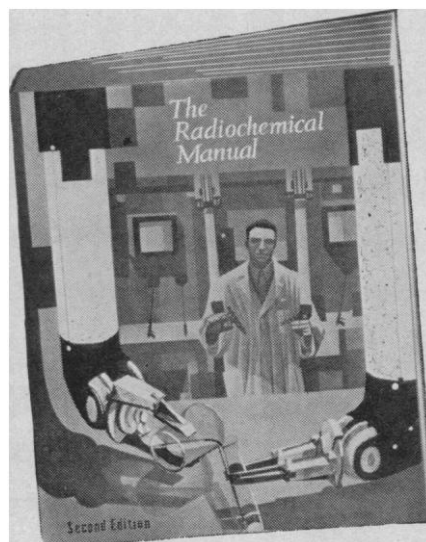


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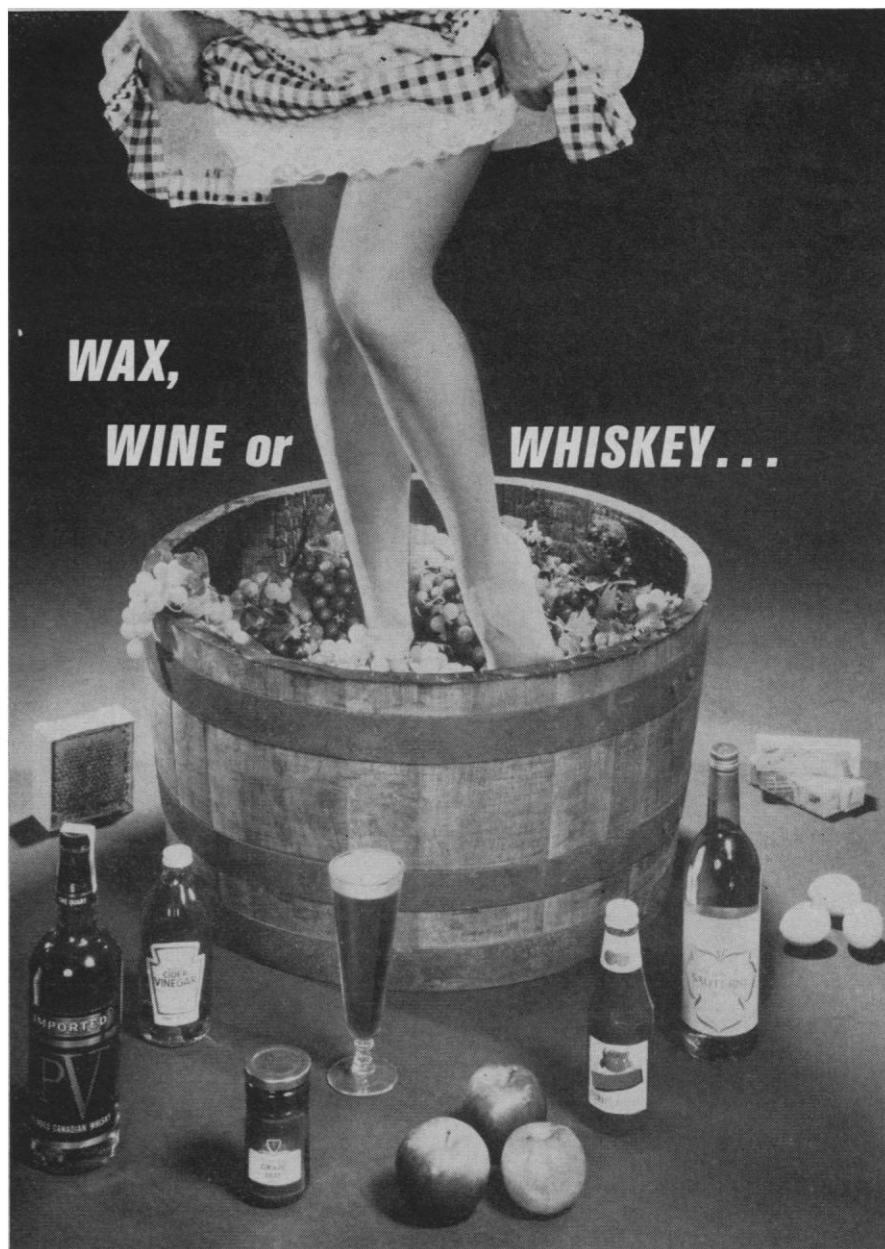
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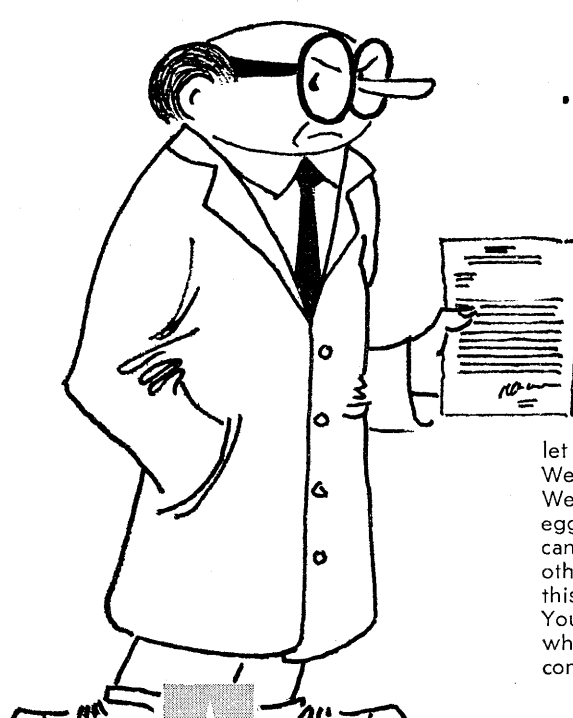
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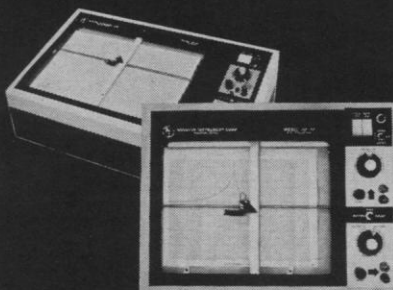
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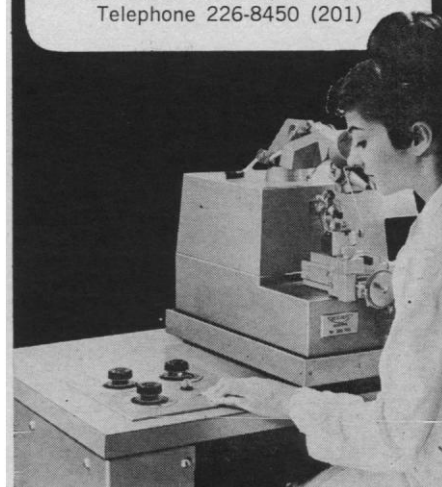
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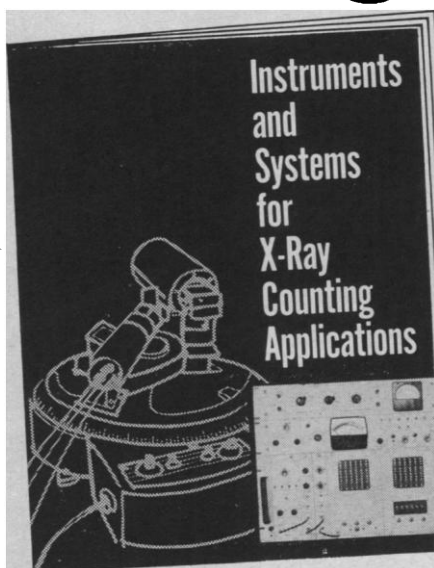
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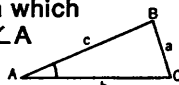
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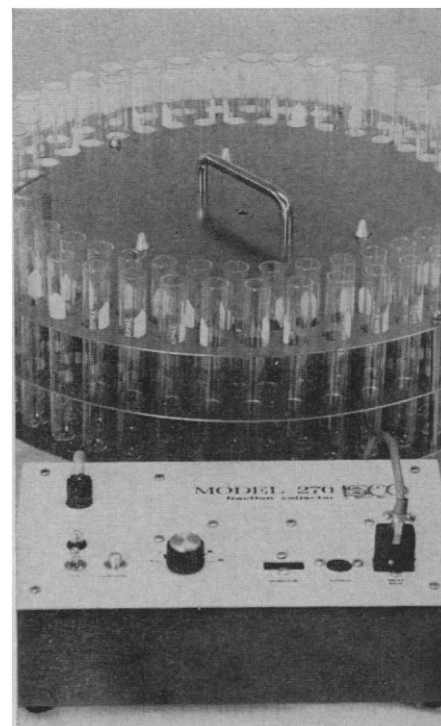
