SCIENCE

15 March 1963

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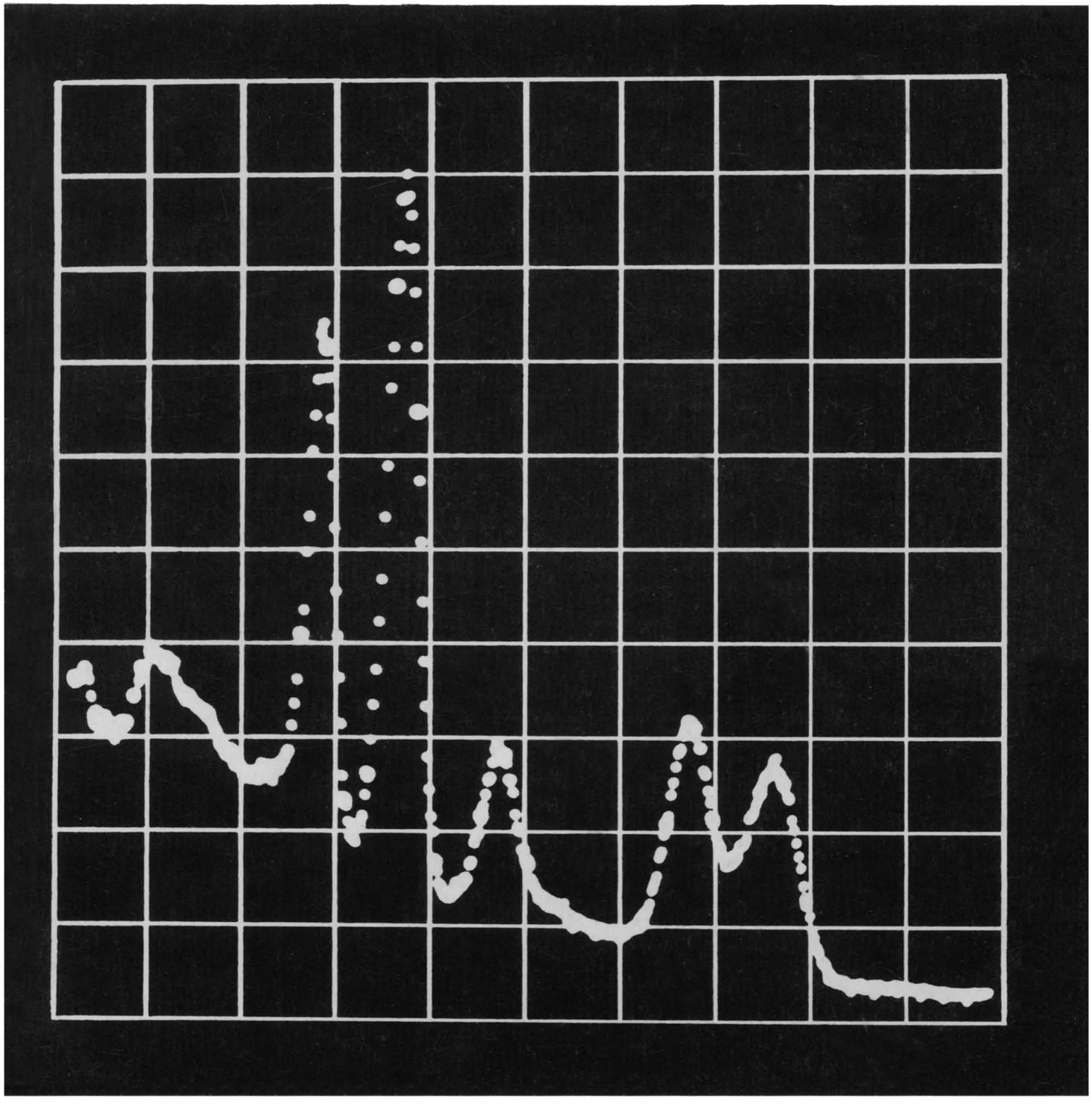
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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this is the Brush Mark II . . . anyone can plug it in put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

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15 March 1963
Vol. 139, No. 3559

SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

The spectrum of several characteristic gamma rays from long-lived radionuclides as recorded on the cathode-ray oscilloscope of a multichannel gamma ray spectrometer. The peaks are indicative of gamma rays which are emitted during radioactive decay and which interact in a thallium-activated sodium iodide crystal to produce pulses of light. A photomultiplier tube in contact with the crystal produces voltage pulses proportional to the light pulses. The voltage pulses are then sorted by a multichannel pulse-height analyzer which produces the composite spectrum. In the case shown, the composite spectrum was produced by cobalt-60, manganese-54, sodium-24, and cesium-317. For a discussion of unclear activation analysis, see page 1027.

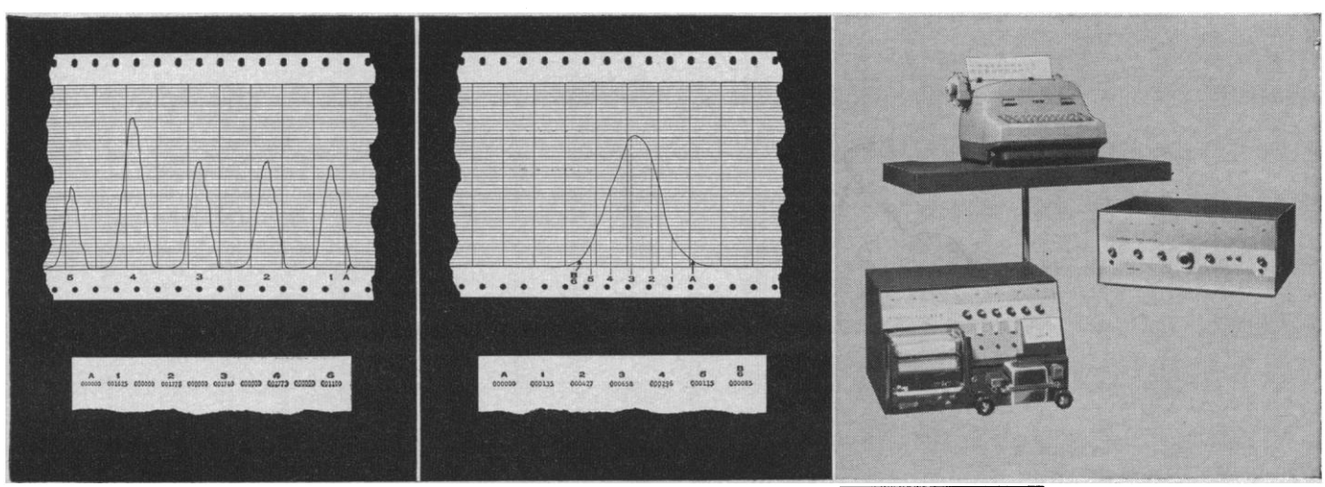
NOW . . .

SCAN CHROMATOGRAMS AUTOMATICALLY

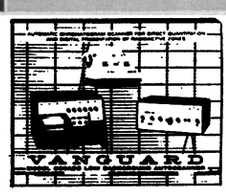
New Ultra-Sensitive Vanguard AUTOSCANNER Detects and Presents Radioactivity In Direct Digital Form

Now both qualitative and quantitative assays of chromatograms can be performed automatically *on the intact strip* with greater accuracy and efficiency than ever thought possible. The exclusive, ultra-sensitive Vanguard Model 880ADS Low Background AUTOSCANNER with Automatic Data System scans, detects and presents radioactivity in direct digital form, eliminating the need for mechanical integration, planimetry and triangulation. Designed for scanning of tritium, carbon-14, sulphur-35 and other low-energy, beta-emitting radioisotopes, the AUTOSCANNER features windowless, 4 pi detection with a total background of less than 10 cpm. Two mode Logic Function Control permits programming to present various parameters of entire scan while eliminating unwanted data. Digital information, therefore, may be utilized through all phases of the quantitating procedure.

Investigate today! See how the designed-in versatility of the Model 880ADS can meet your scanning applications with clear, precise data presentations in a minimum of time with little or no operator supervision.



Shown above are the two modes of Data Presentation available with the model 880ADS. Digital information obtained in the Peak Print mode (left) and the Interval Print mode (right) is utilized through all phases of the quantitating procedure.



WRITE FOR THIS BOOKLET . . . Outlines distinctive features and operational characteristics of the Vanguard Model 880ADS Low Background AUTOSCANNER.

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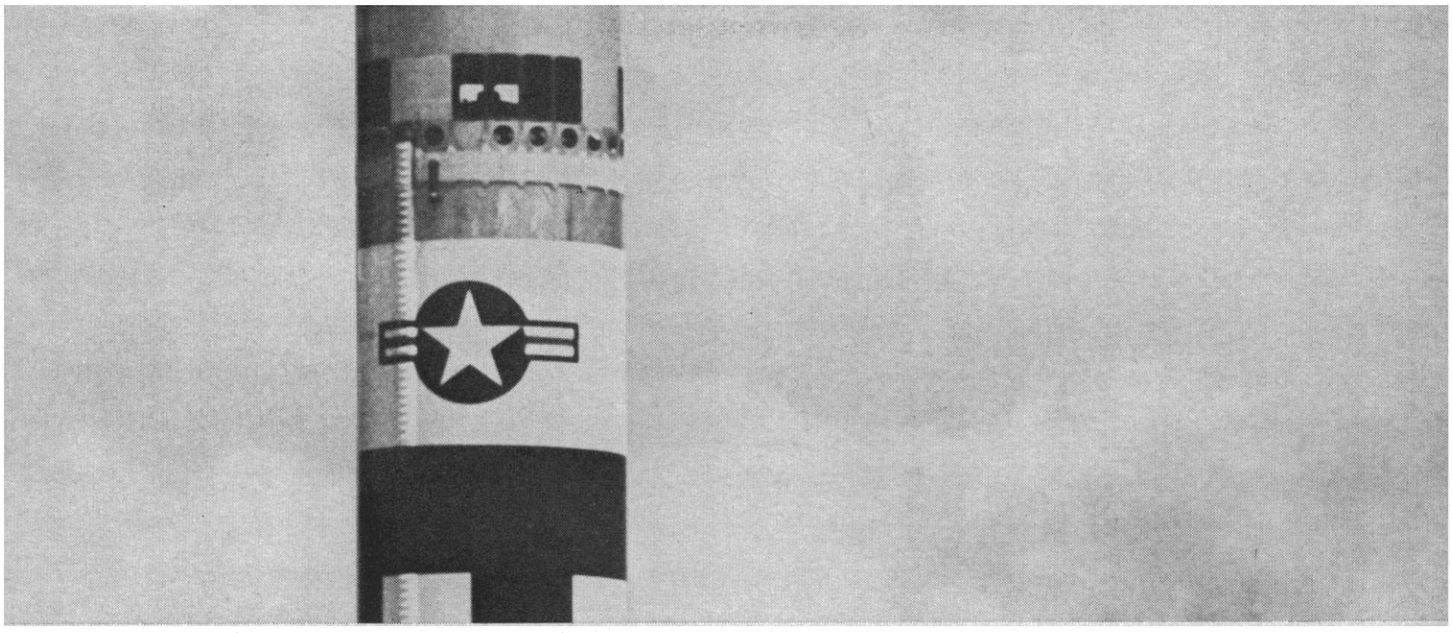

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Engineer it to boost Gemini and other space vehicles.
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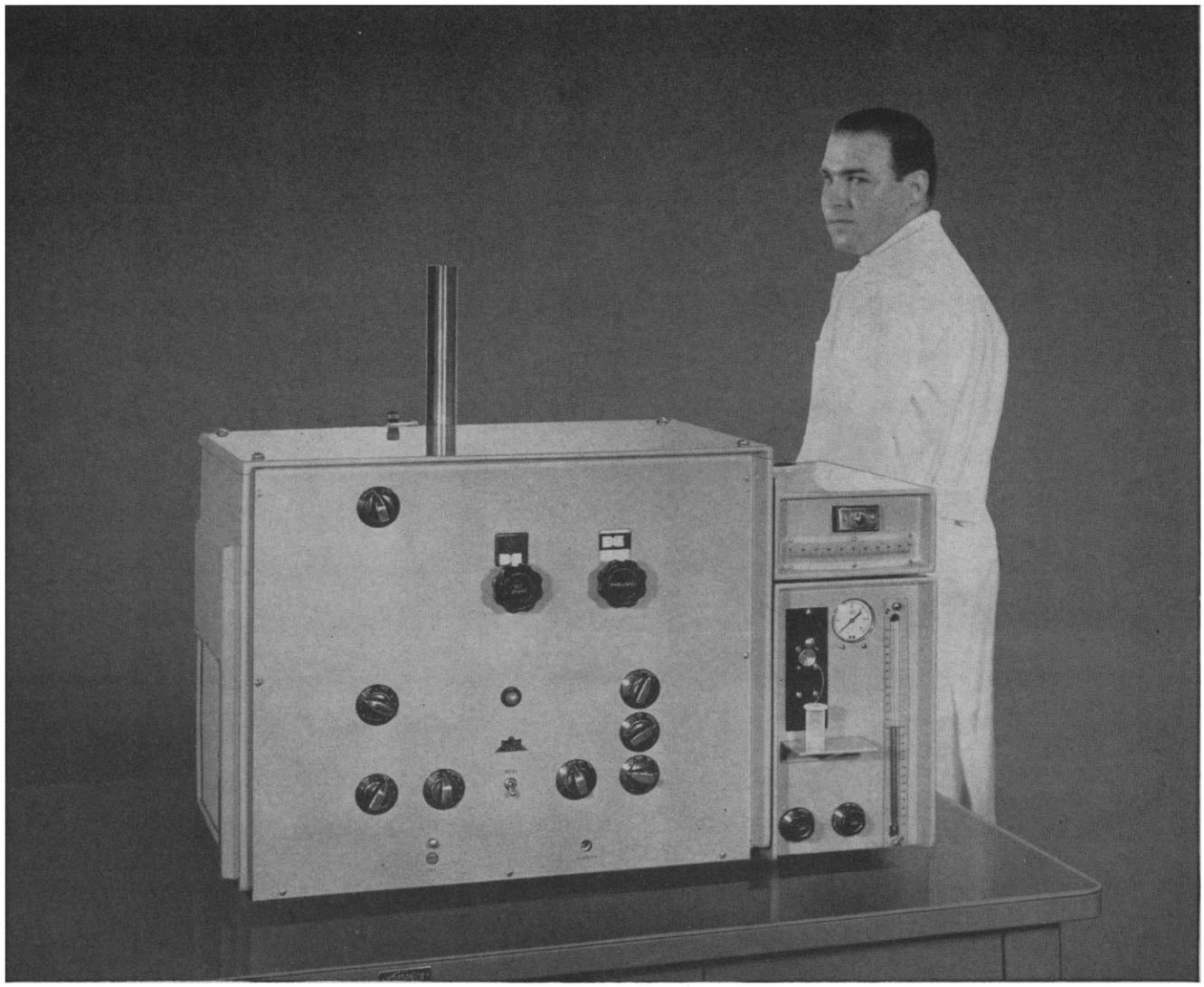
Make it operational with the Air Force in 1963.

SOLUTION: TITAN II

At Martin, systems management means the best possible product in the shortest possible time at the lowest possible cost.

MARTIN MARTIN MARIETTA



Don't turn your back on Flame Photometry!

UNTIL YOU TRY UNICAM

If you think that Flame analysis is too limiting for your work, reserve judgment until you see the new Unicam SP-900 Flame Spectrophotometer.

The Unicam is not an "attachment" or compromise instrument, but a complete Spectrophotometer, designed specifically for emission work. Now you can consider flame analysis for elements other than the Alkali Earth Metals. Manganese, Copper, Boron, Magnesium, Silver and many others are being done routinely on the SP-900.

Unicam's unique burner and atomizer design, coupled with superior electronics, gives stability and reproducibility never before seen with a flame instrument. Permits use of new addition and buffer techniques for the elimination of mutual interferences.

The high light gathering power of the monochromator and the excellent resolution of the optical system, enables the SP-900 to reduce spectral interference to a minimum.

The SP-900 has other noteworthy features. Standard readout is with a spot galvanometer and the addition of any 10 mv external recorder makes the SP-900 a full recording flame spectrophotometer.

So don't sacrifice the inherent speed and accuracy that is possible with flame photometry until you try the Unicam SP-900.

Write today for the Unicam SP-900 Bulletin and to arrange a demonstration of this startling new instrument.

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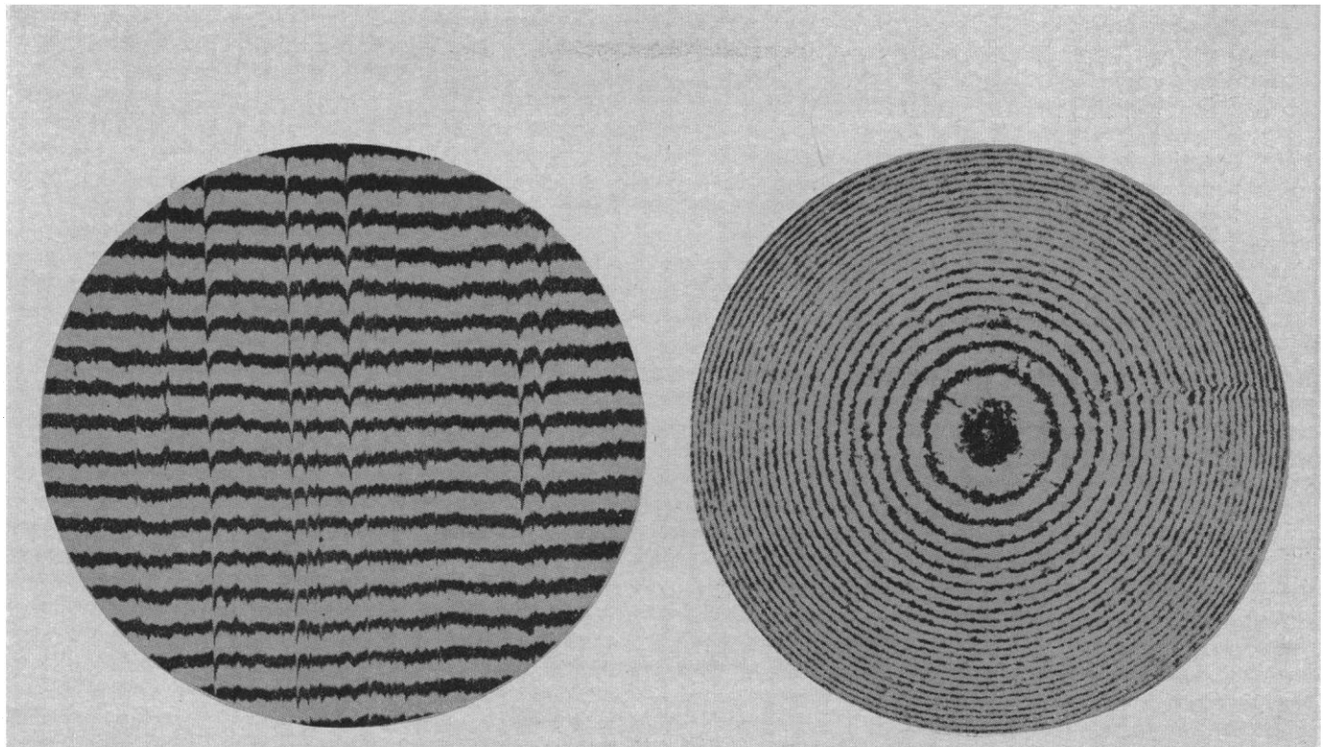
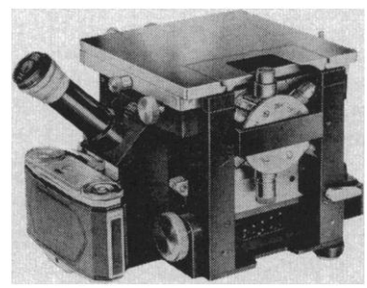


CARL ZEISS INTERFERENCE MICROSCOPE shows surface flaws by deviations in interference bands, at left. (Right) Circular interference bands produced by a sphere.

Measure surface roughness from 1.2 to 80 millionths of an inch

Determine roughness of a super finished surface with the Carl Zeiss Interference Microscope. Check for imperfections in curved and flat surfaces. Set up production standards. See whether finishes fall within pre-set roughness tolerances. Measure thickness of transparent films, coatings and anodized surfaces. Test, for instance, the inside of a ball race either directly or by means of a replica method. A photographic attachment is available to keep records of the examined material. These are some of the things you can do with this instrument.

The objectives of the Interference Microscope are mounted on a revolving nosepiece and can quickly be changed to provide total magnifications of 80x, 200x, and 480x. The surface structure can be viewed as a regular reflected microscope image or as an interference image. Both white light and monochromatic (green) thallium light sources are available. The stage on which the test piece is placed is tiltable for proper alignment of surface to be tested. During operation the number of interference bands used for the measurement can be varied.



The Interference Microscope is a compact instrument: only 6 x 6 x 9½ in. Operators are easily trained in its use. Each instrument is equipped with 35mm film carrier.

For a description of the instrument, send for our literature. Upon request, we will be glad to arrange for a demonstration. **Complete service facilities available.**

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Coleman pH Instrumentation

Three pH meters and complete selection of electrodes meet full range of laboratory pH measurement requirements

Low-cost Metrion pH Meter is a line-operated instrument featuring a basic simplicity of design and operation which make it ideal for general-purpose laboratory use. With measurement accuracy to 0.05 pH, the Metr*ion* provides a level of performance far out of proportion to its moderate cost.

Features:

- Stabilized against line voltage fluctuations over 95-125 volt range.
- Easy-to-read duplex scales cover 0-14 pH range.
- Calibration control provides compensation for temperature effect.
- Simplified operation—"push-to-read" pH control.

Cost—only $139.00.

Increased versatility, Metrion II pH Meter offers the same simplicity of design and operation as the basic Metr*ion*. It also features two additional circuits for increasing versatility of the instrument:

...a true temperature-compensating circuit with a control knob conveniently located on instrument's front panel.

...an output jack for use with an automatic titrator such as the Coleman Titr*ion*.

Addition of these two circuits makes the Metr*ion* II valuable for an increased variety of specialized laboratory applications with only a small price increase.

Cost—$160.00.

Fully-versatile Companion pH Meter is a zero-restoring instrument ideal for a broad range of laboratory applications. It provides pH measurement over the 0-14 pH range with a routine accuracy of 0.05 pH and reproducibility within 0.02 pH. The instrument also may be used for millivolt measurements over a 1400 mv span.

Features:

- Zero-restoring circuit for drift-free operation.
- May be used with recorder, automatic titrator, and automatic temperature compensator accessory.
- Simplified control system for easy operation.
- Manual Temperature Compensator control permits accurate measurement over 0-100° C. range.

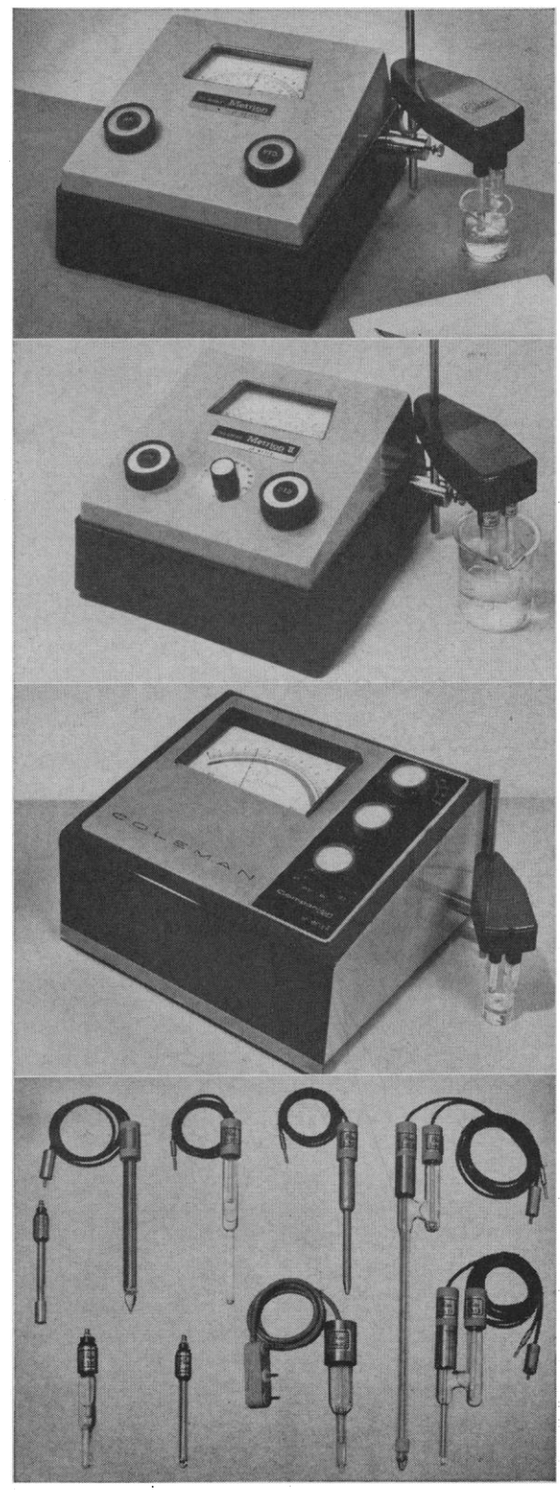
Cost—$300.00

Complete selection of electrodes—Coleman electrodes cover virtually every practical application of laboratory pH measurement. They are usable with any Coleman pH meter or other instrument of modern manufacture.

- Glass electrodes, shielded against stray electrical fields, permit precise measurement over widely-varying conditions of temperature, viscosity, alkalinity.
- Reference electrodes are available in standard calomel or non-mercurous types.
- Metallic electrodes for electometric titrations.
- Special-purpose electrodes for unusual applications.

Coleman electrodes are priced about one-third less than the closest competitive designs.

Write for full details



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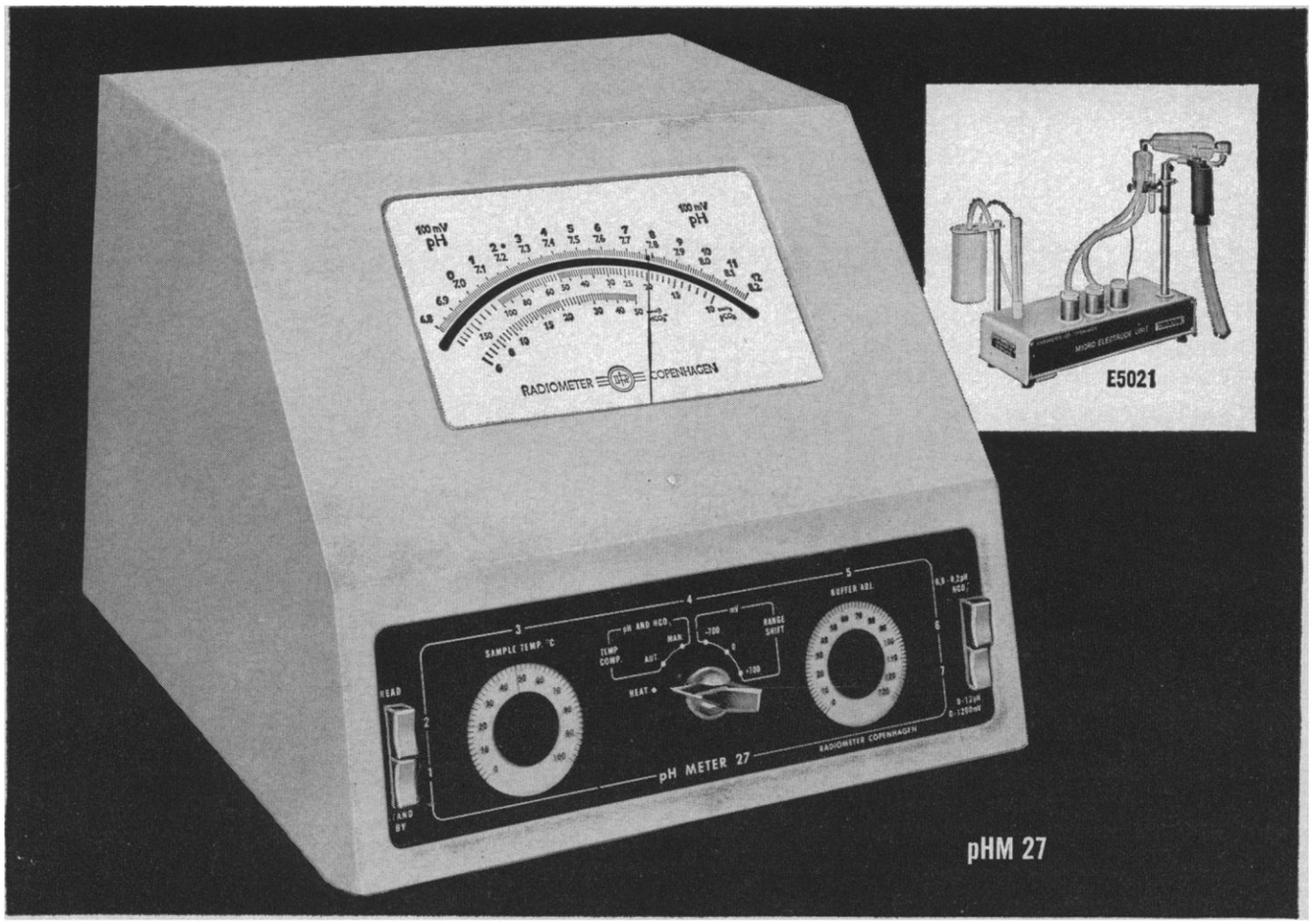

The new pH meter for BLOOD pH

from **RADIOMETER** *of Copenhagen*

A direct reading — expanded scale instrument setting NEW standards of accuracy, reliability and stability — pHM 27.
Teamed with the new Radiometer Ultra-Micro Blood Electrode E5021 (25 ul sample requirement) — this can be the answer to your Blood pH problems — either clinical or research.

- Both normal (0-12 pH) and expanded scale 6.8 - 8.2 pH) provided.
- Reproducibility on blood range, 0.002 pH.
- Line operated — zero drift — and ruggedized. Uses military type components and 10,000 hour tubes.
- Scales provided for pH; Standard Bicarbonate according to Astrup; CO_2 and O_2 tensions.

pHM 27 is a radically new approach to pH instrumentation and designed to function on a modular basis, with a host of accessories to cover blood gas tension measurements (either by direct electrodes or by the Astrup Method), or complete Acid-Base determinations. If you require complete reliability and flexibility of present or future application, **you can't afford to consider any other instrument.** ***Write for complete details***

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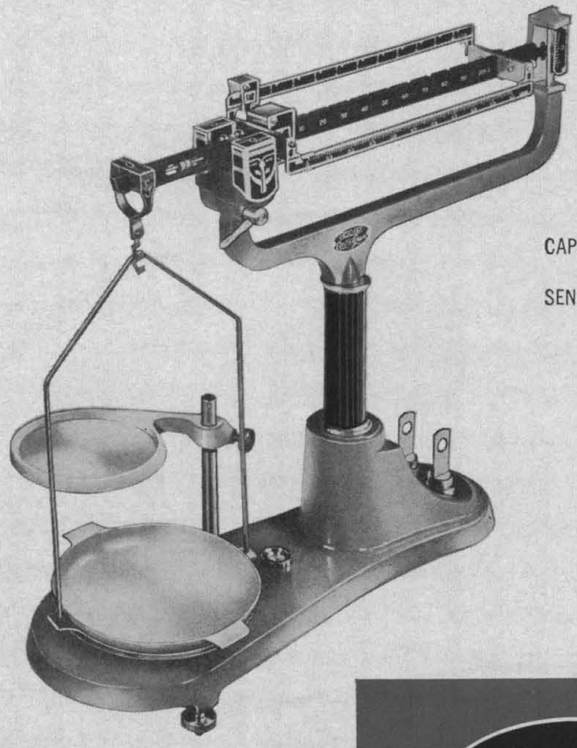


CAPACITY
311 Gram
SENSITIVITY
.01 Gram

THE POPULAR

Cent O Gram

An unbeatable balance for general laboratory weighings, specific gravity work, and preweighing, the CENT-O-GRAM is an accepted pace setter in its field.

