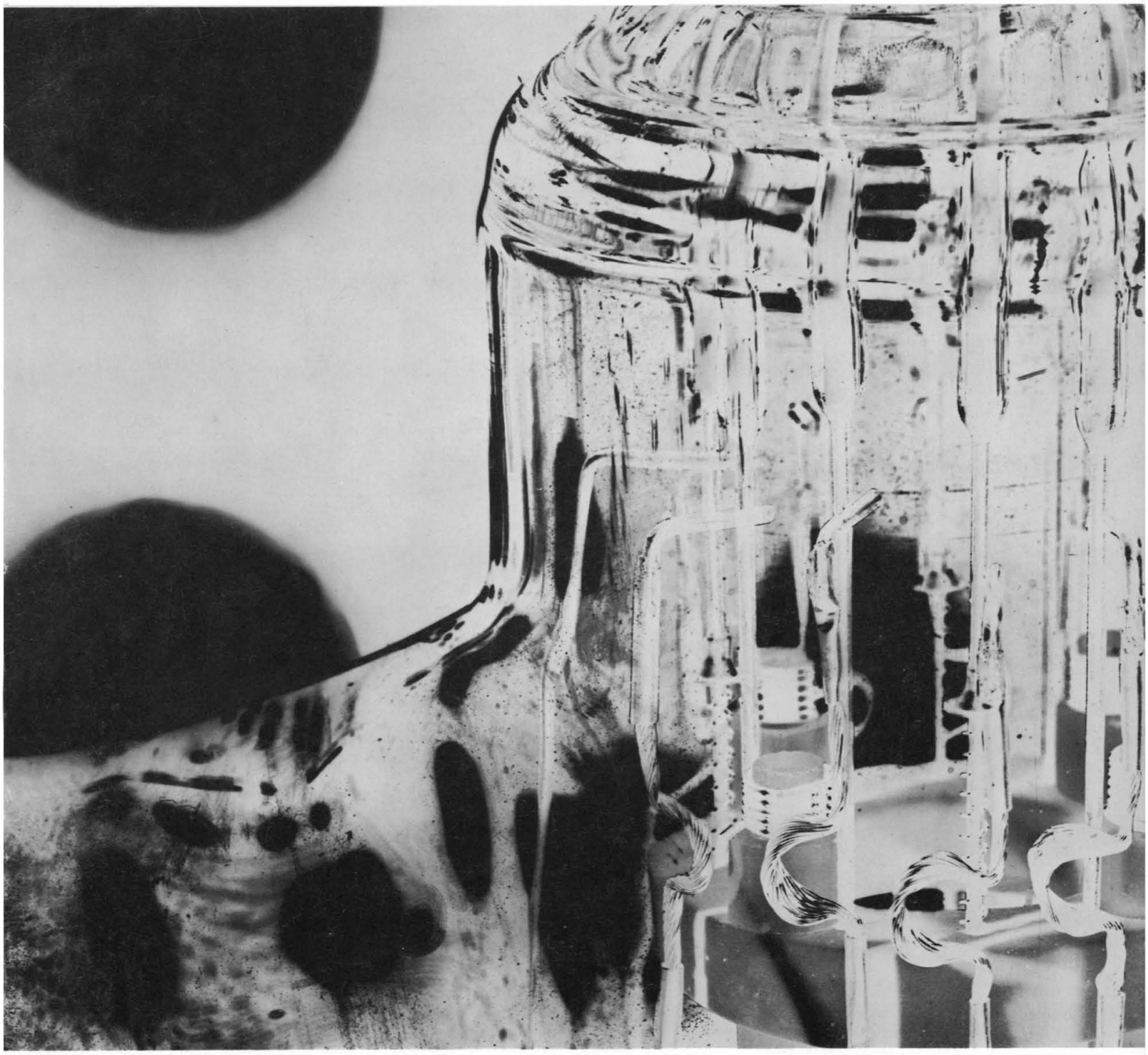
SCIENCE

11 October 1963

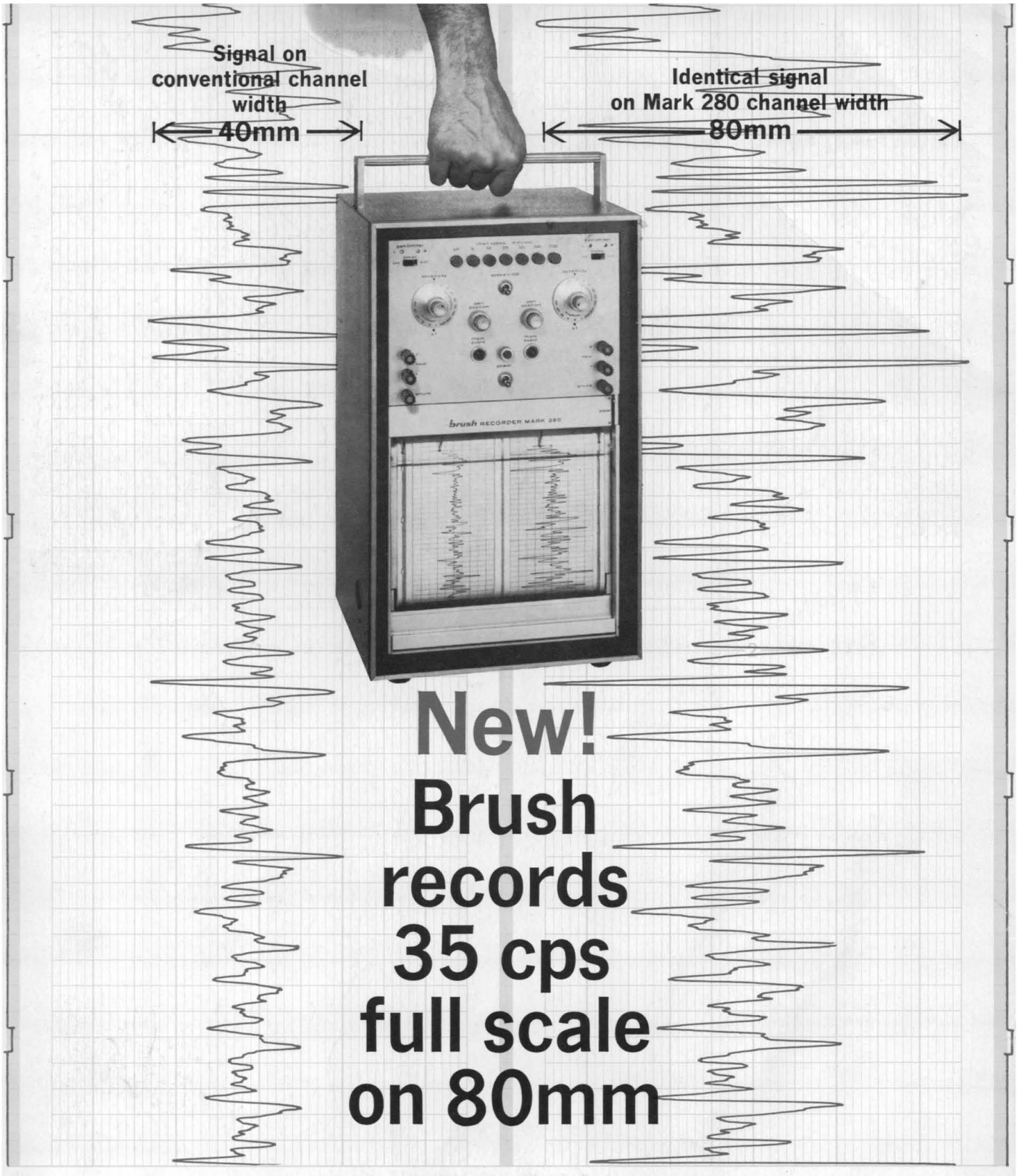
Vol. 142, No. 3589

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



S SPECTROMETER TUBE

Instrument Issue



New! Brush records 35 cps full scale on 80mm

The new portable Mark 280 doubles resolution of traces without sacrificing frequency response! And . . . you get instantaneous rectilinear ink records of unparalleled accuracy and clarity. Forced fluid writing presents traces, at frequencies to 35 cps full scale, on low cost chart paper. Dual channels each have 50 divisions in an 80 mm width, with trace width constant at one-tenth of a chart division. So now, you can easily detect minute signal variations and take *full* advantage of a ½% system accuracy. Matched solid-state amplifiers provide a sensitivity of 0.5 millivolts/div. Operating controls include attenuator, pen-position, variable gain and 12 push-button chart speeds. No other recorder can match the total capability of the Mark 280. Write for details.

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TEMP-BLOK Module HEATER

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no water required

6 INTERCHANGEABLE HEATING BLOKS*

• MODULES HOLD UP TO 30 TEST TUBES

Here's how to improve test tube heating for a variety of laboratory procedures ...get uniform temperatures adjustable from ambient to 130°C ...controllable to ±0.5°C

Only the Temp-Blok dry heat design provides the economy, convenience and versatility of *modular* construction. One heater handles all Module Bloks. So compact, so efficient you wonder why it wasn't developed before. Interchangeable aluminum bloks nest snugly into the heater base; accommodate test or culture tubes 6 mm. to 25 mm. in diameter. Close contact of blok and heater assures exceptionally uniform heating of tube contents; provides rapid temperature rise (from ambient to 37°C in less than 20 minutes). Module blok has opening for thermometer to check temperature.

Designed to facilitate tests for Rh, prothrombin, blood urea nitrogen (BUN), blood matching, incubation and inactivation of cultures, enzyme reactions, melting and boiling points, and a wide variety of clinical and industrial procedures.

*Special Module bloks made to order. Prices on request.

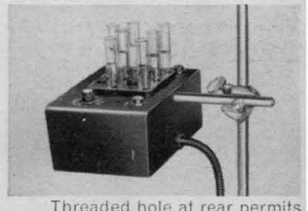
CAT. NO. 2090 TEMP-BLOK Module HEATER (base only). 4 lbs. net. 100 Watts, 115 Volts, 50/60 Cycles. 8" W x 5" D x 3" H. **$34.50**

230 Volts available on request. Stainless steel cover available, also, for shielding of test tubes.

Module HEATING BLOKS, black anodized aluminum. 4" W x 3" D x 2" H.

Write today for Bulletin 325 ▶

Cat. Nos.	No. of openings	Tube diam.	Price
2070	30	6 mm.	
2072	20	12 & 13 mm.	
2073	12	15 & 16 mm.	
2074	8	20 mm.	**$15.00** each
2075	6	25 mm.	
2076 (combination)	3 5 6	25 mm. 12 & 13 mm. 6 mm.	



Threaded hole at rear permits suspending Temp-Blok.

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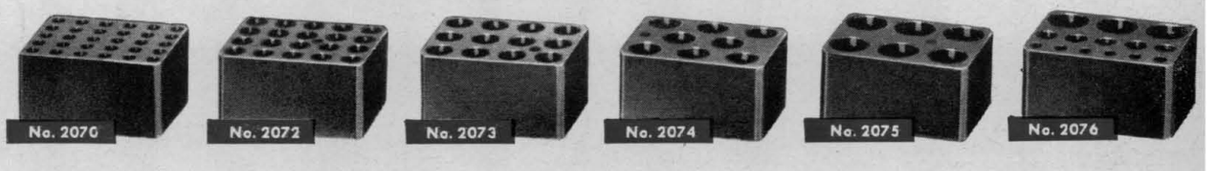

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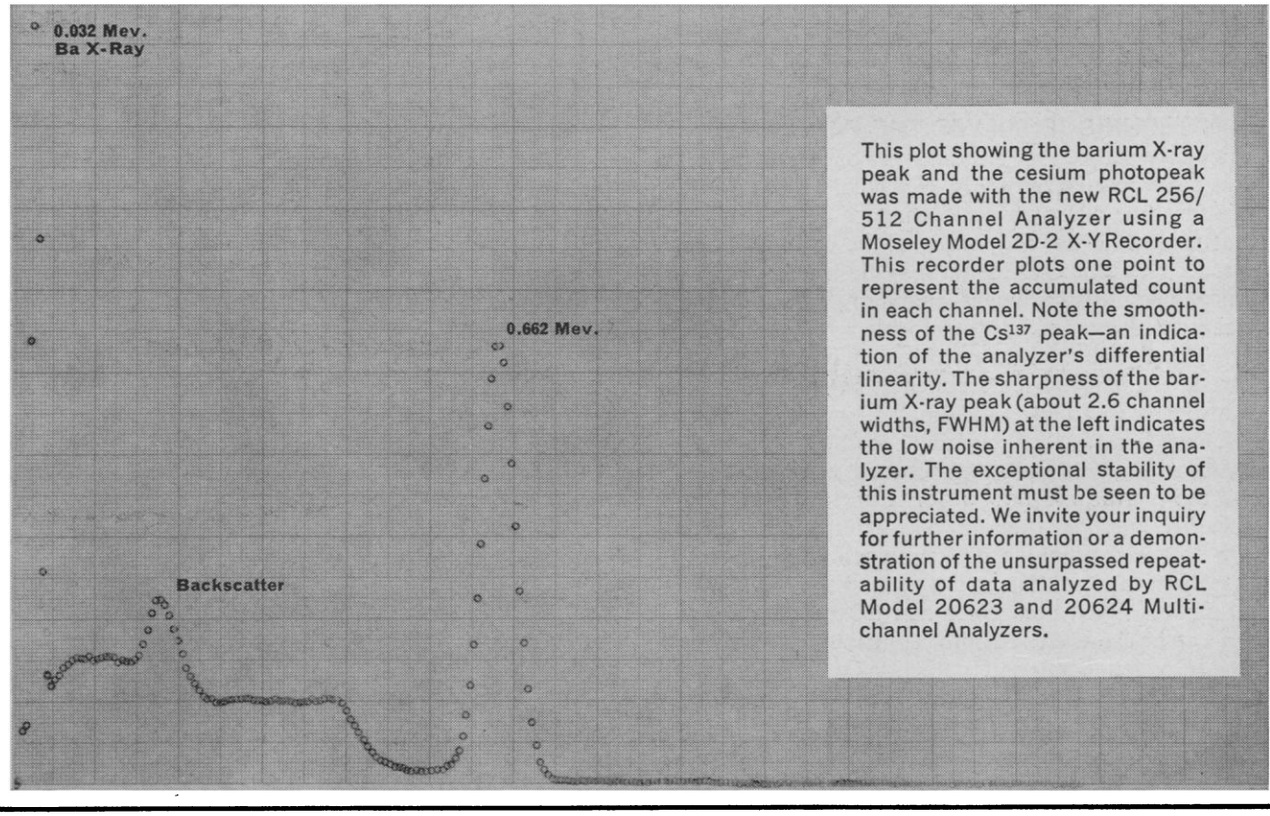
COVER

Close-up view of mass spectrometer tube which was used to measure partial pressures of 10^{-16} torr. This instrument is capable of being outgassed at temperatures of 450°C and has operated at total pressures of 10^{-8} torr. See page 178. [General Electric Company]

HERE'S PROOF!

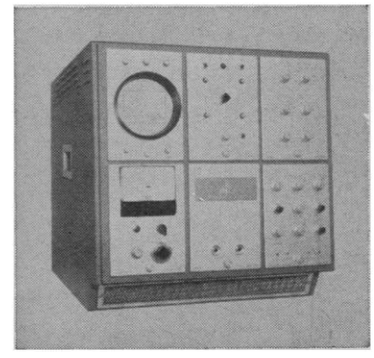
NEW RCL ADC SETS STANDARD FOR MULTI-CHANNEL ANALYZERS



This plot showing the barium X-ray peak and the cesium photopeak was made with the new RCL 256/512 Channel Analyzer using a Moseley Model 2D-2 X-Y Recorder. This recorder plots one point to represent the accumulated count in each channel. Note the smoothness of the Cs^{137} peak—an indication of the analyzer's differential linearity. The sharpness of the barium X-ray peak (about 2.6 channel widths, FWHM) at the left indicates the low noise inherent in the analyzer. The exceptional stability of this instrument must be seen to be appreciated. We invite your inquiry for further information or a demonstration of the unsurpassed repeatability of data analyzed by RCL Model 20623 and 20624 Multichannel Analyzers.

Superior linearity and stability are designed into the new RCL Model 20623 (256 channel) and Model 20624 (512 channel) analyzers. The new analyzers will accept an unprecedented range of input pulse waveshapes and signal levels. One channel is used to store clock pulses and all other channels in the group are useable. These analyzers have two unique features. An expansion control allows detailed examination of the top quarter or half of the energy range. A logarithmic expansion of the energy scale can be made, permitting a full spectrum survey with excellent resolution and linearity over the full energy range. Memory modules are interchangeable (256 or 512 channels) and provide sub-groups in multiples of 64 channels.

In addition to direct display on the self-contained five inch oscilloscope, data may be read out on most conventional devices, including strip chart recorders, X-Y recorders, the IBM typewriter, the RCL Model 21016 Digital Printer, and magnetic or paper tape systems. For complete specifications write: Analyzer Sales Section, Radiation Counter Laboratories, Inc.



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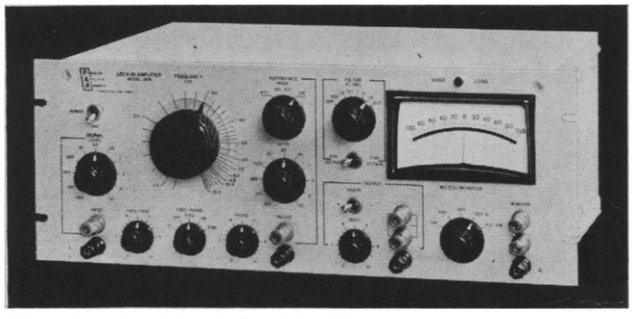
5121 West Grove Street, Skokie, Illinois, U.S.A., TWX: 9675150, Cable Address: RACOLAB / Phone YOrktown 6-8700

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.