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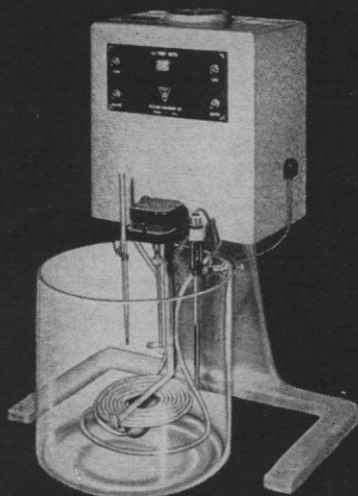
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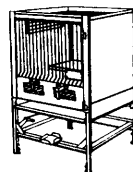
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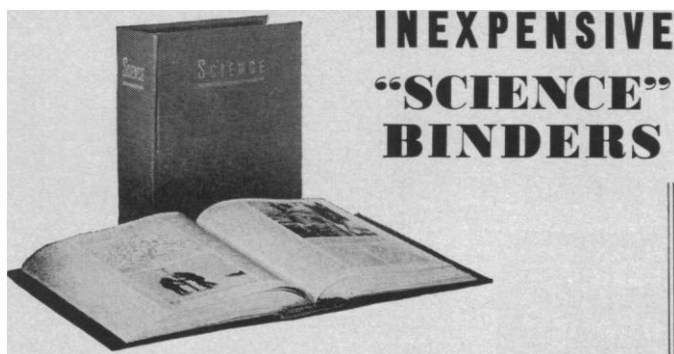
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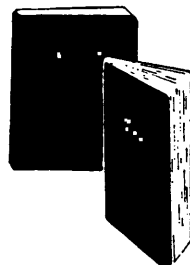
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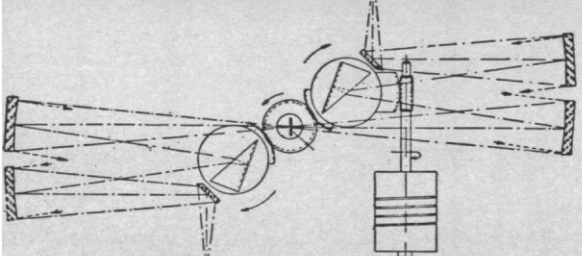
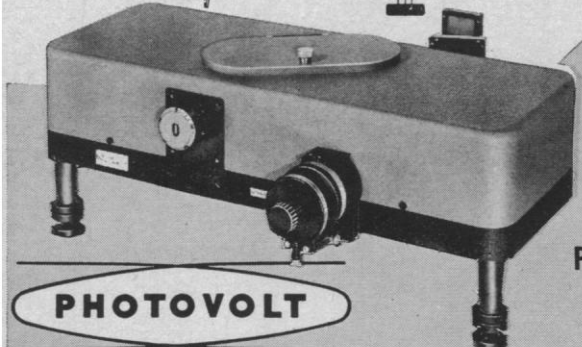
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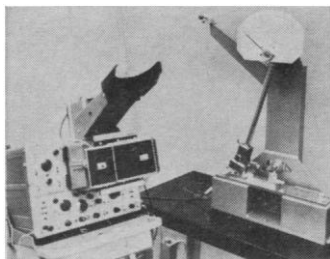
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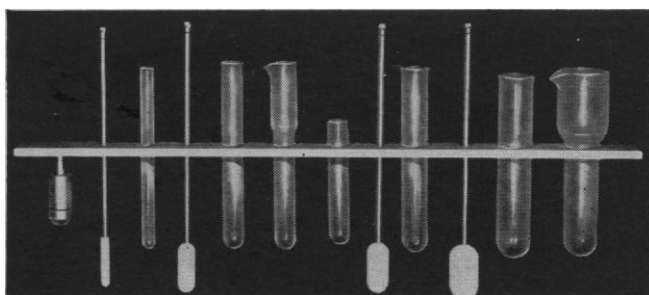