As well as being portable, this balance is adaptable for use in many fields.

The 311 gram capacity is higher than any balance of its type through use of two 100 gram self stored attachment weights.

Comes equipped with stainless steel bows, pan (3-3/4" dia. x 1/2" deep) and specific gravity platform.

OHAUS

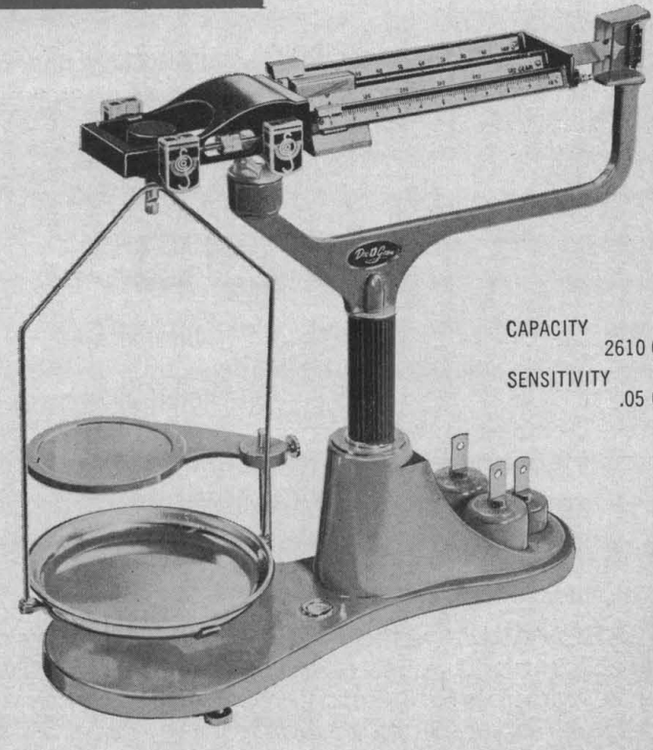
THE ALL NEW

Dec O Gram

This latest OHAUS overhead triple beam balance has a capacity of 2610 gram.

Such other familiar OHAUS features as sturdy box end beam, sliding type poise with center indicating panel, self aligning bearings, self storing attachment weights and specific gravity platform, all add up to fast sensitive high capacity performance.

Available in two models... the Model 3600 (metric) and Model 3601 (avoirdupois).



CAPACITY
2610 Gram
SENSITIVITY
.05 Gram

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1050 COMMERCE AVENUE UNION, NEW JERSEY
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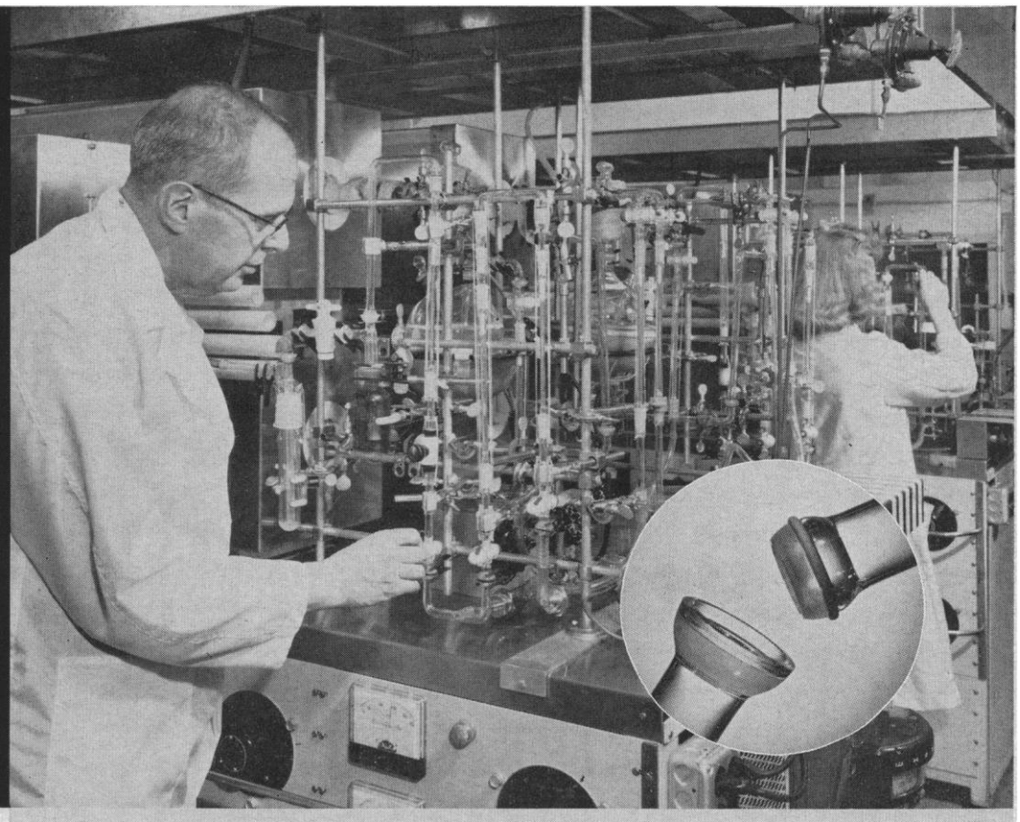
"HVS" (High Vacuum Seal) JOINTS*

another "SGA" exclusive!



Dr. M. Schneider of the National Semiconductor Corporation, Danbury, Connecticut, a manufacturer of high quality silicon semiconductor devices, is shown regulating a Gyco stopcock on "SGA" glassware which incorporates "HVS" joints. Our high vacuum seal joints solved the problem of leakage formerly experienced with conventional joints.

In addition to being vacuum tight, "HVS" Joints do not require any lubrication. Furthermore, since the unique design features an O-ring seal *above* the ground joint, you never have to worry about contamination. (The ground joint surface protects the O-ring from solvents and vapor; the tight seal prevents the atmosphere from attacking the system!)

"HVS" Joints may be incorporated into any apparatus fabricated from hard borosilicate glass. They're easily assembled and disassembled. Buna-N O-rings are standard, but silicone and Viton† are available.

All Inter-Joint® glassware in "SGA" Combined Catalog 63 can be supplied with "HVS" Joints *at no extra charge.* Ask us for details.

*Patent Applied For †DuPont Trademark

JJ-1280X "HVS" SPHERICAL JOINTS. Ball member supplied with "Buna-N" O-Ring. Please specify catalog number and size:

♀ No.	12/1	12/2	12/3	12/5	18/7	18/9
Ball, each	$2.09	$2.09	$1.76	$1.76	$1.82	$1.82
Socket, each	2.48	2.48	1.98	1.98	2.04	2.04
Complete	4.57	4.57	3.74	3.74	3.86	3.86

♀ No.	28/12	28/15	35/20	35/25	50/30	65/40
Ball, each	$2.09	$2.09	$2.48	$2.48	$3.85	$6.33
Socket, each	2.31	2.31	2.70	2.70	4.24	6.44
Complete	4.40	4.40	5.18	5.18	8.09	12.77

JJ-3755X "HVS" ♀ JOINTS. Inner member supplied with "Buna-N" O-Ring. Please specify catalog number and size:

♀ No.	10/18	12/18	14/20	19/22	24/25	29/26
Inner, each	$1.50	$1.50	$1.40	$1.50	$1.60	$1.80
Outer, each	1.70	1.70	1.65	1.75	1.85	2.00
Complete	3.20	3.20	3.05	3.25	3.45	3.80

♀ No.	34/28	40/35	45/35	55/35	71/40
Inner, each	$2.25	$2.75	$3.45	$4.50	$6.15
Outer, each	2.50	3.30	3.85	5.10	7.00
Complete	4.75	6.05	7.30	9.60	13.15

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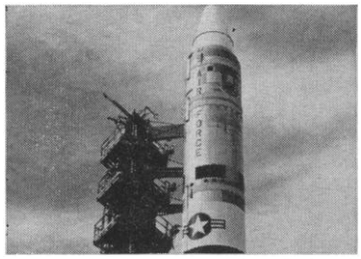
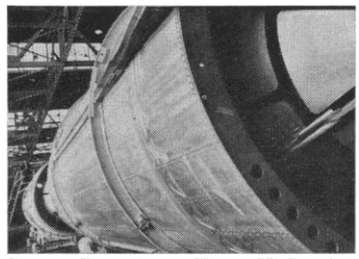
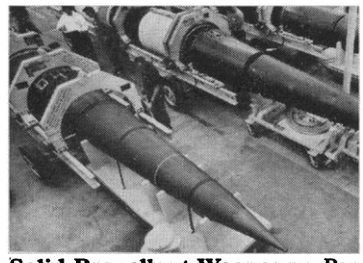
Here are some of the capabilities which have made these achievements possible.



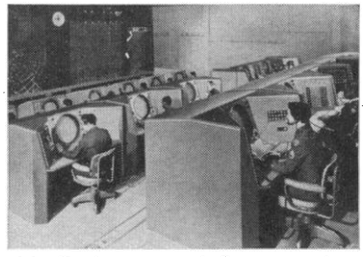
Strategic Weapons. Titan I—hard-based ICBM, operational in underground silos on schedule. Titan II—most powerful ICBM: storable propellants, near instantaneous reaction, silo launched. Highly successful test program. Nearing operational status.



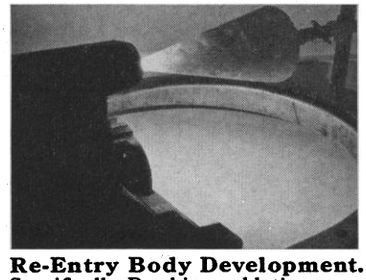
Space Boosters. Titan II Gemini Launch Vehicle. Titan III—Standard Space Launch System—over 2,500,000 pounds of thrust; envisioned as the space "workhorse" for the next decade.



Solid Propellant Weaponry. Pershing—fast accelerating system; built to fire almost instantly under rugged field conditions. Finest test record of any missile. Bullpup—the nation's only supersonic air-to-surface missile. La Crosse—with pinpoint accuracy.

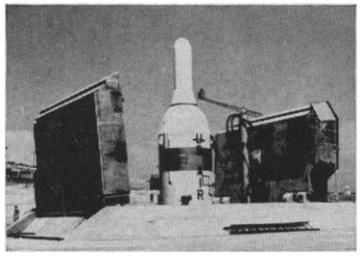


Air Defense and Communications. Missile Master and Birdie, electronic air defense systems operational in 29 major metropolitan areas. RACEP communications system, providing direct-dialing telephone type service. Missile command and control systems, ASW systems.

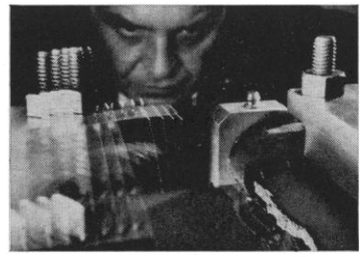


Re-Entry Body Development. Specifically, Pershing—ablative nose cone which withstands rapid acceleration, deceleration and high re-entry heats.

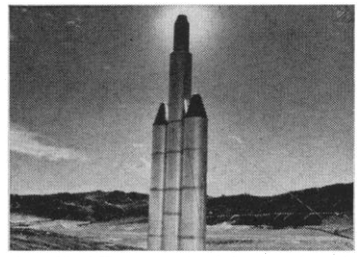
Nuclear Power Systems. SNAP generators for land, sea, and space systems—world's first in space, first undersea, first lighthouse, first weather station. Portable reactors at Sundance, Wyoming, and South Pole.



Hardbase Activation. Responsible for hardbasing Titans I and II—One of history's most difficult construction feats. Completed on schedule for Titan I. Progressing on schedule for Titan II.



Material Development. Exotic materials, with high heat flux, high strength with low weight. First production technique for fusion welding of high-strength aluminum alloy. Semi-conductor materials research, micro-electric elements, cryogenics, ceramic heat shield, plastics, surfex.



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During the past five years 95% of all government work contracted by Martin was delivered within cost and schedule requirements.

MARTIN DIVISION MARTIN MARIETTA

A modern research instrument with built-in Koehler illumination for critical microscopic investigation

In less than one year since its introduction, the Nikon Series S has become one of the most talked about microscopes in the field. It has attracted wide and favorable attention for its mechanical ruggedness, its smoothly responsive controls, its seemingly unlimited versatility, and its almost incredible quality of optics.

The new Series S-Ke offers even more of special interest to the critical microscopist. Except for the base, the S-Ke employs the same construction as the Series S and accepts the same interchangeable eyepiece tubes and stages. The base is larger, and contains the light source and optics of the Koehler illuminator.

Koehler illumination is undoubtedly the most efficient known to optical microscopy, and is virtually prerequisite in photomicrography. Its principle advantage is that it makes the light source and microscope a compatible optical system. All available light is concentrated in the area under investigation. There is no glare or halo. Details, usually obscured by these conditions emerge with new clarity and definition.

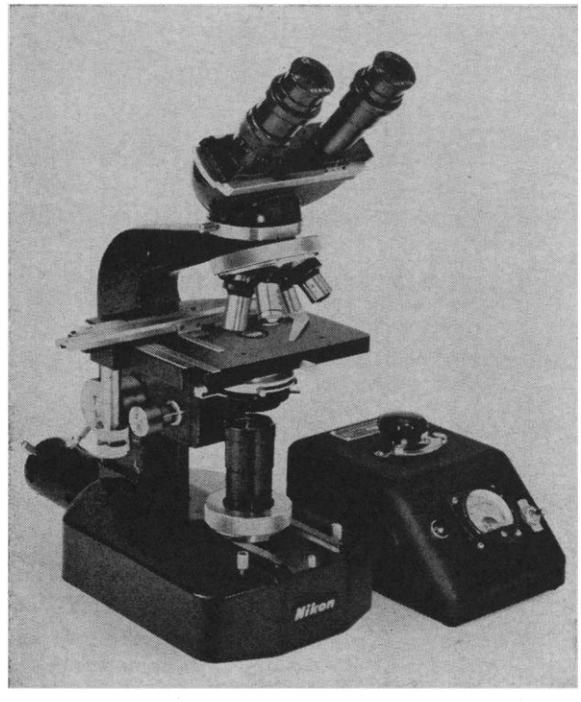
To attempt Koehler illumination with conventional mirror and external lamps is a difficult, time-consuming procedure. With the model S-Ke it is utterly simple and virtually automatic. A sliding, centerable optical system permits the user to enjoy its benefits over the entire magnification range of the microscope.

The S-Ke is supplied with a step-down transformer which provides the correct lamp voltage. This transformer has a built-in voltmeter and a variable intensity control with adjustable high- and low-position 'stops' so that any selected degree of brightness can be repeated.

Optional accessories: Interference-Phase, Phase-Contrast, and Polarizing attachments, Projection Head, Macro-Photo and Photomicrographic equipment.

For complete details, write to Dept. S-3.

Nikon Series S-Ke



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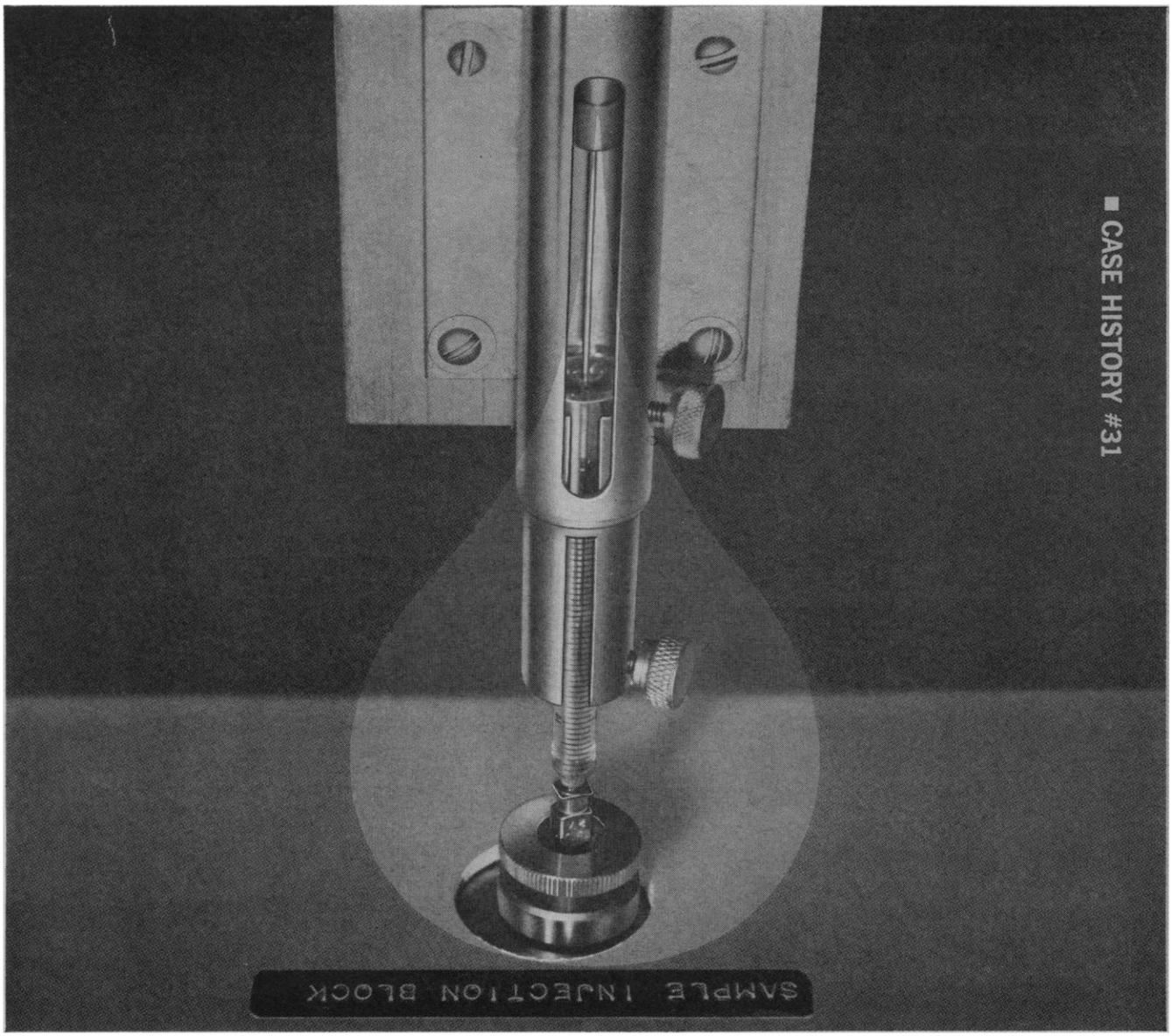

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The University of North Carolina recently developed a unique application for a Hamilton Gas Tight Syringe which permits the use of the frontal technique in gas-liquid chromatography. The syringe is used in conjunction with a synchronous motor and linear screw, to introduce a liquid sample at a constant rate into a moving gas stream. The 2 rpm motor turns a precision lead screw (52 threads/inch) which drives the plunger of the 50 μl syringe resulting in a constant delivery rate of 0.843 μl per minute. This corresponds to approximately one drop per hour! In science and industry, as well as education, research people have discovered that they can depend on Hamilton for precision measuring equipment. **Hamilton manufactures a complete line of precision syringes from a capacity of 0.5 μl to 50 μl and other related chromatograph equipment.**

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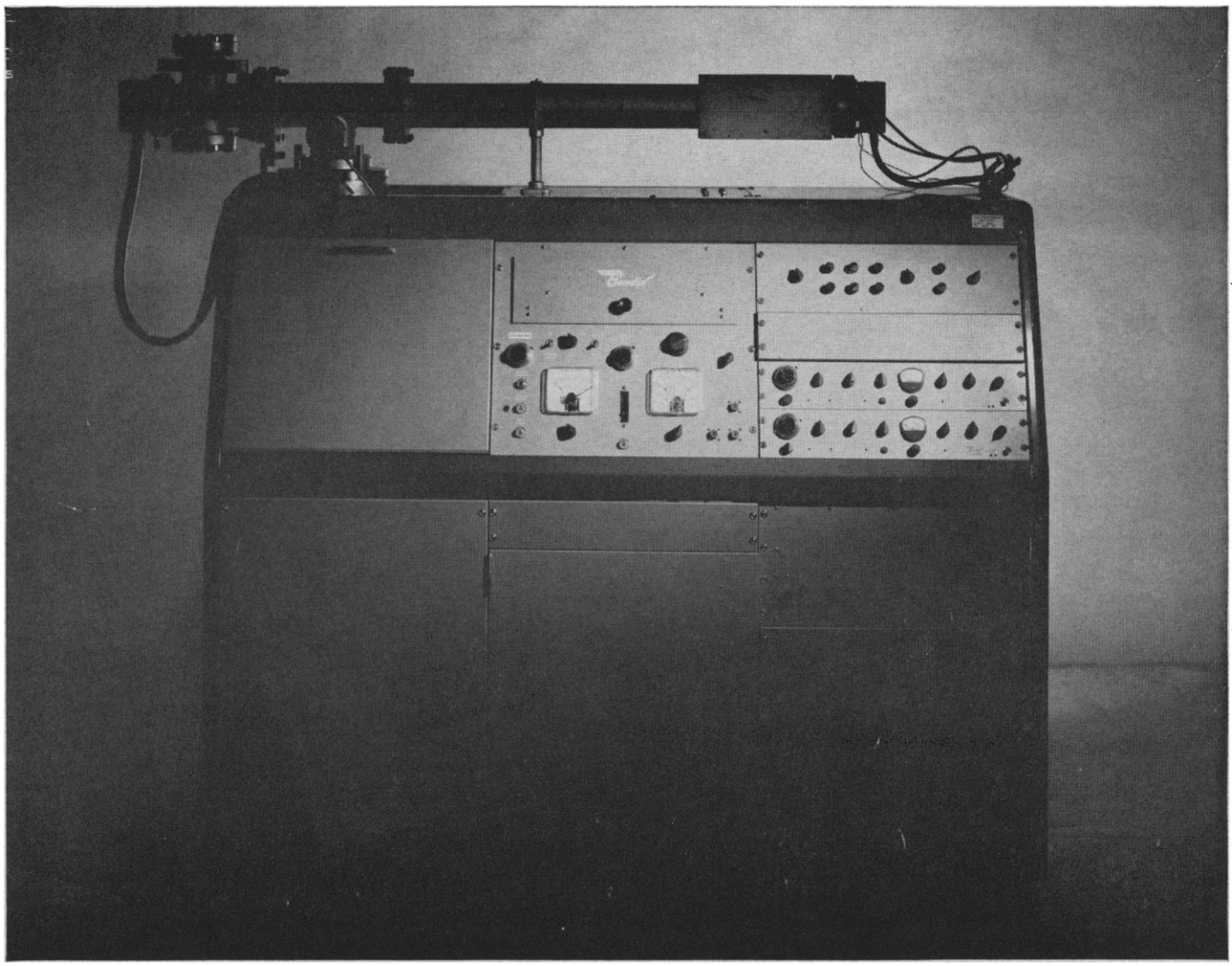

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THE Bendix CORPORATION

Linde Cryobiology NEWS

REPORT NO. 3 FROM LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

New preservation techniques using liquid nitrogen

Notes on...preserving human erythrocytes and leucocytes... plans for establishing tumor and tissue banks for cancer research...new cryobiology equipment.

Some interesting new developments have been reported on the use of liquid nitrogen to preserve biological materials. In the storage of human erythrocytes, it was found that "the original hemagglutinizing activity of the cell was retained 100% after storage frozen in liquid nitrogen for two years". . . Blood samples frozen and stored in liquid nitrogen yielded excellent recoveries with little evidence of hemolysis.(1)

Another research team concluded from their data that . . ."major red cell antigens retain full reactivity when stored in a liquid nitrogen refrigerator for six months." They found that a panel of cells preserved in liquid nitrogen was as satisfactory as fresh cells in defining irregular antibodies encountered in patient sera. Compared to other techniques, erythrocytes frozen and stored in liquid nitrogen had the important advantage of being immediately available for use upon thawing.(2)

RESEARCH AT LINDE

Linde Company is actively investigating several key areas of cryobiology. Cooperative research is being conducted with Roswell Park Memorial Institute on preserving human chronic lymphocytic leukemic leucocytes in liquid nitrogen. Results of these studies indicate that the use of liquid nitrogen preserved leucocytes for routine clinical testing is feasible.(3)

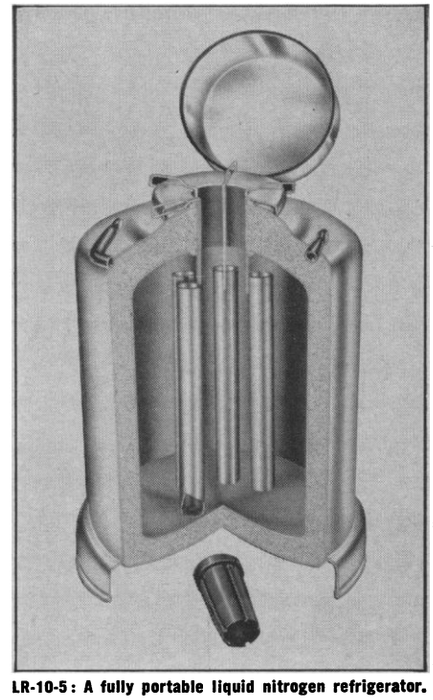
LINDE is also assisting Roswell Park Memorial Institute in setting up a tumor bank which will enable scientists to use original specimens at any time in the future. Such tumor and tissue banks will permit researchers to work on the original specimen now, or ten or more years hence.

In chromatographic or electrophoretic separation techniques, LINDE scientists have used liquid nitrogen to maintain stability of biologic materials sensitive to oxygen. In purifying the enzyme, nitrate reductase, they found that freezing the material soon after collection, followed by storing in a gaseous nitrogen atmosphere at temperatures below −100°C., protected its enzymic activity.(4)

NEW EQUIPMENT FROM LINDE

LINDE has developed the most complete assortment of quality cryogenic equipment. Among these are liquid nitrogen refrigerators, controlled rate freezers, special canister conversion kits for 25- and 10-liter liquefied gas containers, low-loss plastic-handled canisters, and an automatic liquid nitrogen level safeguard. Two recent additions in its line of cryogenic equipment are the LR-10-5 and LR-250 Liquid Nitrogen Refrigerators.

The LR-10-5 is a fully portable liquid nitrogen refrigerator designed for the shipment and storage of small quantities of biological materials safely and economically. When fully charged with 10 liters of liquid nitrogen, it weighs only 31 lb. The refrigerator holds 120 ampules of product in 5 easily accessible canisters at a constant temperature of −196°C. LINDE's patented Super Insulation keeps the liquid nitrogen consumption extremely low—0.55 liters per day (max.) with canisters inserted, producing a minimum holding time of 17 days without refill.



LR-10-5: A fully portable liquid nitrogen refrigerator.

The LR-250 holds 14,400 ampules and has a 250 liter liquid nitrogen capacity. It features a 28.5-in. diameter entrance which affords complete accessibility. Removable baffles divide a stationary storage tray into 90° quadrants. A safety grid designed to hold 2½-in. x 2½-in. boxes can be utilized for indexed storage of biological materials.

In addition, LINDE provides fast nationwide delivery of liquid nitrogen and top-flight technical service.

For further information on recent advances in cryobiology, fill out and return the coupon below.

(1) Gibbs, M. B., McCord, E. B., Collins, W. S. II, Schrider, C. T. Jr., and Akeroyd, J. H., TRANSFUSION, 2:100 (1962). (2) Bronson, W. R., and McGinnis, M. H., BLOOD, *20*:478 (1962). (3) Cohen, E., and Rowe, A. W., BLOOD, (in press) (4) Schreiner, H. R., *J. Chromatog.*, *7*:573 (1962).