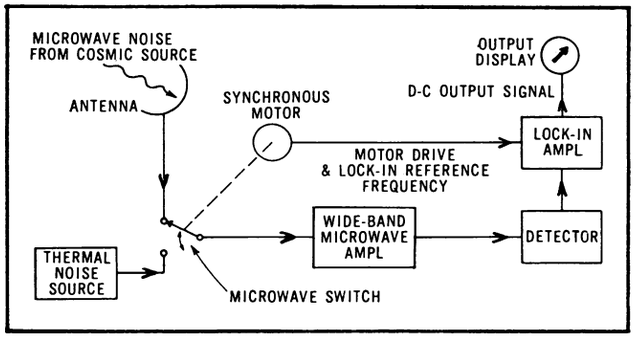


Transistorized Lock-In Amplifier — Model JB-5

**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*).

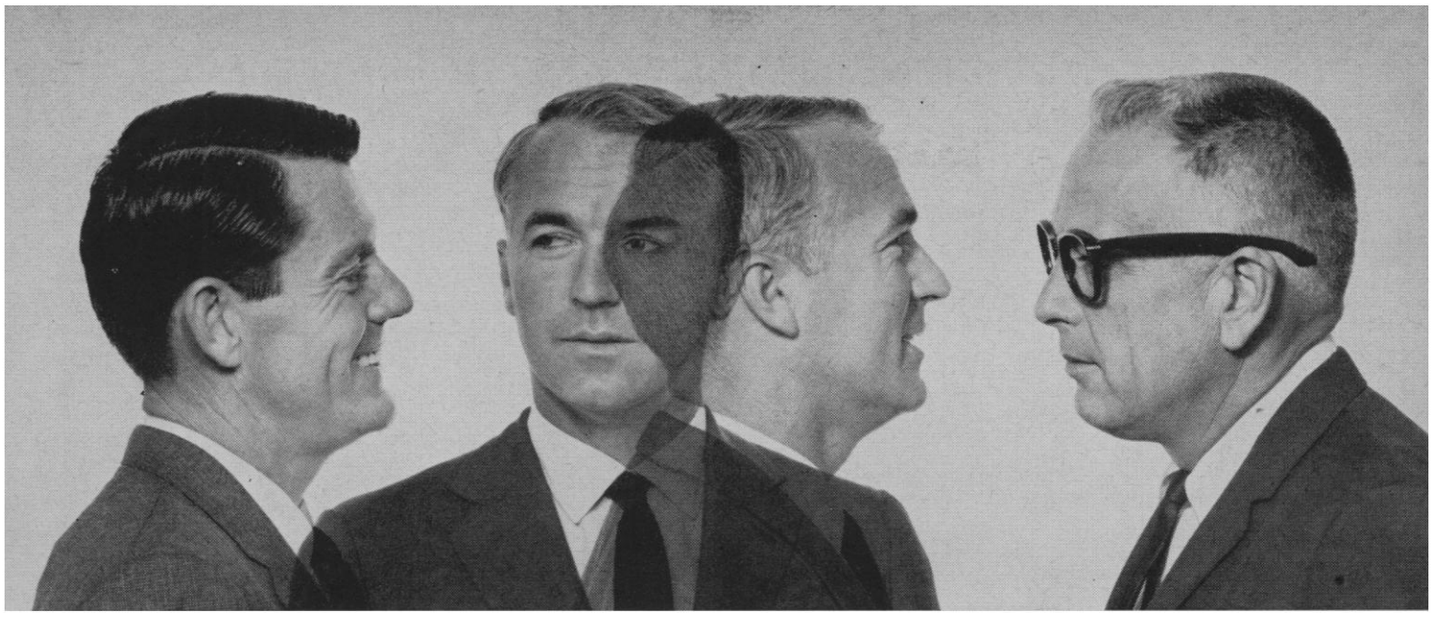
Operating Modes: External, Selective External or Internal. Lock-in accepts sinusoidal or non-sinusoidal reference signal or provides sinusoidal 5V p to p reference from internal oscillator.

Price: $1350.00

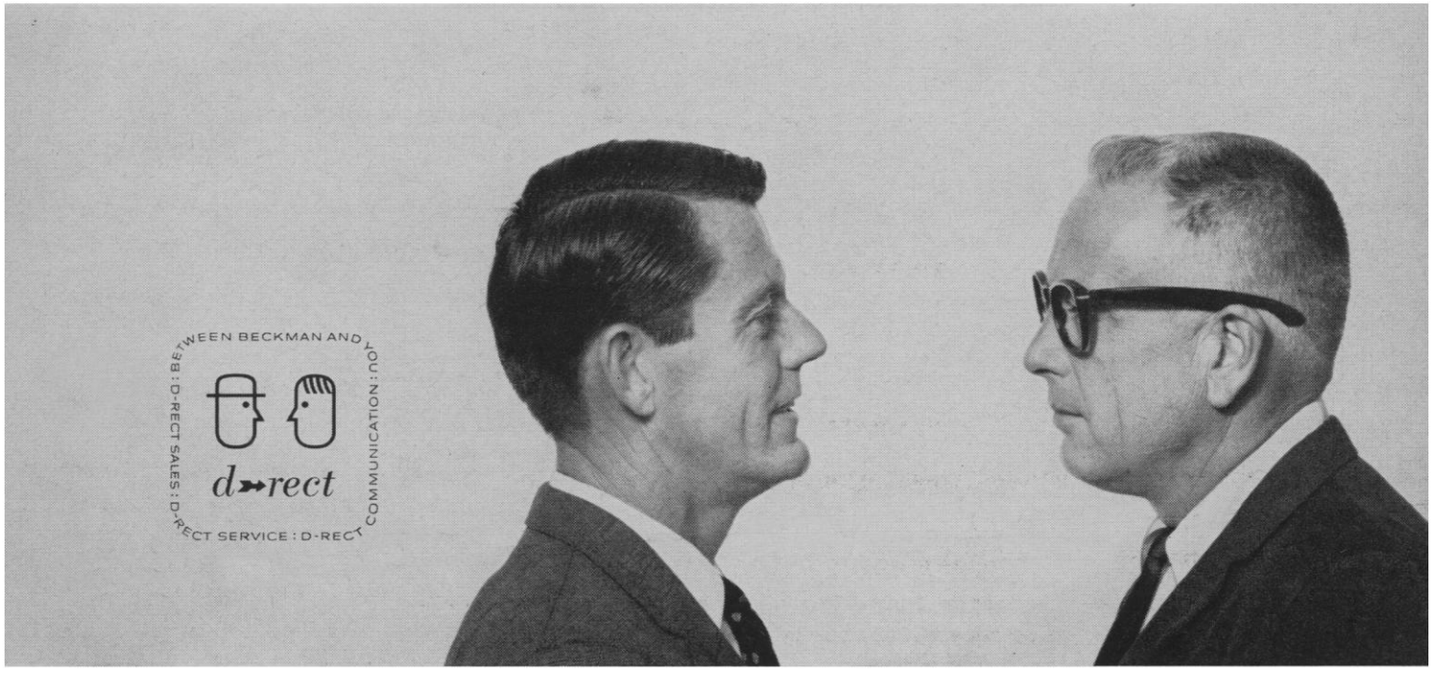
To aquaint those interested we are offering our Bulletin 109 which describes how the PAR lock-in system may be used to advantage in experiments in many fields.

Write for Bulletin 109 to:

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



one step removed



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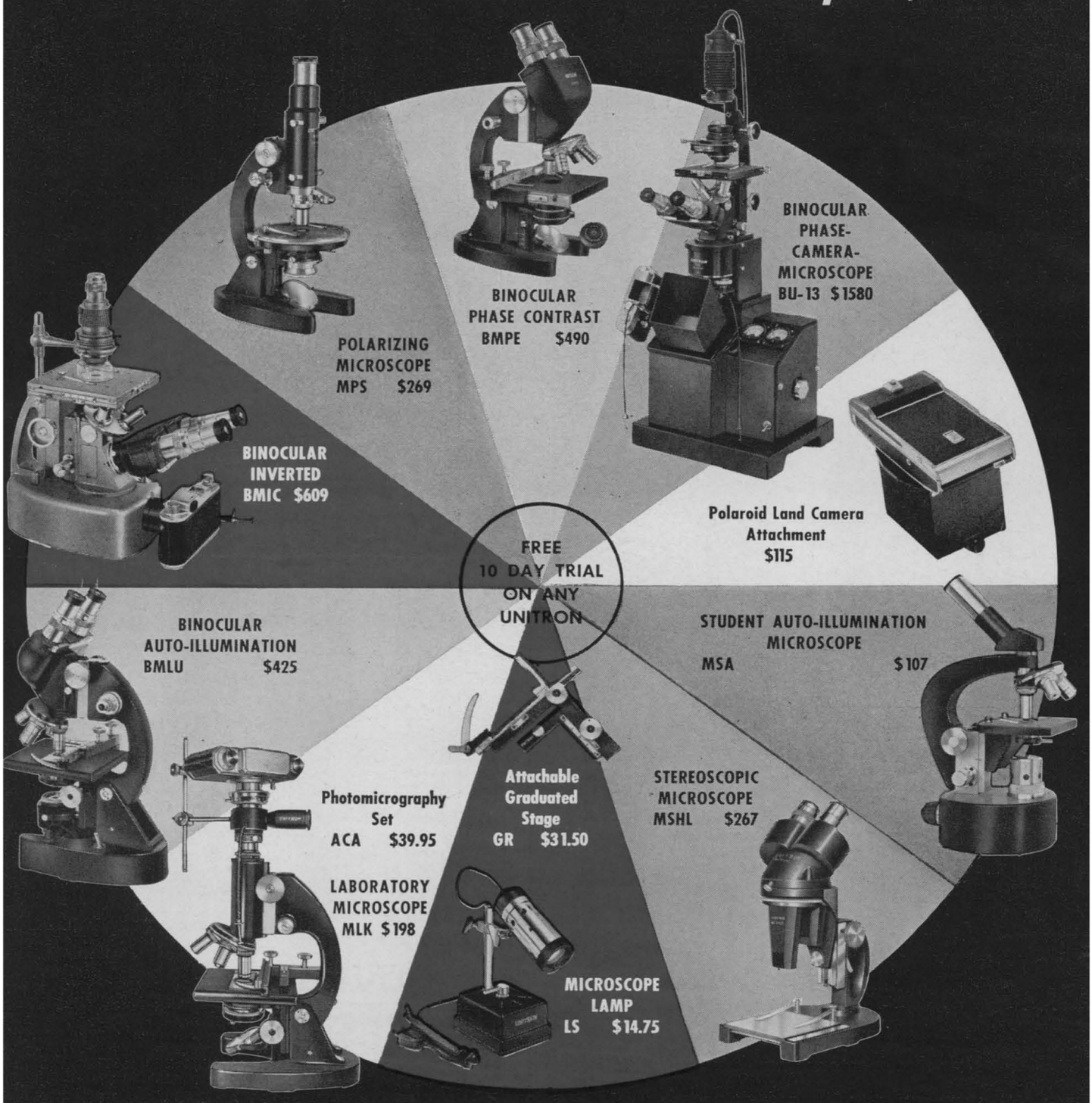

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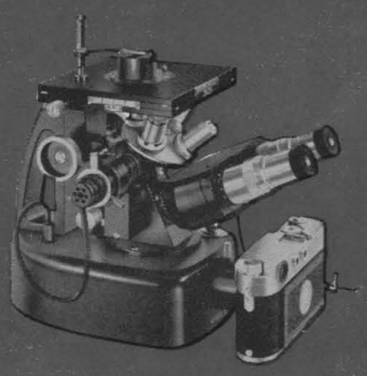

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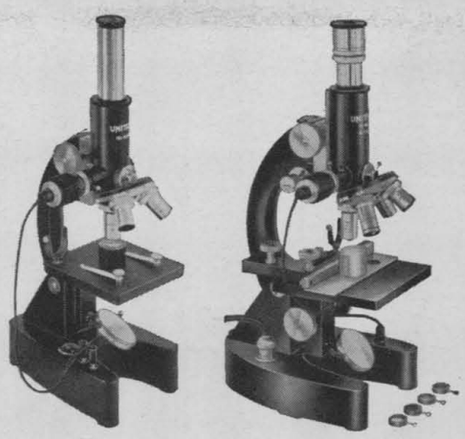

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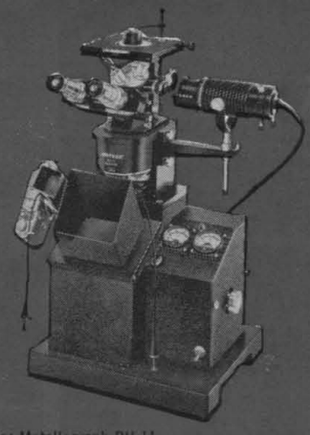

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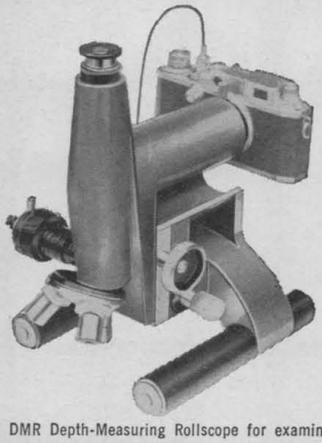

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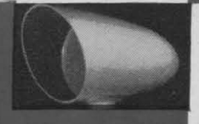

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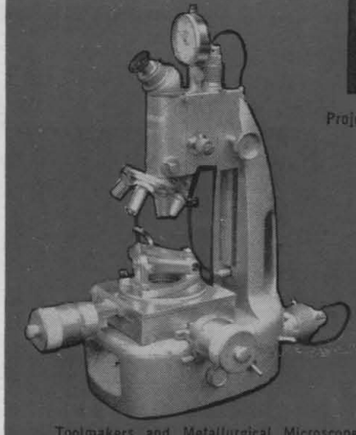

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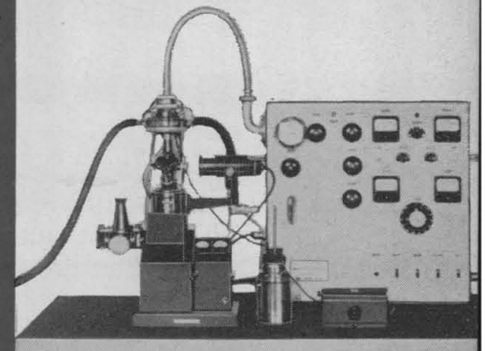

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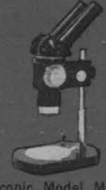

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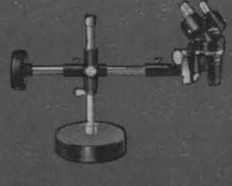

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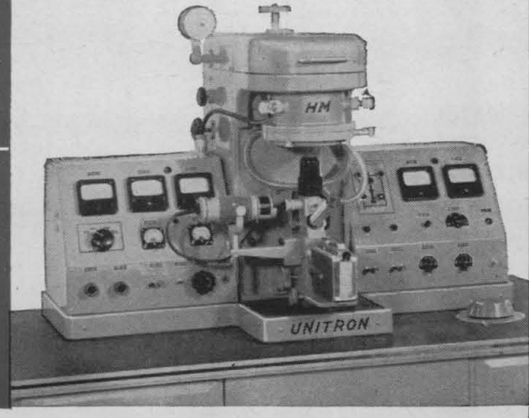

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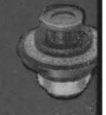

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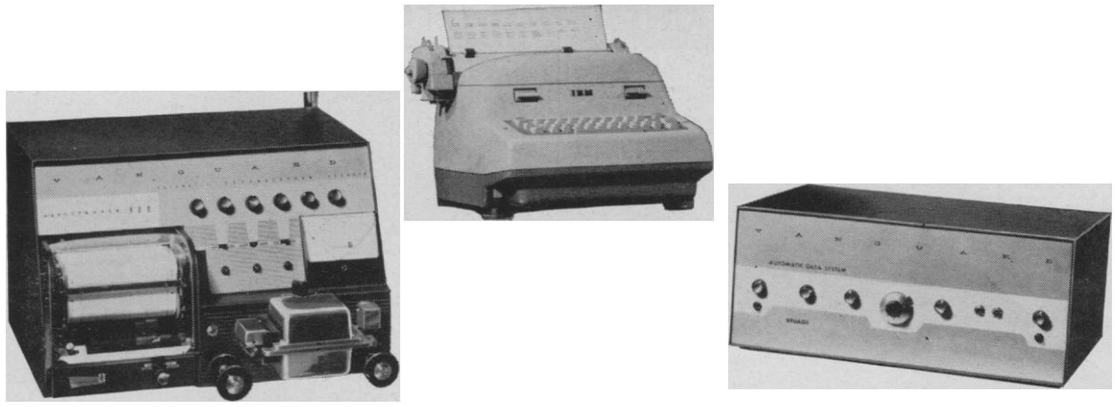

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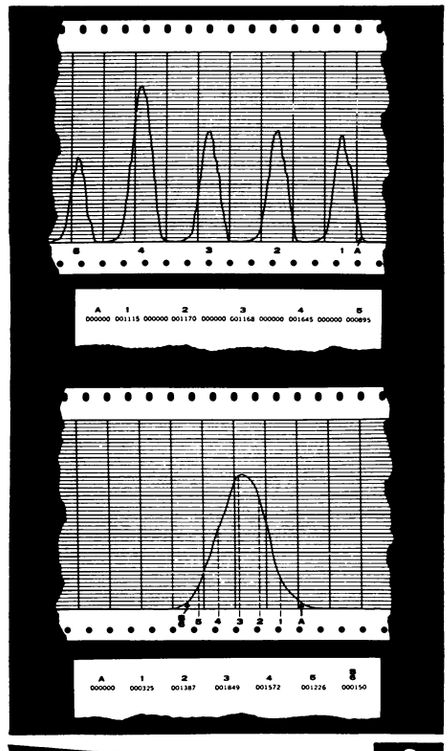

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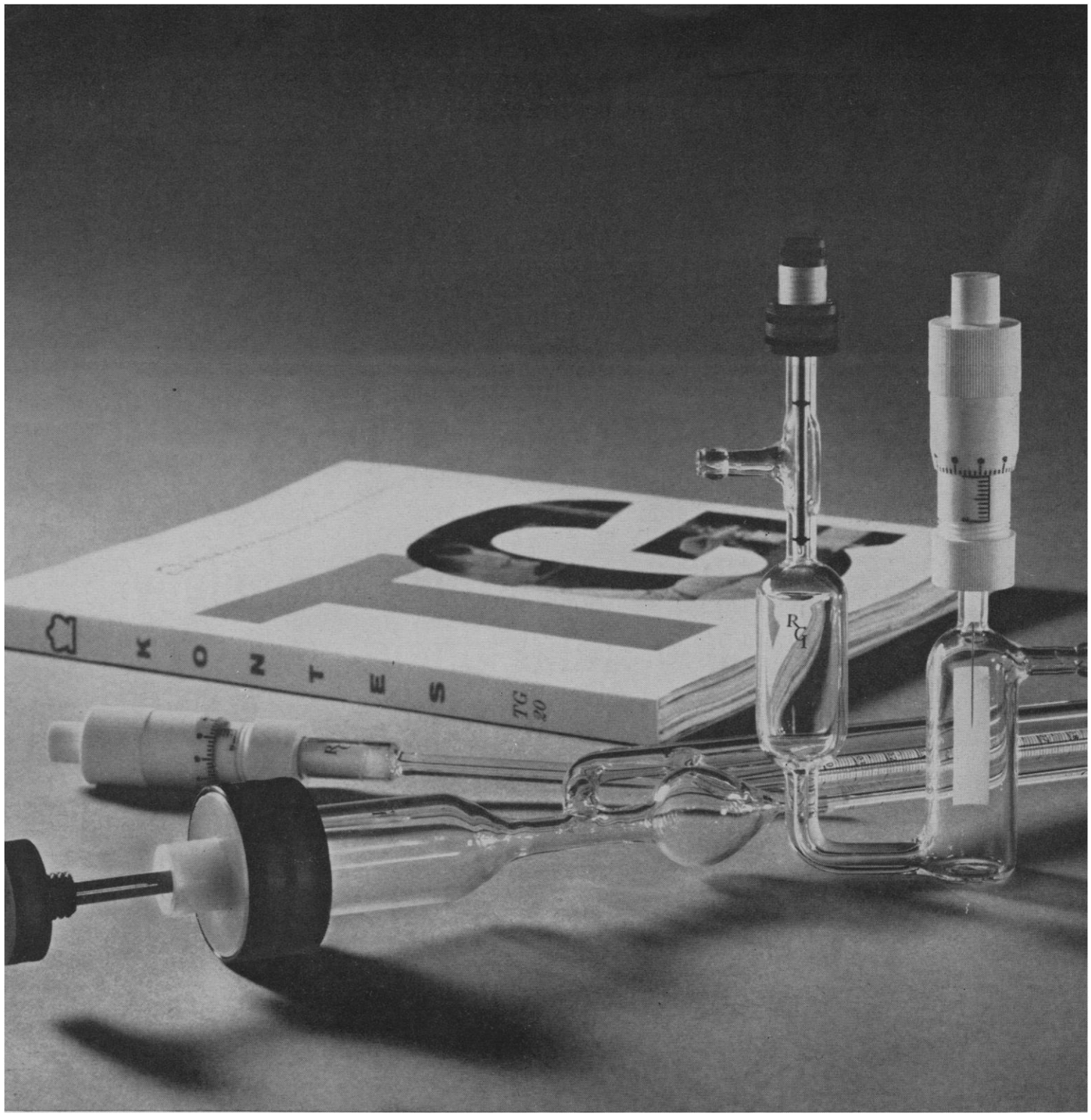