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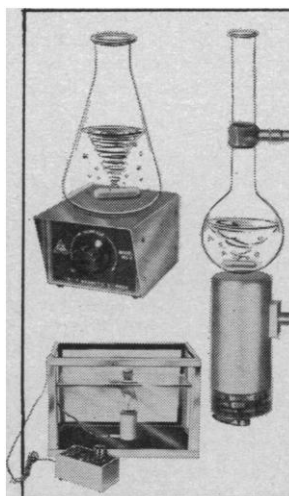
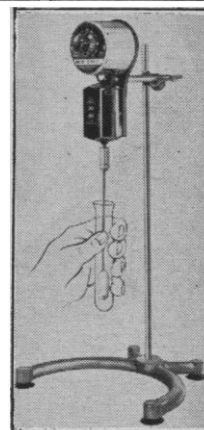
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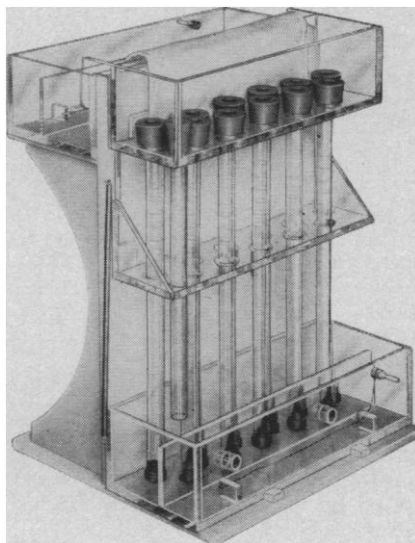
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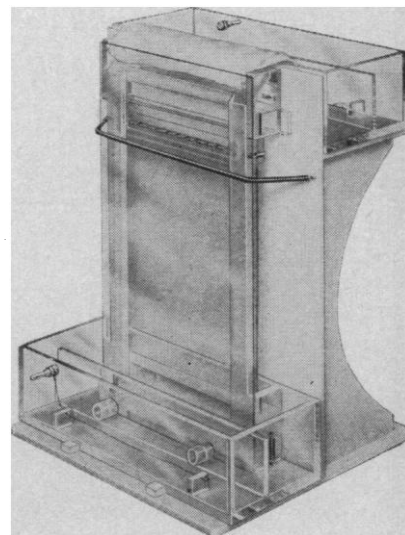
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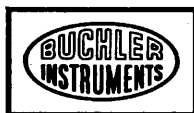
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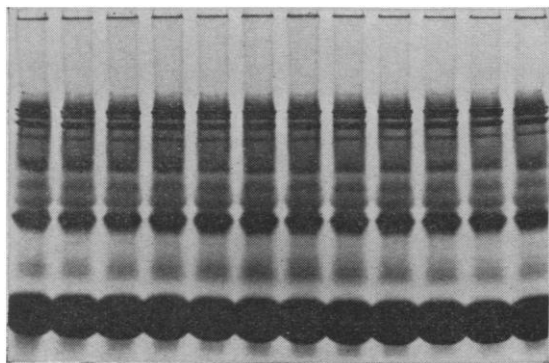
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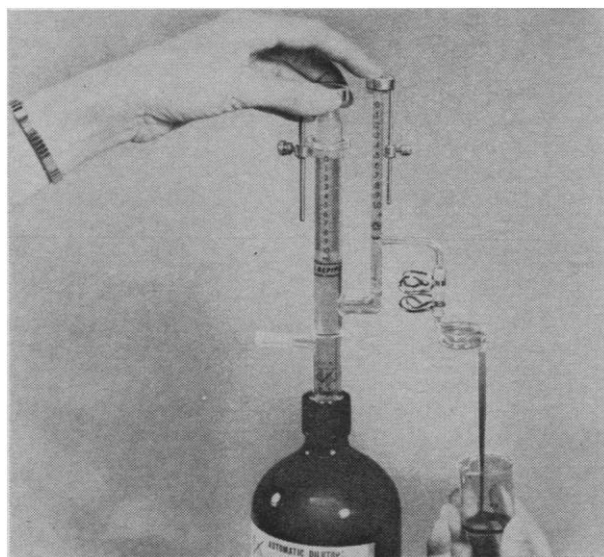