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- ☐ *Reprint:* "Simple Methods of Storage of Human Erythrocytes in Liquid Nitrogen" by Mary B. Gibbs *et al.*(1)
- ☐ *Reprint:* "Chromatography of Unstable Materials of Biological Origin" by H. R. Schreiner(4)
- ☐ *Report:* "The Preservation of Biological Materials with Liquid Nitrogen," F-1270
- ☐ Cryobiology Report No. 2
- ☐ LINDE Liquid Nitrogen Refrigerators, F-1262

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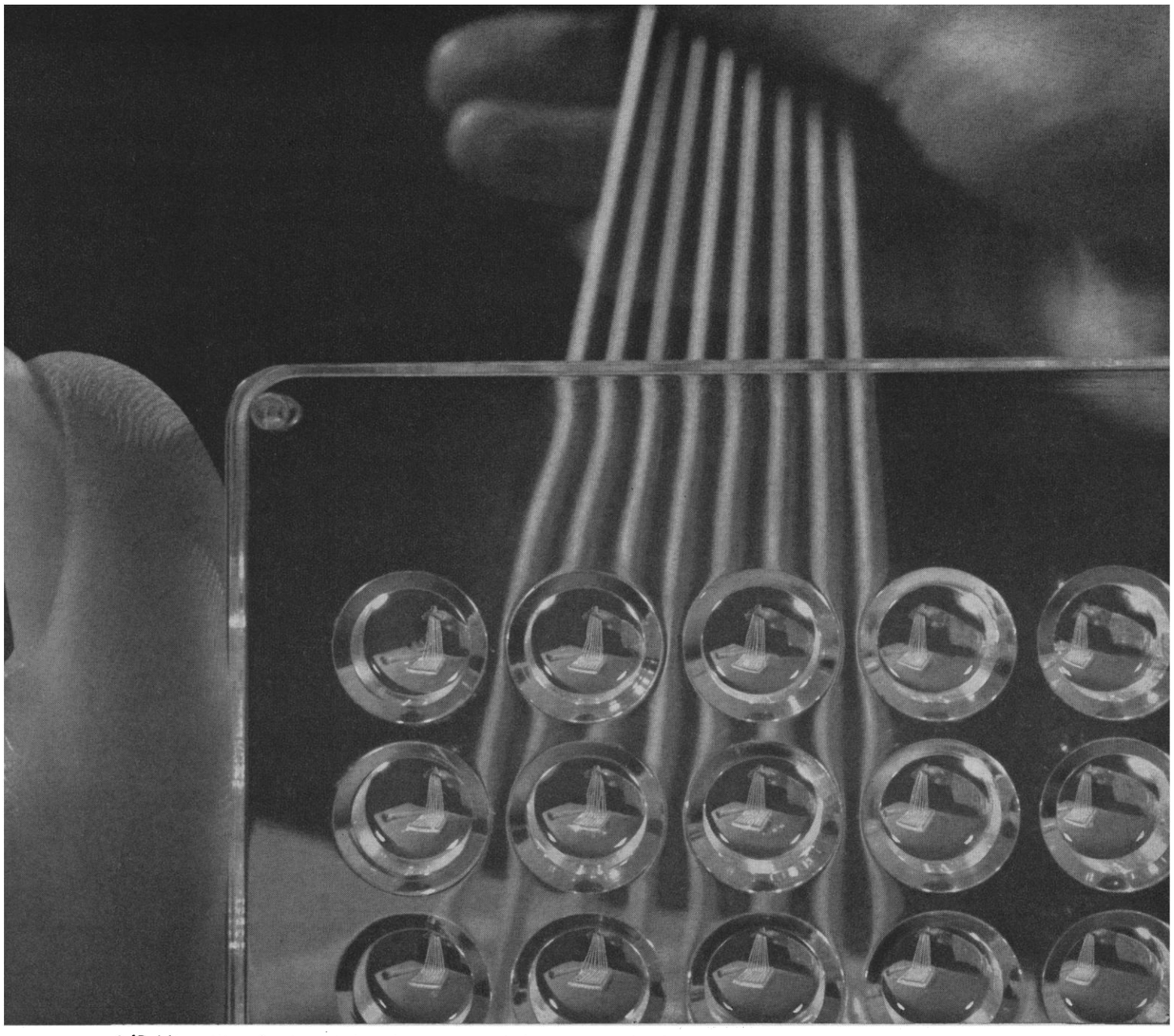

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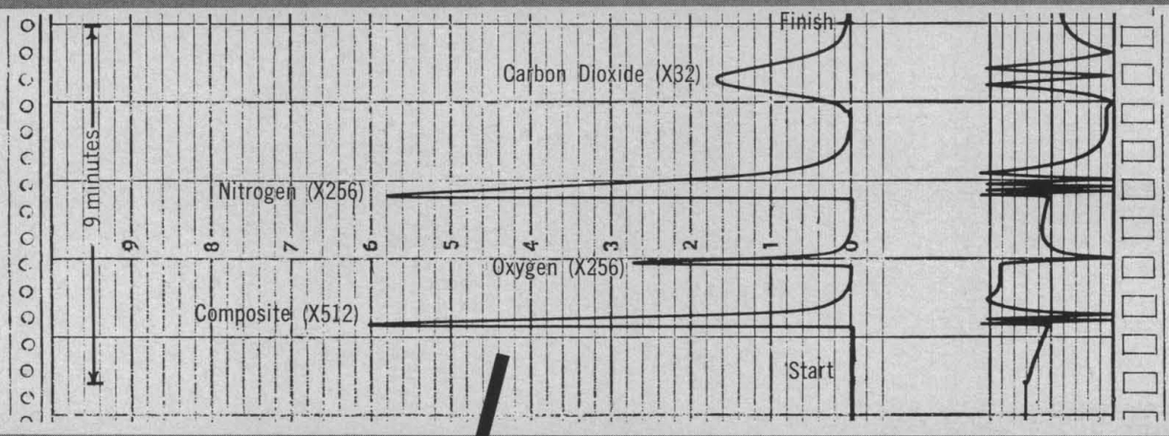

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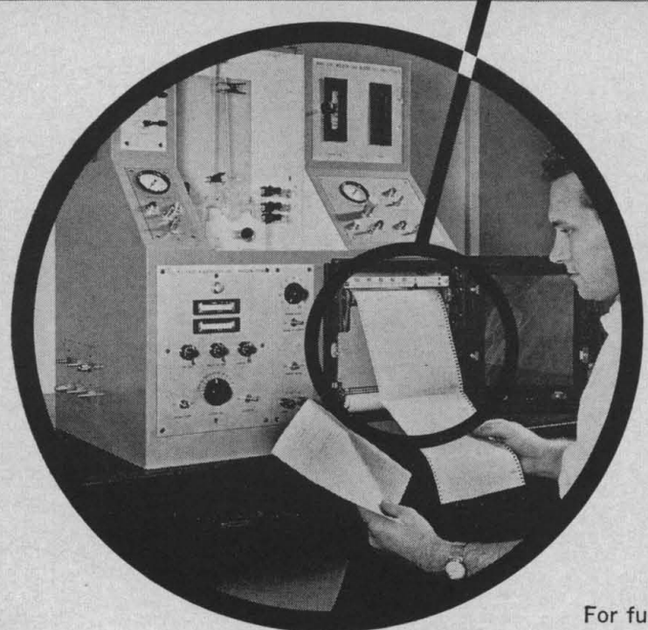

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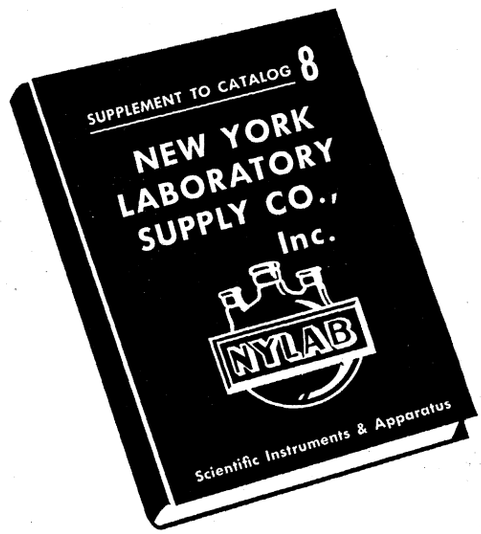

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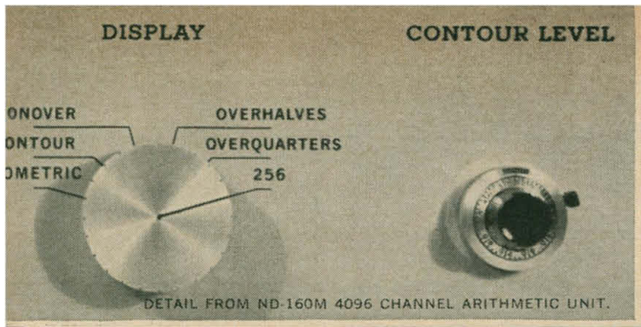

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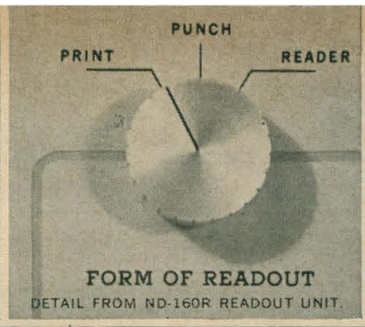
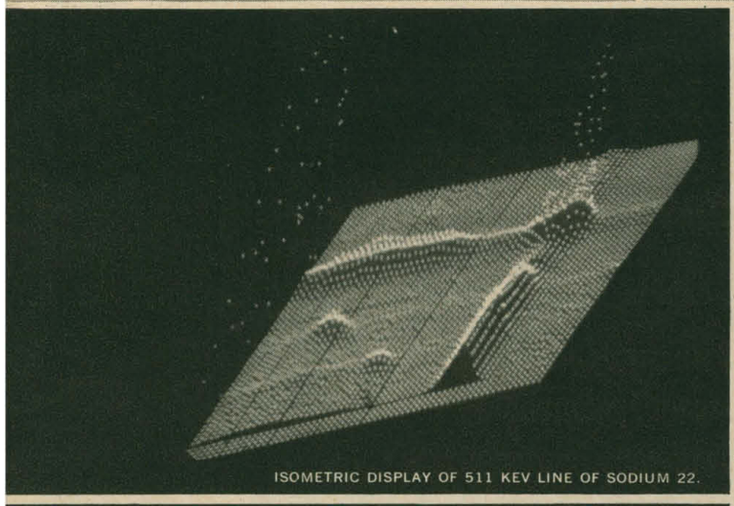
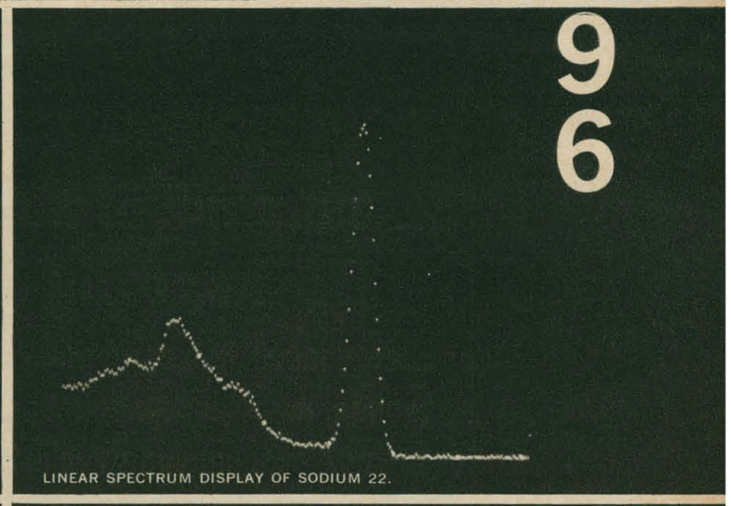
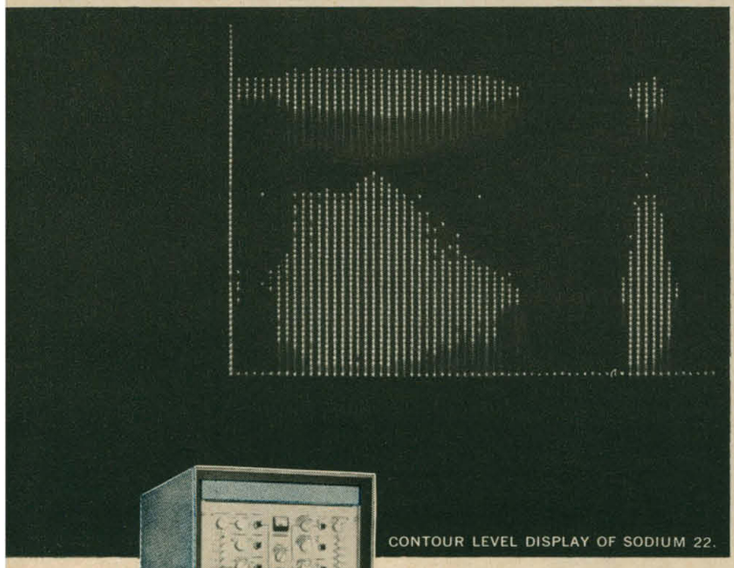


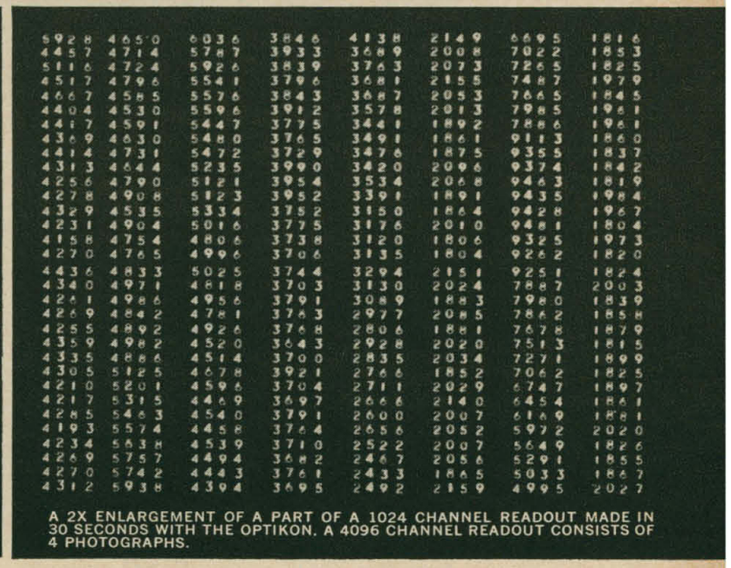
DETAIL FROM ND-160R READOUT UNIT.

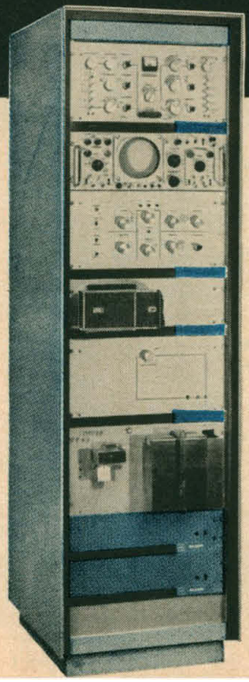
more data in more ways 4096


ISOMETRIC DISPLAY OF 511 KEV LINE OF SODIUM 22.


LINEAR SPECTRUM DISPLAY OF SODIUM 22.


CONTOUR LEVEL DISPLAY OF SODIUM 22.


A 2X ENLARGEMENT OF A PART OF A 1024 CHANNEL READOUT MADE IN 30 SECONDS WITH THE OPTIKON. A 4096 CHANNEL READOUT CONSISTS OF 4 PHOTOGRAPHS.



THE NUCLEAR DATA ND-160FM 4096 CHANNEL ANALYZER

A high capacity, high performance analyzer at a moderate price, the ND-160FM is the most versatile analyzer ever produced. Some of the many new features: improved Nuclear Data ADC's, individually buffered, for high resolution and multi-parameter measurements..... access to address and memory registers...parallel binary memory...quarter million count capacity per channel...conventional live display...multi-channel scaling...linear display with factor-of-two control...isometric display...calibrated contour level display...data transfer between memory halves...all important command signals available at rear deck connector...punched paper tape readout and read-in...fast decimal printout by OPTIKON at more than 20 channels per second.

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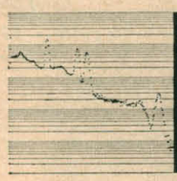
This system includes: ND-160F dual ADC's, ND-160M 4096 channel arithmetic unit, ND-160R readout control unit, ND-307 OPTIKON, ND-404 scope and ND-306 combination punch & reader. Domestic price, FOB Madison, $36,650.
(Cabinet not included)

Write or phone for further information. ALpine 7-4433



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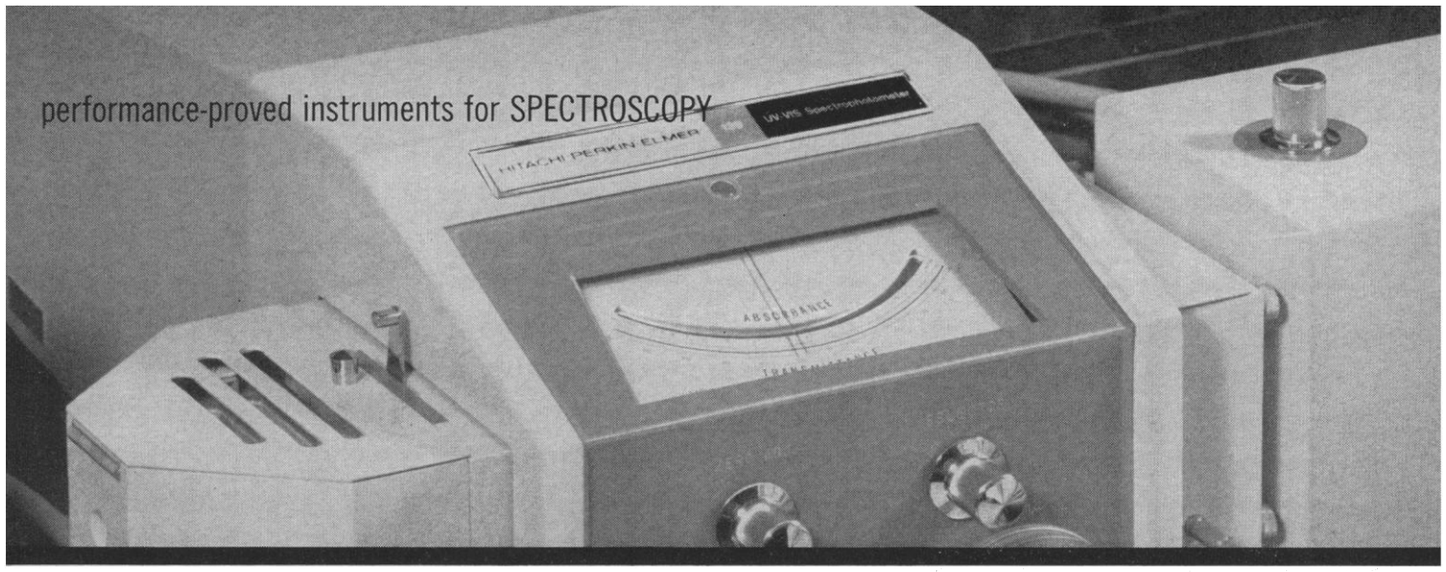

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NEW MODEL 139 ULTRAVIOLET-VISIBLE SPECTROPHOTOMETER —BY ANY STANDARD GIVES MORE PERFORMANCE AT LESS COST

At no extra cost [1] Full coverage of ultraviolet and visible ranges. [2] Transistorized line-operated power supply. [3] High dispersion difraction grating optics. [4] Direct reading in transmittance and absorbance. [5] Precision scale expansion. [6] Linear wavelength output. Normal operating range is 205 to 800 millimicrons for transmittance measurement.

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Pooling two decades of experience in spectroscopic equipment, Perkin-Elmer and Hitachi Limited have joined to create this modern spectrophotometer.

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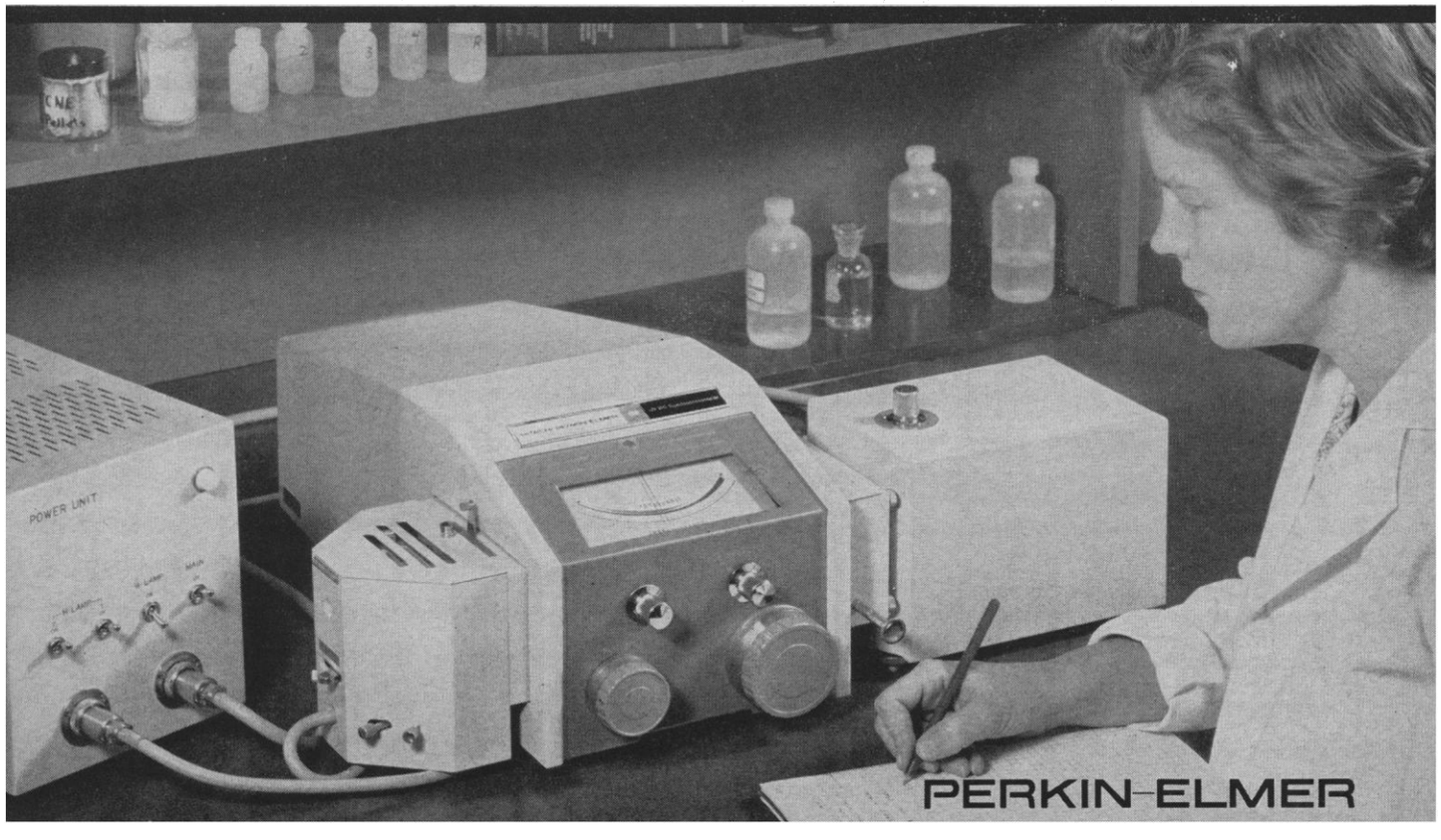
Please write for a complete brochure and price list on this new instrument to Instrument Division, Perkin-Elmer Corporation, **910** Main Avenue, Norwalk, Conn.



THE SAGE INSTRUMENTS TIME LAPSE CINEPHOTOMICROGRAPHIC APPARATUS TAKES SUPERB MOTION PICTURES LIKE THESE...

Sage Model 087 with Reichert Zetopan microscope. Other models are available for use with other microscopes.

Attempts of nematode to escape adhesive hyphal loops of the predacious fungus, **Arthrobotrys conoides.** Pictures taken at 430 x, at 8 frames/min. Sequence covers ½ min of an 8 hr continuous study recorded on 100 ft of 16 mm film by Dr. David Pramer and Dr. Nergish Ghadialy, Dept. of Agricultural Microbiology, Rutgers University.

(Time lapse motion pictures taken through the microscope reveal data never apparent in a series of stills. For example, the incessant cytoplasmic activity within cells of the fungus and nematode cannot be seen in the pictures shown here—until you project them at normal speed. Let us know if you would like to see the entire film.)

...TIME LAPSE PICTURES THROUGH THE MICROSCOPE THAT ARE SHARP, CLEAR, IN PERFECT REGISTER

Designed to take time lapse motion pictures of exceptional quality at high magnification, the Sage Time Lapse Apparatus is an integrated instrument system built into a steel desk. Major components include camera, drive, and observation eyepiece; a specially designed light source; an anti-vibration mount of unique design; and convenient operating controls. Incubator, 400 ft capacity film magazine, and other optional accessories give the instrument great versatility for studying materials which change with time.

Camera, Drive, and Observation Eyepiece. The 16mm camera is provided with 8 framing rates, from 1 frame in 4 min to 32 frames/min. The eyepiece permits observation of the field being photographed.

Dual Light Source. The light source combines a tungsten filament light for viewing, optically aligned with a variable intensity xenon flash lamp for photography. The xenon lamp has a flash duration of about 10^{-4} sec, and minimizes the exposures of sensitive subject matter to unwanted heat or light.

Anti-vibration Mount. The picture-taking assembly is isolated from all sources of vibration, including structure-born vibration, to insure perfect frame to frame register of pictures.

Incubator (optional). The plexiglas incubator has a thermostatically controlled heat source and filtered circulating air system, maintains temperature at any desired value from ambient to 40° C. The incubator has hand ports for focusing, and slides aside for complete access to the microscope.

Controls. Operating controls are conveniently located in the middle desk drawer. The power supply for the flash unit is in the locked upper drawer, and the bottom drawer is for storage

The Sage Time Lapse Apparatus is available in various models to go with the microscope of your choice. Sage makes the installation in your laboratory. For full details, write us for complete catalog information.

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for use in chemical analysis

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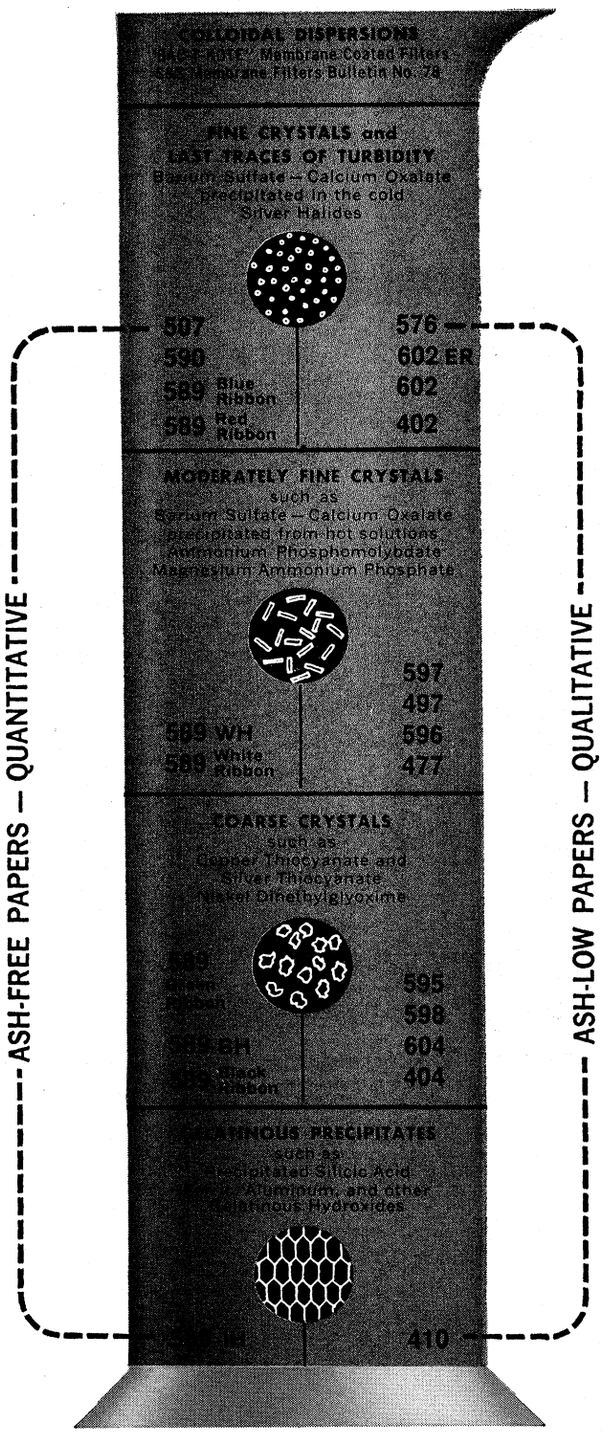
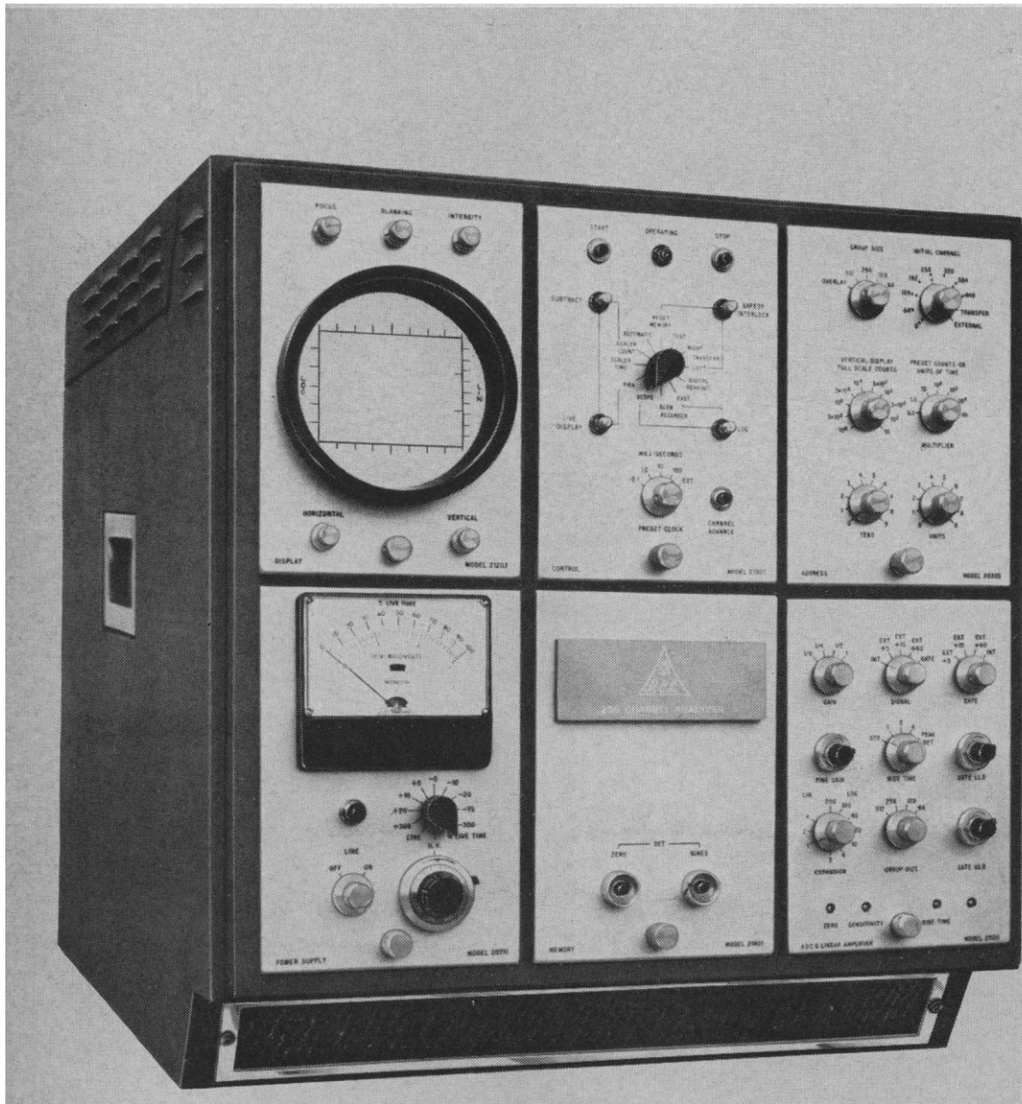
The wide range of this novel retention scale, and the diversity of S & S filter papers, are represented graphically on the sedimentation cylinder. The graphic representation is illustrative of the general range of retention of S&S Analytical Filter Papers. For additional copies of the S&S Filtration Chart, address Dept. JCE-212.



Carl Schleicher & Schuell Co., Keene, New Hampshire

NEW RCL MULTICHANNEL ANALYZER . . .

OUTSTANDING ACCURACY, STABILITY, FLEXIBILITY



ACCURACY

Better than ± 1% differential linearity over the entire analyzed spectrum. Better than ± 0.5% of full scale integral (independent) linearity over the entire analyzer range.

STABILITY

Less than 0.4% of full scale baseline shift (up to 60,000 counts per second). Less than 0.2% of full scale gain shift for ± 10% line voltage change. Amplifier recovers to within 1% of full scale within 25μs after a 500 times overload.

FLEXIBILITY

Accepts a wide variety of input waveshapes, ranging from 0.3 μs to 50μs rise time, with exponential decay from 25 to more than 100 μs.

Input Amplitudes: Input voltage (full scale) 10 millivolts; external amplifier input 5 to 60 volts (full scale).

Log Energy Conversion: A pulse is stored in channel N, where N equals ln energy.

Memory Sub-Groups: Nondestructive transfer of data from one half of the memory to the other. Subgroups of 64, 128, or 256 channels, with 1 x 10^6 counts per channel capacity.

Linear/Log Live Display: Dynamic display of data being accumulated on self-contained oscilloscope. Either linear or logarithmic (number of counts) can be displayed or recorded.

Preset Controls: Any two most significant digits (counts or time) from 1 to 990,000 can be preset.

Precise H. V. Supply: 300 to 3000 volts at 3ma supplied by analyzer. Positive or negative output can be selected.