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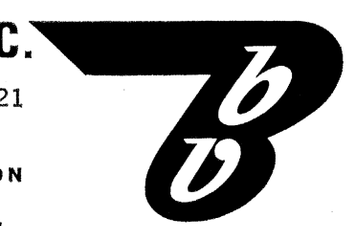
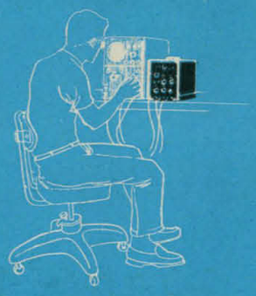




from Nuclear Data:

ANNOUNCING: THE ENHANCETRON 1024

DIGITAL STORAGE OSCILLOSCOPE

a fascinating & important new measurement tool for the enhancement of the signal-to-noise ratio of repeatable or naturally recurrent noisy signals, useful in many fields:

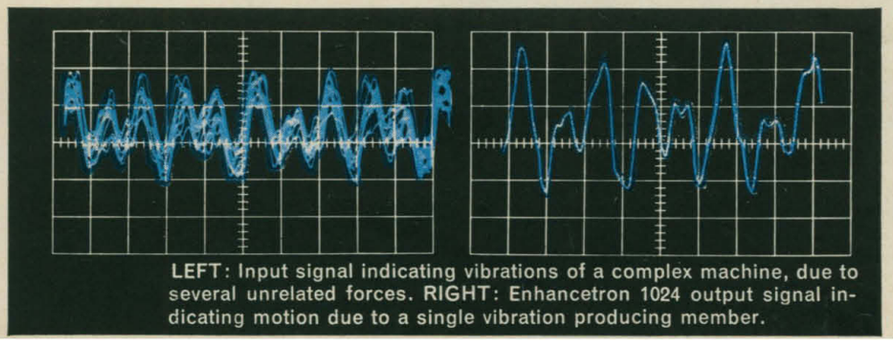
GEOPHYSICS, NUCLEAR MAGNETIC RESONANCE, RADAR ASTRONOMY, ELECTROPHYSIOLOGY, VIBRATION ANALYSIS, BIOCHEMISTRY, SONAR, & OTHERS

Why not use ordinary filtering to eliminate noise? Because noise sometimes has frequency components in the same range as the signal. For example, noise due to unrelated nerve activity in electrophysiological measurements has exactly the same general appearance as the signal of interest. In isolating the vibrations of a complex system, due to one cause such as a motor or engine, in the presence of numerous unrelated vibrations, filtering is usually impossible. In nuclear magnetic resonance measurements, high frequency noise may be filtered by decreasing the sweep rate of the magnetic field and using low amplifier upper passband frequency, but very low frequency noises, such as amplifier gain drifts, become increasingly important as sweep speeds decrease. Filtering therefore has definite limitations.

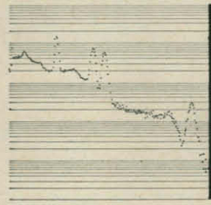
Here is how the Enhancetron 1024 works: Signals obscured by noise are digitized at 1024 time intervals, and the results recorded as 1024 numbers in a magnetic core memory. Positive numbers indicate positive input voltages, negative numbers negative input voltages. This is repeated for each signal recurrence, with the numbers for corresponding time intervals numerically added. Noise in general tends to average toward zero, since it is as likely to be positive as negative. THE SIGNAL OF INTEREST ADDS LINEARLY. The signal-to-noise ratio improves in proportion to the square root of the number of signal recurrences. This number is limited only by the length of each signal and the measurement time available.

Digitizing and storage occurs at a rate of 31.25 microseconds per point. The sweep speed range is operator-selected from 31.25 microseconds to 8 milliseconds per point. Bandwidth is about 10 kc/sec. Results are displayed on a standard oscilloscope, which is also used to view the input signal. If desired, data may be read out by typewriter, or on computer compatible punched paper tape.

Write or phone Nuclear Data for further information and literature.

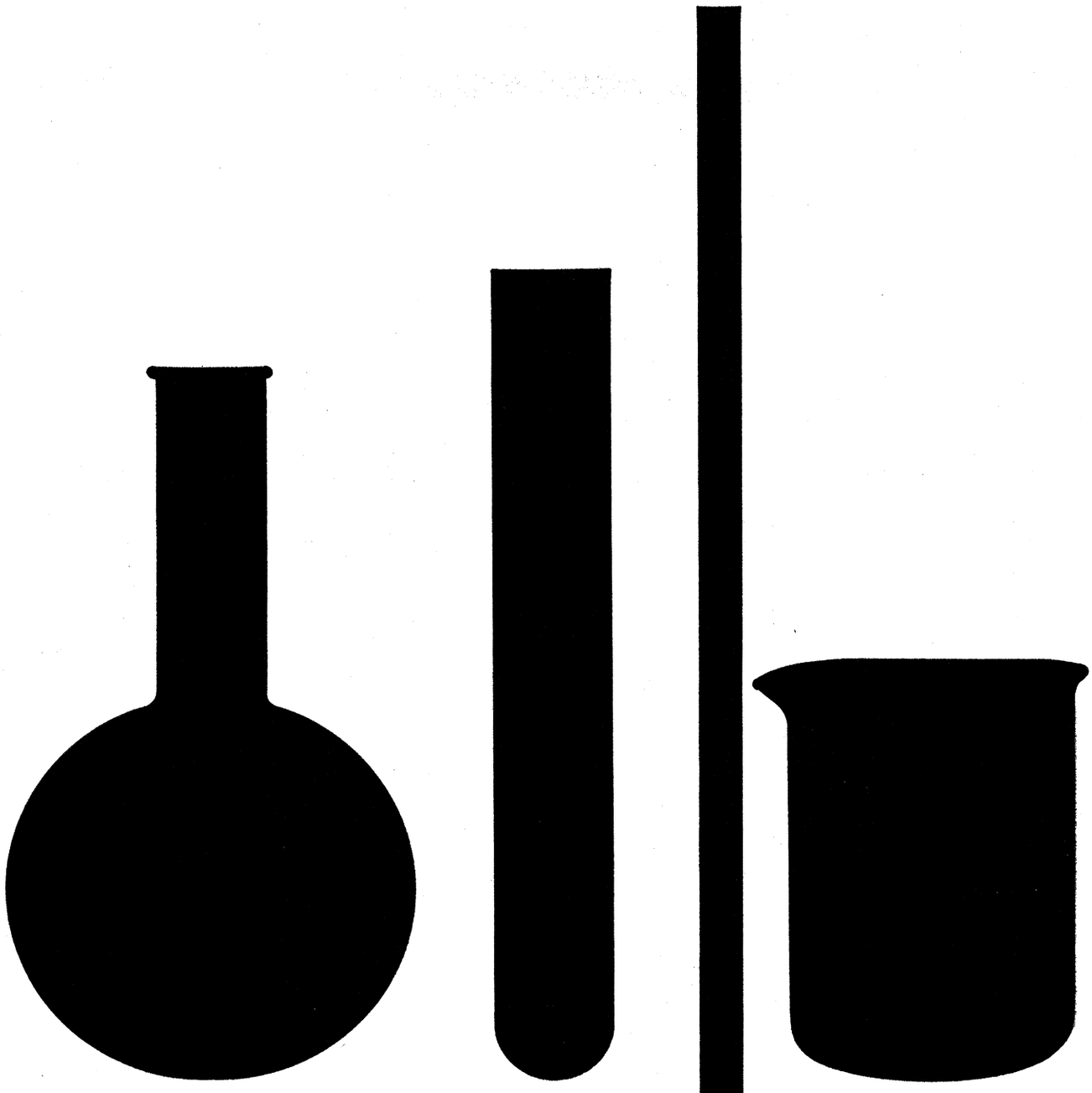


LEFT: Input signal indicating vibrations of a complex machine, due to several unrelated forces. RIGHT: Enhancetron 1024 output signal indicating motion due to a single vibration producing member.



NUCLEAR DATA INC.

3833 WEST BELTLINE HY.
MADISON, WISCONSIN 53701



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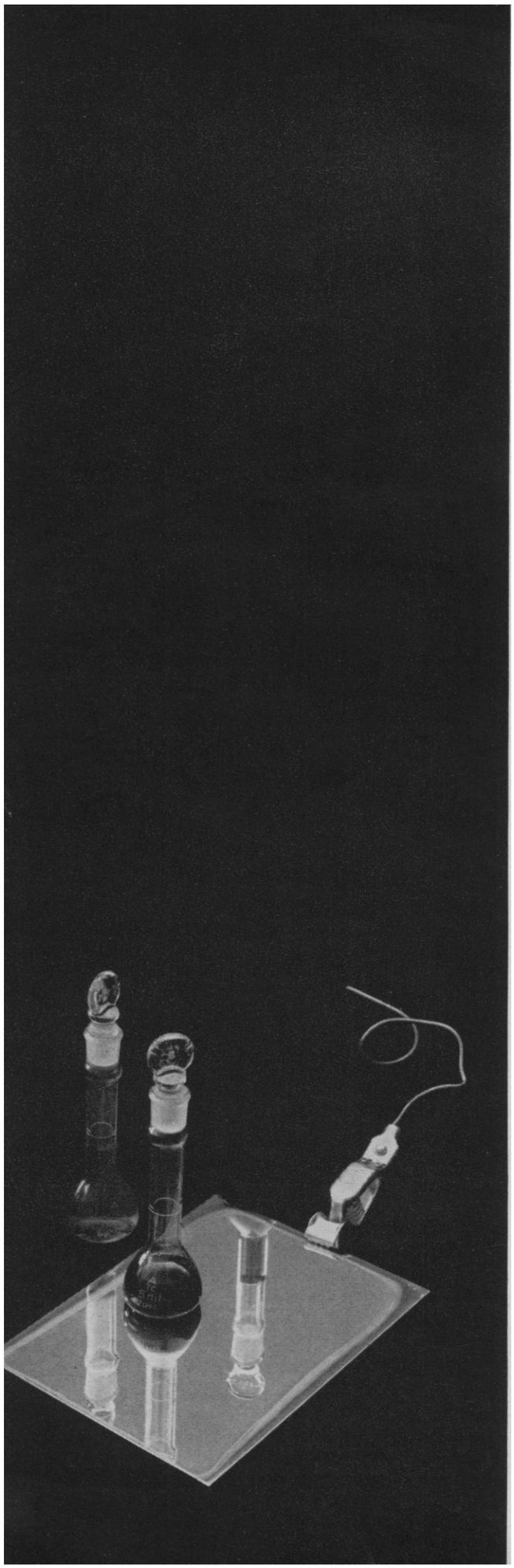

One of a series briefly describing GM's research in depth

ELECTROCHEMICAL ADDITION: 1+1=3

Electroplating is a well-known process . . . on the surface, anyway.

But the plating of just one metal on another may involve a dozen or more physical or chemical events. At the GM Research Laboratories, we are examining some of these to better understand particular idiosyncrasies.

Like the action of organic addition agents. For instance, an organic leveling agent in a plating bath causes more metal to be deposited on low places and less on the high spots—giving a smoother, more level surface. Two together do stranger things. How? Radioactive tracers are telling us.

Example: Take a radioactively tagged leveler. More is adsorbed on the peaks of the surface being plated than in the valleys. Its adsorbed ions tend to block current flow, reducing metal deposition most where the ion concentration is greatest. Then add another leveler. It levels, too, but also causes even more adsorption of the *first* one on the high points. More leveling yet.

This one-plus-one-equals-three synergistic effect has been widely used in decorative plating. Now, supported by unique autoradiographic evidence, we have postulated a theoretical explanation. Details are available on request. Briefly, it involves ion interactions and adsorptions and gets deeper into matters of ion and atom bonding and bond breaking—subjects typical of persistent basic research in General Motors.

General Motors Research Laboratories

Warren, Michigan

	Before plating	With A alone	With B alone	With A & B
Amount of A adsorbed	0	113	0	189
Amount of B adsorbed	0	0	3	49
Surface roughness	304	279	254	140

Relative adsorptions and roughnesses. Plating with two organic levelers, A and B, added to solution singly and together.

in keeping with the times

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❶ Direct reading to 0.02 pH from 0-14. Accuracy ±0.05 pH. Calibration and temperature compensation adjustment.

❷ Similar to Metrion but with control knob for temperature compensation (0-100°C); also provision for use with Coleman Titrion.

❸ Range: pH 0-14, millivolts −1400 to +1400. Direct reading to 0.02 pH. Accuracy ±0.05 pH. Re-zeroes automatically.

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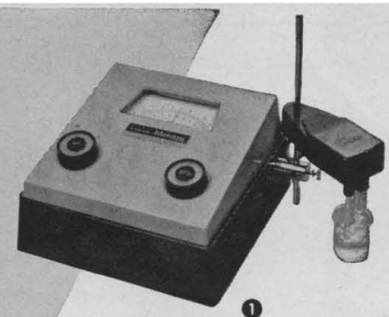
❻ Same pH and millivolt ranges as Model 110. Readable to 0.03 pH unit. Temperature control adjustable from 20° to 100°C.

❼ Battery operated, 2000 hours service. pH range 0-14, readable to 0.03. Millivolt scale. Temperature control adjustable from 0-100°C.

❽ Seven expanded ranges each covering 2 pH units. Also single 0-14 range and millivolt scale for titrations. Readable to 0.01 pH. Battery operated.



❶ Coleman Metrion
H-5305X—$139.00

❷ Coleman Metrion II
H-5306X—$160.00

❸ Coleman Companion
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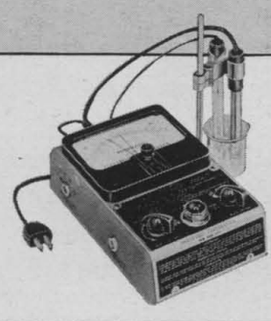
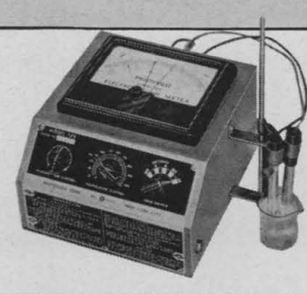
❹ Leeds & Northrup 7401
H-4901X—$330.00

❺ Photovolt Model 110
H-3625X—$265.00



❻ Photovolt Model 115
H-3620X—$175.00



❼ Photovolt Model 125
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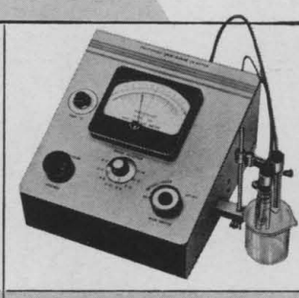

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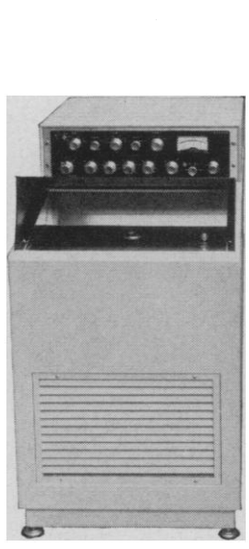

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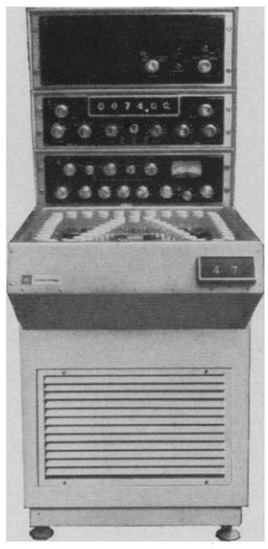

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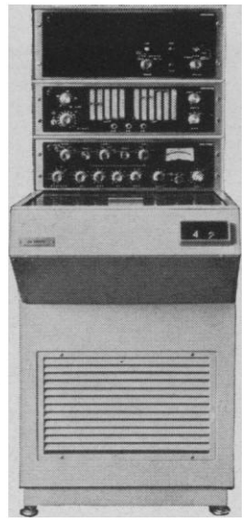

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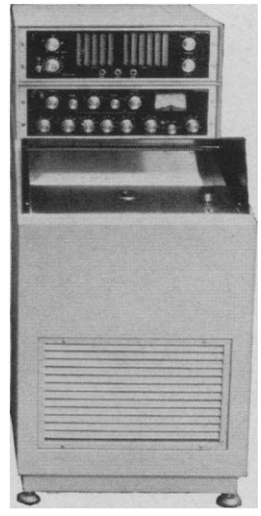