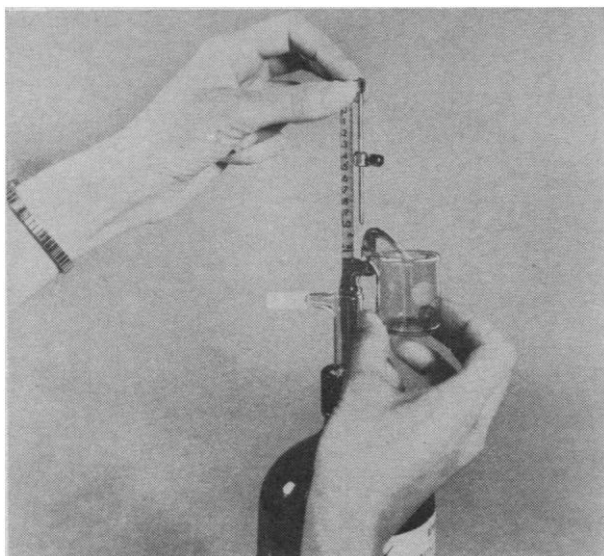
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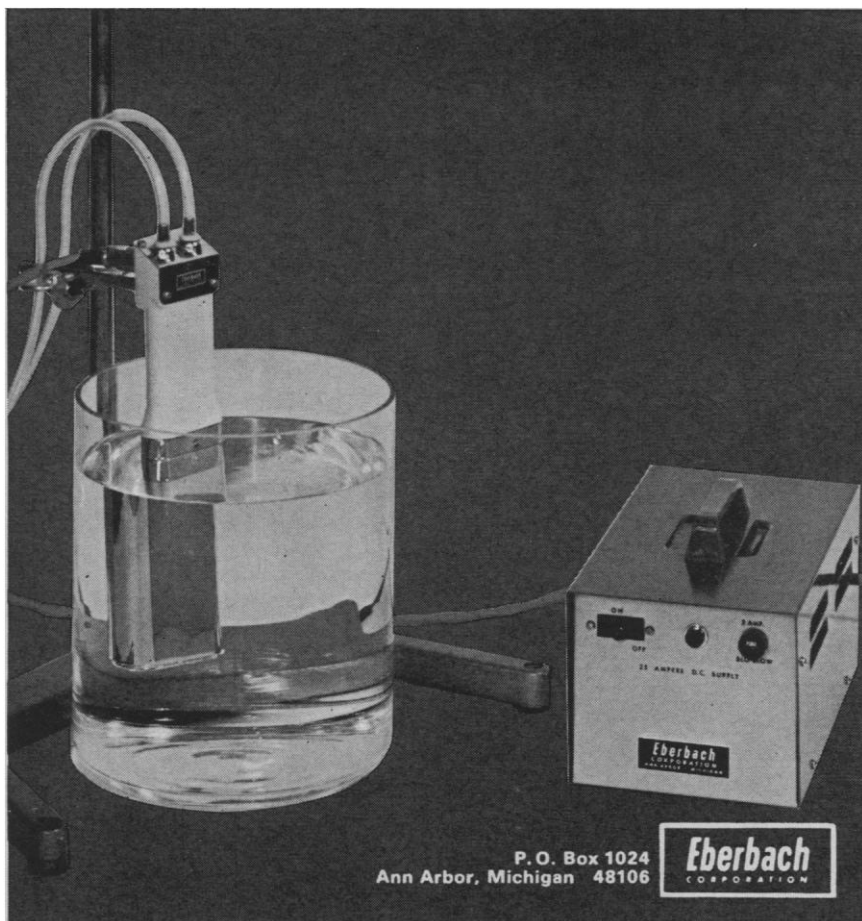
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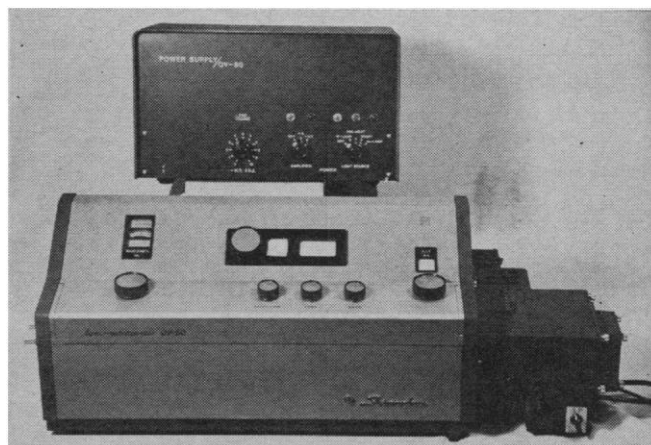
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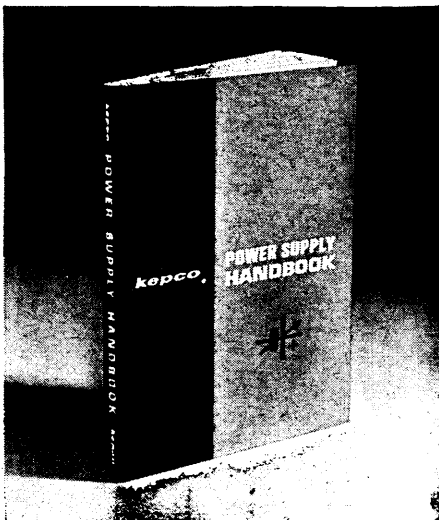
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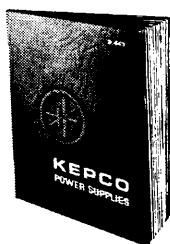
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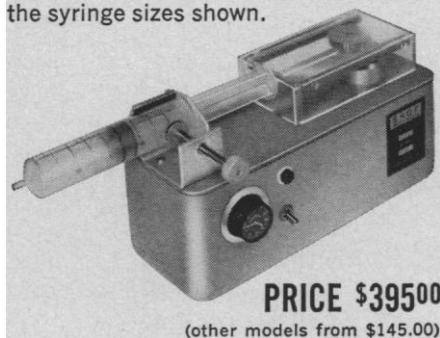
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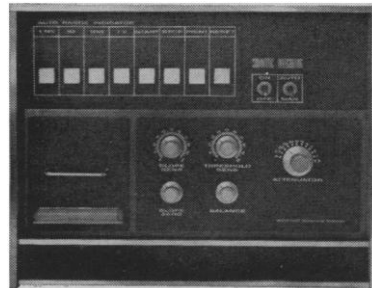