Complete specifications covering 256/512 Channel Analyzer-Scaler, or any of our complete line of detection and analysis instruments supplied on request. Write:

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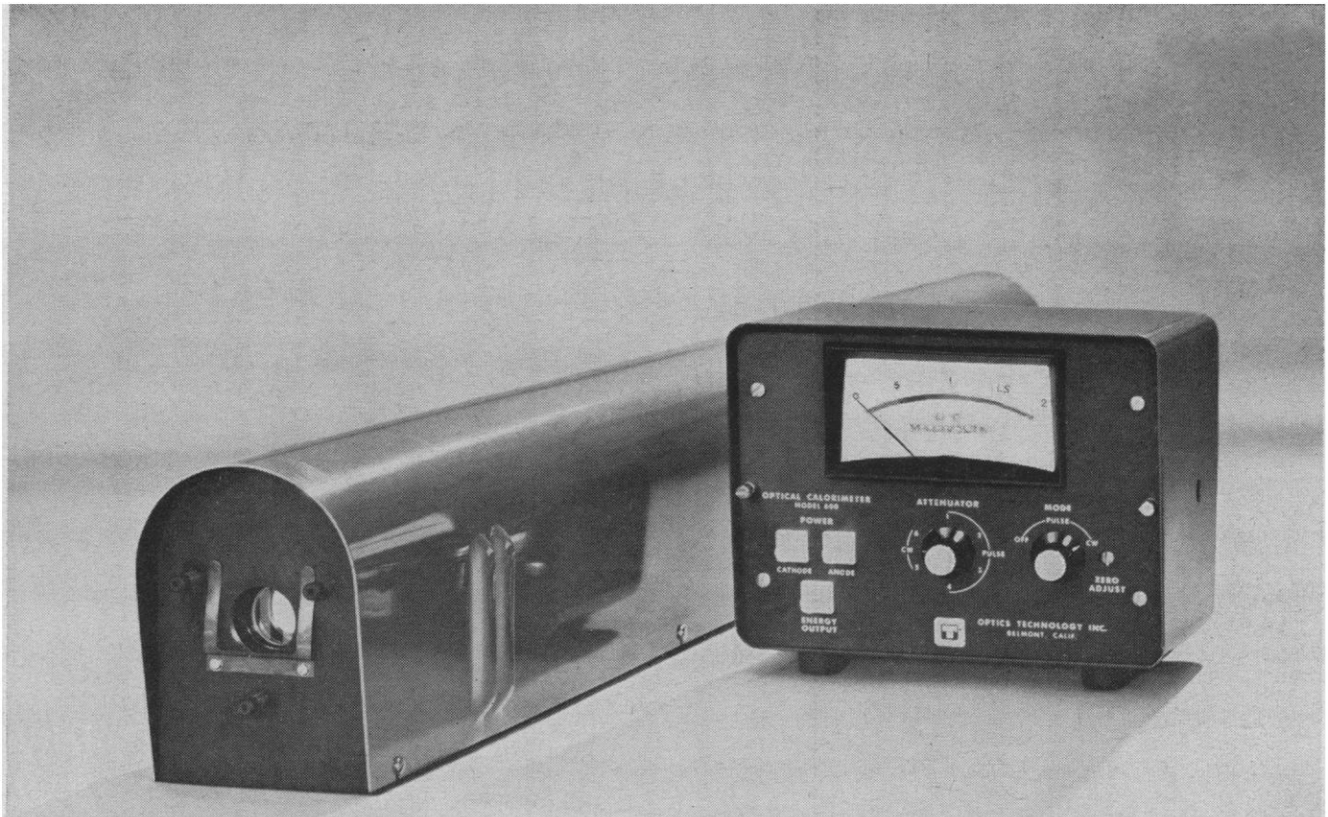

VISIBLE & INFRARED CW LASER

Model 150 is complete with precision multi-layer mirrors in differential thread interferometer assembly and power supply. Gas tube produces continuous coherent output at 6,328 Å and 11,530 Å. Mirrors are available for either wavelength, or for both at once.

Also available:

***Model 120 Pulsed Laboratory LASER**, with power supply, ruby and other LASER crystals, cryogenic cooling and self-contained interferometer accessories.*

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Model 600 calorimeter measures optical energy, power and peak power. It may be used with either pulsed or CW sources. Range: 312 joules (watts CW) to .037 joules (watts CW). From 20,000 Å to 4,000 Å. Absolute accuracy ±10%. New design eliminates error-producing wedge cavities and simplifies alignment. It incorporates highly sensitive calorimeter cell, phototube, amplifier, meter, and broad band attenuators.

Our high-efficiency multi-layer LASER mirrors can be deposited on your own substrates. Contact us for full details.

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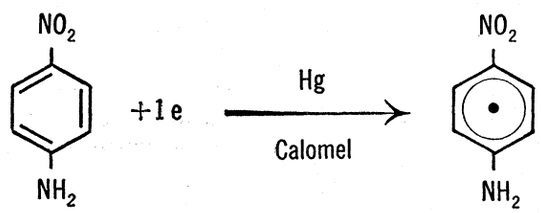
NUMBER 3 IN A SERIES

Chemists seeking to detect the presence of free radicals in chemical systems will find EPR Spectrometry the most sensitive and rapid technique available. The ability of Varian EPR Spectrometers to detect as low as 2 x 10^{11} free radicals (10^{-9} molar concentrations), and to respond in times less than 100 microseconds, has rendered all other techniques obsolete.

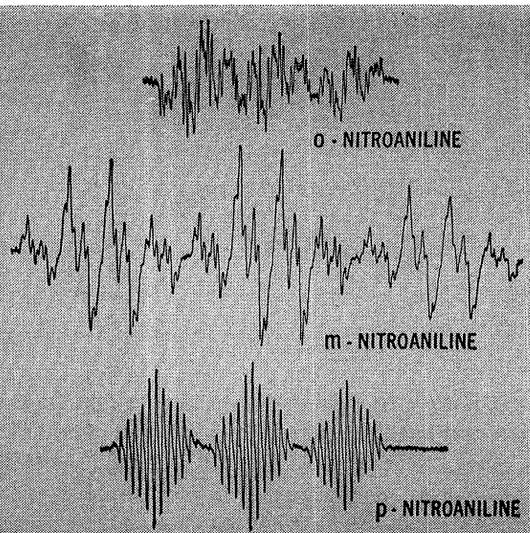
This ability to detect, and in many cases to identify free radicals is inherent in the basic phenomenon of Electron Paramagnetic Resonance, since EPR Spectrometers respond **only** to chemical systems containing unpaired electrons.

EPR IN THE WORLD OF CHEMISTRY

UNIVALENT OXIDATION-REDUCTION BY ELECTROLYSIS



Cyclic voltammetry can be an effective tool for studying univalent oxidation-reduction reactions of organic molecules, provided one observes a split wave in the typical current-potential curve. Very often these split waves are not resolved and an uncertainty arises as to whether one or multiple electron steps are occurring. EPR has eliminated the necessity of observing split waves in such measurements by direct detection of the one-electron intermediate (free radical ion) resulting from a univalent oxidation-reduction.



In situ generation and detection of univalent intermediates in an EPR cavity allow not only positive detection of intermediates in a complex organic electrode reaction, but also permit direct study of the nature of the intermediate.

Fig. 1 illustrates typical one-electron intermediates as detected by EPR in the **in situ** electrolytic reduction of ortho, meta and para nitroaniline in 0.1M KCl solutions.

Attention is called to the radically different EPR spectra obtained for these three intermediates whose molecular structures differ only by the position of substitution of the amino group. It is this difference in the number of lines and spacings of lines (hyperfine pattern) that allows positive identification of these intermediates. How to identify free radicals by means of their "EPR hyperfine pattern" will be discussed in a later number of this series.

Detection and identification of free radicals are not the only results obtainable from the EPR spectrum, however. It is also possible to measure the rate of free radical formation for studies of complete reaction kinetics.

Varian EPR Spectrometer systems and accessories are designed for a wide range of applications in the fields of chemistry, biology, medicine and physics. For additional information about the example above and other chemical applications of EPR, please write: INSTRUMENT DIVISION.

VARIAN associates

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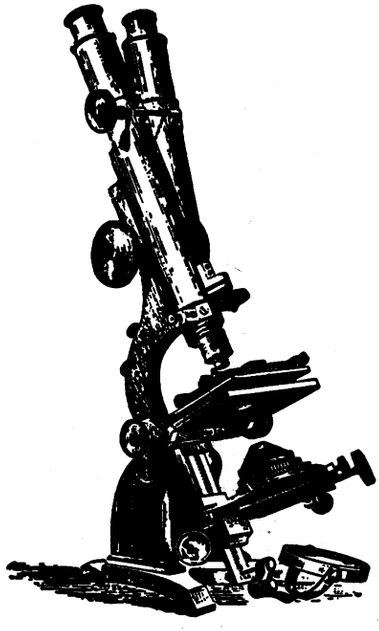


Pillischer's XIX Century Binocular Microscope

Elgeet Stereo Zoom Microscope

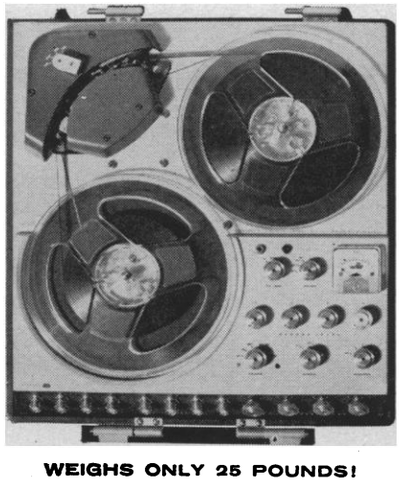
IMAGINE IF...

PILLISCHER, who in the XIX Century was experimenting with binocular optical systems, had been able to provide both **zoom** and **stereo** to the practitioners of his time... imagine if Pillischer instead offered this ELGEET-OLYMPUS STEREO ZOOM MICROSCOPE...how far ahead would the world be today in the sciences and in industry. This Elgeet model features an exclusive prism-design that insures a sharp erect and unreversed image all across the field and all the way through the zoom magnification range from .75X through 3X. Combined with widefield paired 10X eyepieces, a comfortable 45° inclined binocular body, wide field of vision and excellent depth of field, this instrument is ideal for inspection, identification, dissection, biology and other industrial, educational or laboratory uses where a three-dimensional image and zoom magnifications are required at the fingertip. Priced from $332—also universal stand now available. Send for literature. **ELGEET**

EL-85

ELGETT OPTICAL CO. SCIENTIFIC INSTRUMENT DIV., 303 Child Street, Rochester 11, N.Y.

WORLD'S FIRST TRULY PORTABLE, SELF-POWERED DATA RECORDER—FROM LOCKHEED



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It can record 4 tracks, FM or direct, at 3 switchable speeds on standard 7-inch reels. Ideal for recording all kinds of precision data: shock, vibration, temperature, pressure, voltage, torque, acceleration, flow, acoustics and shaft rotation, etc.

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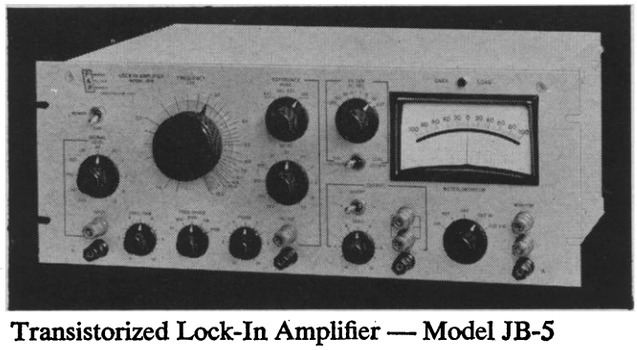
a note to the experimentalist who has signal/noise problems:

It is safe to say that the majority of current research in the physical sciences involves the measurement of small-effect phenomena where noise sets the limit to attainable precision or detectibility. When discussing noise, we include most of the extraneous effects that arise during the course of an experiment that mask the effect under investigation. We also include noise having as its origin either the fundamental thermal fluctuation of all matter not at absolute zero or the quantized nature of radiation. One does not have to be engaged in highly sophisticated research problems such as detecting the Doppler shift of 21 centimeter galactic radiation to have need for modern signal processing techniques. In fact, many less exacting experiments, be they in physics, chemistry, astronomy or even biology, would be rendered more tractable by the application of relatively simple concepts that allow the realization of signal-to-noise ratios near the theoretical optimum.

LOCK-IN TECHNIQUE SOLVES THE PROBLEM

A particularly simple, yet elegant, way of achieving this goal has been pointed out by R. H. Dicke* who applied it to his sensitive microwave radiometer. This technique involves modulation *at the source* of the quantity being measured. The unknown signal may be a voltage, current, mechanical displacement, radiation, or any physical quantity that can be transformed into electrical energy. The signal to be detected is switched on and off at a fixed frequency, f_0, a frequency not too high for the transducer to follow, and not so low as to invite flicker-effect noise. The resulting small AC electrical signal, together with the multi-sourced noise that has entered the picture are now brought up to a high level in a selective amplifier tuned to f_0. A tuned amplifier is used to avoid dynamic range problems (overloading on noise) and to reject harmonics of f_0, when important. The amplified signal plus noise and a large "reference voltage" at f_0 are then fed into a mixer. This mixing process is called "coherent detection" and shifts the information in a given bandwidth at f_0 to an equal bandwidth about DC. The signal at DC is filtered by a simple resistor-capacitor low-pass network and displayed on a D'Arsonval meter or strip-chart recorder. It is easily shown that the equivalent bandwidth of the overall system is the cut-off frequency of this RC low-pass filter, which can be made as narrow as desired.

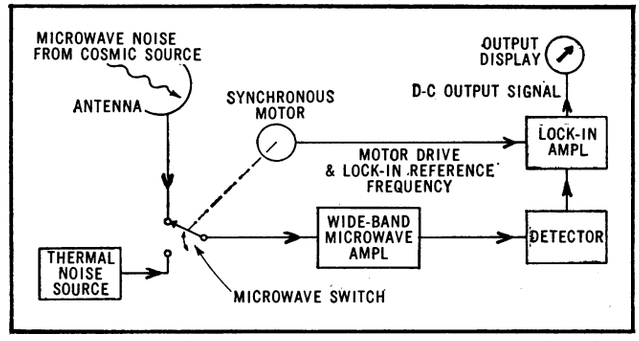


Transistorized Lock-In Amplifier — Model JB-5

**R. H. Dicke, Rev. Sci. Inst. 17, p 268, 1947*

NO FREQUENCY DRIFT PROBLEMS

Inasmuch as the signal frequency is always "locked-in" to the detector, there are no frequency drift problems, regardless of the bandwidth used. The signal/noise ratio can thus be made arbitrarily large at the expense only of observation time. A sample experimental set-up is shown in block-diagram form below.



Lock-in amplifier used in radio telescope. Receiver noise, although much larger than noise signal from antenna, is not modulated and hence contributes little to DC output of lock-in amplifier. With this arrangement, it is possible to detect cosmic noise signals 40 db below the input noise level of the wideband microwave receiver.

Princeton Applied Research can provide the experimenter with a lock-in detection system for implementing this technique, the use of which will allow signals deeply buried in noise to be retrieved and measured with good accuracy. This equipment is contained in a single 7" relay rack chassis and has the following specifications:

TECHNICAL FEATURES

Transistorized Lock-In Amplifier — Model JB-5

Frequency Range: 1.5 cps to 150 kc continuously tunable in five ranges.

Time Constants: 0, 0.001, 0.01, 0.1, 1, 3, 10, EXT. Single or double section RC filtering.

Gain: (rms AC in to push-pull DC out) — Greater than 9,000.

Linearity: Better than ±1% of full scale.

Zero Drift: ±½% of full scale per hour, maximum.

Outputs: (a) ±5 volts DC maximum, balanced to ground into high impedance load. (b) ±1 ma or ±½ ma switch selectable into pen recorder of less than 2K internal resistance.

Frequency Selective Amplifiers: Selectivity characteristic of tuned amplifiers in signal and reference channels is that of parallel resonant circuit with a Q of approximately 25 (*NOT TWIN-T TYPE*).

Operating Modes: External, Selective External or Internal. Lock-in accepts sinusoidal or non-sinusoidal reference signal or provides sinusoidal 5V p to p reference from internal oscillator.

Price: $1350.00

To aquaint those interested we are offering our Bulletin 109 which describes how the PAR lock-in system may be used to advantage in experiments in many fields.

Write for Bulletin 109 to:

PRINCETON APPLIED RESEARCH CORP., Box 565 / Princeton, N. J. / Tel. 799-1222, Code 609

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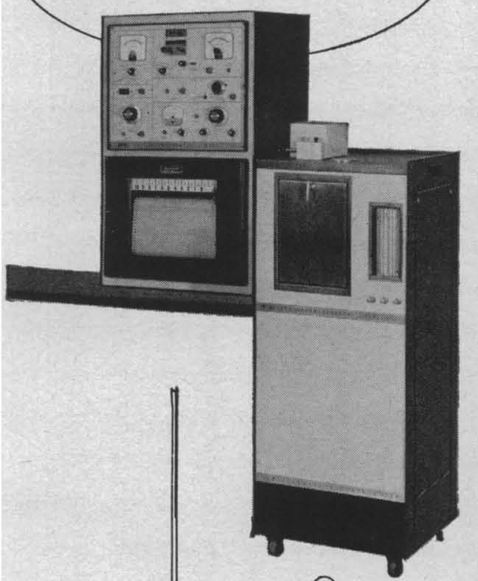
Let us send you complete information. Just mention your application and we'll send you the facts — and samples, too, if you want them — in a hurry. Write:

THE EATON-DIKEMAN COMPANY
Filtertown, Mount Holly Springs, Penna.

New from F & M

MODEL 400 BIOMEDICAL GAS CHROMATOGRAPH



designed for the biochemical and biomedical researcher

The new F & M Model 400 Gas Chromatograph was designed explicitly to meet the strict performance requirements of biochemical and biomedical investigators. The Model 400 gives optimum performance in the analysis of such compounds as vitamins, steroids, alkaloids, bile acids, fatty acids, amino acids, and other similar materials of high molecular weight and low thermal stability.

Detectors: The instrument includes both the flame ionization and electron capture detectors. Either detection system is also available singly; or the micro cross section detector is available as an additional option. This variety of detection systems provides maximum sensitivity and a wide range of linearity for accurate quantitative studies.

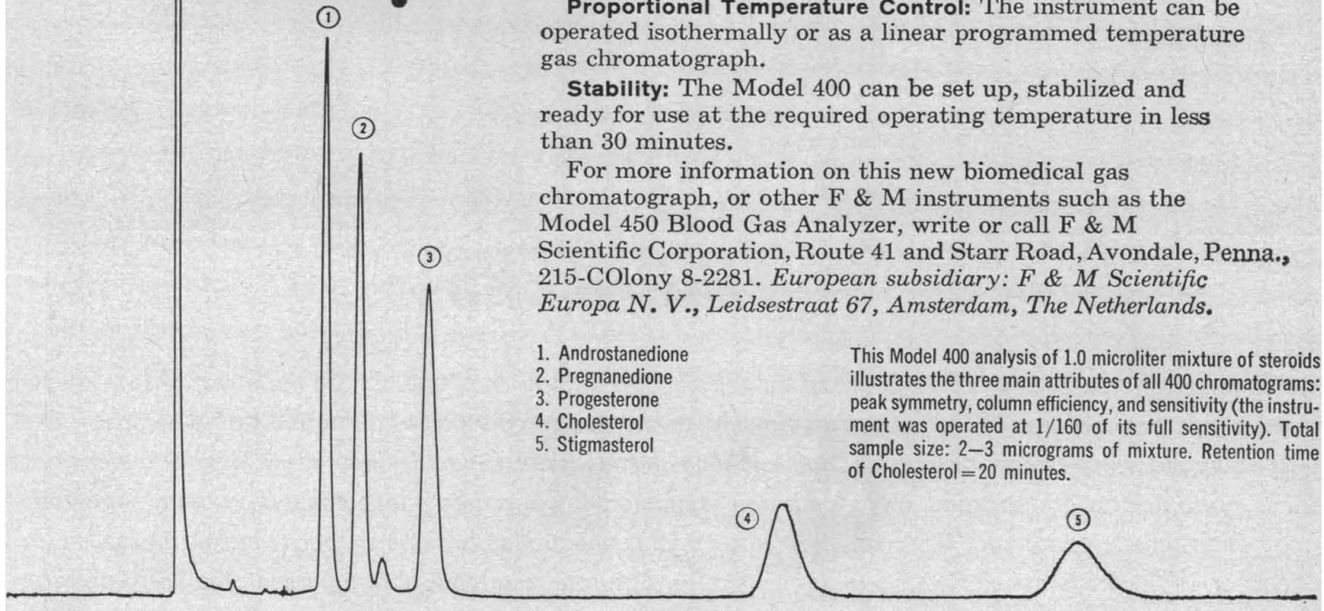
Injection: Direct injection onto the column in the Model 400 minimizes thermal decomposition and isomerization of the sample components. Absorption effects and injection port diffusion are also minimized, increasing sensitivity and providing sharp, symmetrical GC peaks.

Columns: The Model 400 column oven will accept metal or glass columns in U bend or coiled configuration.

Proportional Temperature Control: The instrument can be operated isothermally or as a linear programmed temperature gas chromatograph.

Stability: The Model 400 can be set up, stabilized and ready for use at the required operating temperature in less than 30 minutes.

For more information on this new biomedical gas chromatograph, or other F & M instruments such as the Model 450 Blood Gas Analyzer, write or call F & M Scientific Corporation, Route 41 and Starr Road, Avondale, Penna., 215-COlony 8-2281. *European subsidiary: F & M Scientific Europa N. V., Leidsestraat 67, Amsterdam, The Netherlands.*



1. Androstanedione
2. Pregnanedione
3. Progesterone
4. Cholesterol
5. Stigmasterol

This Model 400 analysis of 1.0 microliter mixture of steroids illustrates the three main attributes of all 400 chromatograms: peak symmetry, column efficiency, and sensitivity (the instrument was operated at 1/160 of its full sensitivity). Total sample size: 2—3 micrograms of mixture. Retention time of Cholesterol = 20 minutes.

F&M

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NO KNIFE EDGES IN NEW

OPTICAL PROJECTION TORSION BALANCE

By eliminating knife edges with Torsion's practically one-piece construction, Model PL-2 is designed to operate even in severely corrosive or dust-laden atmospheres where maintenance costs for ordinary "knife-edge" balances would be prohibitive. ● The long lasting accuracy of this Torsion construction, with Dynavar bands, has been proved by a testing device that made continuous weighings 24 hours a day for six months. Over 1,750,000 operations later the Torsion mechanism still had its original sensitivity and accuracy.

Model PL-2
Capacity 2000 g. • Accuracy ± 0.15 g.
List Price $425

ADDITIONAL FEATURES

True Weight even when out of level

Zero point does not shift even when balance has been moved to a position that is out-of-level.

Weight Loading

Weight loading knobs are conveniently located on both sides of the balance for easy operation by either right or left hand. Weighing by substitution to 1000 grams is used in this New Torsion Laboratory Balance.

Unlimited Tare Range

Taring through a 125 gram range is accomplished with a built-in knob on the side of the balance. By adding weights to the second pan the balance can be made to tare throughout its 2 kilogram capacity.

In addition to these features, Torsion's Model PL-2 offers a sharp image with a high degree of illumination for easy reading and an oil damper to speed up weighing.

Ask your laboratory supply salesman for a demonstration or write us for Bulletin PL-2 which gives complete specifications.

The
Torsion Balance
Company

Main Office and Factory: Clifton, New Jersey
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Attention R&D Laboratories–
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Krypton 85
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Manufactured Gas, Type B
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Methane
Methyl Acetylene
Methyl Bromide
3-Methylbutene-1
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Mixtures, Custom
Monoethylamine
Monomethylamine
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Nitrogen Dioxide
Nitrogen Trioxide
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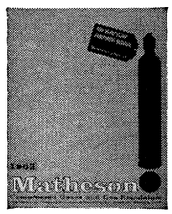

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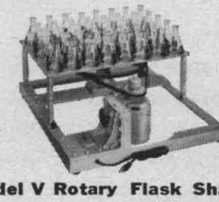
Variable speed range: 140-400 rpm or 50-150 rpm. Uniform 1″ stroke. Holds 40/250-ml flasks*. Larger platform holds 70/250-ml flasks*.

Model G25 Gyrotory Incubator-Shaker
Variable speed range: 140-400 rpm or 50-150 rpm. Uniform 1″ stroke. Thermostatic temperature control to 60° C ± 0.5° C. Optional connections for gassing. Larger refrigerated models also available. Holds 40/250-ml flasks*.

Model R82 Reciprocating Tier Shaker
Speed range: 35-200 strokes per min. Continuously adjustable stroke from 0-4″. Holds 192/250-ml flasks on 6 removable trays*.



Model V Rotary Flask Shaker
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*** Accommodates a variety of flask sizes. 250-ml size used for comparing shaker capacities.**

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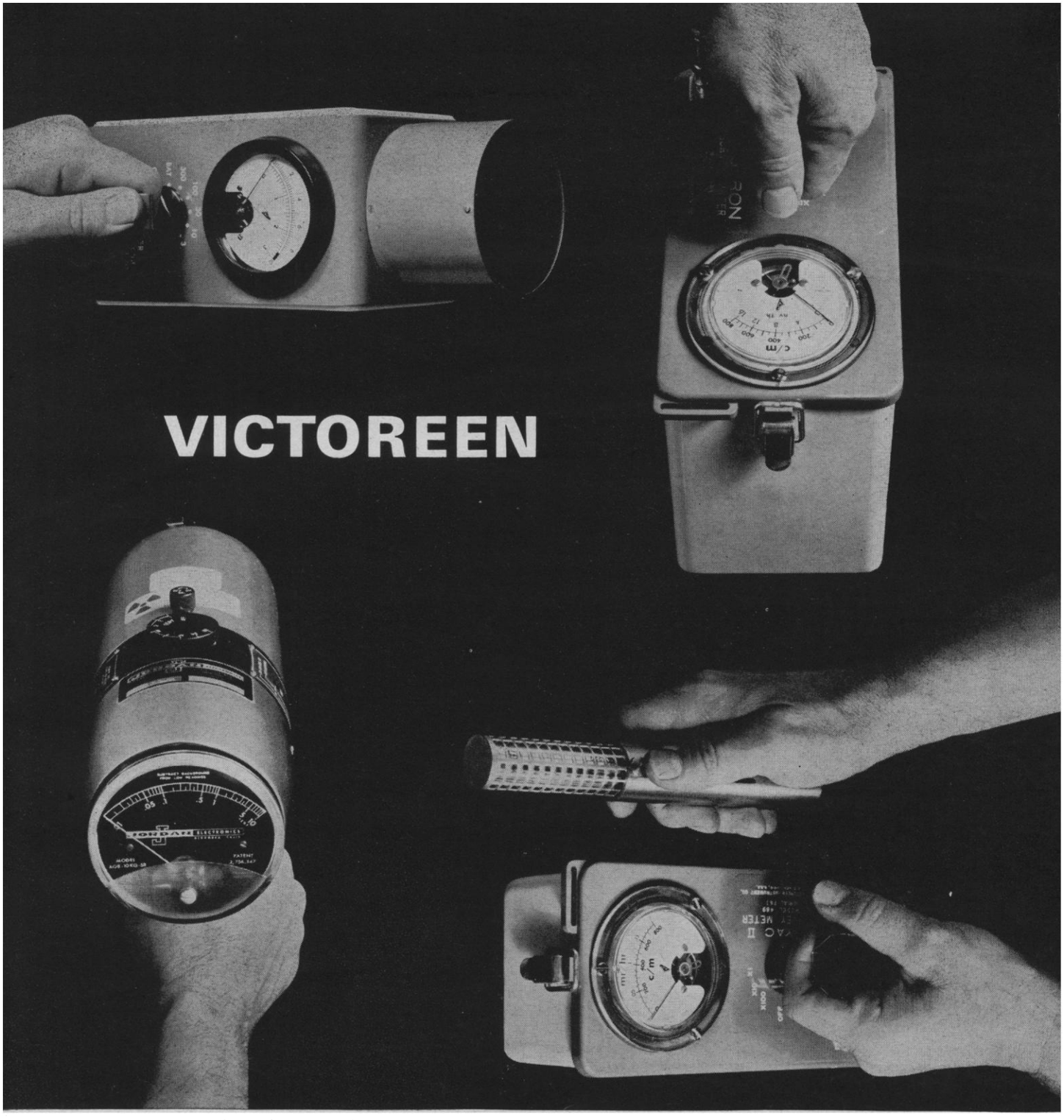

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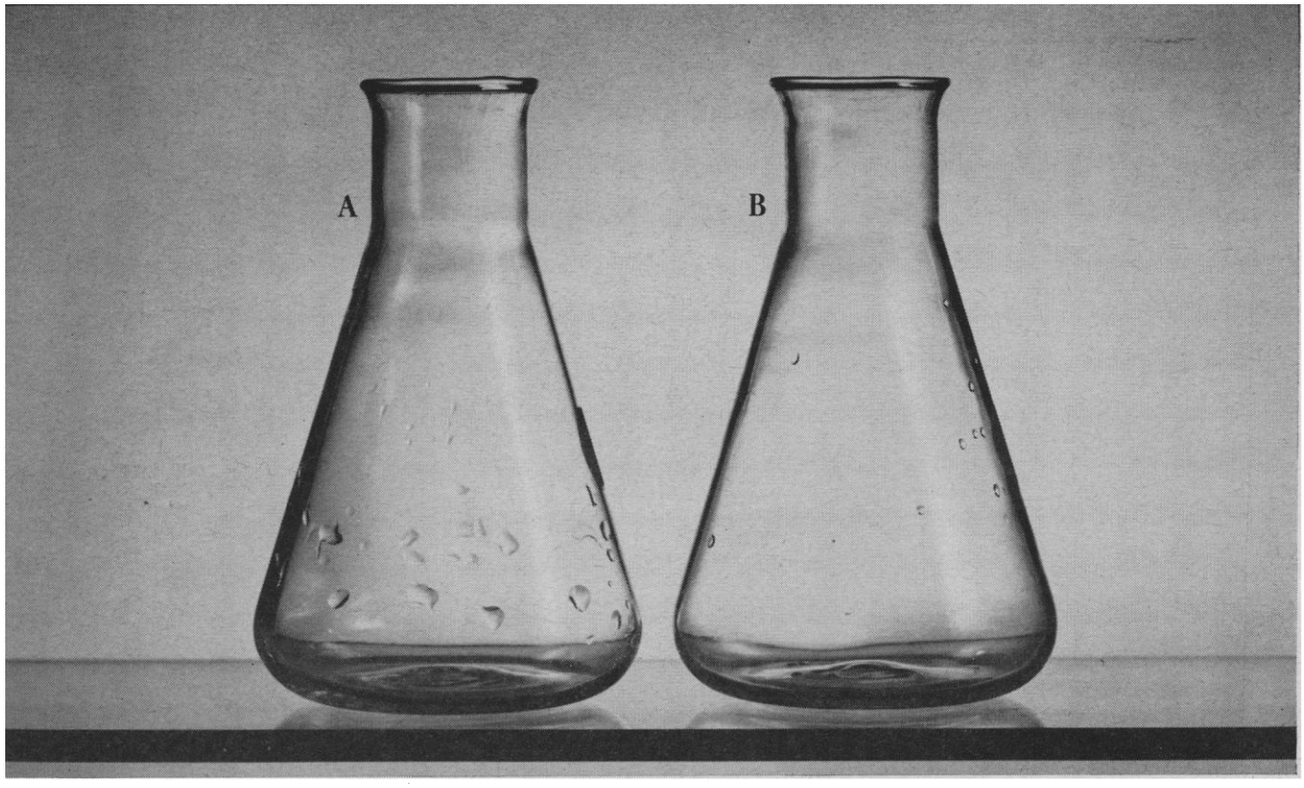
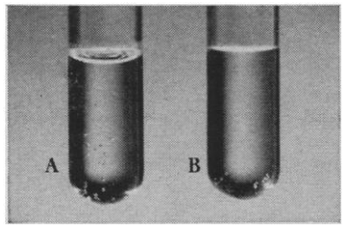


Why is it easier to work with flask B?

Because it's coated with Siliclad, the soluble silicone that sheds liquids, makes cleaning easier and faster, and prevents sticking of rubber or glass stoppers. *And* Siliclad significantly reduces glassware breakage. Glassware coated with Siliclad resists surface scratches, the major cause of breakage.