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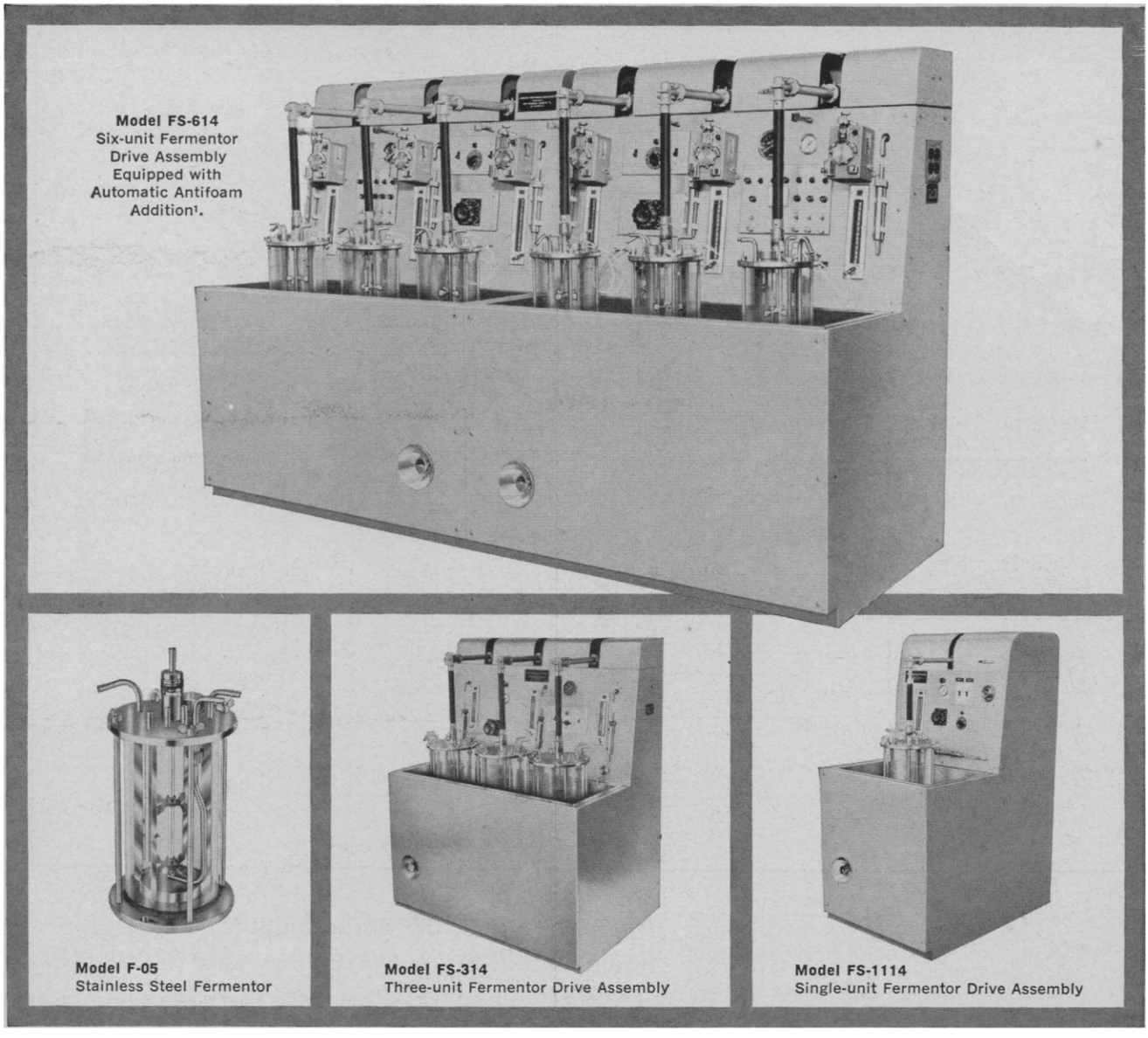

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Six-unit Fermentor
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Equipped with
Automatic Antifoam
Addition[1].

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Stainless steel fermentors with Pyrex glass jars are available in 5, 7½ and 14 liter sizes. Impellers are driven through a non-freezing, stainless steel agitator housing which incorporates stainless steel ball bearings and leak-proof Teflon seals. The fermentors are easily and quickly disconnected from the drive and will sustain *repeated* autoclaving.

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(1) Automatic pH Control and Antifoam Addition optional

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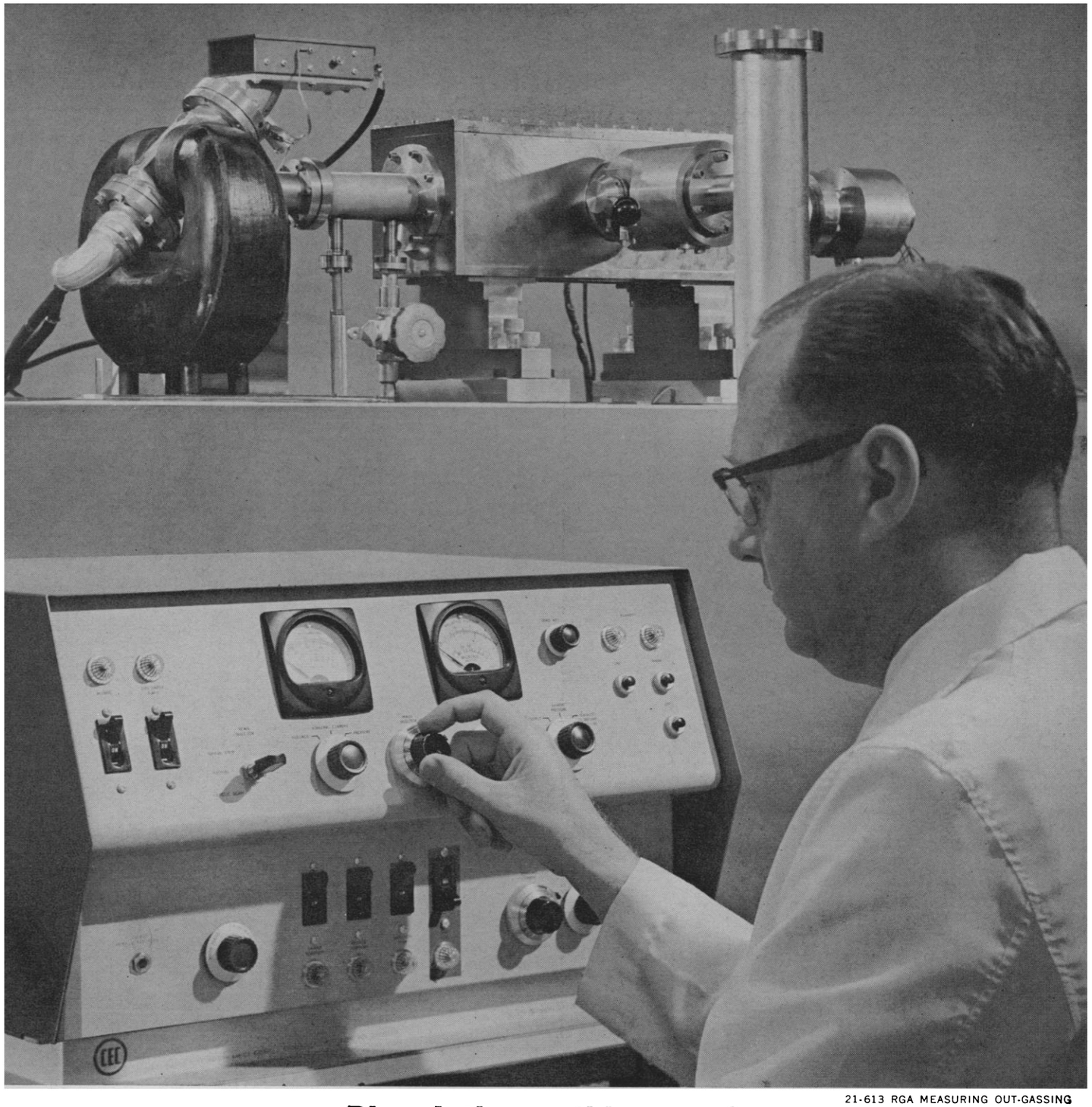

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Pinpointing nothingness?

Cover the spectrum better with CEC's Residual Gas Analyzers

If the realm of high vacuum is your domain, CEC's Residual Gas Analyzers cover the spectrum better than any others, and help you in five areas:

1. Gas identification
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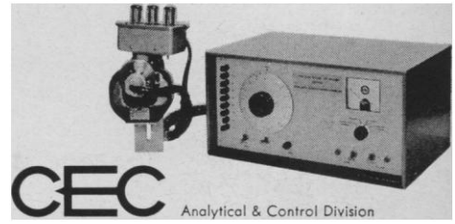
Because they are mass spectrometers, CEC's Residual Gas Analyzers serve as specific vacuum gages, pinpoint and measure leaks, help you study out-gassing and select proper pumping techniques. And, they're the most accurate pressure gages you can get.

Very effective for many applications are CEC's 21-612, 21-613-1, and 21-613-2. The 21-613-1 has high resolution: measures partial pressure 5×10^{-11} Torr, m/e 2-150, complete resolution at 150. The 21-613-2 is more sensitive: a partial pressure 5×10^{-12} Torr, m/e 2-150, resolves at 44. Both have cycloidal tubes for "perfect" focusing, with recorded peaks having "flat tops" and no "tails" thereby allowing better quantitative measurement.

CEC's 21-612 (right) is less expensive, bakeable to 450°C for high vacuum and has a rapid response and linear scan. Further data? Call your CEC office, or write for Bulletins CEC 21612-X7 and 21613-X11.



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The Astrup Technique includes not only an Ultra-Micro arterial blood sampling method, but — with the Radiometer AME1 — a complete system for exposing and evaluating all the separate factors related to both the volatile and fixed acids in the system.

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The unit is completely self-contained for both sampling and measurement, and is mounted in a wheeled cabinet for rapid movement from clinical to research laboratory, to surgery, or to intensive care wards.

Write for complete literature and reprints of pertinent scientific papers — and should you wish it, a list of the many distinguished and satisfied users in your area.

(Radiometer also supplies a Modular system of similar instrumentation for fixed installation on a bench top.)

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UNION CARBIDE **LINDE CRYOBIOLOGY NEWS**

REPORT NO. 4 FROM UNION CARBIDE CORPORATION, LINDE DIVISION

More preservation progress using liquid nitrogen

Notes on preserving parasitic protozoa, tissue cultures... successful applications of new cryogenic cooling systems... latest cryobiology equipment.

Significant achievements were recently reported on the use of liquid nitrogen for freezing and storage of biological specimens. Diamond, et al.[1] successfully applied cryogenic techniques to preserve a selected group of parasitic protozoa for extended periods. Using two- or three-step freezing cycles and storing at liquid nitrogen temperature (-196°C.), this research team was able to preserve *Entamoeba histolytica, Trichomonas gallinae, T. vaginalis, T. foetus, T. hominis, Trypanosoma cruzi,* and *T. ranarum,* for unprecedented times. In evaluating the efficiency of this liquid nitrogen preservation technique, they reported:

"No difference in yields were found between samples of a given species thawed 24 hours after freezing and those thawed after the longest period of storage. This indicated absence of decay during storage . . ."

At dry ice temperature, degradative activity commonly occurs.

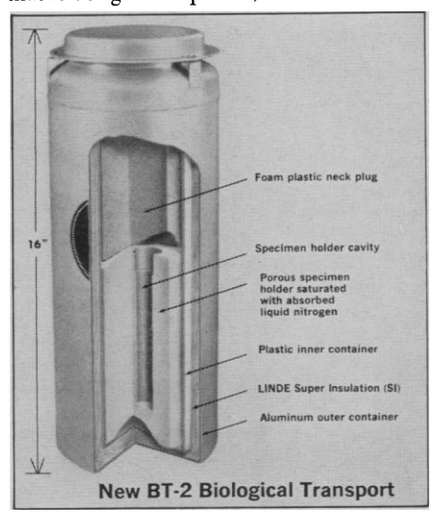
Greaves, et al.[2] designate the two major biological products requiring low temperature storage as: (1) the preservation of cells for tissue culture and (2) the preservation of erythrocytes of rare blood groups. These authors note that the key to very low temperature storage is reliability, and: "The LINDE containers require recharging only once a week as routine and in an emergency (they) will last from 28 to 90 days."

In this paper the authors also describe a modification to the plug of the LINDE LR-25B Refrigerator, which serves as a controlled-rate cooling device.

LATEST EQUIPMENT FROM LINDE

The BF-5 Biological Freezer provides a simple, economical means of freezing small quantities of biological materials with reasonable accuracy. Designed for use with the LINDE LR-35 Refrigerator, this low-cost, plug-type freezer holds nine 1.2 cc. ampules. The refrigerant is cold nitrogen gas, evolving from liquid nitrogen in the refrigerator. Cooling rate, from ½ °C. to 7°C. per minute, depends upon the number and position of ampules.

The BT-2 Biological Transport (see illustration) is a practical, lightweight container that is designed to permit, for the first time, shipment of biological materials at cryogenic temperatures via postal service or common carrier.



New BT-2 Biological Transport

This new container completely eliminates loss of refrigerant by spillage during shipment. The new BT-2 features a porous specimen holder-block, which absorbs liquid nitrogen and retains it as a liquid until heat from the refrigeration load gradually evaporates this liquid as cold gas. Liquid nitrogen lasts up to five days.

The LR-120 Refrigerator combines convenience and space economy. As the first liquid nitrogen refrigerator to offer square exterior and interior geometry, it permits more convenient use of laboratory floor space and more efficient utilization of internal storage space. Completely non-mechanical, the LR-120 features LINDE's exclusive Super Insulation (SI). Storage space, providing a total bulk capacity of four cubic feet, is divided into four compartments. Storage temperature is -196°C. below and -130°C. above liquid level. Access is via a large opening covered by a two-section plastic lid. The LR-120 holds up to 9600 ampules; liquid nitrogen capacity is 120 liters. It is especially recommended for applications requiring frequent handling of stored materials.

LINDE offers a complete line of quality cryogenic equipment – biological refrigerators, freezers, and other cryogenic containers – as well as fast, nation-wide delivery of liquid nitrogen and top-flight technical service. To secure reprints and full information on latest developments in cryobiology, complete and mail the coupon below.

(1) Diamond, L. S., Meryman, H. T., and Kafig, E., CULTURE COLLECTIONS: PERSPECTIVES AND PROBLEMS (Ed. Martin, S. M.): University of Toronto Press (1963). (2) Greaves, R. I. N., Nagington, J., and Kellaway, T. D., *Fed. Proc.,* 22:90 (Jan.-Feb.) 1963.

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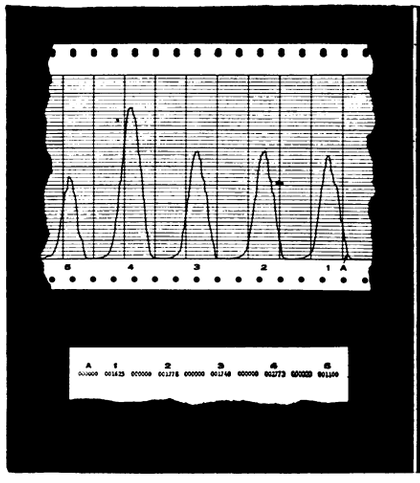
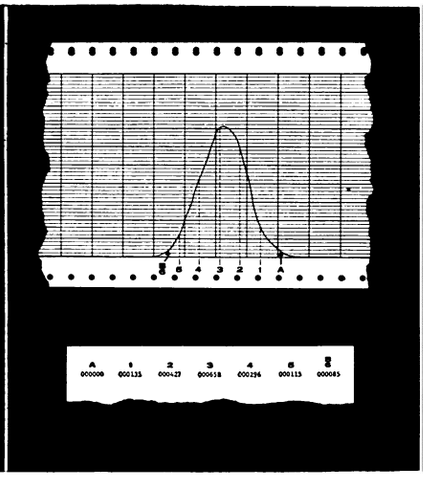
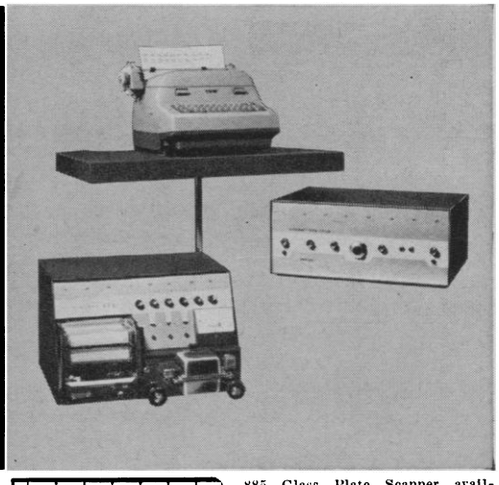
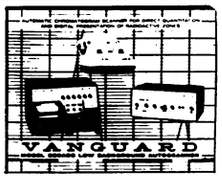
Investigate today! See how the designed-in versatility of the Model 880ADS can meet your scanning applications with clear, precise data presentations in a minimum of time with little or no operator supervision.







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.