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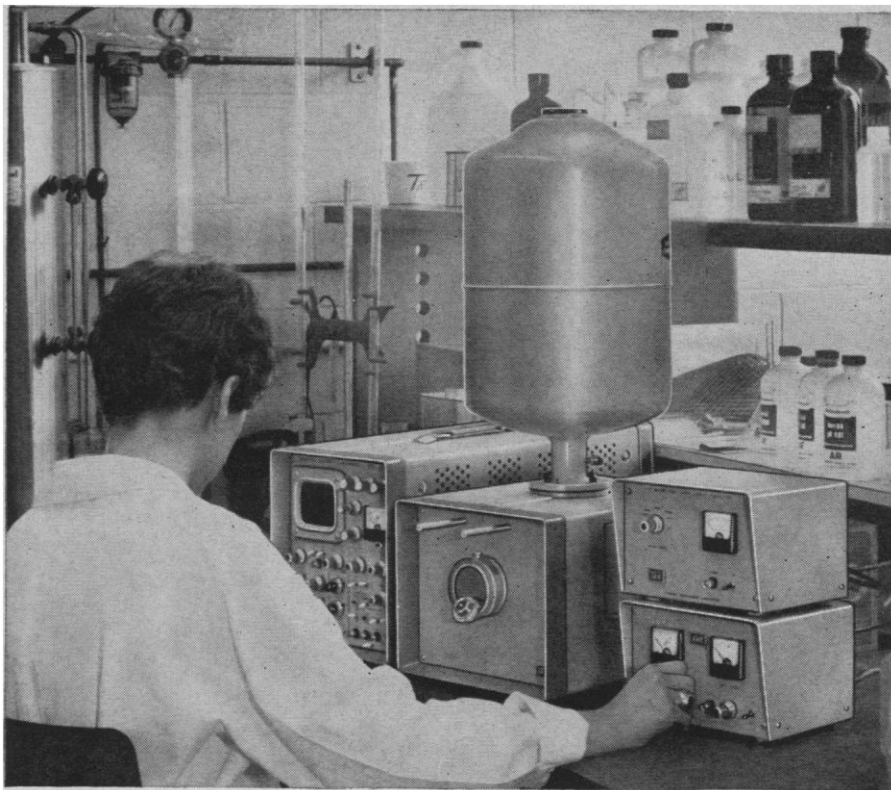
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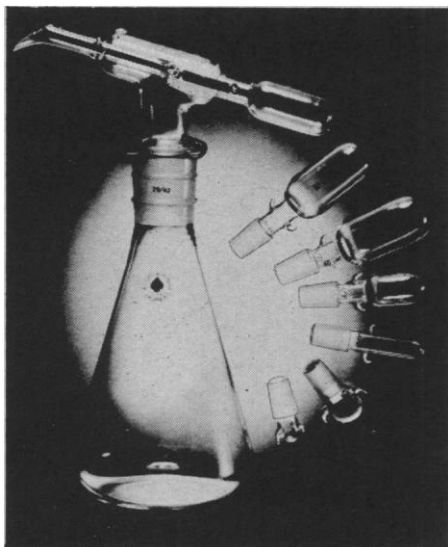
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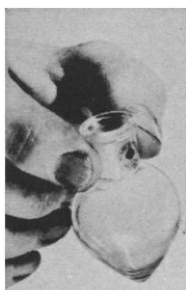
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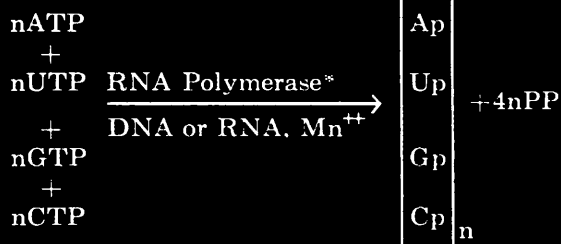
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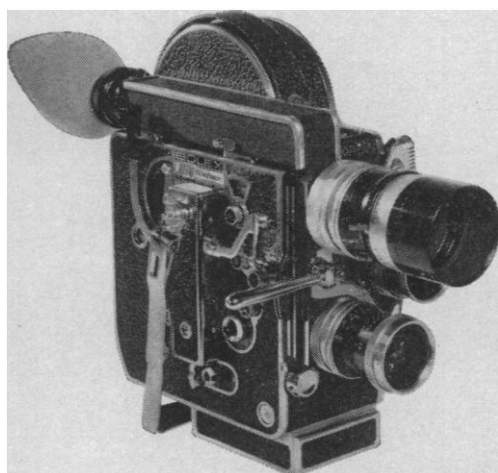
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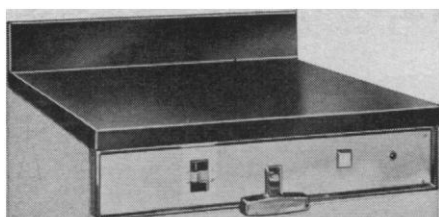
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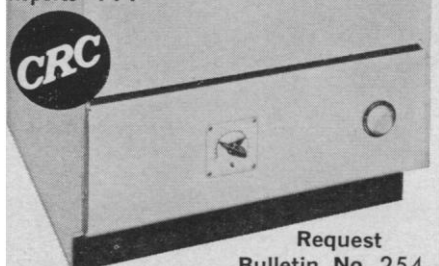