Easier in the laboratory

Siliclad-treated surfaces repel water, blood, mucus, and most organic materials. With the use of Siliclad blood clotting is reduced, more clear serum is obtained, and less hemolysis is found. More accurate determinations are possible because treated cylinders and pipettes deliver full content, do not retain droplets.* Siliclad can also be used to lubricate glass stoppers to prevent fusing, to coat glass apparatus to prevent meniscus formation in fluids, to prevent freezing of glass plungers in hypodermic syringes, and to prevent violent chemical foaming reactions.[1]



Just where is the surface of the liquid in tube A? With ordinary meniscus surface you can't be sure. In Siliclad-treated tube B liquid forms flat surface, allows more accurate determination.

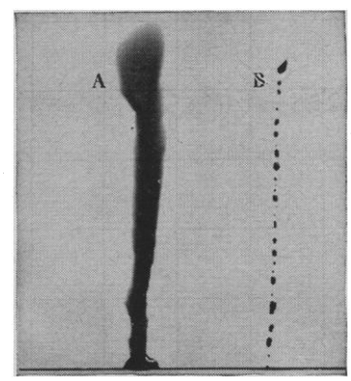
Easier in the hospital

In the hospital, Siliclad can be used to treat tubing and catheters... needles for I.V. applications... I.V. sets... replacement-transfusion sets ...blood reconditioning apparatus... artificial kidneys. In chest drainage tubes, silicone-treated tubes maintain patency and make drainage failure a rarity... add to the ease and safety of postoperative care.[2] Patients have found Siliclad-treated tubing far more comfortable than untreated tubing... less irritating to mucosa.[3] Hospital equipment treated with Siliclad is much easier to clean after use.[3] Siliclad added to sterilizing solutions prevents dulling of sharp instruments and wear and tear of movable parts.[1]

Siliclad-treated surfaces resist heat, moisture, and most common chemicals. Use it for treating ceramic, metal, and plastic surfaces and also for glass and rubber. Siliclad coating resists extreme temperature changes and oxidation. It is nontoxic to body tissues.

Siliclad, when diluted with ordinary tap water, makes 25 pints of solution.

**Note:* Siliclad should not be used for glass items which depend on capillary action or adhesion to perform properly.



ACTUAL PHOTOGRAPH

Equal amounts of blood dropped simultaneously on glass plate at 90° angle.
A. Blood on untreated surface clings to glass, spreads slowly down glass, pools at bottom edge.
B. Blood on Siliclad-treated surface runs down glass plate immediately. Does not cling, stick, or pool at bottom edge of plate. Gentle tapping of glass plate removes few "beads" remaining.

References: (1) Levin, H. L.: Milit. Med. *121*:397 (Dec.) 1957. (2) Harkins, G. A.: J. Thoracic & Cardiovas. Surg. *40*:549 (Oct.) 1960. (3) Cantor, M. O.: Am. J. Surg. *100*:584 (Oct.) 1960.

Price: Siliclad Concentrate, 4-oz. bottle, each $4.00; 1 doz. 4-oz. bottles, $40.00.

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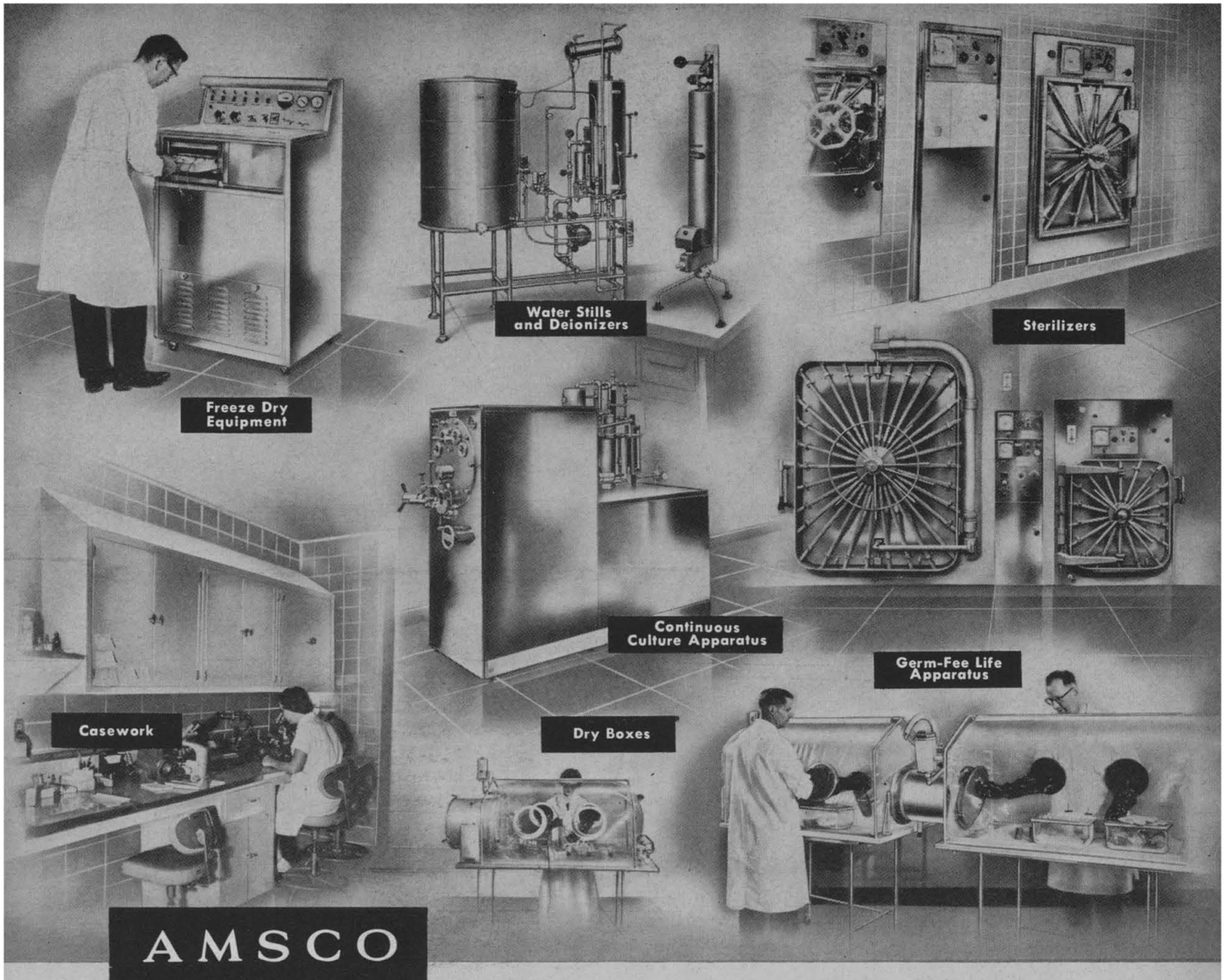

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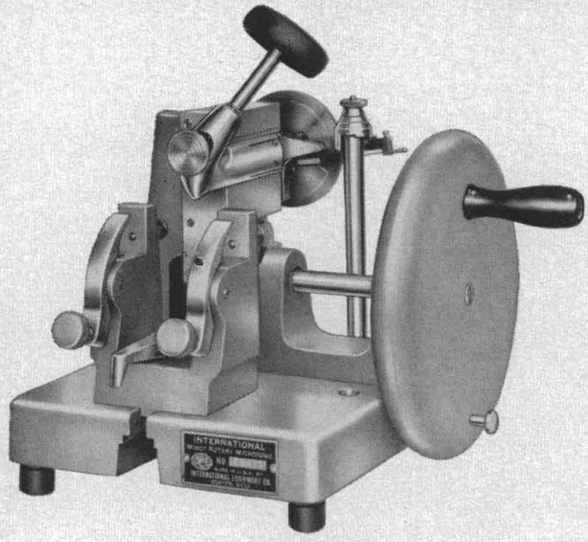

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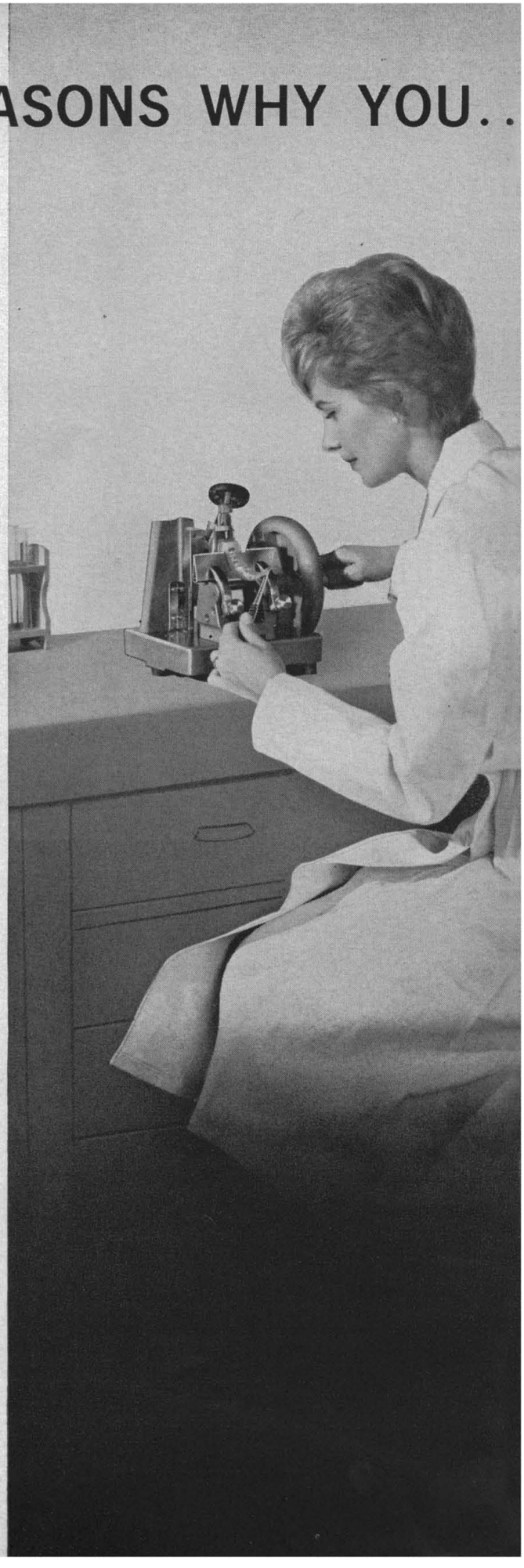

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Now frozen sectioning becomes even more refined with IEC's new CTD. This instrument is an improved model of the famous International-Harris CT that revolutionized frozen sectioning. The CTD features a new **polar zone cold control** that maintains precise temperatures . . . ±1° C . . . right at knife level where temperature is most critical. Just set the selector knob at any temperature between −10° C and −30° C. The CTD will hold this temperature and prove it with a readout device which indicates the actual temperature at knife level. A new thermal insulated clear plastic cover and special anti-fog control eliminates condensation problems regardless of ambient humidity. A drain is provided for ease in cleaning, defrosting, and decontamination when necessary. Everything necessary for precise frozen sectioning has been perfected in this compact, efficient instrument including the 100% rustproof Minot Custom Microtome. Fresh tissue to finished slide takes only minutes with the CTD. It will give you large or small thin, undistorted sections having exceptional cytologic detail for definitive pathologic diagnosis, and histochemistry.

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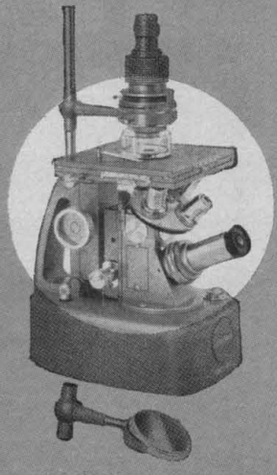
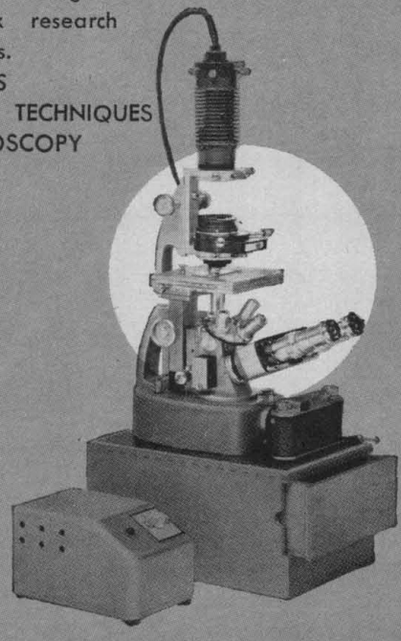


MODEL MIC



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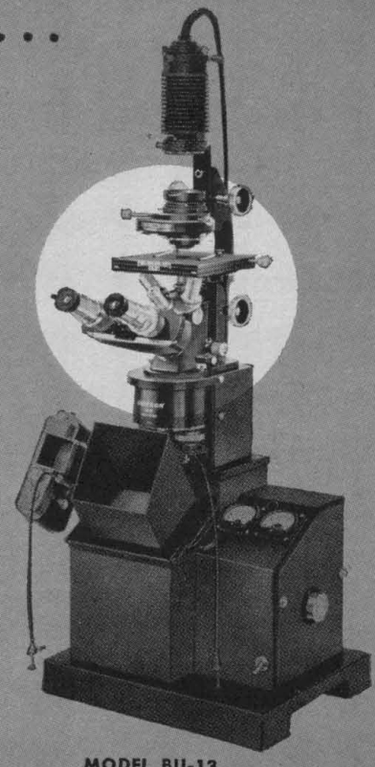

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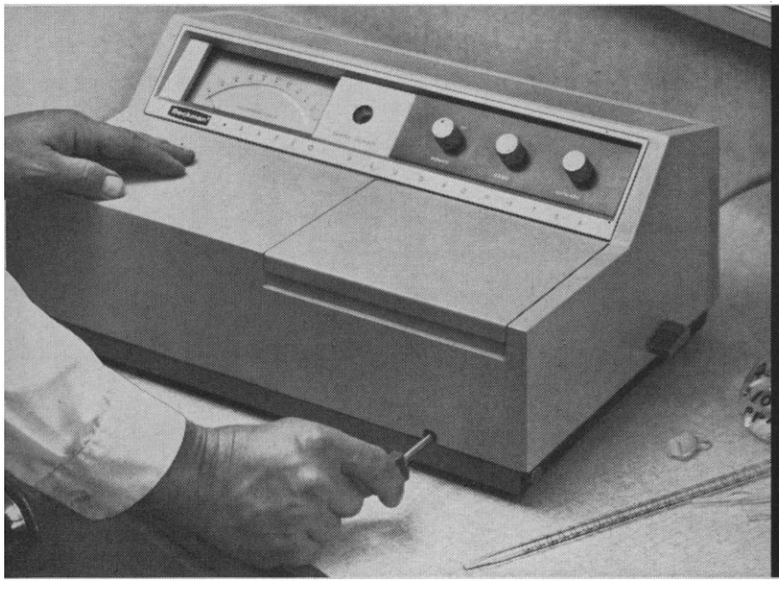

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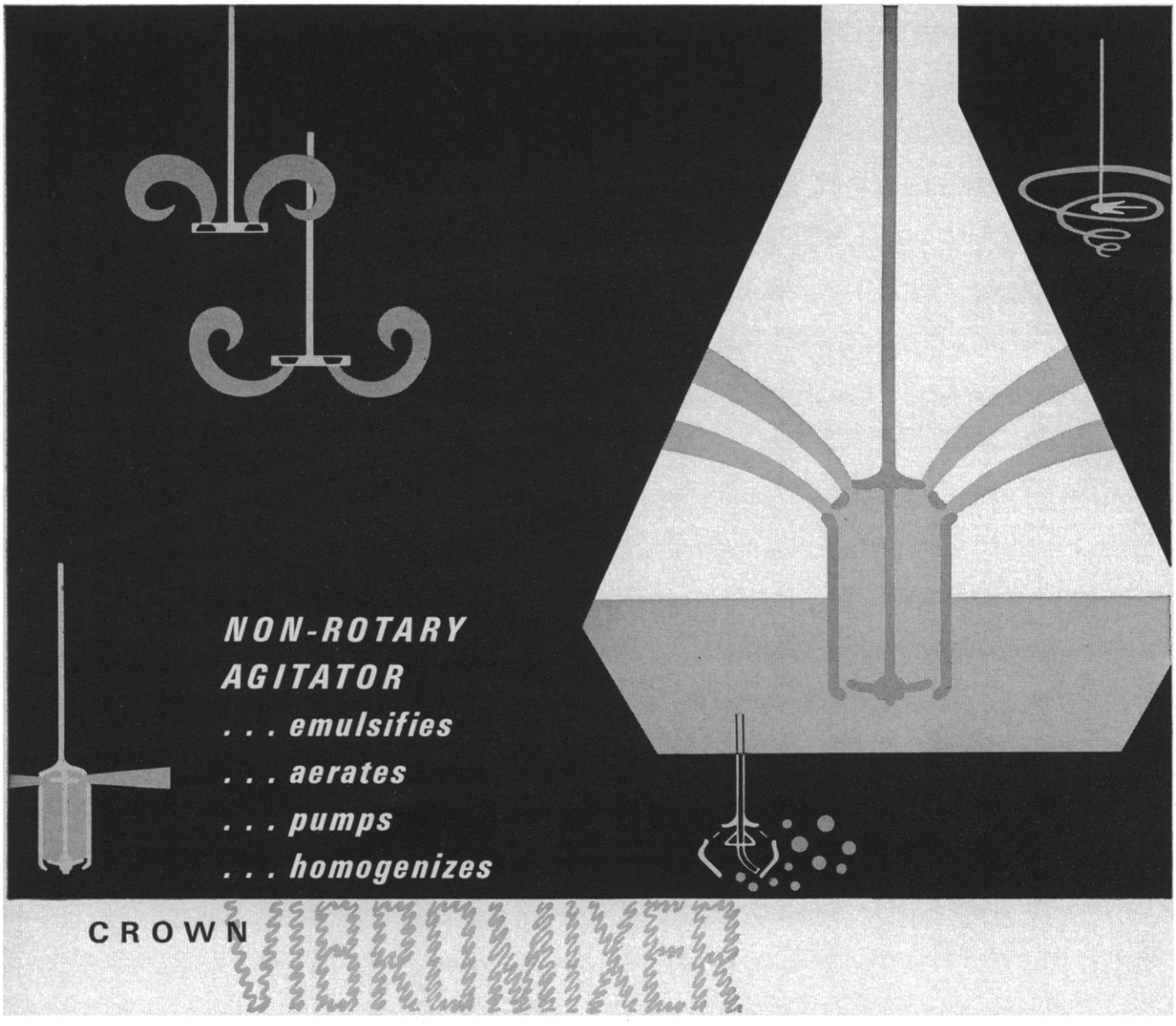

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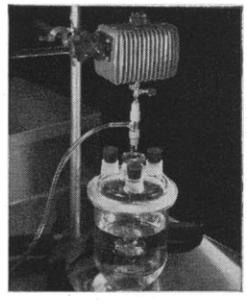

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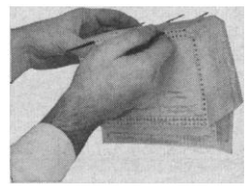

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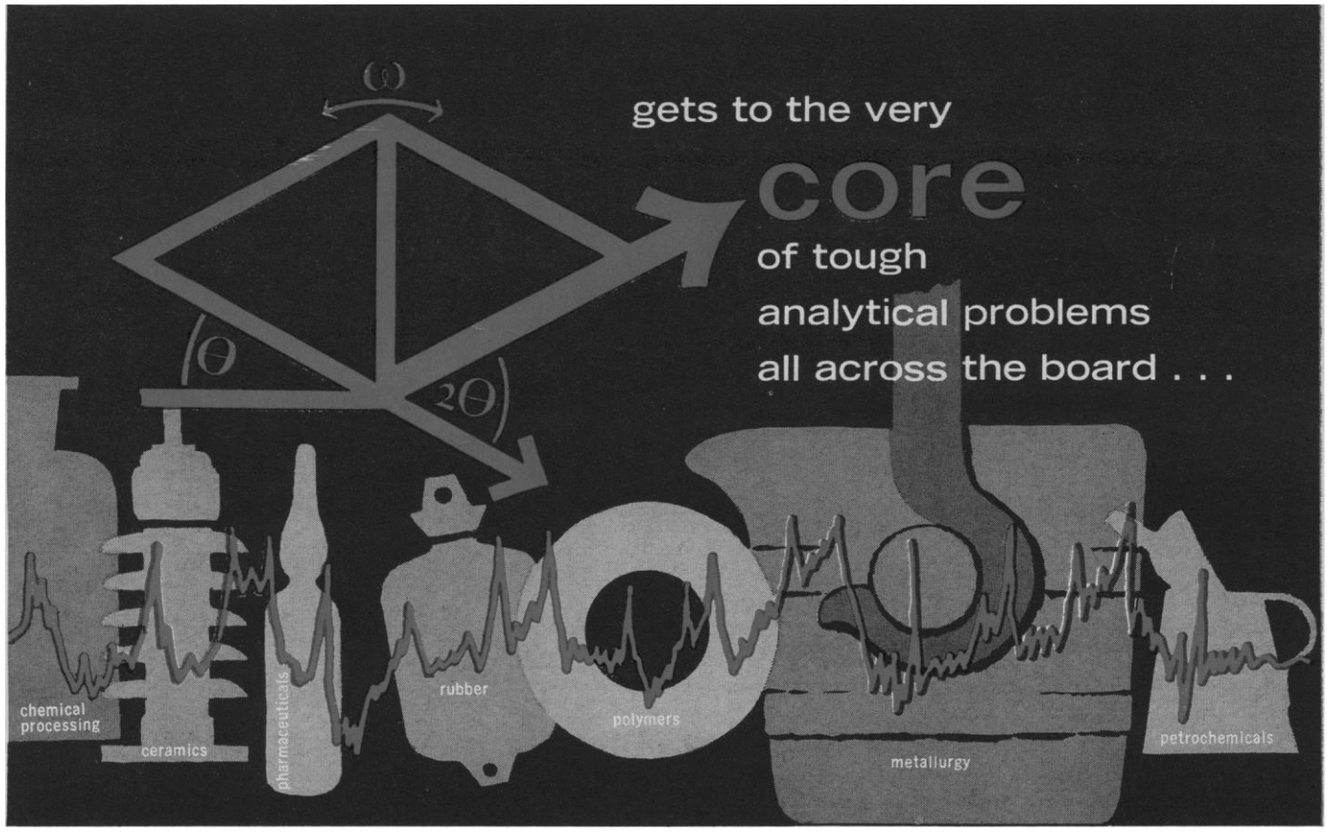

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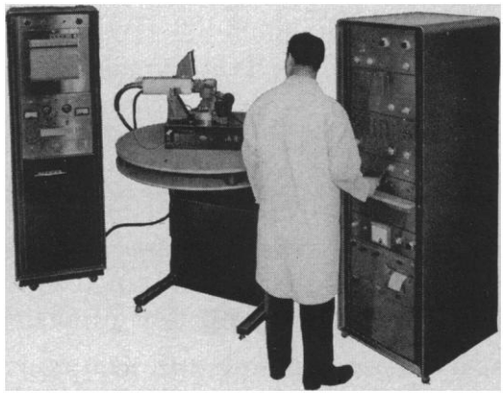

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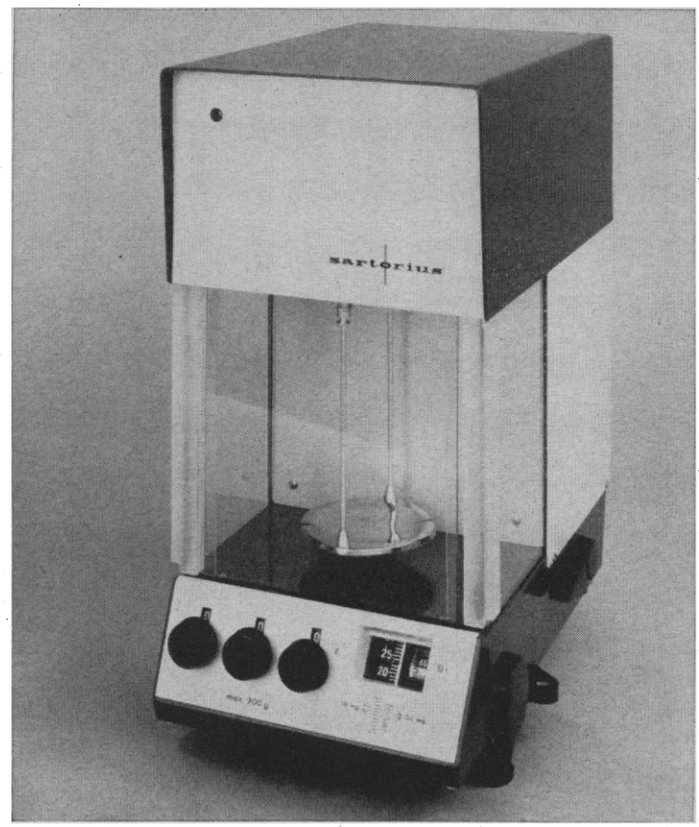

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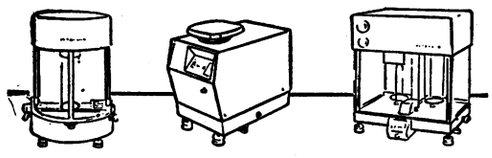

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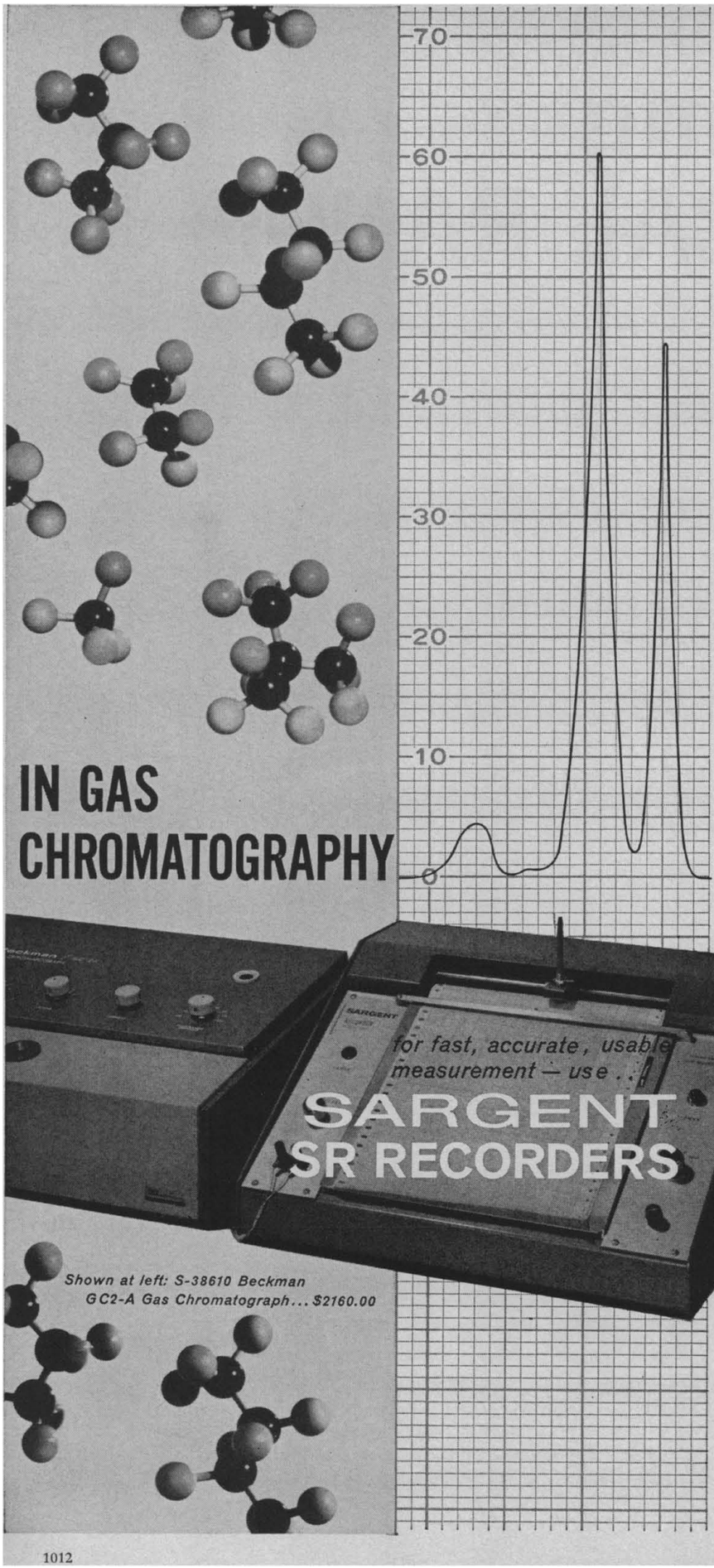

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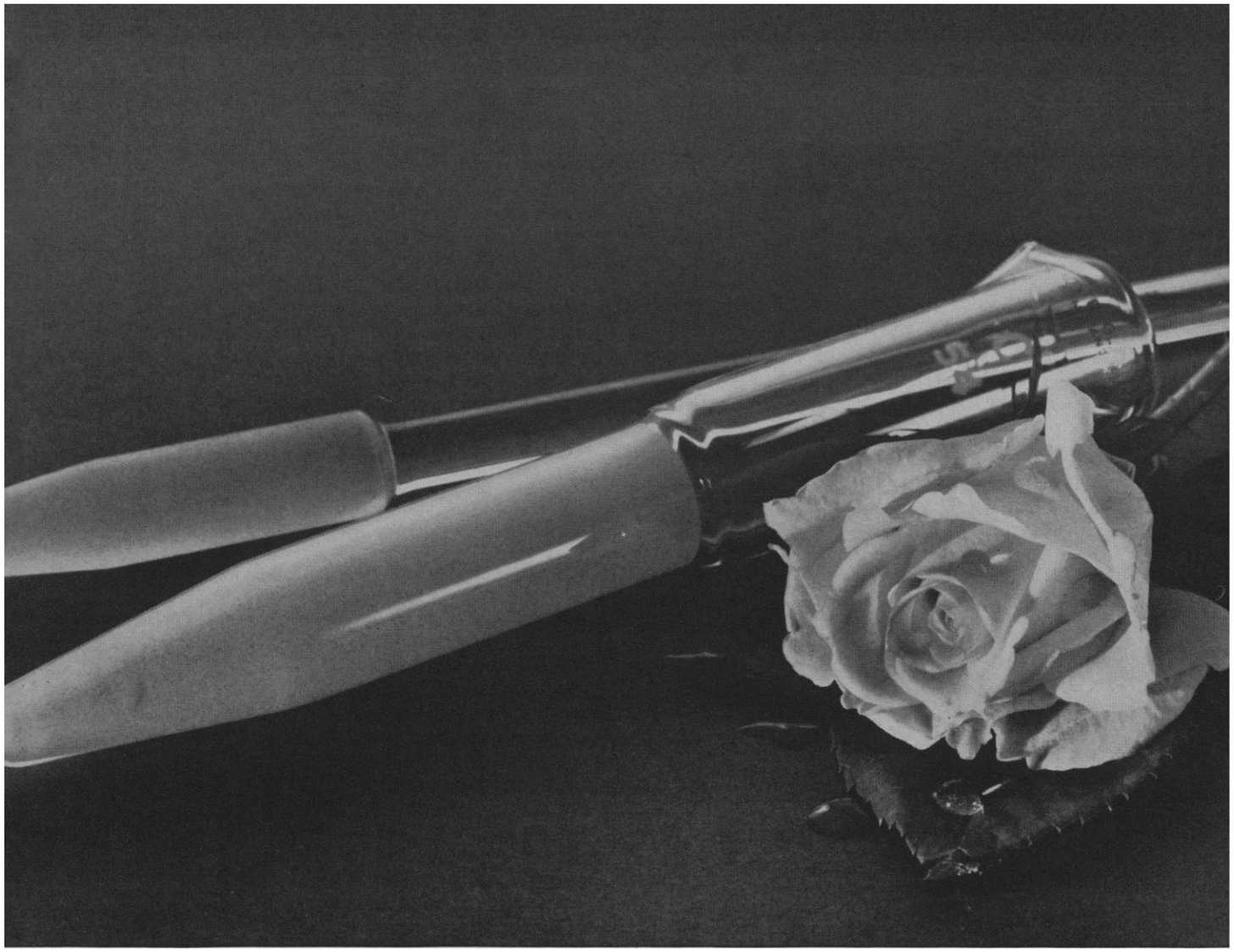

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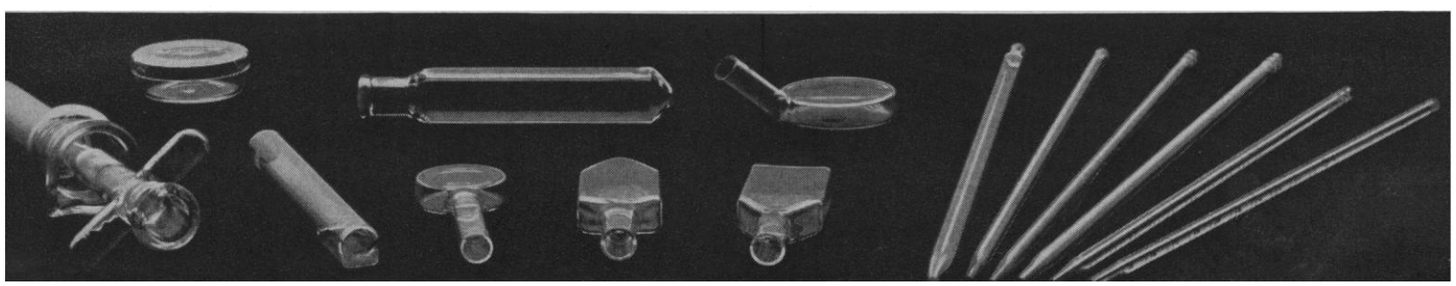


15 March 1963, Volume 139, Number 3559

SCIENCE

Science, Government, and Information

The inventory of scientific literature is enormous and is increasing steadily. The problem of using this literature effectively has become of growing concern, especially to those engaged in applied research. Recently a thoughtful study was made by a panel under the auspices of the President's Science Advisory Committee. The group, with Alvin Weinberg as chairman, prepared a well-written report, *Science, Government, and Information*, which merits wide attention. The 52-page report is strongest when stating the problems; the practicality of some of the remedies outlined is less certain.