885 Glass Plate Scanner available with above model 880. Complete specifications available on request.

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

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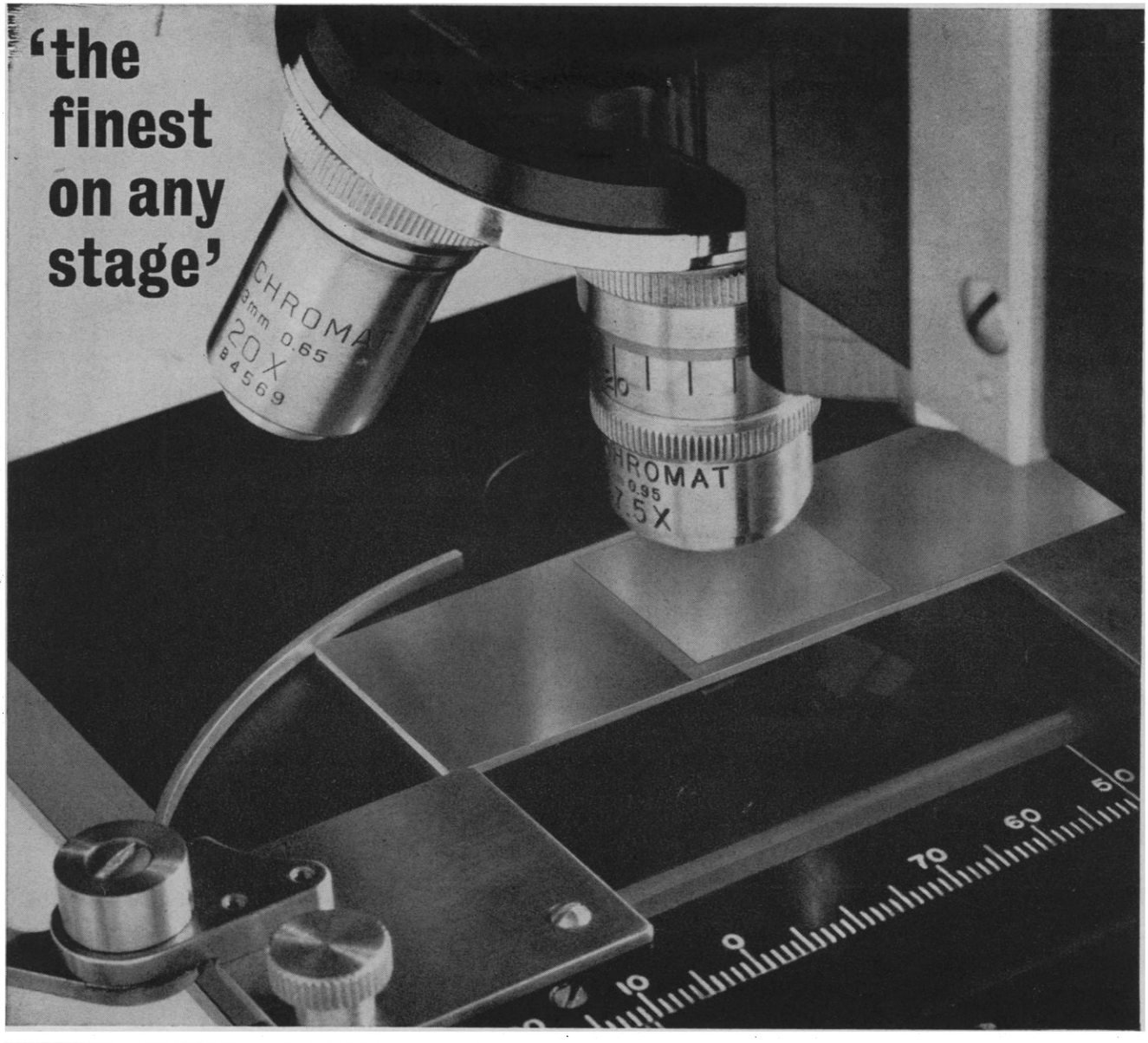

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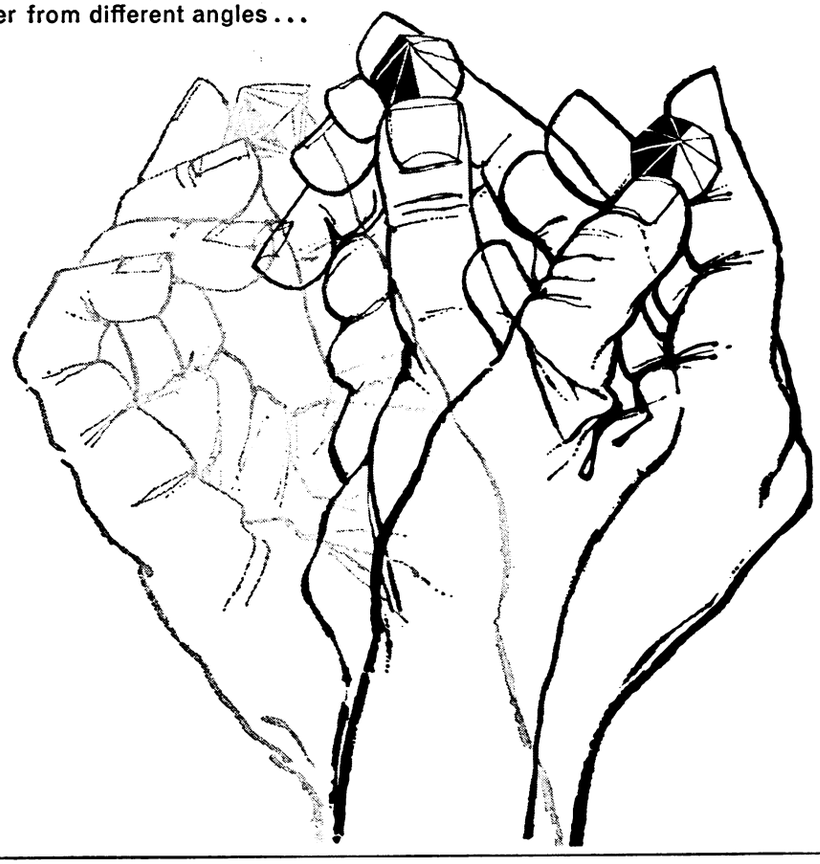

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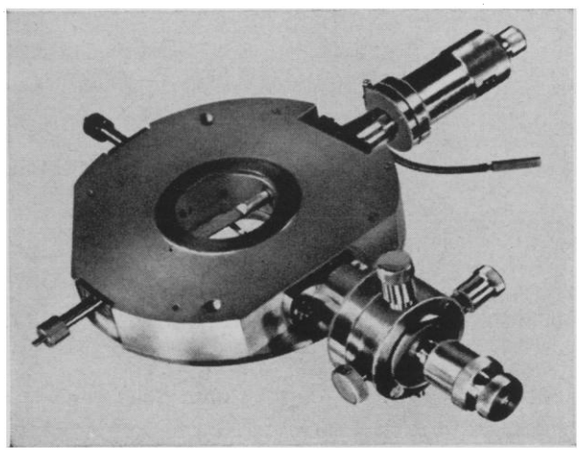

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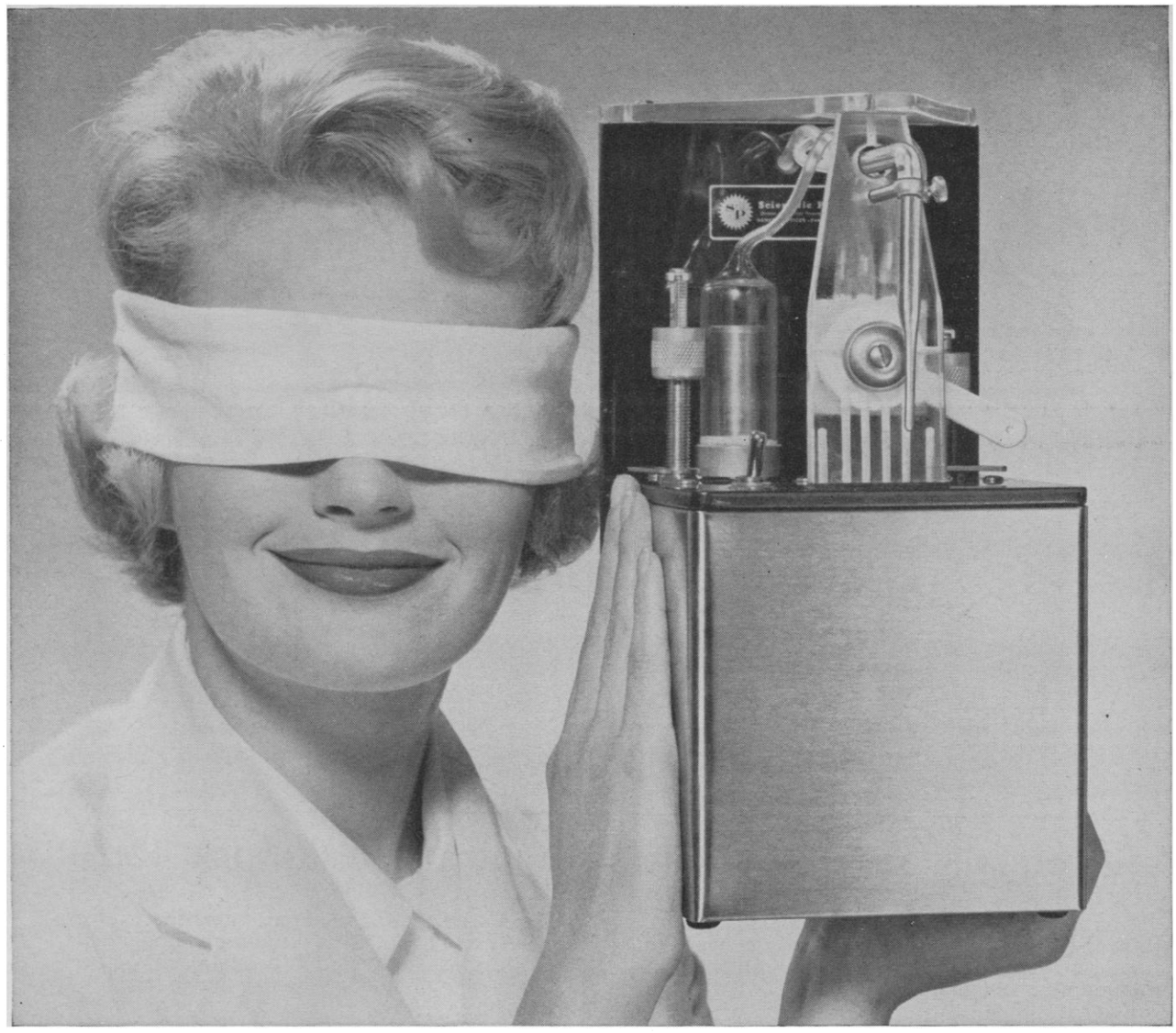

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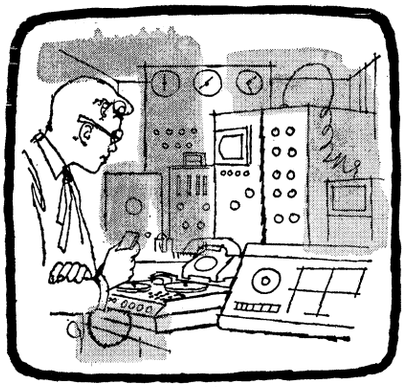

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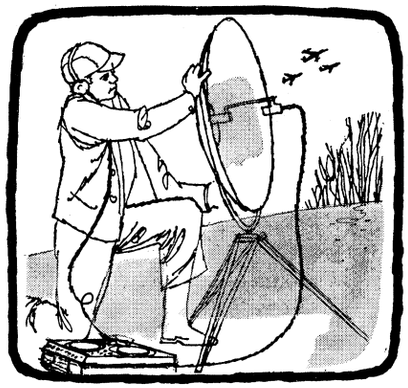

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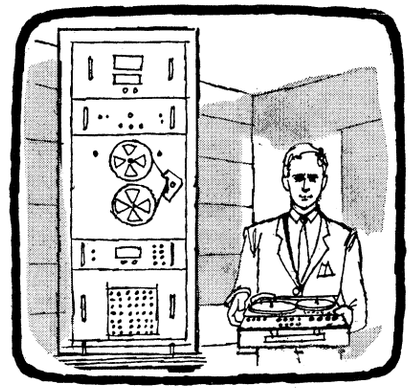

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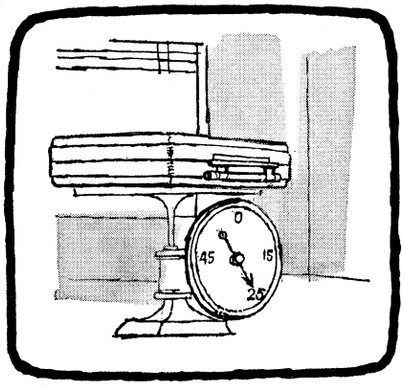

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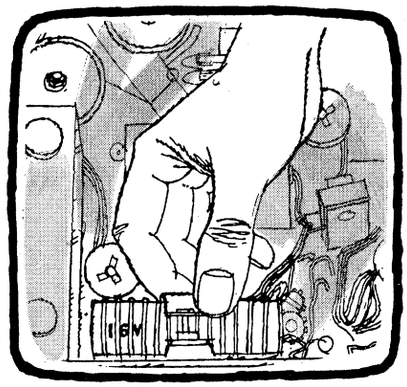

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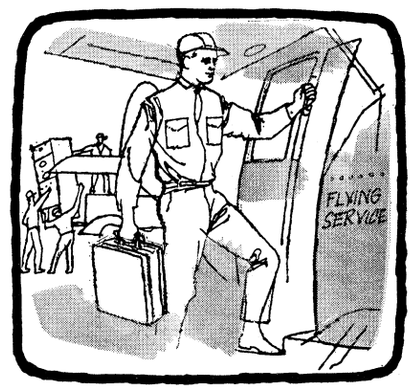

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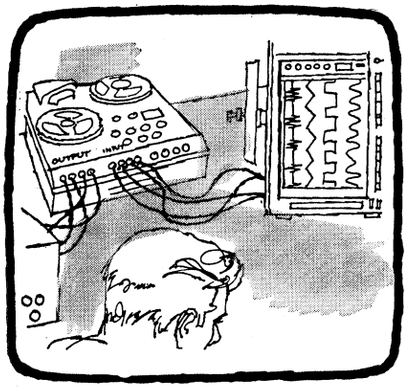

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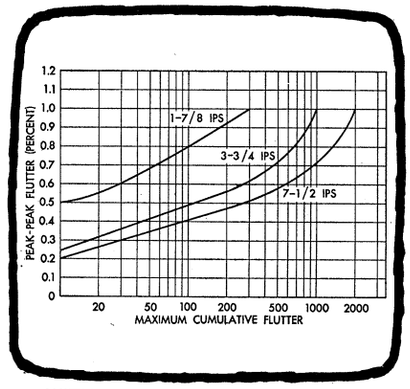

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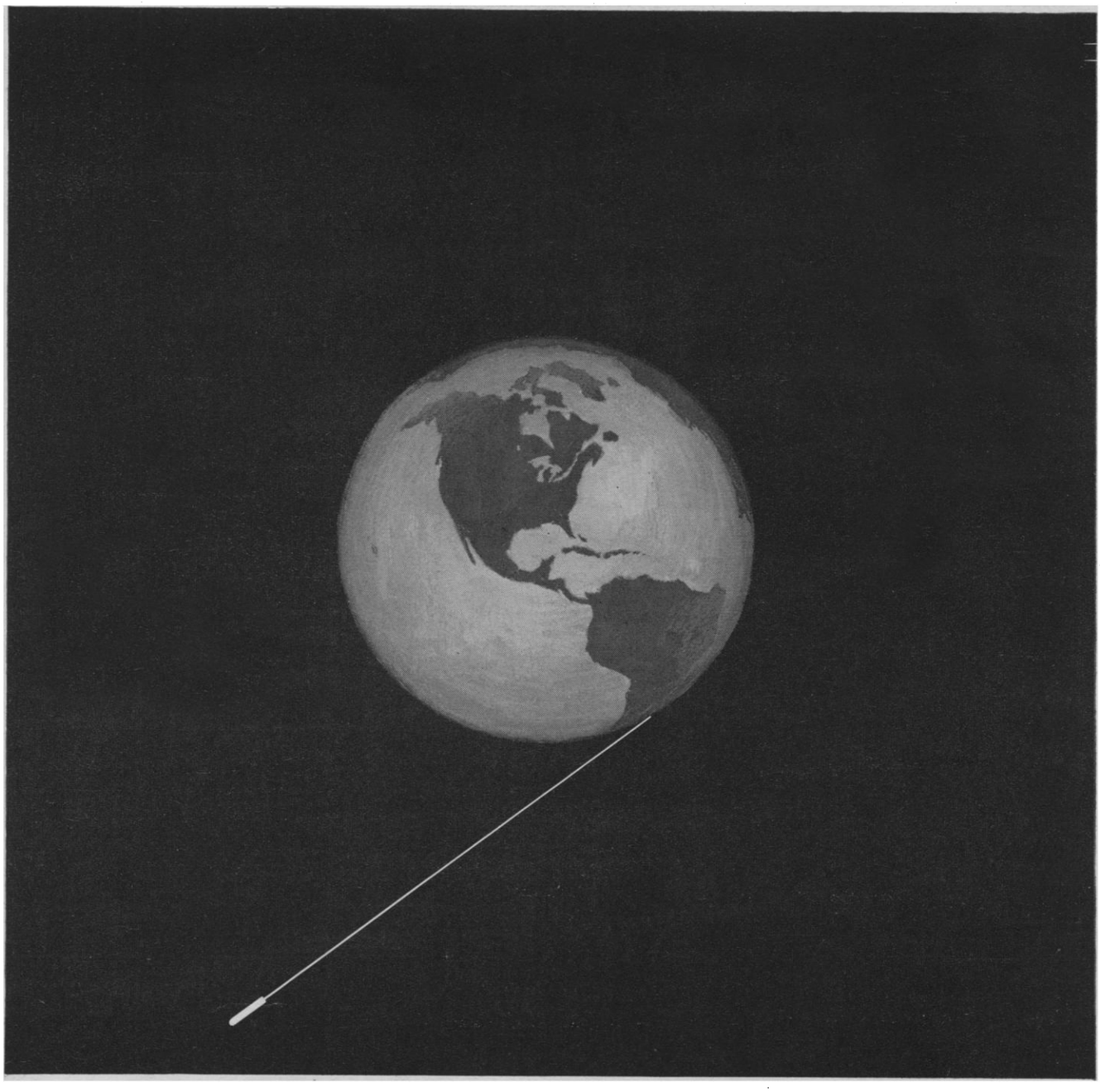

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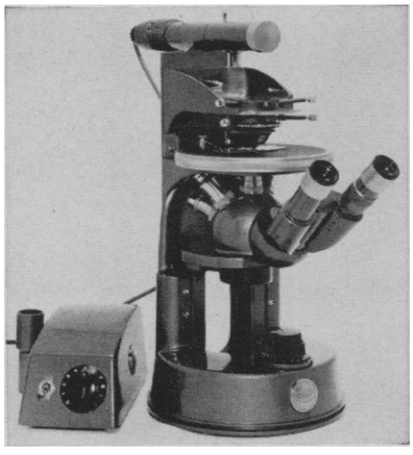
Instruments and Applications

The Vickers Inverted Biological Microscopes



Inverted Microscope with Baker Trilux Condenser allowing instant interchange between regular, dark ground and phase contrast examination.

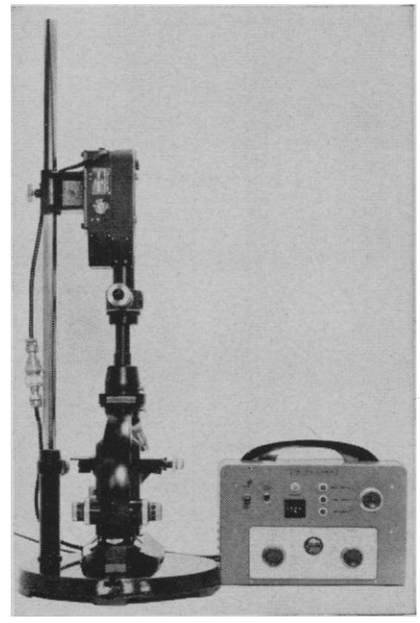
This new series of microscope stands has been produced to suit the needs both of those who are concerned with the examination of material in large flasks and those who wish to employ all techniques of high-powered microscopy and photomicrography on preparations which may or must be viewed with slide or chamber in inverted position.

A feature of the design is that the stage is fixed and does not move upon manipulation of the focusing controls. Stability is further increased by the employment of ball bearing focusing slideways, set unusually far apart and of extra length, which move objectives and body tube. An omni-directional gliding stage provides for fast scanning and precise positioning of the object.