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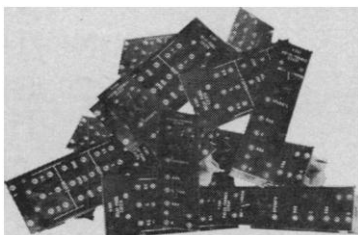
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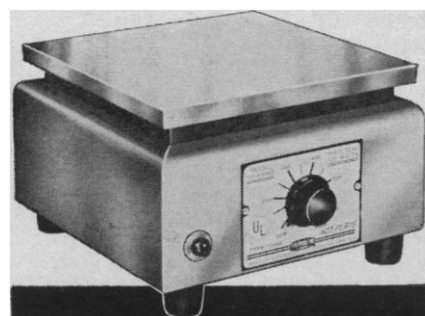
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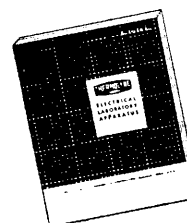
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Native Plants and Animals as Resources in Arid Lands of the Southwestern United States. A symposium (Flagstaff, Ariz.), May 1965. J. Linton Gardner, Ed. Committee on Desert and Arid Zones Research, Southwestern and Rocky Mountain Division, AAAS, Flagstaff, Ariz., 1966. 86 pp. Paper. Eleven papers: "Landholder responsibilities in management of native plants and animals" by Charles H. Stoddard; "Utilization of desert plants by native peoples: An overview of southwestern North America" by Robert L. Burgess; "Possible medicinal uses of native plants" by Mary E. Caldwell; "Grazing and watershed values of native plants" by Charles P. Pase; "Ecological effects of management of vegetation" by F. W. Went; "Management of native animals on federal lands" by Robert J. Smith; "Native fishes as natural resources" by W. L. Minckley; "Game animals as a resource in Arizona, U.S.A., and in Uganda, Africa" by Wendell G. Swank; "International cooperation in managing animals" by S. E. Jorgensen; "Esthetic values of native animals" by William H. Woodin; and "Desert dimension in outdoor recreation" by Frank S. Sylvester.