About one-third of the document is devoted to "analyses of the nature of the information problem" and to "attributes and problems of the information transfer chain and of information systems"; the remainder is a series of recommendations. Some of the recommendations are addressed to the government, some to the technical community. The recommendations to government agencies are explicit and could easily be implemented. For instance, "Each federal agency concerned with science and technology must accept its responsibility for information activities in fields that are relevant to its mission. . . ." Action on the part of a few key men in government is all that is needed to accomplish this.

Some of the recommendations to the technical community seem less practical. Authors of technical papers are urged to "title papers in a meaty and informative manner," to "write informative abstracts," and to "refrain from unnecessary publication." We have had experience with authors. Almost all of them would argue that, whereas others are deficient in these respects, they themselves are not.

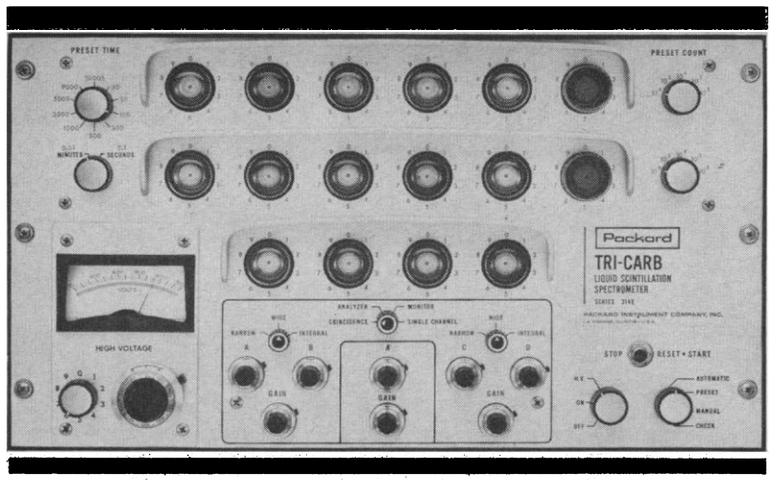
One recommendation which could be implemented is that some scientists and engineers "commit themselves deeply to the job of sifting, reviewing, and synthesizing information," since "reviewing, writing books, criticizing, and synthesizing are as much a part of science as is traditional research." The technical community is urged to accord such individuals esteem commensurate with the importance of their jobs and to reward them well.

The authors of some books and review articles deserve, and get, little esteem. However, the history of almost every branch of science records instances where a book or review article was crucial in advancing a whole disciplinary area. Physicists still speak reverently of two review articles by Bethe and of one by Bethe and Bacher which appeared in *Reviews of Modern Physics* in 1936 and 1937. These articles organized and illuminated the nuclear physics of that day. Many would agree that their impact on physics was comparable to work for which the Nobel prize has been awarded. Unfortunately, these major contributions were not recognized in that way.

One means of getting better review articles and books would be to establish appropriate prizes for excellence. Award of these should be based on the scholarship displayed and the impact of the article or book on the development of a field of science. If the standards of selection were rigorous, the awards large, and the attendant recognition great, the attitude of many scientists toward publication of their work would be greatly altered.

The creation of appropriate prizes is feasible. It could be done by foundations, or by government on the initiative of professional societies. We recommend that the officers of scientific groups give earnest consideration to this suggestion.—P.H.A.

For another view of this document, see page 1088.



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transport in polymeric molecular solids"; Albert Szent-Gyorgyi, (subject to be announced).

12 July. T. C. Harman, "Thermomagnetic transport in semiconductors"; J. M. Honig, "Thermoelectric and thermomagnetic phenomena."

Organic Coatings

Harold L. Jaffe and Joseph Gaynor are *chairman* and *vice chairman*, respectively.

15–19 July. D. R. Hays, "Factors affecting solvent retention: carbon-14 tagged solvents in poly (methyl methacrylate) films"; William E. Weesner, "Sulfur-polyester products"; Kurt Gutfreund, "Instrumental techniques applied to paint film deterioration"; Robert Evans, "The functionality of tars"; Robert Toomey, "Solvent release and paint decomposition"; C. K. Ikeda and S. Hochberg, "2-vinyl-1, 3-cyclic acetals, a new class of paint vehicles"; C. E. Anagnostopoulos, "Nascent ultraviolet screeners for protecting polymers against the effects of weathering"; D. A. Brubaker, "Binder requirements for electrostatic printing papers"; Edward G. Locke, "Surface characteristics of wood as they affect the durability of finishes." Speculative discussion: *Pigmented latex film formation*, George L. Brown, John Brodnyan, Edward Bobalek, Frank J. Hahn and others.

Organic Reactions and Processes

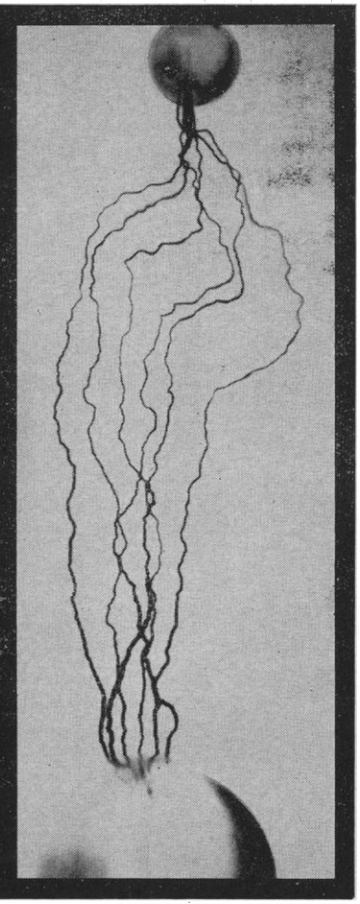
Ellis K. Fields and William E. Truce are *chairman* and *vice chairman*, respectively.

22 July. S. Meyerson, "Organic ions in the gas phase"; M. J. S. Dewar, "Stereochemistry of addition to double bonds."

23 July. L. Horner, "Syntheses with organophosphorus compounds"; T. W. Campbell, "Catalytic conversion of isocyanates to carbodiimides"; G. L. Closs, "Recent developments in carbenes."

24 July. P. Kovacic, "Polymerization of aromatic nuclei"; F. Hubenett, "Preparation and properties of isothiazoles"; H. E. Zimmerman, "Recent developments in mechanistic and exploratory organic photochemistry."

25 July. D. Bryce-Smith, "Unsolvated organomagnesium complexes"; F. Ramirez, "The oxyphosphorane reagents"; A. Schriesheim, "Hydrocarbon carbanions."



26 July. W. M. Wagner, "Reactions of trichloromethyl anions"; K. U. Ingold, "The reaction of peroxy radicals with phenols."

Energy Coupling Mechanisms

D. R. Sanadi and W. Kielley are *chairman* and *vice chairman*, respectively.

29 July. Properties and function of ATPase: M. Avron, "Recent studies on the coupling of phosphorylation to electron transport in photophosphorylation." (B. Petrack, *discussant*). D. E. Koshland, "Properties of the intermediate stage in myosin hydrolysis as indicated by O^{18}-exchange studies"; E. Racker, "ATPase and other coupling factors of oxidative phosphorylation." *Role of iron proteins*: A. San Pietro and K. T. Fry, "Studies on photosynthetic pyridine nucleotide reductase." (R. Bartsch, *discussant*). L. Mortenson, "Ferredoxin and its role in anaerobic electron transport." (J. E. Carnahan, *discussant.*) P. Handler, "Mechanism of action of iron flavoproteins."

30 July. Functional groups: W. Kielley, "Role of sulphydryl groups in the active center of myosin"; A. Stracher. "Studies on the ATPase active center of myosin A"; A. Fluharty, "Evidence for participation of a dithoil function in oxidative phosphorylation"; J. J. Blum, "Activation of myosin ATPase by some uncoupling agents"; J. W. Newton, "Disulfides in the photochemical apparatus of bacteria"; P. G. Heytler, "Study on the mechanism of action of CCP class uncouplers."

31 July. Coupling factors and intermediates: G. Pinchot, "Mechanism at the first phosphorylation site"; D. E. Griffiths, "Oxidative phosphorylation at the pyridine nucleotide level"; P. D. Boyer and J. B. Peter, "Bound phosphohistidine and an activated imidazole structure in phosphorylation and energy transfer reactions"; D. E. Green, M. Hanson, A. Smith, and G. Webster, "On the factors essential for oxidative phosphorylation"; A. L. Lehninger, "Coupling factors of rat liver mitochondria"; D. R. Sanadi, "Oxidative phosphorylation in the DPNH-quinone reductase reaction."

1 August. C. Hind and A. T. Jagendorf, "Intermediates in photosynthetic phosphorylation." (J. W. Hinkson, *discussant.*) M. Morales, "Molecular changes associated with contraction"; D. I. Arnon, "The energy transformation reactions in photosynthesis"; B.

Chance, "Conversion of energy into electron flow, with the formation of 'high energy' intermediates"; J. Gergely and A. Martonosi, "Control mechanisms in muscle contraction and relaxation."

2 August. Quinones in electron transfer: T. Stadtman, "Phosphorylation associated with oxido-reductions in anaerobic bacteria"; F. Crane, M. Henninger and R. A. Dilley, "Plastaquinones and tocopherol quinones in chloroplast"; D. W. Krogman, "The role of quinones in chloroplast electron transfer."

Photonuclear Reactions

D. J. Zaffarano and Evan Hayward are *chairman* and *vice chairman,* respectively.

5-9 August. (Speakers to be announced), "The photodisintegration of light elements"; "Fluorescence of nuclear levels below the particle threshold"; "Experimental evidence for higher order multipole excitations"; "Electron induced reactions and collective excitations"; "Excitation of nuclear states by heavy particle bombardment"; "Review of particle-hole calculations and shell model theory"; "Contributions to nuclear structure from high energy experiments"; "Photonuclear cross-sections above the giant resonance"; "New experimental techniques applied to particle emission cross-sections."

Fluorine Chemistry

Leo A. Wall and Murray Hauptschein are *chairman* and *vice chairman,* respectively.

12 August. (Glenn Finger, *chairman*): Cedric L. Chernick, John G. Malm, and Howard H. Claassen, "Preparation and properties of inert gas compounds"; A. V. Grosse, A. D. Kirshenbaum, A. G. Streng and L. V. Streng, "Preparation and properties of krypton tetrafluoride." (J. C. Tatlow, *chairman*): B. Sukornick, "Chemistry of some NF, OF and SF compounds."

13 August. (Michael Szwarc, *chairman*): K. O. Kutscke, "Photochemical production and reactions of perfluoroalkyl radicals"; A. F. Trotman-Dickenson, "The reactions of fluorinated cyclopropanes"; S. V. R. Mastraneglo, "Chemical evidence for two forms of CF_2."

14 August. (Colin R. Patrick, *chairman*): John L. Margrave, "Thermodynamic properties of inorganic fluorine compounds"; Donald W. Scott, "Experimental and statistical thermodynamics applied to fluorine compounds." (Robert Simha, *chairman*): Colin R. Patrick, "Solution properties of aromatic fluorocarbons and some observations on the theories of solutions of fluorocarbons"; A. J. Havlik and Robert Simha, "Considerations on the equation of state for chain-like liquids; fluorine and non-fluorine containing oligomers."

15 August. (Murray Hauptschein, *chairman*): William T. Miller, "Substitution and addition reactions of fluoroolefins"; Carl G. Crespan, "Sulfur and oxygen containing derivatives of fluoroolefins"; Joseph D. Park, "Recent advances in nucleophilic displacement reactions of fluorinated cyclobutenes."

16 August. (William Postelnek, *chairman*): J. C. Tatlow, "Synthesis and reactions of aromatic fluorocarbon derivatives"; Christ Tamborski, Robert J. Harper, Jr., and Edward J. Soloski, "Preparation and reactions of perfluoroaryl organo-metallic compounds."

Geochemistry—Origin of Petroleum

Frederick D. Rossini and Harold M. Smith are *co-chairmen.*

19 August. Basic geological concepts (H. D. Hedberg, *discussion leader*). *Basic geochemical concepts* (J. M. Hunt, *discussion leader*). *The raw material for bacterial action* (J. R. Vallentyne, *discussion leader*). *The course and results of bacterial action* (S. C. Rittenberg, *discussion leader*).

20 August. Organic compounds formed as a result of and subsequent to bacterial action (J. G. Erdman, *discussion leader*). *Hydrocarbons in petroleum* (B. J. Mair, *discussion leader*). *Sulfur, nitrogen and oxygen compounds in petroleum* (J. S. Ball, *discussion leader*).

21 August. Porphyrins, pigments and metals in petroleum (G. W. Hodgson, *discussion leader*). *Isotopes in petroleum* (S. R. Silverman, *discussion leader*). *Thermodynamics, equilibrium and thermal stability* (F. D. Rossini, *discussion leader*). *Clay-organic complexes* (R. A. Rowland, *discussion leader*). *Catalysis under geological conditions* (R. B. Anderson, *discussion leader*).

22 August. Compaction and migra-

tion: (I. H. Milne and E. G. Baker, *discussion leaders*). G. D. Hobson, "The occurrence and origin of oil and gas."

23 August. Synthesis of ideas on origin of petroleum—a panel discussion (W. E. Hanson, *leader*): N. P. Stevens, E. Eisma, P. A. Dickey, U. P. Colombo, F. J. Stevenson, M. Louis, and C. H. Oppenheimer.

Glass

Norbert J. Kreidl and Martin Goldstein are *chairman* and *vice chairman,* respectively, for these sessions on defect structures.

26 August. High energy radiation effects (J. R. Hensler, *chairman*): R. A. Weeks, "Introduction to defect structures"; F. Laves, "Infrared absorption of hydrogen and other impurities in quartz and silica." *High energy radiation effects* (continued) (R. A. Weeks, *chairman*): J. Weil, "Paramagnetic impurity centers in quartz"; G. W. Arnold, "Influence of growth rate on radiation induced defects in quartz."

27 August. High energy radiation effects (continued) (J. G. King, *chairman*): J. G. Castle, "Spin lattice relaxation at defect sites in quartz"; S. Weissmann, "X-ray and electron microscope studies of fast neutron irradiated quartz and fused silica." *High energy radiation effects* (continued) (E. W. J. Mitchell, *chairman*): E. W. J. Mitchell, "Defect structures"; J. H. C. Lietz, "Luminescence and absorption in zircon and fused silica."

28 August. High energy radiation effects (continued) (S. D. Stookey, *chairman*): P. J. Bray, "Magnetic resonance studies of the structure of glass"; R. E. Strakna, "Effects of fast neutron irradiation on elastic properties of fused silica." *High energy radiation effects* (continued) (M. Goldstein, *chairman*): R. W. Douglas, "Ideal and real glasses"; P. Acloque, "Studies on defects in glass at St. Gobain Laboratories."

29 August. Stimulated emission (R. J. Ginther, *chairman*): H. Kallman, "Radiative processes"; F. J. McClung, Gisela Eckhardt, R. W. Hellwarth, and D. Weiner, "Stimulated Raman scattering." *Stimulated emission* (continued) (H. Kallman, *chairman*): H. W. Gandy, "Stimulated emission in silicate glasses." Brief papers on stimulated emission will also be presented.

30 August. (N. J. Kreidl, *chairman*) Continued brief papers.

Meetings

Forthcoming Events

April

8–10. **Seismological** Soc. of America, Berkeley, Calif. (K. V. Steinbrugge, 465 California St., San Francisco 4, Calif.)

8–11. American **Personnel and Guidance** Assoc., Boston, Mass. (APGA, 1605 New Hampshire Ave., NW, Washington 9)

9–11, American Assoc. of **Anatomists,** Washington, D.C. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia)

10–11. Engineering Aspects of **Magnetohydrodynamics,** 4th symp., Berkeley, Calif. (G. S. Janes, Avco-Everett Research Laboratory, Everett 49, Mass.)

11–13. Natural **Radiation** Environment, intern. symp., Houston, Tex. (J. A. S. Adams, Dept. of Geology, Rice Univ., P.O. Box 1892, Houston 1)

11–13. Eastern **Psychological** Assoc., 34th annual, New York, N.Y. (M. A. Iverson, Dept. of Psychology, Queens College of the City University of New York, Flushing 67)

11–13. **Pulsatile Blood Flow,** intern. symp., Philadelphia, Pa. (E. O. Attinger, Presbyterian Hospital in Philadelphia, 51 N. 39 St., Philadelphia 4)

11–13. Southern Soc. for **Philosophy and Psychology,** Miami Beach, Fla. (E. A. Alluisi, Human Factors Research Lab., Lockheed Georgia Co., Marietta, Ga.)

12–13. Pennsylvania **Acad. of Science,** East Stroudsburg, (K. B. Hoover, Messiah College, Grantham, Pa.)

14–18. **Electrochemical** Soc., Pittsburgh, Pa. (ES, 30 E. 42 St., New York 17)

15–16. American Soc. for **Artificial Internal Organs,** annual, Atlantic City, N.J. (B. K. Kusserow, Medical College of Vermont, Burlington)

15–20. Association for Research into **Periodontal Diseases,** 17th intern., Athens, Greece. (O. Louridis, ARPA, 8 rue Hippocratous, Athens)

16–18. **Optical Masers,** intern. symp., New York, N.Y. (L. Bergstein. Symp. Committee, Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

16–19. USAF **Aerospace Fluids and Lubricants** Conf. (unclassified), San Antonio, Tex. (J. Harmon, Southwest Research Inst., 8500 Culebra Rd., San Antonio)

16–20. American **Physiological** Soc., Atlantic City, N.J. (H. Rahn, Dept. of Physiology, Univ. of Buffalo, Buffalo 14, N.Y.)

16–20. British Inst. of **Radio Engineers,** Southampton, England. (BIRE, 9 Bedford Sq., London, W.C.1, England)

16–20. Federation of American Societies for **Experimental Biology,** annual, Atlantic City, N.J. (M. O. Lee, 9650 Wisconsin Ave., NW, Washington 14)

16–21. American Soc. for **Experimental Pathology,** Atlantic City, N.J. (K. M. Brinkhous, Dept. of Pathology, Univ. of North Carolina, Chapel Hill)

16–21. American Inst. of **Nutrition,** Atlantic City, N.J. (A. E. Schaefer, Bldg. 16, Rm. 207, NIH, Bethesda 14, Md.)

16–24. **Forensic Immunology, Medicine, Pathology, and Toxicology,** 3rd intern. meeting, London, England. (I. Sunshine, 2121 Adelbert Rd., Cleveland, Ohio)

17–19. Institute of **Environmental Sciences,** technical meeting and equipment exposition, Los Angeles, Calif. (Natl. Office, P.O. Box 191, Mt. Prospect, Ill.)

17–19. **Institute of Physics and the Physical Society**/Joint British Committee for Vacuum Science and Technology, conf., Liverpool, England (Inst. of Physics, 47 Belgrave Sq., London, S.W.1, England)

17–19. **Nonlinear Magnetics,** intern. conf., Washington, D.C. (Inst. of Radio Engineers, 1 E. 79 St., New York 21)

17–19. **Plastics,** joint congr. of West Germany, Switzerland, and Austria, Vienna. (Wirtschaftsförderungsinstitut der Bundeskammer der gewerblichen Wirtschaft, 3 Hoher Markt, Vienna 1, Austria)

17–20. American **Astronomical** Soc., meeting, Tucson, Ariz. (P. M. Routly, 265 Fitz Randolph Rd., Princeton, N.J.)

17–20. American **Geophysical** Union, annual, Washington, D.C. (AGU, 1515 Massachusetts Ave., NW, Washington 5, D.C.)

17–20. German Soc. of **Surgery,** 80th meeting, Munich. (E. Derra, Chirurgische Klinik der Medizinischen Akademie, Moorenstr. 5, Düsseldorf, Germany)

17–21. Man, **Technology, and Medicine in Nuclear and Space Age,** 3rd intern. congr., Rome, Italy. (A. J. Shneiderov, 1945 Calvert St., NW, No. 44, Washington 9)

18. Society of **Plastics Engineers,** regional technical conf., Syracuse, N.Y. (R. R. Collis, c/o Joseph Cashier & Co., Inc., 810 E. Water St., Syracuse)

18–20. **Neurosurgery,** 2nd European congr., Rome, Italy. (B. Guidetti, Viale Universita 30, Rome)

18–20. **Stereology,** 1st intern. congr., Vienna, Austria. (Vienna Medical Acad., Alserstrasse 4, Vienna 9)

18–21. Radiology in **Otolaryngology,** intern. symp., Bordeaux, France. (G. Guillen, 45, cours du Marechal Foch, Bordeaux)

20. New Jersey **Acad. of Science,** annual, Glassboro, N.J. (H. L. Silverman, 361 Highland Ave., Newark 4, N.J.)

21–24. **Rare Earth,** conf., Grand Bahama Island. (K. S. Vorres, Dept. of Chemistry, Purdue Univ., Lafayette, Ind.)

21–25. International College of **Surgeons,** North American Federation, annual, Los Angeles, Calif. (W. F. James, 1516 Lake Shore Dr., Chicago 10, Ill.)

22–24. Institute of the **Aerospace** Sciences, Dallas, Tex. (R. R. Dexter, 2 E. 64 St., New York 21)

22–24. American **Oil Chemist** Soc., Toronto, Ont., Canada. (K. F. Mattil, Swift & Co., Packers and Exchange Ave., Chicago 9, Ill.)

22–24. **Biomedical Engineering,** 3rd symp., San Diego, Calif. (J. H. McLeod, Program Committee, 8484 La Jolla Shores Dr., La Jolla, Calif.)

22–25. American **Physical Soc.,** Washington, D. C. (K. K. Darrow, APS, Columbia Univ., New York 27)

22–26. **Radioisotopes and Radiation** in Plant and Animal Insect Control, intern. symp., Athens, Greece. (J. H. Kane, In-

tern. Conferences Branch, Div. of Special Projects, U.S. Atomic Energy Commission, Washington 25)

22–27. American Acad. of **Neurology**, Minneapolis, Minn. (C. A. Kane, 80 E. Concord St., Boston, Mass.)

23–25. Electronic Processes in **Dielectric Liquids**, Durham, England. (Administration Assistant, Inst. of Physics and the Physical Soc., 47 Belgrave Sq., London, S.W.1, England)

24–26. German Soc. of **Hygiene and Microbiology**, Würzburg. (W. Herrmann, Städtischen Krankenanstalten, Robert Koch-Haus, Essen, Germany)

24–26. Institute of **Radio Engineers**, regional conf., San Diego, Calif. (E. Herz, 4444 Mt. Castle Ave., San Diego 17)

24–28. German **Roentgen** Congr., 44th, Baden-Baden, Germany. (H. Lossen, GRC, Universitäts-Strahleninstitut, Langenbeckstr. 1, Mainz, Germany)

25–27. Mississippi **Acad. of Sciences**, University. (C. Q. Sheely, Dept. of Chemistry, Mississippi State College, State College)

25–27. Ohio **Acad. of Science**, Wilberforce. (G. W. Burns, 505 King Ave., Columbus 1, Ohio)

25–27. **Population** Assoc. of America, Philadelphia, Pa. (P. C. Glick, Bureau of the Census, Washington 25)

25–27. West Virginia **Acad. of Science**, Buckhannon. (J. A. Duke, S.J., Dept. of Chemistry, Wheeling College, Wheeling, W. Va.)

25–28. Association of **Clinical Scientists**, Louisville, Ky. (R. P. MacFate, 54 W. Hubbard St., Chicago 10, Ill.)

26–27. American **Mathematical** Society, University Park, N.M. (AMS, 190 Hope St., Providence 6, R.I.)

26–27. American Assoc. of **University Professors**, San Francisco, Calif. (W. P. Fidler, AAUP, 1785 Massachusetts Ave., NW, Washington 6)

26–27. Illinois State **Acad. of Science**, Carbondale. (C. L. Kanatzar, MacMurray College, Jacksonville, Ill.)

26–27. South Dakota **Acad. of Science**, Rapid City. (T. Van Bruggen, State Univ. of South Dakota, Vermillion)

27. American Soc. for **Experimental Pathology**, Atlantic City, N.J. (K. M. Brinkhous, Dept. of Pathology, Univ. of North Carolina, Chapel Hill)

27. Clinical and Diagnostic Aspects of **Enzyme Multiplicity**, colloquium, Ghent, Belgium. (R. J. Wieme, Laboratory of the Medical Clinic, Pasteurdreef 2, Ghent)

27–28. American **Psychosomatic** Soc., 20th, Atlantic City, N.J. (APS, 265 Nassau Rd., Roosevelt, N.Y.)

27–2. American **Ceramic** Soc., Pittsburgh, Pa. (C. S. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio)

28–3. American Assoc. of **Cereal Chemists**, Minneapolis, Minn. (C. L. Brooke, Merck & Co., Rahway, N.J.)

28–29. **Electron Beam Technology**, 5th intern. symp., Boston, Mass. (J. R. Morley, Alloyd Electronics Corp., 35 Cambridge Pkwy., Cambridge 42, Mass.)

29–30. **Combustion** Inst., Western States Div., San Diego, Calif. (G. S. Bahn, 16902 Bollinger Dr., Pacific Palisades, Calif.)

29–1. International Acad. of **Pathology**, 52nd, Cincinnati, Ohio. (F. K. Mostofi, Armed Forces Inst. of Pathology, Washington 25)

29–2. U.S. Natl. Committee, Intern. **Scientific Radio** Union, annual, Washington, D.C. (Miss J. Hannaum, Natl. Acad. of Sciences, 2101 Constitution Ave., NW, Washington 25)

29–3. Society of **Photographic Scientists and Engineers**, annual, Atlantic City, N.J. (D. L. Castellini, 98 Leland Terrace, New Shrewsbury, N.J.)

May

1–2. **Polymer** Science and Technology, conf., London, England. (J. N. Radcliffe, Plastics Inst., 6 Mandeville Pl., London, W.1)

1–3. American Assoc. for **Contamination Control**, natl., Boston, Mass. (AACC, 6 Beacon St., Suite 626, Boston 8)

1–4. American **Film Festival**, New York, N.Y. (Educational Film Library Assoc., 250 W. 57 St., New York 19)

2–3. **Human Factors in Electronics**, 4th annual symp., Washington, D.C. (F. Chernikoff, U.S. Naval Research Laboratory, Code 5124, Washington 25)

2–4. Kansas **Acad. of Science**, Lawrence. (G. A. Leisman, Dept. of Biology, Kansas State Teachers College, Emporia)

2–4. American **Philosophical** Assoc., Western Div., Columbus, Ohio. (L. E. Hahn, Washington Univ., St. Louis 30, Mo.)

2–4. Virginia **Acad. of Science**, Roanoke. (P. M. Patterson, Hollins College, Hollins College, Va.)

2–5. Council of Long Island **Technical Societies**, exposition of technology and industry, West Hempstead, N.Y. (CLITS, Route 110, Farmingdale, N.Y.)

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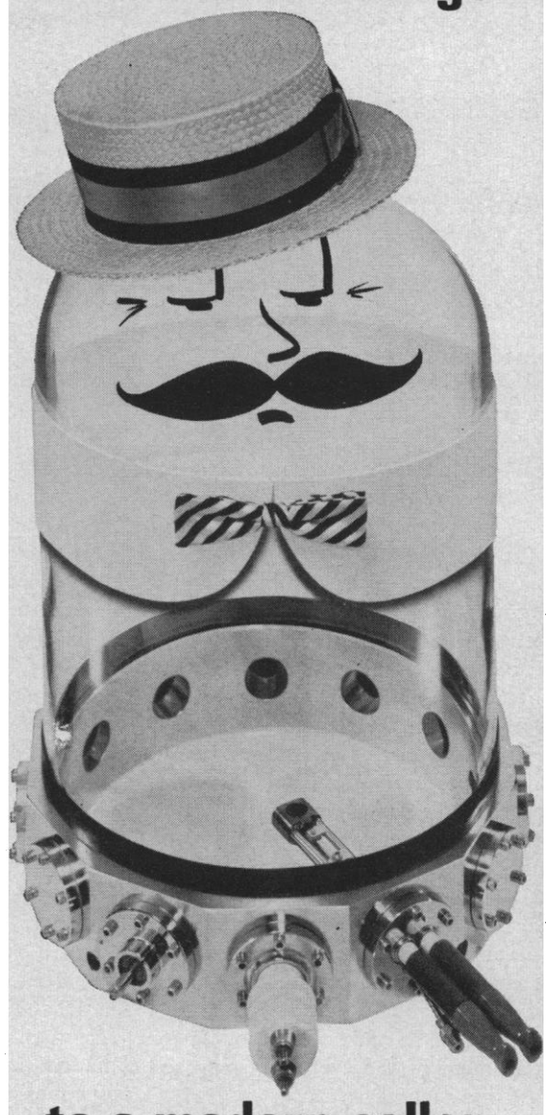

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of these causes is the belief, in the minds of most people, that when it is considered totally, science is a relevant and important aspect of our society and individual lives.