The focusing substage can be swung off the optical axis so as to accommodate even very large bottles and flasks. With the substage in use accessories are provided for normal transmitted light, dark ground or phase contrast examinations at all magnifications. A special long working distance objective is offered, initial magnification 20X, N.A. 0.25, working distance 14mm, which can be used either dry or immersed, with or without a cover-slip.

Accessory equipment for simultaneous viewing and 35mm photography can be employed. The new Vickers Automatic Exposure equipment (which provides for automatic integrating calculation of exposure time and actuation of electromagnetic camera shutter) ensures the obtaining of rapid, correct and uniform exposures.

Vickers-Vinten Equipment for Time-Lapse Cine-photomicrography



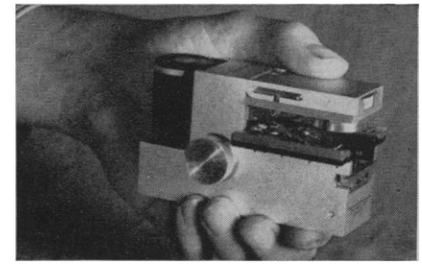
Vickers-Vinten Time Lapse Equipment.

Featured in this new equipment is an Electronic Time Lapse unit of extraordinary versatility which has been developed in collaboration with Dr. R. Barer and Mr. J. Underwood, Oxford University. With this unit the 16mm Vinten Camera can be operated on Single Shot, Time Lapse or Continuous (8, 16 or 24 frames per second) settings, with changeover between these instantaneous. On the Time Lapse setting any of 15 time intervals from ¼ second to one hour can be dialled in. Nine different exposure times from ¼ sec. to 1 minute can be selected. A zeroing frame counter is fitted as well as provision for switching off an external light source between exposures (when interval times longer than one minute are selected).

The Vinten 16mm Scientific Camera Mk 1. has been especially designed for time-lapse applications. It is remarkably free of vibration. Construction is at once rugged and precise — its operation is absolutely dependable at any speed and over long periods of time. A 200 ft. film magazine is supplied.

The viewing system shown in the photograph allows the operator the choice of (1) viewing object or (2) monitoring light level, either simultaneously with exposure.

The McArthur Microscope



The McArthur Microscope shown was originally designed for malaria diagnosis and control work in the field in Southeast Asia. It can be quite easily carried in a coat pocket, but retains all the performance advantages of a full size instrument. A full range of achromatic and fluorite objectives is available as well as dark ground accessories. Illumination can be by mirror or by a battery or transformer operated built-in light source.

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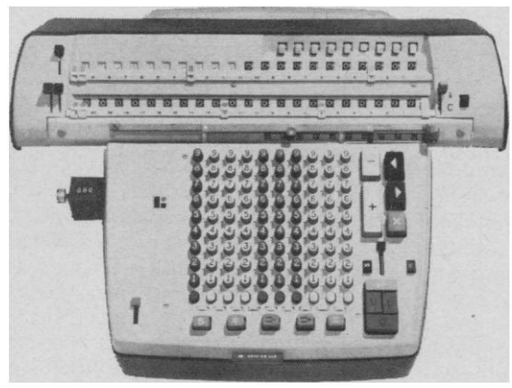

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Applications include determination of magnesium, calcium, potassium, sodium and trace metals in blood, urine and tissue samples; magnesium, zinc and lead content in ferrous, aluminum and copper alloys; trace metals in plants and animals; metal components in process streams; and changes in metals content of lubricating oils, as a check on engine performance.

For complete Model 303 specifications write to Instrument Division, Perkin-Elmer Corporation, 910 Main Avenue, Norwalk, Connecticut.

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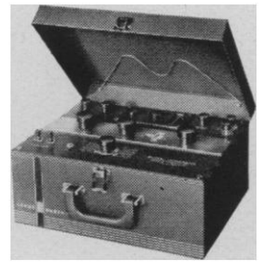

The use of this three-dial 8686 Portable Potentiometer is rapidly spreading in research laboratories. It features a central reading window . . . where measured values appear as a row of digits plus a scale value . . . for rapid reading of test results. This instrument has a wide operating range of −10.1 to +100.1 mv and an accuracy of ±(0.05% of reading +3μv) without reference junction compensation; ±(0.05% of reading +6μv) with ref. jct. comp. Write for Data Sheet E-33(1a).

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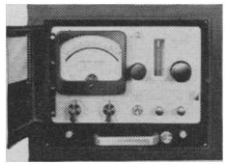

For measurements of O_2 in medical and environmental research, in combustion processes and in testing applications, the new L&N 7308-G Thermo-Magnetic Oxygen Analyzer features maintenance-free operation, quick calibration against air and compact size (9-1/2" x 11-1/2" x 16-3/8").

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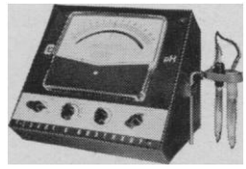
TO OBTAIN DRIFT-FREE MEASUREMENTS OF pH AND REDOX



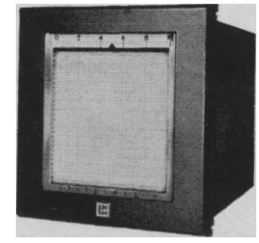
Only one initial calibration setting is required on the L&N Stabilized pH Indicator. Synchronous conversion of d-c input with amplification eliminates zero-drift. An electronic converter provides d-c feedback to stabilize gain. Ranges are 0 to 14 pH, in 0.1 pH divisions, and for measuring redox potentials, 0 to ± 700 mv and ± 1400 mv—both in 10 mv divisions. Write for Folder E-96(4).

TO MAKE CONTINUOUS CONDUCTIVITY MEASUREMENTS "ON-LOCATION"

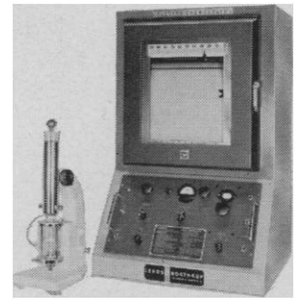
This continuous indicating Conductivity Monitor is competely transistorized. It is provided with a linear scale calibrated 0 to 100 micromhos/cm (scale reading is multiplied by cell constant). Lightweight, the Monitor is extremely convenient for checking in the laboratory or on the process line. Exceptional design permits automatic or manual compensation . . . provides d-c output signal for recorder or other data-logging equipment. Write for Data Sheet E-95(3).

With L&N Automated Equipment

TO RECORD TEMPERATURE & MILLIVOLTS MEASUREMENTS



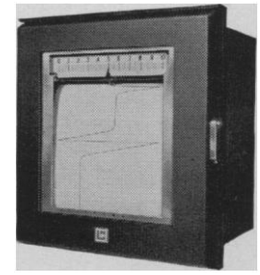
These compact, low-cost Speedomax® H Recorders are widely used in laboratories for measuring temperatures, millivolts, pH, gas chromatography, etc. With interchangeable ranges—50 for temperature and six for millivolt (0 to 1, 0 to 5, 0 to 10 mv, etc.)—these instruments will record practically any variables encountered in research work with a limit of error of ±0.3% of span. Write for Data Sheet ND46-51(100).



TO MAKE FAST, ACCURATE POLAROGRAPHIC ANALYSES

For analyzing metals, organics or biochemicals in solution, the combination of the L&N Electro-Chemograph® and Polarotron® is unmatched in accuracy and speed. The Electro-Chemograph provides: fast determination — one-second recorder balancing time for full scale travel; minimum error—polarizing accuracy to 4 mv. The Polarotron facilitates time-saving operation; stable (reference) half-cell comes prepared for immediate use. Write for Data Sheet E-97(1).

TO RECORD TEMPERATURES WITH AN ACCURACY OF ±0.01 C



Invaluable in advanced research laboratories, this High Precision Speedomax G Recorder is used with L&N Resistance Thermometers for a variety of temperature measurements over a range of −190 to +500 C with an accuracy of ±0.01 C. An "automatic Mueller Bridge," this recorder is used in cryoscopic determinations of purity, in measuring boiling ranges of liquids and in general calorimetry, etc. Write for Data Sheet E-ND46(7).

These are only a few of the modern, precise instruments that L&N provides for today's exacting research requirements. For further details, write to Leeds & Northrup Co., 4926 Stenton Ave., Philadelphia 44, Pa.

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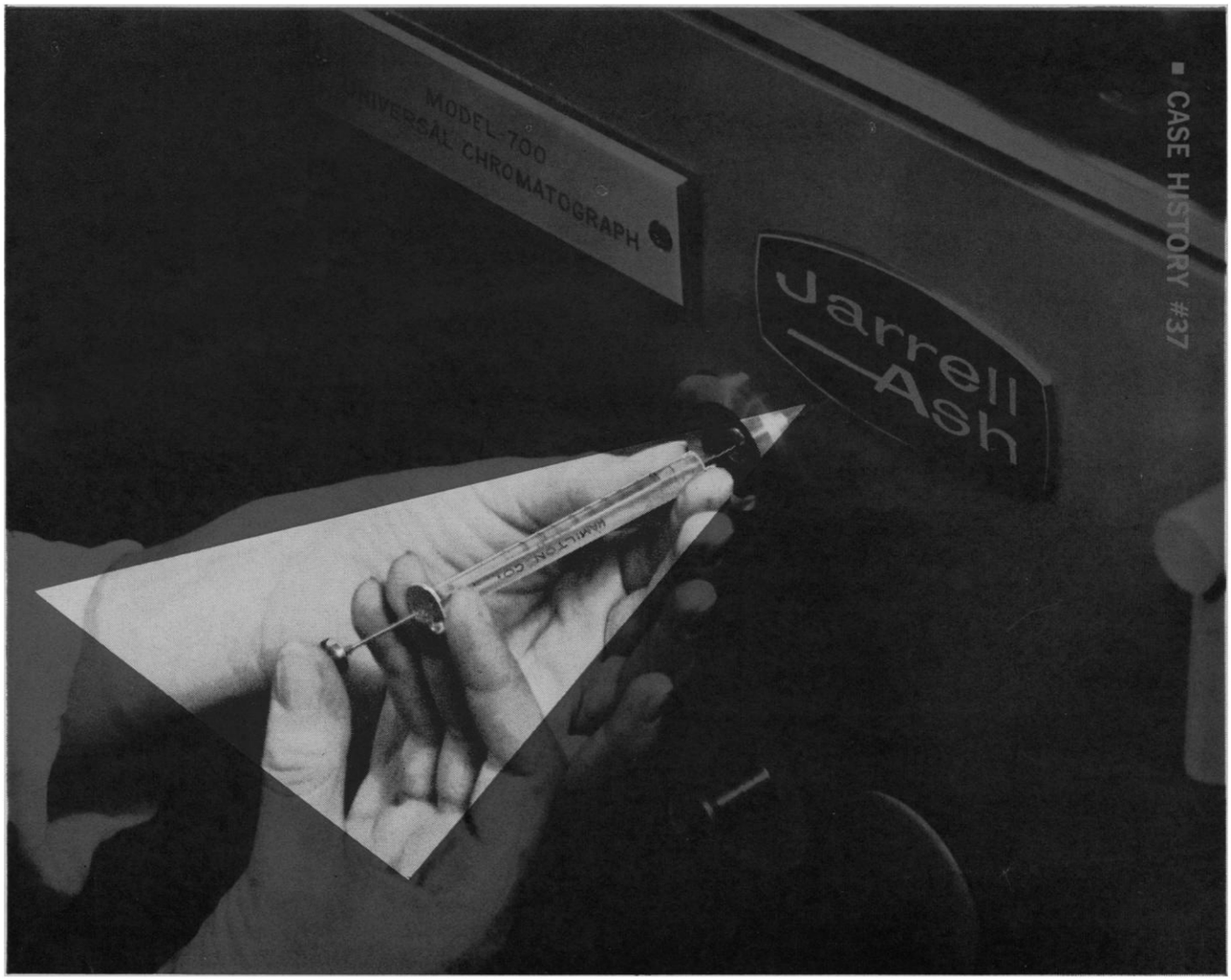

Electron Capture Detection used in G. C.

Gas chromatography utilizing electron capture detection is employed by the Agricultural Analytical Development Department of **Eli Lilly and Company** for the quality control of herbicide and pesticide formulations. John R. Koons, Eli Lilly Analytical Chemist, relates that a Hamilton 701 syringe is filled with sample and the plunger is advanced to the 1.0 microliter mark. The plunger is then withdrawn so that the total volume in the stem and the needle can be measured. The injection is made in the normal manner and then the plunger is again withdrawn to measure the remaining sample which has not been flashed off in the needle. For quantitative work a standard pre-determined volume must be delivered by the syringe for each injection. The standard volume delivered will depend upon the syringe and solvent. Using this technique, Heptachlor, at levels of 0.1, 0.2, and 0.3 nanograms per microliter, can be measured with a precision of ±4.56%, +3.75%, and ±2.65%, respectively at the 95% confidence level calculated for a single injection. By shooting duplicate samples a precision of approximately ±2.5% from the true mean is obtained 95% of the time. **Hamilton manufactures a complete line of precision syringes from a capacity of 0.5 μl to 500 μl and other related chromatograph equipment.**

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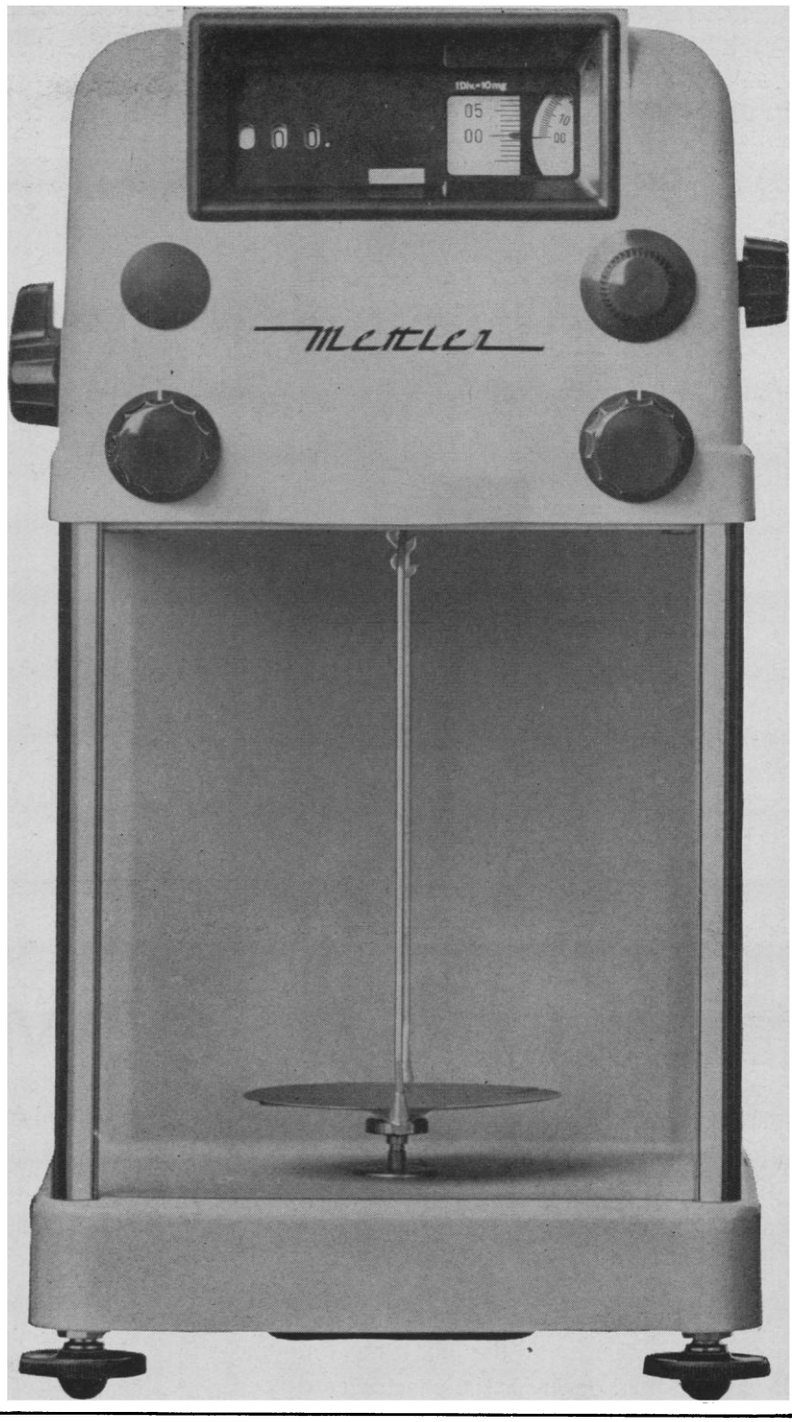

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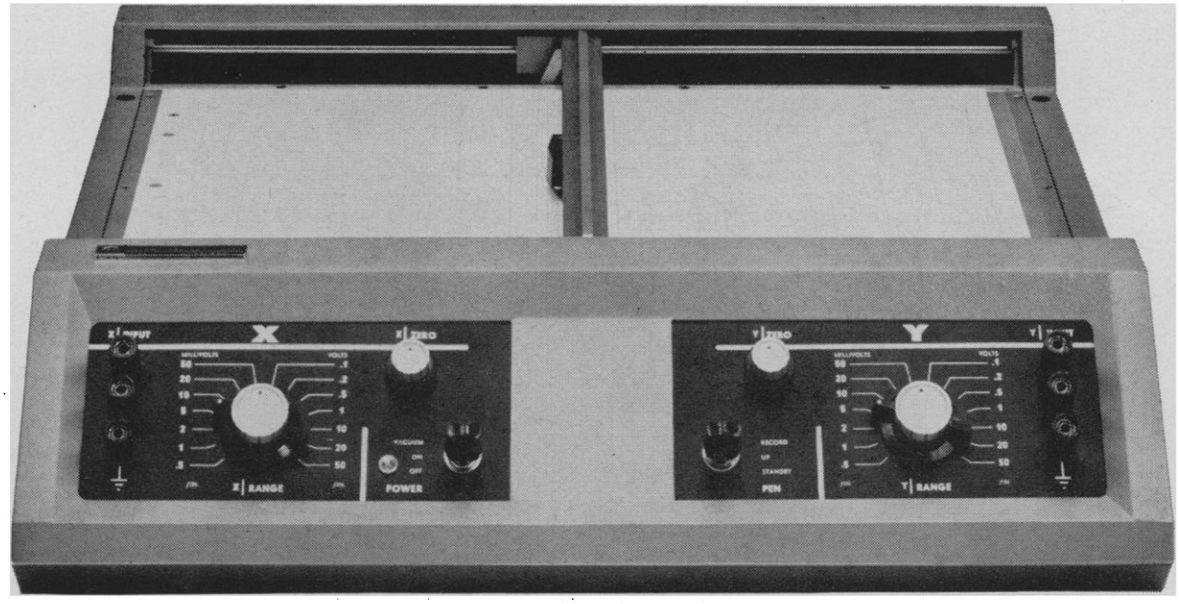

ANOTHER NEW X-Y RECORDER FROM VARIAN?