Nerve as a Tissue. Proceedings of a conference (Philadelphia), November 1964. Kaare Rodahl and Bela Issekutz, Jr., Eds. Harper and Row, New York, 1966. 480 pp. Illus. \$18.50. Seventeen papers on the following topics: morphology (4 papers); biochemistry (5 papers); physiology and pharmacology (4 papers); and pathophysiology (4 papers). See Meeting Reports, *Science* 147, 414 (1965).

Neuroblastomas Biochemical Studies. C. Bohuon, Ed. Springer-Verlag, New York, 1966. 82 pp. Illus. \$4. Recent Results in Cancer Research Series, vol. 2. Eleven papers presented at a Colloque (Paris), May 1964.

Neurosciences Research Symposium Summaries. vol. 1. Francis O. Schmitt and Theodore Melnechuk, Eds. M.I.T. Press, Cambridge, Mass., 1966. 590 pp. Illus. \$7.50. Twenty-five papers that were given at nine work sessions held in 1963 and 1964 by the Neurosciences Research Program.

Neutron Dynamics and Control. Proceedings of a symposium (Tucson, Ariz.), April 1965. David L. Hetrick and Lynn E. Weaver, Eds. U.S. Atomic Energy Commission, Oak Ridge, Tenn., 1966 (available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va.). 619 pp. Illus. Paper, \$4.50. Thirty-two papers.

Nuclear Spin-Parity Assignments. Proceedings of a conference (Gatlinburg, Tenn.), November 1965. Norwood B. Gove and Russell L. Robinson, Eds. Academic Press, New York, 1966. 475 pp. Illus. \$7.50. Sixty papers.

Numerical Solution of Partial Differential Equations. Proceedings of a symposium (College Park, Md.), May 1965. James H. Bramble, Ed. Academic Press, New York, 1966. 389 pp. Illus. \$16.50. Twenty papers.

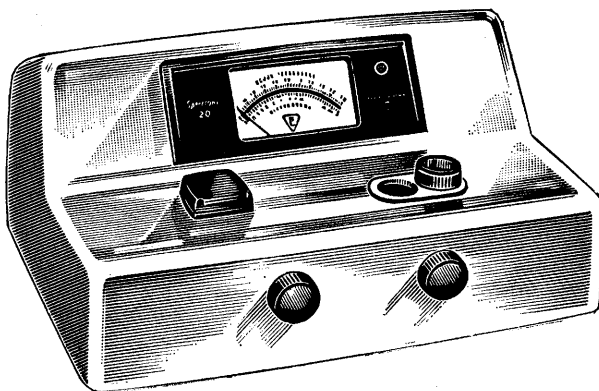
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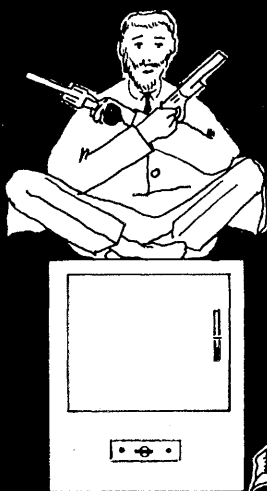
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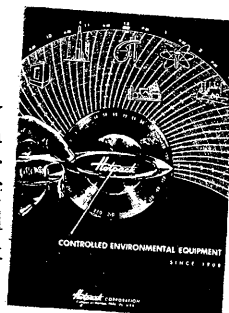


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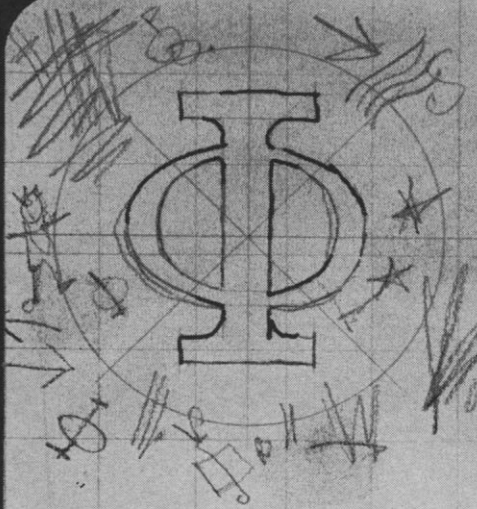


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the International Colloquium (Paris), September 1965. F. Abeles, Ed. North-Holland, Amsterdam; Interscience (Wiley), New York, 1966. 655 pp. Illus. \$18.50. 53 papers.

Perturbation Theory and its Applications in Quantum Mechanics. Proceedings of an advanced seminar conducted by the Mathematics Research Center, U.S. Army, and the Theoretical Chemistry Institute, University of Wisconsin (Madison), October 1965. Calvin H. Wilcox, Ed. Wiley, New York, 1966. 438 pp. Illus. \$6.95. Fourteen papers.