Until radio astronomy is as important to the Paterson wards as it is to the administration, Noyes and others like him will do well to caution the government to save its money and go slowly. If New Jersey cannot afford to forego an additional TV channel, our nation cannot afford an accelerated science training program.

R. C. A. MOORE

Tektronix, Inc., Beaverton, Oregon

Memory, Enzyme Induction, and Porphyrins

C. E. Smith speculates shrewdly [*Science* **138**, 889 (1962)] on the question of whether memory may be associated with enzyme induction. He indicates at least three aspects of experimental evidence suggesting that the basis of a form of biological "memory" lies in an increase in enzyme concentrations associated with transmitter substances "as a long-lasting effect of stimulation."

From the viewpoint of enzyme induction it may be in order to consider the two different components in the enzyme—namely, the template protein and the prosthetic porphyrin. Chemically, these parts of the molecule are different in structure and action. While the bonding compound has not yet been identified, in the scheme suggested by Smith, the question arises whether the substance might be a porphyrin, either metal-containing or metal-free?

There seems to be another factor which deserves investigation. This is the increase in the concentration of porphyrins in the central nervous system with evolutionary development. This has been clearly shown by H. Klüver [*Science* **99**, 482 (1944); *J. Psychol.* **17**, 209 (1944); *Biochemistry of the Developing Nervous System* (Academic Press, New York, 1944), pp. 137–144]. Porphyrins have not been isolated from the peripheral nervous system. There appears to be an "ascending porphyrinization" in the postnatal development of the central nervous system in birds and mammals.

It has been found that porphyrins exist in both the metal-containing and the metal-free conditions. In the enzyme the porphyrin is associated with a metal; the metal-free derivatives are located

in the nerve system. How the sodium and the potassium ions pass through the nerve tissue, and whether the porphyrin residues are involved in allowing the ions to diffuse, is worthy of study. The holes which are known to exist in membranes and the open ring in porphyrins are of the same size.

Conductivity measurements have been made on closely allied chemical species of the porphyrins—namely, the phthalocyanines and the benzazporphyrins. At the meeting of the Organic Crystal Symposium in Ottawa on 10–12 October 1962, Harrison and Heilmeir demonstrated the Hall effect in metal-free phthalocyanines.

In view of the increasingly provocative relationships that are becoming evident between computers and brains, it would seem that any factor involving semiconduction might be an important aspect of "memory" phenomena. Memory may reside in the arrangement, stacking and interplay of the prosthetic moieties of the enzyme. Currently, we are engaged in the synthesis and the preparation of single crystals of porphyrins which may be examined from the viewpoint of conductivity.

E. L. KROPA
Battelle Memorial Institute, Columbus, Ohio

CHAUNCEY D. LEAKE
University of California School of Medicine, San Francisco

In his recent article "Is memory a matter of enzyme induction?" (*1*), Smith develops a theory which states essentially that memory may be a function of changes in the synaptic concentration of the neuroenzyme acetylcholinesterase. These variations in enzymatic activity are considered to be the result of alterations in the rate of neurostimulation which cause, momentarily, changes in the concentration of "free" substrate (transmitter substance). The amount of "free" substrate is considered to be the factor responsible for altered enzyme activity, since the transmitter substance induces the formation of the neuroenzyme. Therefore, the concentration of substrate present at any time regulates the rate of enzyme production.

In our laboratory we have come to these same conclusions independently, on the basis of results of several experiments in which changes in the level of acetylcholinesterase activity in the brain of the killifish *Fundulus heteroclitus* in response to thermal stress (*2*) were measured. It was found that a

homeostatic mechanism exists in the brain of this fish which regulates the activity of brain acetylcholinesterase and maintains it as a constant, after a period of acclimation, regardless of any modification in ambient temperature. We have considered this to be a case of alteration in the rate of enzyme induction due to temporal changes in the concentration of the neurohumor acetylcholine. Thermal stress changes the substrate-enzyme relationship by modifying enzymatic activity. It is clear from studies in which enzymatic activity has been depressed by treatment with irreversible cholinesterase inhibitors (*3*) and in which additional transmitter substance has been added to biological systems (*4*) that there is a dynamic balance between enzyme concentration and substrate liberation at all times. In normal neural function this balance is probably upset by the liberation of varying amounts of acetylcholine per unit of time, due to changes in the rate of neuronal firing. Thus, it is not necessary to postulate, as Smith does, "that each nerve impulse would release from the bound form more acetylcholine than an equivalent impulse released before induction" to account for changes in the rate of enzyme induction.

We have expanded this theory to consider the role of a feedback mechanism for neuroenzyme induction in terms of neuro-integration, and also to consider the method by which the individual neurons can reliably retain their independent and integrated functions (memory) over long periods of time in the apparent absence of repetitive input.

If the enzyme-induction hypothesis is correct, we may postulate a dual role for synaptic cholinesterase. First, this enzyme must, within a very short time, hydrolyze all of the transmitter substance liberated, to prepare the nerve for further transmission. Second, since the presence of acetylcholine at the presynaptic membrane depolarizes the nerve and prevents further impulse transmission, the synaptic concentration of this enzyme apparently must also function to regulate the time interval before a second action potential can be transmitted. Cells containing more enzyme will hydrolyze acetylcholine at a higher rate, with resultant shortening of the "no-impulse" period, and will therefore be capable of transmitting impulses at a higher frequency. Cells having a lower concentration of enzyme will have a longer "no-impulse" period, and therefore the maximum

rate of impulse transmission will be lower.

Since much information is passed through the nervous system in terms of impulse frequency alone (*5*), and since it appears possible for neurons to modify their frequency response, "learning," on the biochemical level, may be considered to be the result of altered synaptic enzyme concentrations, mediated by changes in the rate of enzyme induction. Thus, repeated stimulation of a nerve with, initially, low-frequency transmission capability should result in attenuation of the nerve for the passage of coded information of high as well as low frequency,

Finally, we have postulated that long-term stability of synaptic enzyme concentrations and "memory" may be a function of rhythmic excitory waves that are found in the brain and also in individual nerve cells (*6*). It is possible that a single periodic pulse through a nerve or a neuronal relay system may be sufficient to maintain synaptic enzyme concentrations that allow for passage of impulses at a preset frequency.

The hypothesis outlined certainly cannot in itself account for the complex nature of neuro-integration, but, in connection with other information about coding, may clarify the picture of brain function. The question of whether there are similar compensatory mechanisms in other neurohumoral systems remains to be answered.

MORRIS H. BASLOW
Department of Marine Biochemistry and Ecology, New York Aquarium, Brooklyn, New York.

References

1. C. E. Smith, *Science* **138**, 889 (1962).
2. M. H. Baslow, *Am. Zool.* **2**, 504 (1962).
3. C. M. Weiss, *Trans. Am. Fisheries Soc.* **90**, 143 (1961).
4. A. Burkhalter, M. Jones, R. M. Featherstone, *Proc. Soc. Exptl. Biol. Med.* **96**, 747 (1957).
5. D. R. Evans and D. Mellon, Jr., *J. Gen. Physiol.* **45**, 651 (1962).
6. J. B. Preston and D. Kennedy, *ibid.* **45**, 821 (1962).

Baslow's data do suggest both enzyme induction and a feedback system, but I feel that he and I are not talking about the same thing when we refer to learning. He states that it is not necessary to postulate an increase in the amount of transmitter liberated by any one impulse in order to account for induction. My point is quite the opposite: After induction has occurred —the induction of enzymes essential to *synthesis* of a transmitter—the consequence would be the liberation of

more transmitter per impulse. Briggs and Kitto [*Psychol. Revs.* **69**, 537 (1962)] reached essentially similar conclusions in a paper I wish I had written. Although they published the hypothesis at the time I did, they have clear priority because their manuscript was accepted some 7 months before mine was. Their work, like Baslow's, deserves the attention of readers interested in this problem.

C. E. SMITH
San Jose State College, San Jose, California

Smoking, Arteriosclerosis, and Age

The excellence of the report "Cigarette smoking and arteriosclerosis" [*Science* **138**, 975 (1962)] is lessened by the fact that the statistics were not adjusted for age. In large epidemiological studies the average age of nonsmokers is usually 4 or more years higher than that of smokers. In this particular study the age difference of the two groups might have been greater or it might have been insignificant. It is not possible to correctly interpret the author's conclusion without this information because of the association of arteriosclerosis with age.

GEORGE E. MOORE
Roswell Park Memorial Institute, Buffalo, New York

In the report "Cigarette smoking and arteriosclerosis," Sigmund L. Wilens and Cassius M. Plair state, "There is no proof that sclerosis of coronary arteries develops more rapidly in cigarette smokers than in nonsmokers." However, they fail to present the distribution, in tabular or statistical form, of their subjects' ages, and their most sophisticated evidence (Table 3) seems to contradict their statement. They do say that the cigar and pipe smokers (for whom they have no criterion for determining intensity of smoking) tend to be older than the other groups, and that the light and moderate smokers of cigarettes are "a somewhat younger group on the whole, than . . . the other groups." No comparison of the age of the nonsmokers and the heavy smokers is presented, though such a comparison is essential if we are to interpret the findings objectively. The authors are analyzing for evidence of degenerative diseases (or the effects of aging), such as myocardial infarcts, vascular scars of kidneys, cerebral infarcts, and

cerebral hemorrhage. Surely the age of the people at death is a critical, pivotal characteristic in this type of research, for if the smokers of cigarettes are generally younger than the nonsmokers, one should naturally expect them to show fewer of the degenerative diseases (other things being equal)—not more, as is generally the case in the evidence presented for the "diseases" listed above.

In the one case where they make specific use of the subject's age in relating smoking habits to the severity of aortic sclerosis at necropsy (see their Table 3), they gave each aorta "an 'arteriosclerotic age' through comparison with a set of previously prepared photographic transparencies of aortas which represented the standard or average degree of sclerotic change observed in each half-decade of adult life." As a result of this method of analysis, Wilens and Plair found highly significant differences ($P = .001$) in the degree of aging, favoring 40 percent of the non-smokers as compared to the heavy smokers.

I was confused by the fact that the probability figure in their Table 1 was given as $P = .028$, while they claimed that this was not significant, until I discovered that this was a typographical error and that the probability should actually have read .28.

We need more information before it can be so firmly stated that cigarette smoking does not contribute to the development of arteriosclerosis.

CARL L. JOHANNESSEN
College of Liberal Arts, University of Oregon, Eugene

The mean and median ages of the various categories of smokers discussed in our report are shown here in Table 1. Undoubtedly, if heavy smokers of cigarettes had survived, on the average, 3 years longer, as the nonsmokers did, the incidence of myocardial infarcts among them would have been somewhat but not greatly increased. The reports on the clinical incidence of myocardial infarcts suggest that the increased susceptibility in heavy smokers of cigarettes is so pronounced that it is not concealed by their tendency to develop fatal cancer of the lung.

The development of one fatal condition unquestionably influences the incidence at necropsy of other fatal conditions. In other words, if a high percentage of heavy smokers of cigarettes did not die of cancer of the lung, they might die a few years later of myocardial infarction. Our observation that the severity of aortic sclerosis is significantly increased in such smokers suggests that this might be the case. Whether or not this is so, the fact remains that in our series there was no significant increase in the number of myocardial infarcts at necropsy in the heavy smokers of cigarettes, contrary to what the clinical reports would have led one to expect.

Table 1. Mean and median ages of smokers in various categories.

Category	No.	Age	
		Mean (yr)	Median (yr)
Nonsmokers	161	60.2	64
Cigarette smokers:			
Light	153	59.3	64
Moderate	289	58.3	61
Heavy	199	57.7	61
Pipe and cigar smokers	71	66.5	68
Unknown or unclassified	120	63.3	65

We did not intend to state "firmly" that "cigarette smoking does not contribute to the development of arteriosclerosis" but meant to suggest that the connection between the two, if it exists, is much more tenuous than has been claimed and that, as a practical matter, the heavy smoker of cigarettes may not be much more likely to develop a myocardial infarct than a nonsmoker.

S. L. WILENS
New York Veterans Administration Hospital, New York

Science Reporting in Journals and Newspapers

The editorial of 18 January, "Science reporting," treats fairly neither the problem nor the proposed solution. The policy of the American Institute of Physics, I believe, is to deny publication to papers the main contents of which have been released by the authors or their organizations to the daily press, but to encourage the publication and the release to the public of such information after it has appeared in the scientific journals. Thus, reporters who wish to verify the relevance of a release may consult their scientific advisers, who will have details at hand in a form guaranteed by the editorial standards of the scientific journal to be reasonably lucid, complete, and of some novelty. In my opinion, the results of a scientific investigation do not exist until

they have been published in a form sufficiently complete for the scientific community to judge the value and the validity of the work.

It is hard to believe that the general public loses anything by waiting for scientific news. If the work is of real interest, it gains because the informed opinion of the scientific community is made available to the reporters. Too often flamboyant scientific results appear in the press and are later found to be incorrect. The correction is not newsworthy and does not reach the general reader.

A man or organization can make a public reputation by releasing his results to the general press without fear of effective criticism. Often it is the fault of his organization and not on the initiative of the individual scientist that such releases are made. The policy of the American Institute of Physics thus gives scientists incentive to police their own organizations and to eschew publicity at the expense of other scientists who publish in scientific journals.

RICHARD L. GARWIN
I.B.M. Watson Research Laboratory, Columbia University, New York

For *Physical Review Letters* and *Applied Physics Letters* to refuse reports of research because there has already been a report in the public press is to debase scientific integrity by applying personal or moral standards, or sometimes even adventitious ones, to the dissemination of research findings.

Such a discountenanced author may indeed have been seeking a cheap publicity, or he may sincerely have believed that he was helping the public to understand science and thus ultimately to support it. With a good science reporter he could have been right. Maybe his enthusiastic colleagues or a hopeful committee on public relations pushed him into prominence reluctantly or even unwittingly. Suppose, moreover, that the implicated author is really at bottom a publicity hound; what business is it of the scientific fanatic to deny his research an equal chance to be judged along with the work of more modest investigators? The weight of the history of science is on the side of personal vanity's favoring discovery.

It is also true that even good science reporting in the public press is unlikely to become a proper substitute for the scientist's own report in a standard journal. . . . No scientist goes to the New York *Times* for such information and his abstract journals do not cover

it. Exclusion of investigators from the normal channels of scientific communication because they have consorted with the press seems to me to be partly a moral issue and an uncertain one at that.

EDWIN G. BORING
Harvard Psychological Laboratories, Cambridge, Massachusetts

. . . Any effort to restrict or confine coverage of scientific news seems to me incredibly shortsighted. I cannot see how it serves scientists' interests. Or those of citizens generally.

Some science reporting is irresponsible. So is some reporting of government news. But shall we wait for the history books, a generation or more from now, to know in what directions our world has gone? . . .

ROBERT SOHNGEN
No address given

. . . I do not believe a scientist's behavior can be divorced from his standards of work in the laboratory. Restraint in stating conclusions in *Science* presupposes restraint in headline-seeking in the New York *Times*. . . .

The public is, undoubtedly, entitled to know what is being done with the tax funds it spends on research. The way to keep it informed is not by competitive advertising on the part of individual investigators. The responsibility lies with the granting organizations which deal out the money.

B. RAYMOND FINK
College of Physicians and Surgeons, Columbia University, New York

. . . The tragedy of the situation is that the two publications of the American Institute of Physics, *Physical Review Letters* and *Applied Physics Letters*, are both financially endowed by a public agency, the National Science Foundation. . . . So taxpayers are heavily subsidizing, on the basis of speed of announcement, two more or less private publications which inhibit, and in practice prohibit, the speedy announcement of scientific findings through any other media. . . .

ARTHUR KRANISH
Washington Science Trends, Washington 4, D.C.

. . . An article in *Organic Gardening* (December 1962) mentioned results of some research on activities of earthworms which I did not know about. After some correspondence I have been informed that the material mentioned

presumably was taken from newspaper reports of a paper presented at the annual meeting of the Soil Science Society of America last August. None of the results of the research have been submitted for publication, but the author hopes to submit a manuscript to the Soil Science Society of America Proceedings.

G. E. GATES
251 Silver Road, Bangor, Maine

. . . An item noticeably missing, which might also cause concern on "prepublication," is the technical report. Much research is performed under federal support, and research progress is published in report form, or in manuscripts incorporating their contents in part, which are also submitted to the scientific journals.

These reports have, at best, limited circulation. A given report presents only a single facet and includes either data and details too voluminous for inclusion in journals at current page costs, or information of a progress nature which needs integration with future results before journal publication would be appropriate.

ROWENA SWANSON
505 Seward Square, SE, Washington, D.C.

. . . The policy of the American Institute of Physics makes the barrier between scientists and the public higher and thicker. . . . It will not improve the quality of science news published in mass media. In fact, it may dissuade competent and honest scientists from cooperating with science writers.

H. P. LEIGHLY, JR.
Department of Metallurgical Engineering, University of Missouri, Rolla

The timely release to the press of scientific news involves a deeper question than how much is owed the public. . . . Who owns science? Whom does science serve? Is the scientific fraternity truly a type of Greek-letter society, whose mysteries are to be withheld from the barbarian non-fraternity men? In recent years a widened chasm between scientists and the public, resulting from the increasing complexity of maintaining meaningful communication, has created the non-scientists' reaction against "eggheads."

Accurate reporting of science news is the reporter's responsibility. The scientist has discharged his responsibility in providing information fairly and accurately and in as simple language as the complexity of the subject matter will allow. If the reporter then errs, it is the public he fails, not the scientist; his disservice is to journalism more than to science. But to withhold science news from the press as a whole because of the malfeasances of some of its members is illogical.

The gee-whiz approach to science journalism flourishes not entirely because science writers "tend to seek the more glamorous items." The public is interested in such items more than the others, but also shows interest in what will, or can, affect it directly. It is more interested in reading of the possibility of controlling weather by means of black asphalt ground coatings than it is in the effect of estradiol on the hypothalamic neurons of rats. The latter may eventually have more direct effect on the lives of humans than the former, but this is difficult for the public to see immediately.

Both of these items are taken from the same issue of *Science* in which the editorial now under discussion appears; the item on weather control did appear in the daily press. If the other appeared, I missed it.

The American Institute of Physics has a legal right to buttress the walls of its tower with more ivory, and to its opinion that "scientific discoveries are not the proper subject for newspaper scoops." But it only makes itself, and by extension all scientists, look foolish and petty.

E. E. SLOMAN
1100 Armada Drive, Pasadena, California

I was somewhat surprised because you apparently misunderstood the *raison d'etre* of the two express journals, *Physical Review Letters* and *Applied Physics Letters*, and chagrined because you call their respective editors on the carpet for obstructing rapid release of scientific information to the public.

The original intention leading to the establishment of an express journal such as *APL* was to expedite, rather than to delay, the appearance of urgent results in a form useful to the research physicist. Urgency is not necessarily synonymous with importance. There are many research papers of immediate and lasting importance which are not urgent. On the other hand, urgent "letters" may not have appreciable durability. A communication is judged to be urgent primarily because in the editor's or reviewer's considered opin-

ion it may exert a strong influence on the direction of future effort and the present expenditure of resources in an active field of physical research. Only a small fraction of urgent communications are of immediate interest to the general public, at least judging by the treatment given the various topics covered by *APL*.

The space available for these urgent letters is premium space. It is both costly and limited, as we can carry only about 20 letters each month. Why then should this premium space be used to announce to the scientific community research results already disclosed in the public press, or, for that matter, in the Bulletin of the American Physical Society in abstract form? The purpose of early announcement has already been fulfilled and the urgency in large measure has been removed. Further airing of this information would only reduce the available space in *APL* for the not so "newsworthy" but, nevertheless, urgent letters.

There is another point which the gentlemen of the press do not seems to have grasped. The *APL* is only one activity in our editorial office. It is, in fact, auxiliary to the *Journal of Applied Physics*, which carries full length research papers as well as short scientific communications. There is no restriction relating to prior, brief disclosure on papers submitted to *JAP*. Therefore, we have left the choice with the author: (i) He may submit his contribution in abbreviated form to *APL*, agreeing to withhold public announcement until after the letter's appearance. (Acceptance, of course, is contingent upon the recommendation of a qualified reviewer. Failing acceptance on the basis of urgency, the contribution may still be considered as a communication to *JAP*.) (ii) He may announce his results to the news media immediately and submit either a full length paper or a short communication to the *JAP*. The reviewing procedures are equally rigorous for the two publications, but the minimum publication delay is 4 months for the *Journal* and 15 days for the *Letters*.

Our contributions are unsolicited (except for an occasional review paper) and there is no attempt to tell the author which course to follow. Our prime consideration is to serve the scientific community and it is to this end that our policies are formulated.

However, a deeper issue seems to be involved: Is the public interest better

served by *rapid* reporting or by *accurate* reporting? Toth infers that speed should be the overriding consideration. He is impatient with the reviewing system that the scientific community has voluntarily adopted in the interest of preserving the integrity of its record. If he had to wait 4 to 6 months to check his story, one might be sympathetic with his impatience. However, when the period required for publication is only 3 to 4 weeks, during which time the article has been critically reviewed by a qualified individual, one wonders, "Why all the fuss?" Indeed, it seems that express-letters journals offer a service to the general public as well as to the research community. At the cost of only a small temporal inconvenience, the public may now obtain through news media information which has been reviewed and which therefore bears a much stronger claim to objectivity and accuracy. In the same sense, express publication can be considered a service to the science news writer himself: He has reasonable assurance that the facts in his story have been checked at a level of competence higher than he can muster without a considerable degree of inconvenience.

These remarks should in no way be construed as disparaging of the valuable service rendered by science reporters. Theirs is a difficult calling and their efforts deserve the respect of both scientists and the general public. Moreover, there should be no fear that scientific journals will ever compete with the daily press or that their editors will as a matter of deliberate policy obstruct the reporter's access to information. Rather, I am convinced that the innovation of express journals will assist the science reporter in his important function of linking the scientist with the general public.

J. H. CRAWFORD, JR.
Journal of Applied Physics,
Oak Ridge, Tennessee

Consumption of Water

The article, "Human water needs and water use in America," by Charles C. Bradley [*Science* **138**, 489 (1962)] appears to be based on erroneous assumptions. It is conceivable that Malthusian limits will be imposed upon the population of North America, but it will not be in the foreseeable future and least of all will it be because of lack of water resources.

If we accept Bradley's argument that "3300 billion gallons per day are productive of crops or surplus water," and that this figure less unconsumed runoff gives "a remainder of about 2500 billion gallons per day which we are *consuming*, though perhaps wastefully, to produce our crops," then we can agree with him that, after "metered consumption" is added in, the total of 15,200 gallons per day per person is reasonable.

In the literature, however, *consumption* is generally taken to refer to the loss of water as a result of its withdrawal from streams, lakes, reservoirs, and ground-water storage by man. In effect we ask how much the "loss" due to natural causes has been increased by human development and use of the resource. *In toto* man's activities have had a number of consequences, but the impact has been small. Evapotranspiration in the humid East, the area with which Bradley is mainly concerned, has probably not changed greatly from the days of the pristine forests.

Bradley indicates that the figure for consumption is to be obtained "by subtracting the water which we are not using [runoff] from the total water available." This appears to correspond to the familiar formula: evapotranspiration = precipitation − runoff. Consumption so defined is relatively constant through time, if no great climatic change occurs. Application of the formula for an earlier year—1910, for example—yields results as follows. In 1910, when the population of the United States was half what it is now, the per capita consumption would have been 28,470 gallons daily, if we assume the withdrawal to have been only half that cited by Bradley. Hence, it appears that per capita use of water has been rapidly diminishing, and that this trend will continue with rising population.

Bradley proceeds to multiply the figure for present per capita "consumption" by that for anticipated population and concludes that "young Americans alive today will see a significant deterioration in their standard of living before they are much past middle age." To determine the validity of this prediction let us find whether a prediction made 50 years ago on the basis of per capita "consumption" and the anticipated population for 1960 would have been borne out, had the population been correctly predicted.

Using the 1910 per capita figure of 28,470 gallons per day in this man-

ner, we find that by 1960 the use of water should have been 5125 billion gallons per day, or more than the total daily supply of 5000 billion gallons which Bradley claims is now available in the United States (exclusive of Hawaii and Alaska). The limit should already have been reached, and Americans should now be experiencing a significant decline in their standard of living.

Readers may wish to consult the most comprehensive estimates, to date, of present and future water use—those prepared by Nathaniel Wollman for the recent Senate Select Committee ["Water Resources Activities in the United States: Water Supply and Demand," *Select Committee on National Water Resources, U.S. Senate, 86th Congress, 2nd Session, Print No. 32* (Government Printing Office, Washington, D.C., 1960)]. These estimates indicate that consumption (in the widely accepted use of the term) in 1954 was 109 billion gallons per day, estimates for the years 1980 and 2000 being put at 190 and 253 billion gallons per day, respectively.

IAN BURTON
University of Toronto, Toronto, Canada
ROBERT W. KATES
Clark University, Worcester, Massachusetts

I share Bradley's concern over the need to manage our water supplies wisely, and in general I accept his figures on water supply. But my interpretation of those figures leads me to more optimistic conclusions for the future.

For the portion of the country accounting for the bulk of our crop production, Bradley gives a figure of 2500 billion gallons per day for evapotranspiration—the return of water to the atmosphere through transpiration from plants and by evaporation. This may be divided into two parts. (i) Evapotranspiration from cropland and nonforested pastureland. This was estimated for 1959 at about 1000 billions of gallons per day for the United States, by Ackerman and Löf in their book *Technology in American Water Development*. (ii) Evapotranspiration primarily from forest land, of which about a third is grazed, and from other rural land not used for farming.

Let us consider first the evapotranspiration from cropland and pastureland. According to *Land and Water Resources, a Policy Guide*, published in

1962 by the U.S. Department of Agriculture, we are expected to provide for 261 million Americans in 1980 from a smaller acreage of cropland and pasture than was needed to support 180 million in 1959. Certainly, the continued yield increases required to make this possible will result in materially increased evapotranspiration per acre, but at a much lower rate of increase in water use than in population growth. As yield increases, evapotranspiration does not rise in proportion.

This argument applies even more strongly to the share of evapotranspiration from forest land and other rural lands. With increased population these lands will require more intensive management for increased timber harvests, recreation, and other uses. But more intensive use does not always imply much higher evapotranspiration. Conceivably it may even mean less evapotranspiration in some cases.

Therefore it seems to me that lack of water need not be a bar to a rise in population and a sustained high standard of living, provided, as Bradley points out, that we make full use of human ingenuity to prepare for the future.

KARL GERTEL
Economic Research Service,
U.S. Department of Agriculture,
Washington, D.C.

It is probably true, as Burton and Kates say, that man's activities have not altered very significantly the total evapotranspiration figure since 1910, although I strongly suspect these activities have shifted the balance significantly from transpiration to evaporation. However, in 1910 Americans were still a long way from complete utilization of America's arable land. Transpiration was not yet working directly for us on a full-time annual basis. In 1910 we were at the peak of our exploitation of renewable resources—we were "mining" our forests, grasslands, and natural reservoirs. This amounts to living mainly off water capital instead of income. Those days are almost gone, and as a nation we are about down to income and are using our land (and the water that falls on it) far more fully than we did in 1910. I suggested in my article that we may have about 10 percent of highly productive land left to put into use. Gains beyond this will probably be marginal. While I could be wrong in this assumption, I do not believe the error would have any long-run significance when

we are considering a population that is now doubling every 40 years. It is one thing to double the 1910 population of 60 million, quite another to double the 1960 population of 180 million.

My remarks on the American standard of living were, to a certain extent, made tongue-in-cheek. The rich flavor of chlorine in my drinking water, an open sewer named Clearwater Creek, the green scum and aroma of dead fish coming from my old swimming hole all tell me that something obscene has long since affected the *quality* of my "water standard of living." More important, perhaps, is the fact that, in the last 10 to 15 years, *quantity* of water has become an expanding problem in more and larger areas of the United States. There are very few major areas left where no water problem exists. Some places are in deep trouble. It therefore really takes no sophisticated mathematical insight to see that the limits of water supply in the nation as a whole, for the ways in which we are now using it, are practically at hand. In other words, I don't argue too much with Burton and Kates's manipulation of my figures since to me they merely suggest that we already have *passed* the peak in our water standard of living.

Regarding Gertel's comments, is he saying that increased yield of crops (forest and pasture included) per acre will not require a linear increase in *transpired* water, or does he perhaps mean that by more thorough plant cover and management a larger proportion of the rainfall can be shifted from evaporation to transpiration? If he means the former the statement should be documented. If he means the latter I agree. In fact I hinted in my article that herein lies our biggest opportunity to effect water conservation.

Gertel suggests that the "people versus water" picture is not as bleak as I have painted it. Would he care to apply his own figures toward answering the question posed in my article: How many more years can we sustain our present water standard of living with the projected population curve?

I realize that the timetable for Malthusian limits to be imposed on the population of the United States is not really foreseeable. I merely indicated that present population trends and present rate of rainfall would, in 200 years, bring us to the point of using all our rainfall to raise our food; I based the calculation, of course, on the transpiration ratios and the assumed diet of 2 pounds of bread and 1 pound of meat per day per person. I understand that the latest census studies indicate a slight leveling in the population growth curve, and this curve, of course, is the key to any calculation of timetables. Furthermore, I am certain that long before we begin to approach Malthusian limits we will not be insisting on a daily ration of steak. Any wholesale dietary shift from bread and meat to, say, marine plankton would make the transpiration ratios meaningless although few Americans today would construe such a shift as a gain in our standard of living.

CHARLES C. BRADLEY
Division of Letters and Science, Montana State College, Bozeman

"Critical Periods" in the Development of Behavior

Scott's interesting article (*1*) on "critical periods" in behavioral development merits a thoroughgoing critical review bearing on the validity of his general conceptions of behavioral ontogeny basic to the idea which he has extrapolated from embryology to the study of behavior. Here, however, we comment specifically on certain inferences that might be drawn from his allusion to our recent article on behavioral development in cats (*2*).

In discussing his concept of critical periods, Scott reports us as having "suggested that there are critical stages of learning—that what has been learned at a particular time in development may be critical for whatever follows."

Although we are not disposed to dispute this broad statement, it is not ours. In our view, any such sentence should have a more comprehensive context, to the effect that what the young animal may attain in behavior at any phase of ontogeny depends upon the outcome of earlier development in its every aspect. The point we wish to emphasize here, however, is that our position might be seriously misunderstood in at least two important respects from Scott's allusion to our article. (i) Although, as our study of social behavior in newborn kittens (*2, 3*) indicated strongly, learning is involved at all phases in behavior development, our findings have broader and very different implications for social ontogeny than might be gathered from Scott's mention of the work. (ii) The

context indicates that Scott has misunderstood the criticisms we have offered (*2*, *3*) of his "critical periods" concept.

The gist of our objection is not that we favor describing three critical periods of social development, corresponding to the three main stages in the ontogeny of social-feeding behavior in kittens for which we found evidence, or whatever number of critical periods might be advanced as an alternative. We were interpreting our results from a viewpoint definitely at odds with Scott's notion of "critical periods" when we wrote (*2*): "These considerations favor a very different view of the concept of 'critical periods' from the one now held by many writers. In the social development of the cat, we are led to the idea that striking changes in the essential progression are grounded not only in the growth-dependent processes of maturation but also, at the same time, in opportunities for experience and learning arising in the standard female-litter situation. This conception of social ontogeny encourages stressing not just one or a few chronologically marked changes in the behavior pattern, but rather indicates that normally each age period is crucial for the development of particular aspects in a complex progressive pattern of adjustment." We consider the implications of this theoretical viewpoint for developmental research very different from those of Scott's concept.