Yes and no. The new F-81 is the same high quality recorder as our recently introduced F-80. It is also the most accurate, fully-equipped X-Y you can buy for under $1900. Here's a basic instrument that comes with all the features you need to do the job. It has a unique vacuum hold down for the chart, electric pen lift, and solid-state ruggedness throughout. You can use any size or shape of paper from 2" x 2" to 11" x 17", without masking. And you can position the chart with the vacuum on. □ Human engineering on the F-81 gives you new operating convenience. Simple control panel, easy-to-service magnetic pen holders and field-convertible bench top or rack mounting make it easy for you to build this X-Y recorder into test consoles, control panels, and analytical instruments.

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- accuracy 0.2%
- 17"/sec pen speed
- 14 DC voltage ranges, 0.5 mv/in to 50 v/in
- vernier adjustment between ranges
- full scale zero plus 100% suppression
- exceptionally high input impedance
- zener diode reference
- independent servo-operated X and Y axes
- weight, 29 pounds
- F-81 price $1875

What's the difference between the F-80 and the F-81? The F-80 has an automatic-cycling time base and sells for $2025. □ For further information or a demonstration write Recorder Products. In Europe contact Varian A.G., Zug, Switzerland.

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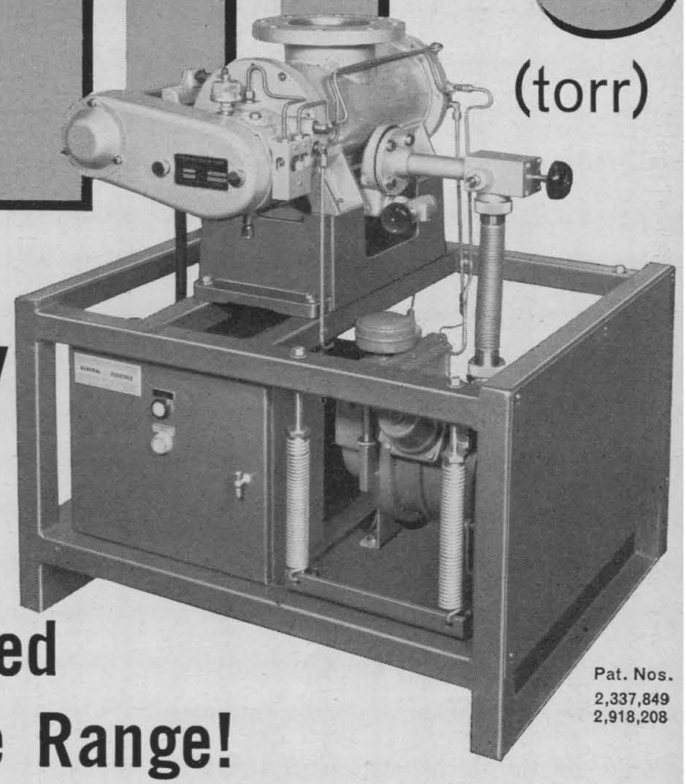
1X10^{-9} (torr)



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SPEED (AIR) — 140 LITERS/SECOND

The new, Welch 3101A Turbo-Molecular Pumping System has a blank-off pressure lower than 1 x 10^{-9} torr and a constant speed (air) of 140 liters per second over a range of 10^{-2} to 10^{-9} torr. It combines a Welch No. 3101 Turbo-Molecular Pump (manufactured under a license of the Becker patent for the U.S.A. and Canada) with the well-known Welch "Duo-Seal" No. 1397, two-stage mechanical pump in a completely assembled and tested package, ready for use.

The clean, *vapor-free* No. 3101 Turbo-Molecular Pump embodies a major advance in the design of molecular pumps, permitting the use of running clearance as much as ten times that of previous designs. Risk of damage by sudden air inrush, thermal expansion and dirt particles has been eliminated and higher pumping speeds and pressure ratios have been achieved.

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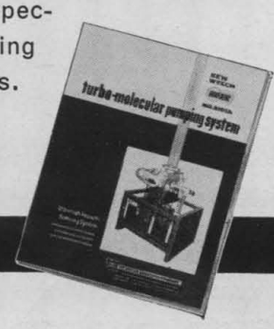
Wherever a **vapor-free** high or ultra-high vacuum is required. Typical Uses: ● Evacuation of power tubes and X-ray tubes ● Solid state research ● Semiconductor production ● Thin film metallizing ● Purification of metals such as silicon and germanium ● Optics coating ● Separation of materials or isotopes with different molecular weights, as in particle accelerator work ● Space simulation chambers ● Mass spectrometers ● Roughing ion pump systems.



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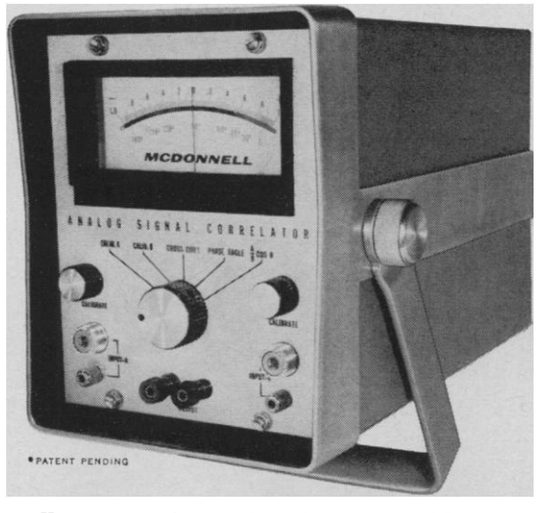
SCHIZOPHRENIA and the AIRPLANE WING

A discussion of a unique instrument we have developed which seems to be useful to the aircraft designer, the medical researcher, the oceanographer, the meteorologist, and in a number of other scientific disciplines . . .

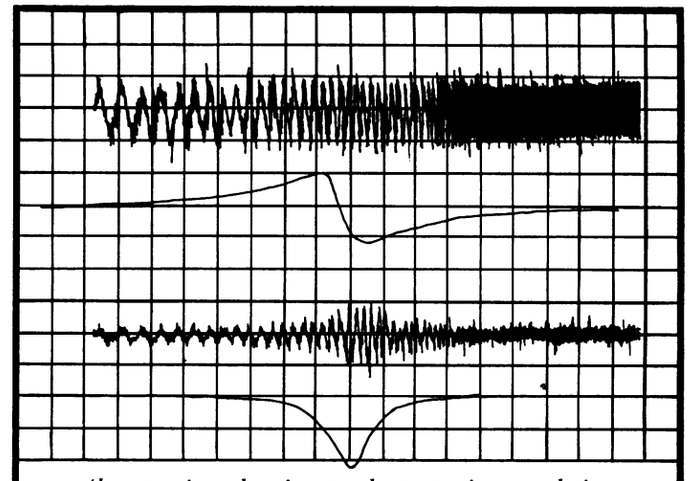
The relationship between the human brain and an aircraft wing seems remote, yet engineers at McDonnell who are working on America's fighter aircraft, and medical researchers in St. Louis, have discovered that study of events in these two unlikely areas involves a common technique called "pattern recognition".

The measurable dynamics of the brain are recorded as variations in voltages, in the same way engineers measure stresses on an aircraft wing during critical flight maneuvers at supersonic speeds.

Recording these dynamic parameters has been possible for several years. Isolating them for immediate interpretation was not. Data engineers at McDonnell have now developed a device called an Analog Signal Correlator, which not only solves the problem for military aircraft designers, but for the medical researcher as well. With this device, medical researchers have been able to establish definite relationships between psychological functioning and the recorded waveform patterns of the brain as they exist in normal and schizophrenic humans.



The McDonnell Analog Signal Correlator* provides, in real time, a dynamic measurement of coherence between any two random signals. The output is visually displayed for immediate interpretation and is simultaneously provided as a voltage output for recording.

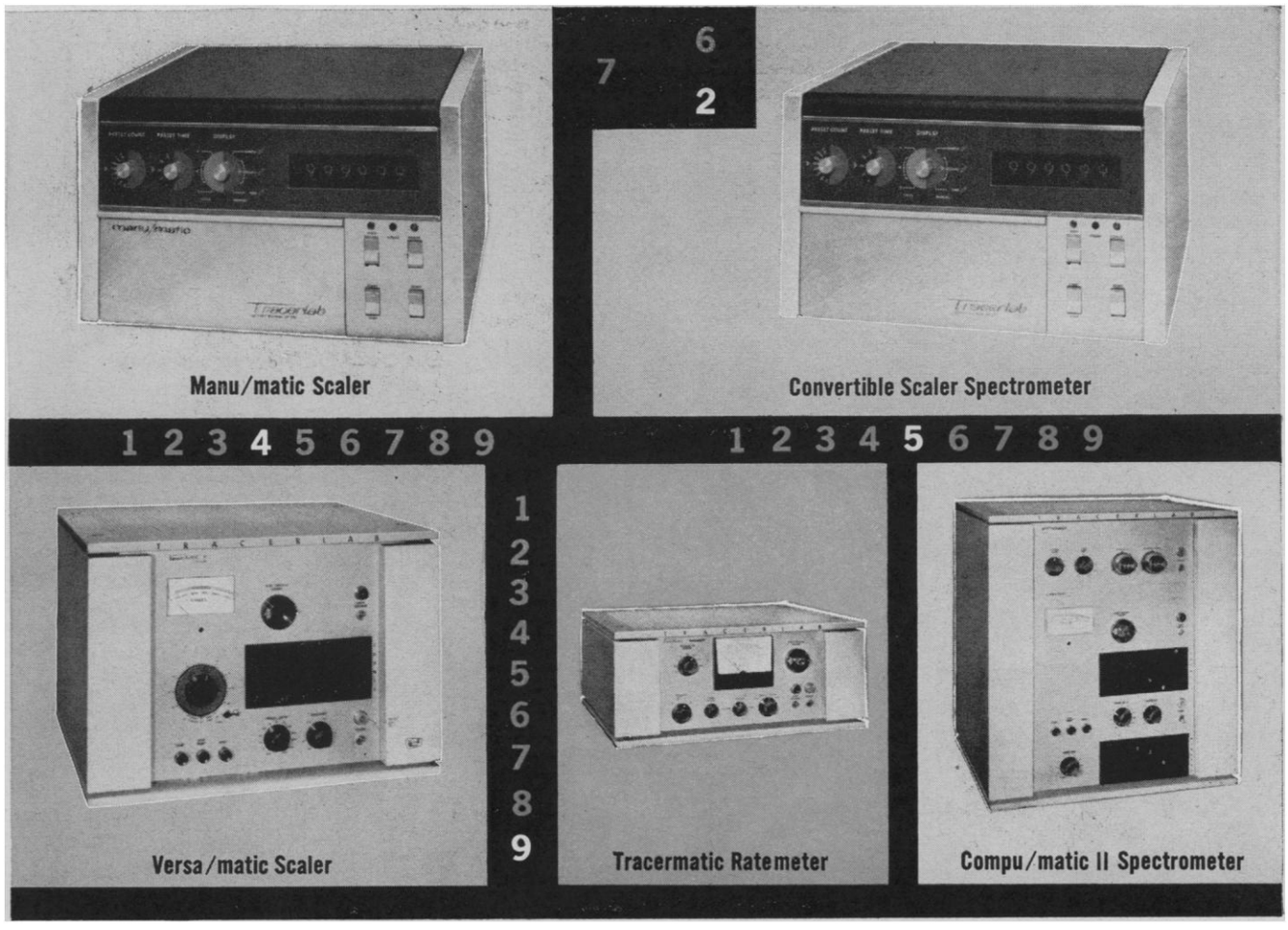


Above tracings show input and output using correlation method for evaluation of system transfer functions.

Data stored on magnetic tape is converted to "hard numbers" at real time rates. Voluminous archives and painstaking visual evaluation with its potential for bias are avoided. Operation of the Analog Signal Correlator "on line" reduces research time by making data results immediately available. Sampling, digitizing-rate and time restrictions are eliminated thus providing thorough and complete data for analysis.

The application of this device is just beginning. Current contract programs include such diverse studies as noise, vibration and flutter onset as they apply to supersonic development-flights and wind-tunnel research. In biomedicine, the Analog Signal Correlator makes possible the study of EEG bilateral phase relationships in humans. It is a significantly useful device for determining human habituation to external stimuli. Other areas which may be studied with this new research tool include pharmacology and fetal electrocardiography as well as aircraft-related research involving pilot proficiency and detection of pilot stress during hyperventilation.

We have already learned that Analog Signal Correlation can be utilized to improve data analysis in Biomedicine, Seismology, Radar, Sonar, Structural Dynamics, Oceanography, Bionics, Automatic Control, Radio Astronomy, Meteorology. Our engineers would be pleased to discuss this device with you and are especially interested in applications you might suggest. Additional information about the design, operational parameters, price and delivery schedule is available. **Write W. W. Toole, McDonnell Electronic Equipment Division, Department 946, Box 516, St. Louis 66, Missouri.**



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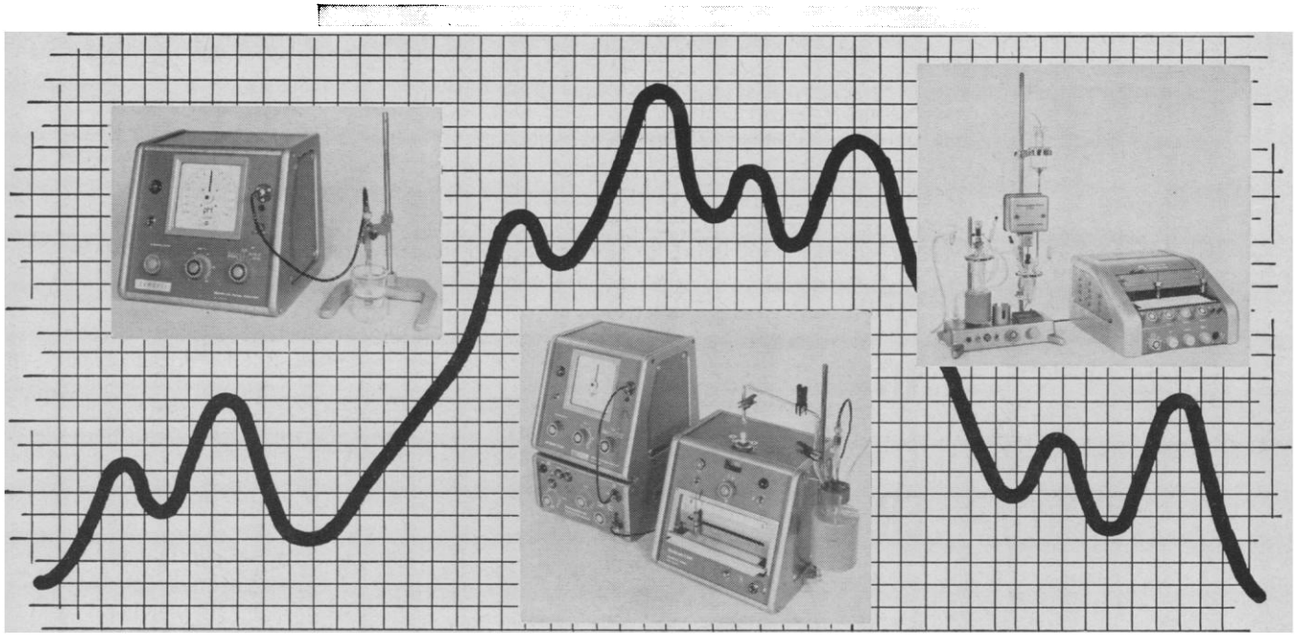

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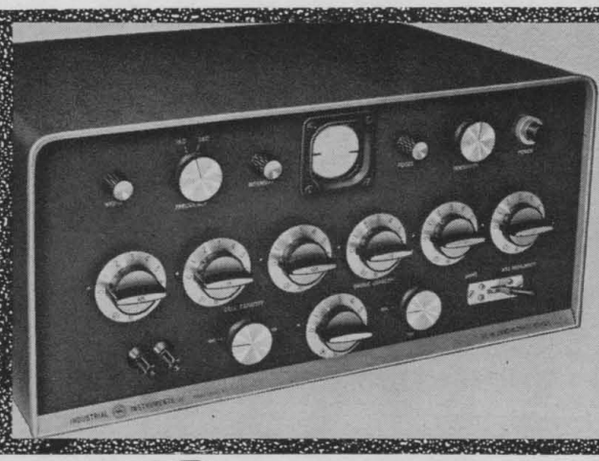
Price $237.00



Model RC-18 Conductivity Bridge ... a precision laboratory instrument measuring electrolytic conductivity and resistivity in micromhos and ohms to ±0.1% accuracy. Internal generator frequencies of 1000 and 3000 cps are provided, and balance indication is by means of a self-contained, two-inch oscilloscope.

Bridge balance is obtained through operation of 6 decades of card-wound resistors of 0.1 to 10,000 ohms each. The overall instrument range is 0-100,000 ohms. Sensitivity is better than ±0.01%. A decade of 100 pf mica capacitors and two 10-100 pf adjustable air capacitors permit balancing the reactive component of the conductivity cell impedance.