Polarography 1964. vols. 1 and 2. Proceedings of the Third International Congress (Southampton, England), July 1964. Graham J. Hills, Ed. Interscience (Wiley), New York, 1966. vol. 1, 713 pp.; vol. 2, 507 pp. Illus. \$49.50 set. Ninety-one papers; most of the papers are in English; some are in French or German.

Proceedings of the Ninth International Conference on Cosmic Rays (London), September 1965. vols. 1 and 2. Institute of Physics and the Physical Society, London, 1966. vol. 1, 619 pp.; vol. 2, 530 pp. Illus. Paper, £10 10s.; members, £5 per set. 317 papers.

Process Simulation and Control in Iron and Steelmaking. Proceedings of a symposium (New York), February 1964. J. M. Uys and H. L. Bishop, Eds. Gordon and Breach, New York, 1966. 350 pp. Illus. Paper, \$9; cloth, \$19.50. Eleven papers.

Quantum Fluids. Proceedings of the Sussex University Symposium (Brighton, England), August 1965. D. F. Brewer, Ed. North-Holland, Amsterdam; Interscience (Wiley), New York, 1966. 368 pp. Illus. \$13.50. Thirty-four papers.

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Refractory Metals and Alloys 3: Applied Aspects. Proceedings of the third conference (Los Angeles), December 1963. Robert I. Jaffee, Ed. Gordon and Breach, New York, 1966. 1038 pp. illus. Paper, vol. 1, \$10.80; vol. 2, \$9.50; cloth, \$59.50. Seventy papers.

The Solar Wind. Proceedings of a conference (Pasadena, Calif.), April 1964. Sponsored by the Jet Propulsion Laboratory, California Institute of Technology. Robert J. Mackin, Jr. and Marcia Neugebauer, Eds. Pergamon, New York, 1966. 449 pp. Illus. \$17. 28 papers.

Space Power Systems Engineering. Based on the American Institute of Aeronautics and Astronautics Third Biennial Aerospace Power Systems Conference (Philadelphia), September 1964. Academic Press, New York, 1966. 1322 pp. Illus. \$13. Fifty-seven papers.

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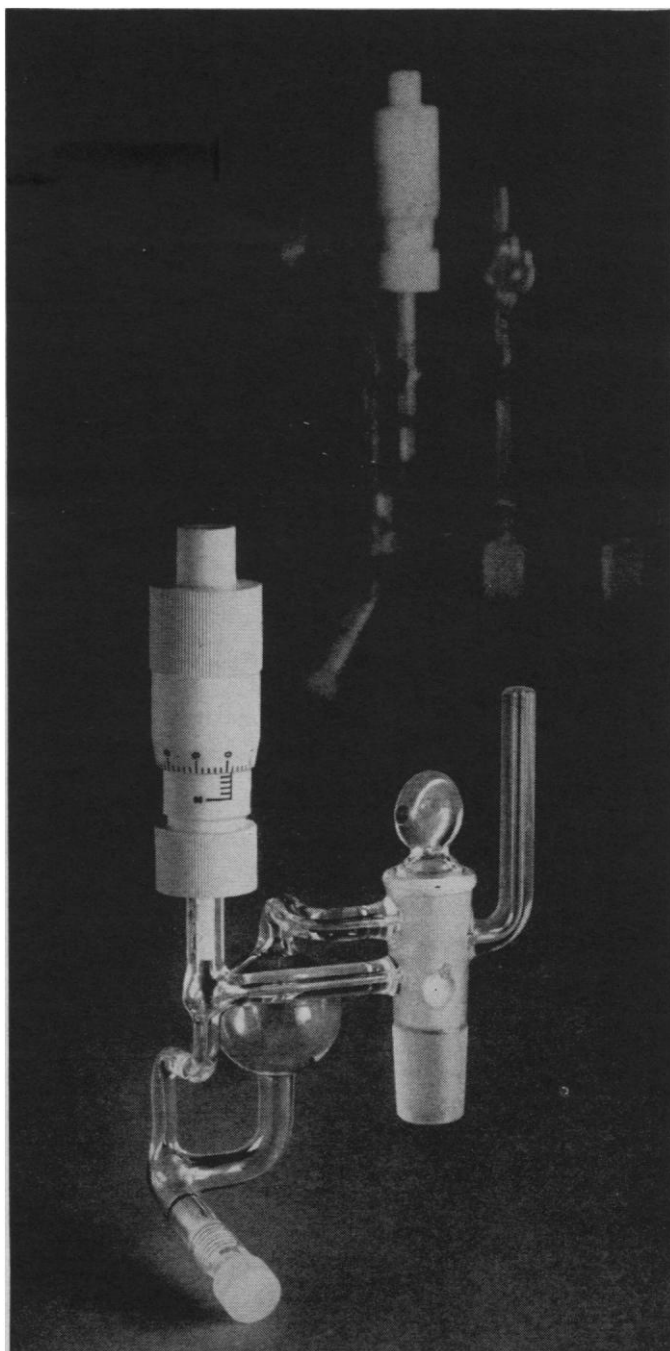
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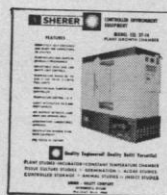
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