Evidence supporting our view demonstrated that in kittens, at all age periods, social approaches preliminary to feeding behavior undergo a course of development in the litter situation significantly different from the behavior of kittens reared under conditions of isolation and fed from an "artificial mother" (*2*, *3*). No evidence was found for any time interval in which the different conditions of rearing failed to produce a pattern of feeding approaches and suckling in kittens reared in isolation that was significantly different from that in normally reared kittens of corresponding ages. This result had been predicted from the theory of social ontogeny (*4*) which guided our work.

Those who examine this theory (*4*, *5*) and related considerations (*2*, *6*, *7*) will find an emphasis upon the fusion of maturation (growth-contributed) and experience (stimulation-contributed) processes at different stages in

behavioral ontogeny, together with the contention that the contributions both of maturation and of experience (the latter including, but not confined to, conditioning and learning), as well as the interrelations of these contributions, may differ greatly according to stage in any animal. This theory thus differs sharply from Scott's, with its emphasis (see *8*) upon factors of maturation presumably specific for "critical periods" and its apparent assumption that "learning" is a distinct and probably a delayed contributor.

From our theory of behavioral development (*4–6*), we conclude that factors of maturation may differ significantly in their influence upon ontogeny, both in the nature and in the timing of their effects, according to what relations to the effects of experience are possible under the existing conditions. We found, in support of this view, that gains in suckling made by kittens reared in isolation differed greatly from gains made by litter mates reared by the mother, and that the kittens reared in isolation were, at best, only partially adapted to the demands of social feeding and suckling of the mother at the time of their return to the litter. The differences between the experimental animals and the control litter mates were striking. In no single phase of development during the first 2 months of life did these two very different conditions of rearing—with mother and litter or isolated, with an "artificial mother"—fail to have very different effects on the development of suckling responses, despite the presumable equivalence of potential factors of maturation for kittens in the two groups. The results indicate that the actual effects of maturation differed considerably in the two cases. We do not find such evidence compatible with the meaning of *maturation* that would seem to follow from the critical-period hypothesis.

What is social behavior? Scott states (*1*) that in puppies the period of socialization begins at approximately 3 weeks of age. We submit, however, that much of the evidence he cites bears only tangentially on the question of when socialization really begins. Although his article is mainly concerned with social behavior, it does not deal primarily with *intra*species behavioral relationships but deals, instead, with the responses of puppies to human handlers, of young birds to artifacts, and the like. Under the heading, "Process of

primary socialization" we find, for example, citations of tests in which machine-fed and hand-fed puppies "became equally attached to people . . .," hand-fed puppies "yelped more when they saw the experimenter . . .," "hungry puppies became more rapidly attached to the handlers . . . ," and "separating young puppies overnight from their mother and litter mates . . . speeded up the process of socialization to human handlers."

The degree of equivalence between such results and the ontogeny of interactions among species mates may prove to be appreciable, but it has not been determined. We suggest that Scott, in basing his principal treatment of social development upon experimental interventions featuring responses to conditions other than association with species mates has been led astray. In our studies of the social-feeding behavior of kittens we were able to distinguish early forms of intraspecies social responses not evident in reactions to human handlers or to artifacts such as the "artificial mother." A dependence upon the latter two sources of evidence might have led us to neglect aspects of intraspecies behavior which we found crucial for the understanding of social ontogeny.

With due emphasis upon intraspecies behavioral relations, we maintain that processes of socialization and formation of the social bond begin at birth, if not earlier (*2–6*). Kittens make consistent progress from an hour or two after birth in becoming oriented to their environment and to species mates, in becoming adjusted to the litter situation and the "home area," and in making individual, distinctive responses to particular nipples. Such aspects of behavior concern reciprocal relations of dependency with the mother and with litter mates, hence are social.

Because Scott was concerned with giving an account of the critical-period concept and illustrating it, evidence centered on the ontogeny of intraspecies responses may not have seemed relevant to him. Yet, because his reference to our article might imply that it supports his own concepts of behavioral development, we assert that there is an important difference between his view and our own.

T. C. SCHNEIRLA
JAY S. ROSENBLATT
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Statements of contrasting theoretical positions are useful if they stimulate the collection of additional data, leading in turn to the modification and evolution of theory. I am sure that the comments of Schneirla and Rosenblatt were offered in this spirit, as is my reply.

The points raised in their letter go far beyond the scope of my original article. I believe that most of them are complementary rather than contradictory.

1) Failure to find a critical period for primary socialization in the cat. In order to thoroughly understand the development of behavior in a given species, one should have timed data on the development of basic behavioral capacities, including sensory, motor, and learning capacities, as well as on the development of patterns of social behavior. In addition, one should have a description of adult social organization, to which behavioral development seems to be strongly related. In the absence of such general background information for the cat, I have been unable to evaluate Schneirla and Rosenblatt's data in terms of evidence for the existence or nonexistence of a critical period for primary socialization. Although cats are not highly social animals, I would be surprised if there were no such period in this animal, in view of the wide occurrence of the phenomenon in social birds and mammals, and even in insects.

2) Role of learning in behavioral development. With respect to the importance of learning in behavioral development, our points of view are supplementary rather than antithetic. Where Schneirla and Rosenblatt emphasize the fusion of maturation and learning, I would add that the learning process also changes with time and can itself be thought of as a developmental process. Much evidence indi-

cates that the rate of development of the capacity for learning varies widely from species to species, but additional information is badly needed along these lines. To my knowledge, in no species, not even the human, has a study of any simple learning capacity been carried completely through the stages of early development.

3) Nature of the process of socialization. Schneirla and Rosenblatt have concerned themselves with the point at which the process begins; my article dealt with the period during which the process proceeds most rapidly. Both kinds of information are necessary for understanding the process. As I said in the article, processes are not necessarily limited to the periods in which they are most prominent.

4) Experimental methodology. Two principal methods of studying the development of social behavior have been used: cross-fostering between species (or upon models) and social isolation. The two methods produce quite different results. In general, cross-fostering transfers social relationships but often has little effect on the development of social behavior patterns. Social isolation prevents the development of social relationships and may distort or inhibit the development of certain social behavior patterns. Both methods contribute to our understanding of the process of socialization. Schneirla and Rosenblatt observe that the cross-fostering method is more likely to reveal the existence of critical periods; this method has not yet been applied in the cat.

5) The nature of behavioral development. Two testable hypotheses can be stated (in stating them I do not ascribe either extreme of the two viewpoints to Schneirla and Rosenblatt). (i) Behavioral development is a unitary process, and what takes place in one period of development is dependent on everything that went before. (ii) Behavioral development may be composed of many different processes having a considerable degree of independence, both within the individual and between species. The actual facts probably lie somewhere between these two viewpoints.

Behavioral development is an extremely complex phenomenon. In interpreting any given set of data it is important that alternative hypotheses be considered and eventually tested.

J. P. SCOTT

Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine

Bodega Bay Nuclear Plant

The editorial "Civilian nuclear power" in the 14 December issue (*1*) very appropriately brings attention to the recent Atomic Energy Commission report which documents U.S. achievement in reactor technology. Although the quotation from this report cites the remarkable reduction in cost of fission-generated electricity to an "estimated 5.5 to 6 mills [per kilowatt-hour] for a large plant to be built in the near future at Bodega Bay, California," the editorial fails to point out that such economical operation of the proposed plant would be possible primarily because of the site. Were the plant to be situated in a more remote place where cooling water, transportation facilities, and other features of construction and operation are less readily available, the electricity could not be sold at so low a price—that is, nearly in the range of cost of electricity generated by fossil fuels.

The Bodega Bay reactor, would be the largest nuclear plant for generating electricity in the world. Water wastes would be discharged into the ocean, with resulting thermal changes and deposition of radionuclides similar to those in the discharge from the Hanford reactors into the Columbia River. Low-level gaseous wastes would be discharged at a point windward of a highly productive agricultural area which supports a 70-million-dollar-a-year dairy industry in the San Francisco milkshed. The plant would conform to AEC regulations regarding safety measures; nevertheless, the proximity of the reactor site to populated areas and areas of agricultural production would create special problems which should be taken into consideration. The site is just *under* ¼ mile from the San Andreas fault (previous regulations regarding the location of reactors stated that "no facilities should be located closer than ¼ to ½ mile to a known active earthquake fault," but the regulations were altered in April 1962 to read only "¼ mile"). Thus the hazard of possible natural catastrophe is added to the hazard of possible man-made catastrophe. Normal operating conditions would add detectable radiation to the local biosphere.

The site has long been considered a unique natural preserve; for this reason Bodega Head had been selected by the University of California as the location for a marine biological laboratory. A

faculty committee of the university has so far failed to find an alternative laboratory site which would be as suitable, quite apart from considerations of accessibility. The propriety of the political maneuvers by which the Pacific Gas and Electric Company acquired land rights has been questioned; moreover, alterations in federal and local regulations have facilitated the development of the project, although none of this help can be classed as subsidy.

The implications of the AEC report might well have been examined in the editorial from the viewpoint of the AAAS Committee on Science in the Promotion of Human Welfare: What is the impact of science on society as exemplified by nuclear technology at Bodega Bay? The AEC report states that over half the electricity in the United States may be generated by nuclear reactors by the year 2000. While such reactor development can be beneficial, is it not fitting to ask whether those who are affected by such growth are participating in the decisions which make such economic developments feasible? Are consumers of electricity willing to buy the product for 5.5 mills per kilowatt-hour and take an admitted but as yet unmeasured health risk (*2*) and sacrifice the ecological and scenic assets of Bodega Bay? Where will the public have an opportunity to register its opinion? The AEC has not yet held hearings for granting the license for the Bodega Bay reactor. (Recent legislation has reduced the number of mandatory public hearings for reactor licensing. The AEC report suggests that further simplification and streamlining of licensing procedures will encourage utilities to develop more nuclear power stations. Would it not be in the public interest to hold hearings regarding site selection before the utilities present a *fait accompli*?) Will the development of nuclear power demand that Bodega Bay be selected, as the only suitable location? Will all who are affected participate in that decision?

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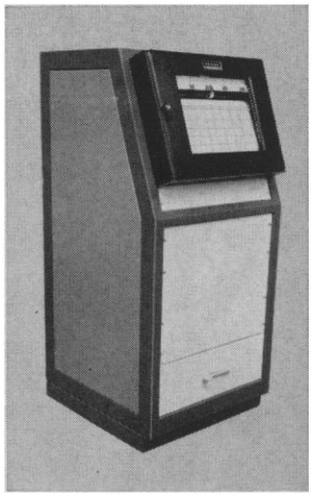
The proposed Bodega Bay Atomic Park of the Pacific Gas and Electric Company is cited in a recent editorial as a breakthrough in nuclear power economics. The editorial quotes excerpts from AEC chairman Seaborg's recent report to the President and asserts that the power rate figure "does not involve a subsidy."

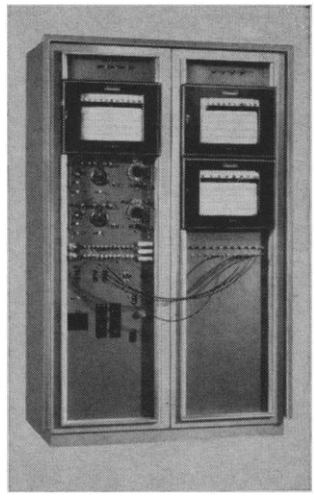
It happens that this particular power plant will be built on a scenic headland, about 50 miles north of San Francisco, which was included in the 1955–56 California State Park master plan. For some reason the state master plan did not receive open and public consideration by the Sonoma Planning Commission, and this apparent pocket veto made it possible for Pacific Gas and Electric to purchase the initial site on Bodega Head and to acquire an additional 67 acres for an exclusion zone through exercise of its rights of eminent domain. Further, Sonoma County has granted an easement for three lines of high-tension wires along the entire length of its only coastal park, Doran Beach County Park.

Bodega Head had been selected by the University of California as the site for its future Marine Biological Laboratory. Through construction of an access road and the emission of 250,000 —perhaps eventually 1 million—gallons of hot water per minute, the power station will transform the area from a unique class A site to a class B site for a marine facility. The history of this somewhat controversial matter is documented in the booklet "A Visit to the Atomic Park," published and circulated under the auspices of the Sierra Club in San Francisco.

The power economics of the Bodega Bay reactor are discussed in an article by Dresner and Weinberg in *Reviews of Modern Physics* [**34**, 747 (1962)]. These authors point out that the price of fossil fuel at Bodega Bay is much higher than the average for the rest of the United States. They go on to say that the exact method of calculating the fixed plant cost, the initial outlay for fuel, the plutonium buy-back arrangement, the lease charge for U^{235} hold-up, and the assessment for spent-fuel reprocessing will all be instrumental in dictating the ultimate cost of mills per kilowatt-hour at the Pacific Gas and Electric facility. The authors state: "These prices are set largely by government fiat; the current prices represent a substantial government subsidy for the Bodega Bay plant."

Assuming that the radioactive waste





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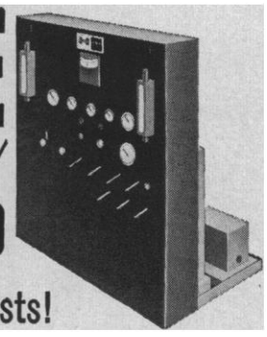

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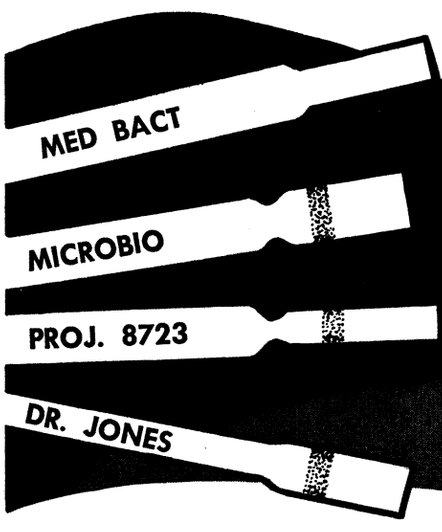

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problem can eventually be solved, Dresner and Weinberg conclude that the development of "breeder" reactors which can utilize abundant low-grade uranium and thorium ores is "one of mankind's most important ultimate tasks." Reactors of the Bodega design will decimate the national reservoir of high-grade uranium ore without making any substantial contribution to technology. Nonetheless, convertors of this type are fostered by the AEC, probably because, as Chairman Seaborg has said, the intensely competitive nuclear equipment industry is "over-capitalized and under-used at the present time" and it is thought necessary to keep the uranium industry "viable" during the period of transition to breeder reactors.

Finally, the Price-Anderson Act of 1957 provides a federal liability indemnity of $500 million for each catastrophic accident in a nuclear installation. Through this subsidy, ethical standards of safety may have been bypassed and ultimate liability transferred to the taxpayer [A. Ackermann, *Proc. Am. Soc. Civil Engrs.* **87**, No. PP2 (1962)]. This point is especially relevant to the Pacific Gas and Electric reactor in view of the proximity to the San Andreas fault and the meteorological instability of the Bodega area.

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In my editorial I cited the proposed Bodega Bay plant with its estimated cost of 5.5 to 6 mills per kilowatt-hour merely as an example of a continuing trend toward lower costs of nuclear power. I was unaware of the controversy over the site of the proposed installation. On that matter I have little knowledge. With respect to estimating future trends in costs of nuclear power I do have a special basis for the opinion that figures considerably lower than those cited for Bodega Bay are in sight. Indeed, Alvin Weinberg has recently spoken of costs as low as 1.5 mills per kilowatt-hour for a very large installation.

As for the matter of subsidy, the monetary value of the government insurance is small. The utilities are re-

quired to obtain a substantial amount of insurance with private companies. This covers most of the accidents which might occur. The government insurance in effect amounts to a $60 million deductible policy. The utilities pay AEC a fee of $30 per thousand kilowatts of thermal energy as a premium to obtain the additional coverage up to $500 million.

It is difficult to establish what the true competitive position of oil and nuclear energy would be in the absence of federal action. The government has set an artificially high price for natural uranium. In a free market its price might be half what it is at present. The 27½-percent depletion allowance for oil is worth about a billion dollars a year to the petroleum industry. If this allowance were removed, the competitive situation with respect to energy in California would be considerably changed.—P.H.A.

Activists and Nonactivists

The article "Divergent reactions to the threat of war" [*Science* **139**, 88 (11 Jan. 1963)] raised a number of important issues, mainly in the realm of group perception. For instance, the restudy seemed to suggest that both groups had been attentive to those arguments and points of view presented publicly that were most closely in accord with their previous thinking. After intensive public propaganda by opponents of Medicare, as well as by its supporters, the OASIS group was more against it, and the People for Peace group were more in favor of it.

In their conclusion the authors express surprise at the "similarity between the two groups" and suggest that this may have been due to the "particular community studied." May I suggest another alternative, which evidently was not considered by the authors? It is significant that out of a community of 8000 people (3500 adults?) only 54 sought concrete community action of any kind during the Berlin crisis (unless there was other activity which the authors do not tell us about). Perhaps the two groups are relatively similar in a number of ways because they represent the activists in the community. They are probably the best-informed members of the community and those who tend to respond to emergency conditions with some kind of concrete ac-

tion. Despite fundamental differences between the two groups, the many overlapping areas of attitude and belief would seem to support this hypothesis.

In any case, it would be interesting to compare the beliefs, attitudes, and personalities of the members of these two groups with those of a sample of nonactivists in the same community, to see whether the differences between the joiners and the nonjoiners is any greater than the differences between the two groups of joiners.

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Ultrafiltration Membrane Performance

Clark states (*1*) that the driving force for ultrafiltration is the chemical potential. This is a misleading statement. Any difference in chemical potential that arises across the membrane is a (hitherto unexplained) *result* of the pressure ultrafiltration process and not its *cause*. The driving force for ultrafiltration is the applied-pressure difference across the membrane. It is immaterial whether this pressure difference be expressed as such, or as, for instance, a chemical potential gradient, but in order not to confuse cause and effect, and in order to explain clearly the various phenomena inherent in pressure ultrafiltration, it is best to consistently view the external energy source, the applied-pressure difference, as the driving force for ultrafiltration.

A paradoxical phenomenon is this: The higher the pressure is, the more salt the cellophane membrane retains in an ultrafilter containing a solution of salt in water. Clark (*1*) has not explained this phenomenon. For its explanation one needs more facts than just the data from Ambard and Trautmann's Table 2 (*2*), given by Clark. A few more useful data can be found elsewhere in their book: Tables 4, 5, and 6 demonstrate that salts with bivalent anions and monovalent cations are more strongly retained than salts with monovalent anions and monovalent cations, while salts with bivalent cations and monovalent anions are hardly retained at all, as compared to salts with monovalent cations and anions.

When we relate these data to the

fact that cellophane is negatively charged, it becomes clear that the salt retention must be due to electrostatic repulsion of the anions by the negatively charged membrane, a repulsion which is strongest when the anions carry the highest charge and weakest when the cations carry the highest charge (*3*).

The paradoxical phenomenon that the salt retention becomes more pronounced at higher pressures can only be due to the contribution of the streaming potential to the charge of the membrane (*4*). For the streaming potential E, caused by pressing the solution through a charged membrane, is proportional to the applied pressure P, to the potential of the membrane ζ, and to the dielectric constant ϵ, and inversely proportional to the viscosity η of the solution and to its conductivity λ. This relationship is usually expressed, according to Overbeek (*5*), as

$$E = \frac{P\epsilon\zeta}{4\pi\eta\lambda} \qquad (1)$$

A final proof of this hypothesis would be furnished if it could be shown that salt retention is higher at higher values of ζ potentials of otherwise identical membranes and under otherwise identical conditions. I recently made an experiment along these lines, ultrafiltering salt solutions at various *p*H's, and I found that the salt retention is indeed highest at the highest *p*H (when the acid groups of cellophane are highly dissociated), and lowest at the lowest *p*H(when these acid groups are hardly dissociated) (*6*).

Equation 1 for the streaming potential also shows why at the lowest salt concentrations the salt retention is highest: When the conductivity λ of the solution is lowered, the streaming potential E becomes higher (see *2*, Tables 4 and 5). The necessity for turbulence above the membrane for obtaining maximum salt retention (see *2*, Table 1; *4*) is now easily understood, for without it salt enrichment just above the membrane would occur, locally raising the conductivity λ of the solution, which would cause a lowering of the streaming potential E (*7*). The at-first-sight surprisingly small influence of temperature changes becomes clear when it is realized that while the conductivity λ rises with the temperature, the viscosity η diminishes at a slightly higher rate. So a rise in temperature will result in a slight decrease in $\eta\lambda$, resulting in a small increase in the streaming potential E—an increase even

further attenuated by a slight decrease in the dielectric constant of water, $\dot{\epsilon}$. Thus, the theoretical increase in streaming potential E, when the temperature is raised from 8° to 18°C, can be calculated to be of the order of 1.6 percent—a value in reasonably good agreement with Ambard and Trautmann's observation (*2*, Table 3), that the salt retention rises 1.8 percent under these conditions.

It becomes evident that the requirements for an ideal membrane for desalting with the pressure method are as follows. (i) It has to have the highest possible charge (either negative or positive); (ii) it has to have a very small pore size, of the order of 30 Å or less [otherwise the electrostatic repulsion of small ions seems to be ineffective (*4*)]; (iii) it has to be as thin as possible (to allow for the highest rate of filtration at a given pressure); and (iv) it has to be strong (to withstand the highest possible pressure) (*8*).

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References and Notes

1. W. E. Clark, *Science* **138**, 148 (1962).
2. L. Ambard and S. Trautmann, *Ultrafiltration* (Thomas, Springfield, Ill., 1960).
3. Ambard and Trautmann's thesis is that all these phenomena can be explained by invoking differences in hydrated volumes of ions at different concentrations. But (hypothetical) differences in hydration can explain neither the difference in influence of multivalency of anions and cations nor the enhanced salt retention at higher pressures.
4. C. J. van Oss, thesis, Sorbonne (1955).
5. J. Th. G. Overbeek, in H. R. Kruyt, *Colloid Science* (Elsevier, Amsterdam, 1960), vol. 1, p. 204.
6. C. J. van Oss, in preparation. (When a 10-milliequivalent sodium chloride solution is ultrafiltered under a pressure of 110 lb/in.^{2}, the salt retention rises from 5 percent at *p*H 3 to 20 percent at *p*H 11 for the first ultrafiltrates.)
7. The obvious necessity for agitating the solution has nothing to do with the overcoming of Clark's "film resistances," for the rate of filtration remains unchanged, whether or not the salt solution is agitated.
8. I am indebted to Professor A. M. Monnier (Laboratoire de Physiologie Générale, Sorbonne) for the many fruitful discussions we have had on this subject.

Numerous ultrafiltration data show that salt rejection increases as the pressure difference across the membrane increases (*1–3*). Two hypotheses were advanced to explain the increase in salt rejection with increase in pressure: (i) that pressure on the membrane increased the resistance to flow of salt (*2*); (ii) that pressure affected the hydrated ions, presumably increasing hydration (*1*). The first purpose of my report (*4*) was to show that neither of

Table 1. Summary of calculations for Fig. 1 from data of Ambard and Trautmann (*1*).

Experiment			
2	3	4	5
Data: Filtering solution (NaCl, mg/lit.)			
500	200	100	50
Filtrate (NaCl, mg/lit.)			
460	160	70	28
Calculations: n_1 (10^{-7} mole NaCl/mole H_2O)			
1,540	616	308	154
n_2 (10^{-7} mole NaCl/mole H_2O)			
1,417	493	215	86
RT ln (n_1/n_2) (cal/mole)			
49	130	208	338
n_1^2 ($\mu'_1-\mu'_2$), (10^{-9} cal/mole)			
1,170	494	197	80
J'/J (10^{-6} g NaCl/g H_2O)			
460	160	70	28

these hypotheses was necessary. Mahon had suggested earlier that the driving force for water flow was pressure, and that the predominant driving force for salt flow was difference in concentration (*5*). The second purpose of my report was to show that a single driving force was sufficient.

My reasoning was as follows. Salt and water will flow through a permeable membrane, even in the absence of a pressure difference, until equilibrium is established. At equilibrium, the chemical potential of the salt is the same on both sides of the membrane, and the chemical potential of the water is the same on both sides. Therefore, difference in chemical potential, or some quantity related to difference in chemical potential, is a logical choice as a general driving force for flow. In keeping with the formalism of the thermodynamics of irreversible processes, I selected difference in chemical potential as the single driving force and found, as shown in my report, that the flows of water and salt could be considered independent of each other for the range of data presented there. The rate of flow of water was directly proportional to the difference in chemical potential of the water, and the rate of flow of salt was directly proportional to the difference in chemical potential of the salt. Skiens and Mahon, viewing difference in activity as the driving force, have independently reached similar conclusions (*3*).

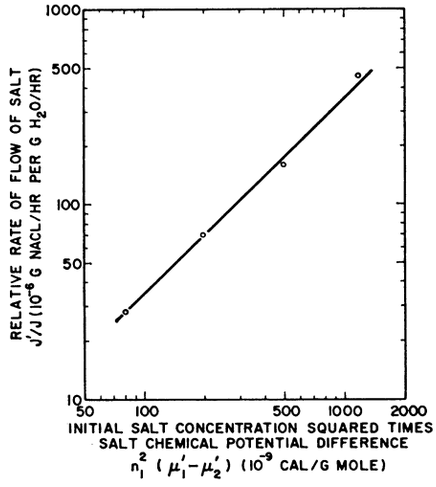

Fig. 1. Relative rate of flow of salt across an ultrafiltration membrane. The slope of the line is unity, showing that the rate of flow of salt is directly proportional to the difference in chemical potential of the salt [From data of Ambard and Trautmann (*1*)].

The data from Ambard and Trautmann which appeared in my report were selected because they illustrated the points which I wished to make quite clearly. Unfortunately, those data also masked other effects, because the initial salt concentration was held constant. Van Oss is quite correct when he maintains that the kind of salt and the concentration have marked effects on the rate of flow of salt across the membrane. Table 1 and Fig. 1 show the results of some calculations based on other data from Ambard and Trautmann (*1*, Table 4) in which the initial salt concentration, n_1, is allowed to vary. The approximation that the difference in chemical potential, $\mu'_1 - \mu'_2$, is equal to RT ln (n_1/n_2) is used in the calculations. Since the slope of the line in Fig. 1 is equal to unity, the data show that the rate of flow of the salt, J', remains directly proportional to the difference in chemical potential of the salt even though the initial concentration of the salt changes tenfold. The data also show that the resistance to flow varies inversely with the square of the initial concentration of the salt. Thus, in the method which I suggest for predicting the flows of salt and water during ultrafiltration, the changes in flow rate for different salts and different concentrations which cannot be accounted for by changes in chemical potential are ascribed to differences in resistance to flow. Why these resistances vary as they do is an interesting problem, on which van Oss's views may shed some light. I am sure that, as we learn more about ultrafiltration, the viewpoints of both van Oss and myself will be modified until we meet upon some common ground.

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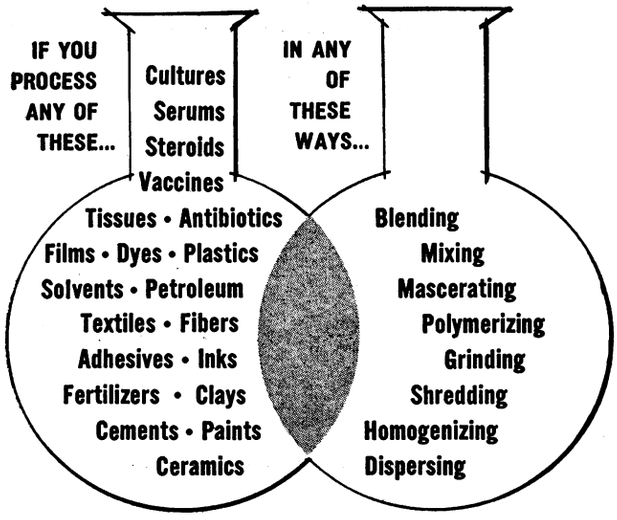

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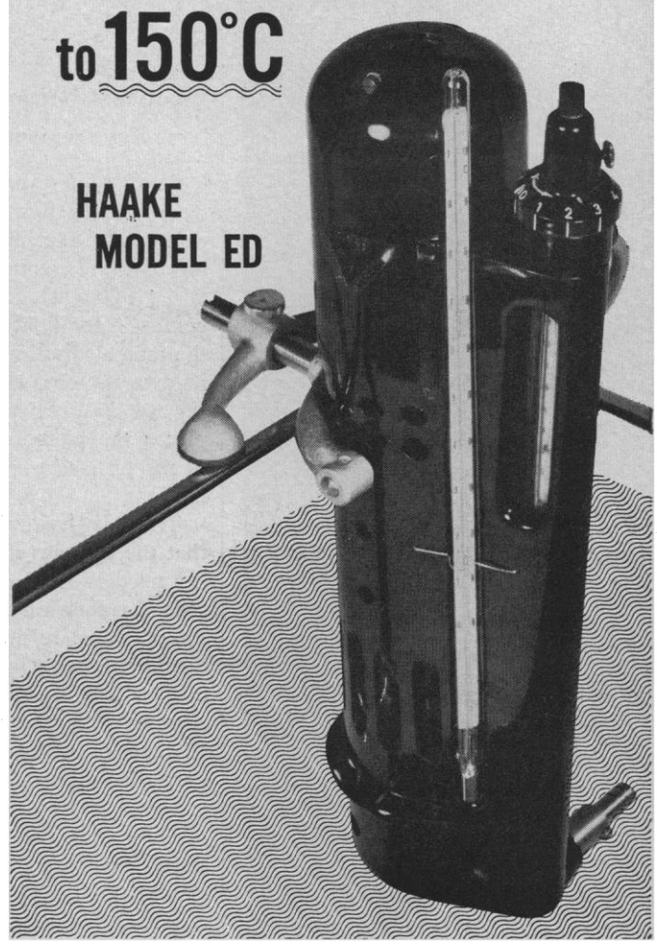

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2. E. J. Breton, Jr., *U.S. Dept. Comm. Office Tech. Serv. PB Rept. 161391* (1957), pp. 18–19.
3. W. E. Skiens and H. I. Mahon, "Permeation rate constants for water and salt flux through synthetic membranes," paper presented at the American Chemical Society meeting in Washington, D.C., March 1962.
4. W. E. Clark, *Science* **138**, 148 (1962).
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Emotional Response to Nonreinforcement

In an interesting report describing cycles in the force of a lever response during the execution of fixed-ratio reinforcement sequences [*Science* **138**, 516 (1962)], D. E. Mintz interprets his results in the light of a supposition that the animal discriminates the strength of its own response on the occasions when reward is obtained. This explanation places the phenomena in the category of response-shaping by operant discriminations.

There is, however, a clear possibility that the changes in response force during fixed ratio reinforcement sequences reflect, rather, an emotional reaction of the organism to nonreinforcement. One would expect such responses, if they occur, to contaminate the strength of instrumental level press, because tension of both smooth and skeletal muscle is part of the pattern of emotional discharge.

That conditioning procedures produce emotionality is, of course, a classic finding of Pavlov and Liddell. A particular verification as regards the case of the fixed-ratio paradigm demonstrates that gradually shifting the ratio toward higher values produces, in the cat, muscular tension which may conveniently be measured by the number of vocalizations emitted but which includes, in a pattern, tail-flicking, flexion of limbs, pacing, and so on [M. F. Halasz and H. F. Hunt, report to the 3rd World Congress of Psychiatry, Montreal (1961)]. Thus, the schedule employed by Mintz seems to be one where failure to obtain reward may have emotional repercussions. If the consequent tonus be thought of as cumulating from one nonreinforced response to the next, and as declining over successive reinforced presses, the curves presented might well be accounted for by simple superposition of general tension on the lever response.