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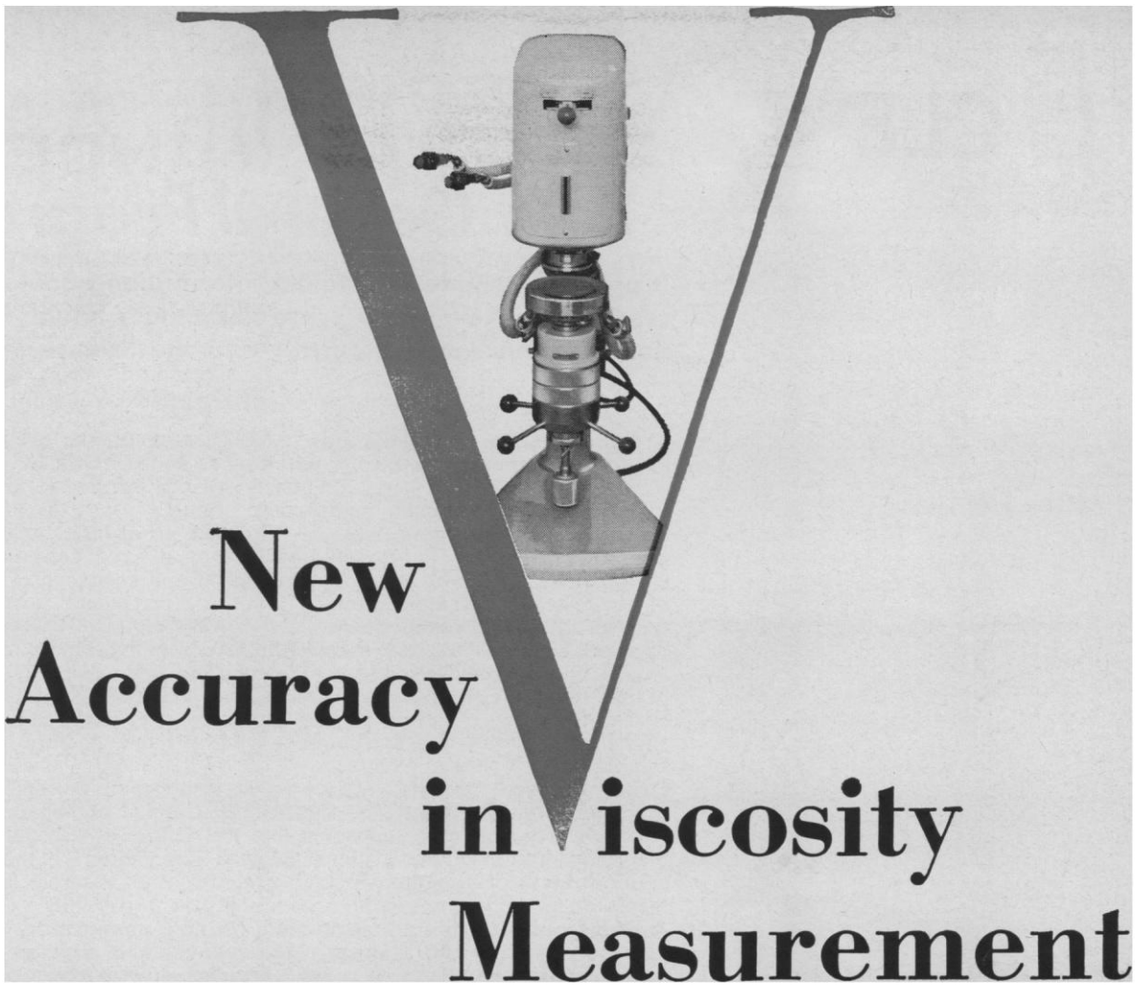

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With today's new formulations of liquid products, and the need for new and speedy handling, processing and packaging methods, a more precise knowledge of fluid behavior is essential. The advanced Ferranti-Shirley Electronic Viscometer fills this exacting need. It is especially valuable in handling complex non-Newtonian materials. Methods formerly used were often subject to error, which would be costly under today's streamlined production techniques. The viscometer shown here operates on the principle of a cone rotating against a stationary plate, with the material (less than 0.5 ml. in volume) in between.

Shear rate can be controlled, variable from 0.2 to 20,000 sec.$^{-1}$ and accurate to 0.2% under potentiometer control. The characteristics of the fluid can be read on a meter, or recorded as chart flow curves.

The viscometer permits rapid examinations, and importantly, it is very easy to clean. It is of great value both in the laboratory and in production.

VISCOSITY MEASUREMENT
A new attachment is now available which simplifies the use of the Ferranti-Shirley and makes it particularly suitable for use under production conditions where very highly skilled operators may not be available.

This latest improvement is the automatic gap stabilizer, a simple addition which insures that the gap is maintained to within 0.0001 inch at all times irrespective of temperature variations. Variations in results due to the techniques employed by different operators are thus eliminated and the full benefits of the instrument with regard to the speed and accuracy of making determinations and the very small sample size can be realized under production conditions. Other accessory items already available include:

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Interdisciplinary Symposia AAAS day: Uses of lasers and masers; philosophical aspects of present-day cosmogony and cosmology; developmental aspects of immunity; biological and sociological research on the effects of human reproduction control; the federal government, science, and the universities.

Special Sessions AAAS Presidential Address by Paul Gross; the AAAS Distinguished Lecture on ideology and income by J. K. Galbraith; the Joint Address of Sigma Xi and Phi Beta Kappa by Paul Sears; the George Sarton Memorial Lecture by Hudson Hoagland; and the National Geographic Society Illustrated Lecture on Mozambique by Volkmar Wentzel.

Other General Events Three-session symposium on the sciences in Japan sponsored jointly by the Science Council of Japan and the AAAS. Two symposia sponsored by the Office of Economic and Statistical Studies of the National Science Foundation: Planning and administration of scientific research programs, and the role of instruments and equipment use in research program planning.

AAAS Committees Joint symposium of the Committee on Meetings and the Committee on Science in the Promotion of Human Welfare on chemical control of heredity, arranged by Barry Commoner and David R. Goddard.

Sections and Societies The 20 AAAS Sections and some 70 participating societies are scheduling specialized symposia, and many have sessions for contributed papers.

Science Theatre The latest foreign and domestic films.

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MEETING • 26-30 DECEMBER

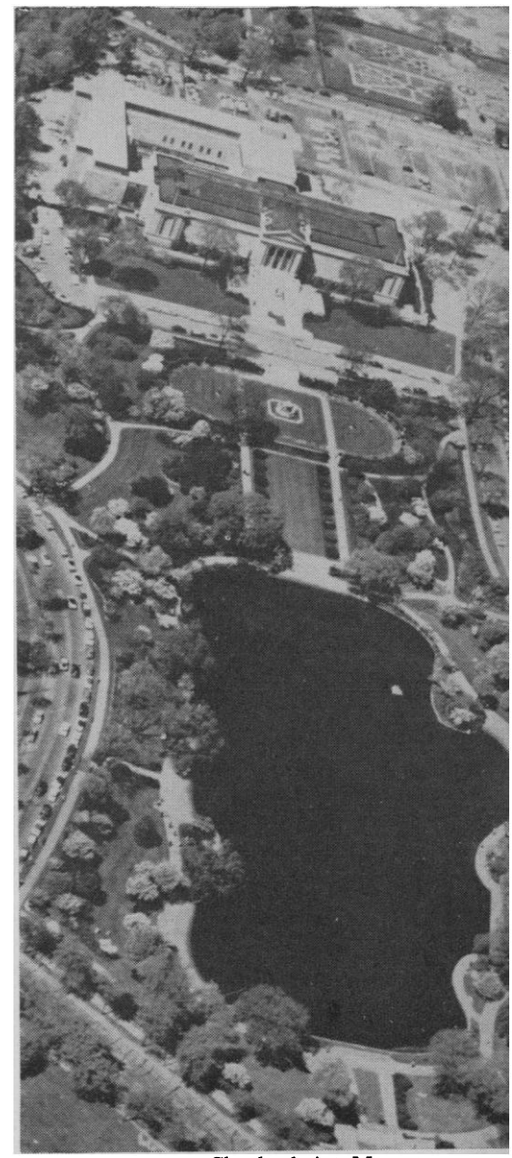
Reserve Your Hotel Room

Make sure you have the accommodations you prefer. A list of headquarters hotels of participating societies appears on page 280, 19 July, SCIENCE. The AAAS headquarters is the Sheraton-Cleveland.

The hotels for the AAAS Cleveland meeting have established special, low flat rates and have reserved large blocks of rooms for the meeting.

Use the coupon below to make your hotel reservation in Cleveland. Send your application to the AAAS Housing Bureau in Cleveland, not to any hotel. Give a definite date and estimated hour of arrival, and also probable date of departure. The Housing Bureau will make the assignment and send you a confirmation in two weeks or less.

A rollaway bed can be added to any room at $3.00 per night. Mail your application now to secure your first choice of accommodations.



Cleveland Art Museum

HOTEL RATES*
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

For a list of the headquarters of each participating society and section, see page 280, *Science*, 19 July.

Hotel	Single Bed	Double Bed	Twin Beds	Suites
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Statler-Hilton	8.50	14.00	15.50	28.00— 59.00
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* All rooms are subject to a 3% Ohio state sales tax.

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(List name and address of each person, including yourself. Attach list if space is insufficient.)

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DATES: ARRIVAL ..... A.M. .....P.M.....DEPARTURE .....
(These must be indicated—add approximate hour, A.M. or P.M.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
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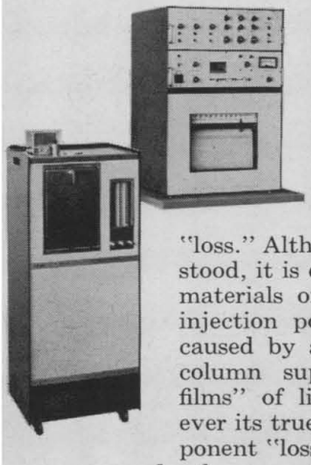
eliminate component "loss" in steroid analysis . . . even at **nanogram** levels



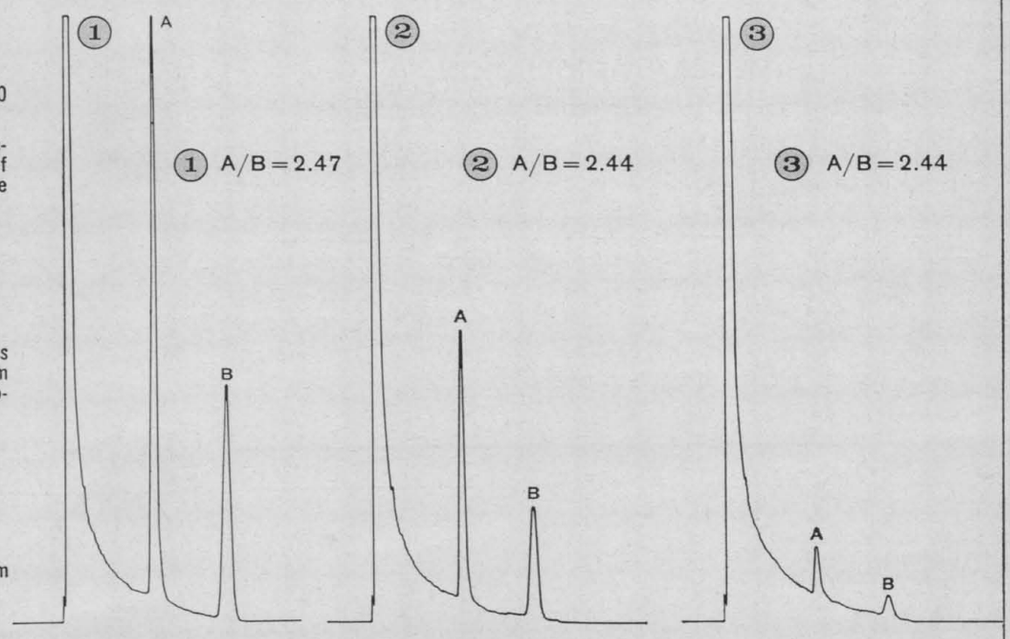
The quantitative analysis by gas chromatography of many biological compounds such as steroids and other substances with polar functional groups has not been entirely satisfactory. Of the several factors which may be involved, one of the most critical is the phenomenon of component "loss." Although this is not completely understood, it is due in part to adsorption of polar materials on metal or glass surfaces in the injection port or detector. It may also be caused by adsorption on active sites of the column support, particularly when "thin films" of liquid phase are employed. Whatever its true cause and its correct name, component "loss" is a very real problem that has made the quantitative analysis of very small amounts of such compounds difficult, thus limiting the usefulness of gas chromatography in certain biochemical and medical investigations . . . until now.

The F & M Model 400 Biomedical Gas Chromatograph eliminates the component "loss" phenomenon, even when sample size is reduced to the nanogram level. Dramatic proof of the accuracy with which steroids may be quantitatively analyzed is illustrated in the series of chromatograms below, covering a range of sample quantities from 0.1 *microgram* down to 5 *nanograms*.

There are excellent reasons for the almost perfect results obtained with the Model 400 in the analysis of biological compounds such as steroids, vitamins, alkaloids, bile acids, fatty acids and amino acids. Foremost among these reasons are exclusive design features that permit sample injection directly onto the column, the use of glass U-tube columns, the complete absence of "plumbing" at the detector, and the extremely sensitive but stable and linear flame detector.

For complete information about the Model 400 Gas Chromatograph or for a demonstration of the separation and quantitative analysis of other types of biological compounds, contact the Applications Laboratory, F & M Scientific Corporation, Route 41 and Starr Road, Avondale, Pennsylvania, 215 COlony 8-2281. *European subsidiary: F & M Scientific Europa N.V., Leidsestraat 67, Amsterdam, The Netherlands.*

INSTRUMENT: F & M Model 400
DETECTOR: Flame Ionization
SAMPLE: 1.0 microliter of successive dilutions of a mixture of testosterone (A) and cholestane (B) in chloroform:
#1: A=0.1 microgram/ul
B=0.05 microgram/ul
#2: A=0.05 microgram/ul
B=0.025 microgram/ul
#3: A=0.01 microgram/ul
B=0.005 microgram/ul
COLUMN: 4′ x ¼″ OD, glass U-tube, 2% SE-30 silicone gum rubber on 80-100 mesh Diatoport S
TEMPERATURES:
Column—230°C
Injection port—300°C
Detector—250°C
CARRIER GAS:
Helium at 60 ml/min
SENSITIVITY: 1/32 of maximum



In this series of chromatograms, successive dilutions of a mixture of testosterone (a highly polar, easily "lost" steroid) and cholestane (a saturated, non-polar hydrocarbon that is readily chromatographed without "loss") were injected into the Model 400. If testosterone "loss" were occurring, the peak height ratio of testosterone to cholestane would decrease as the amount of sample injected decreased (because the amount "lost" would be a larger percentage of the smaller sample.) But this ratio (A/B) remains constant through all three injections, even the most dilute run #3 where only 0.01 microgram of testosterone was injected. Note also the almost perfect symmetry of all the peaks, including the cholestane peak in run #3, which represents only 5 nanograms of sample. In all cases, the detector was operated at 1/32 of full sensitivity.

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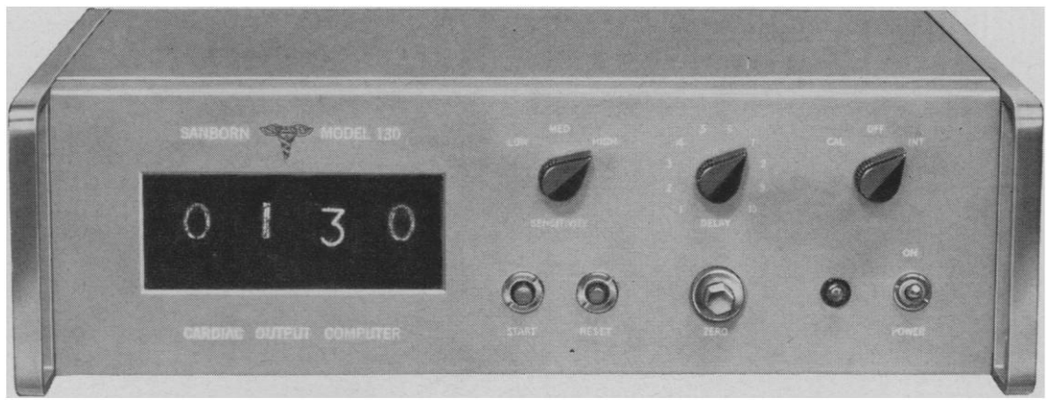

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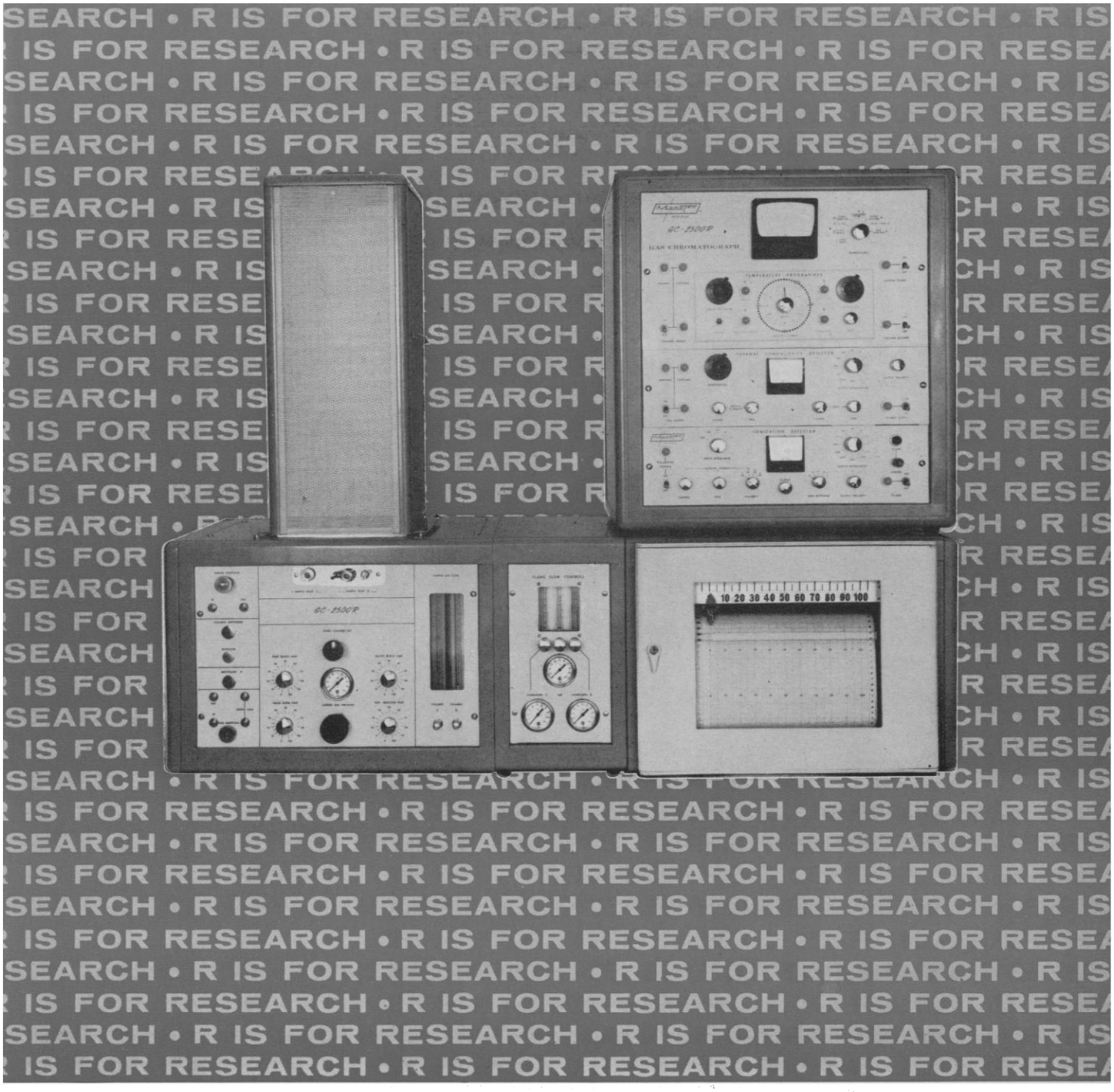

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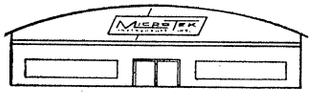

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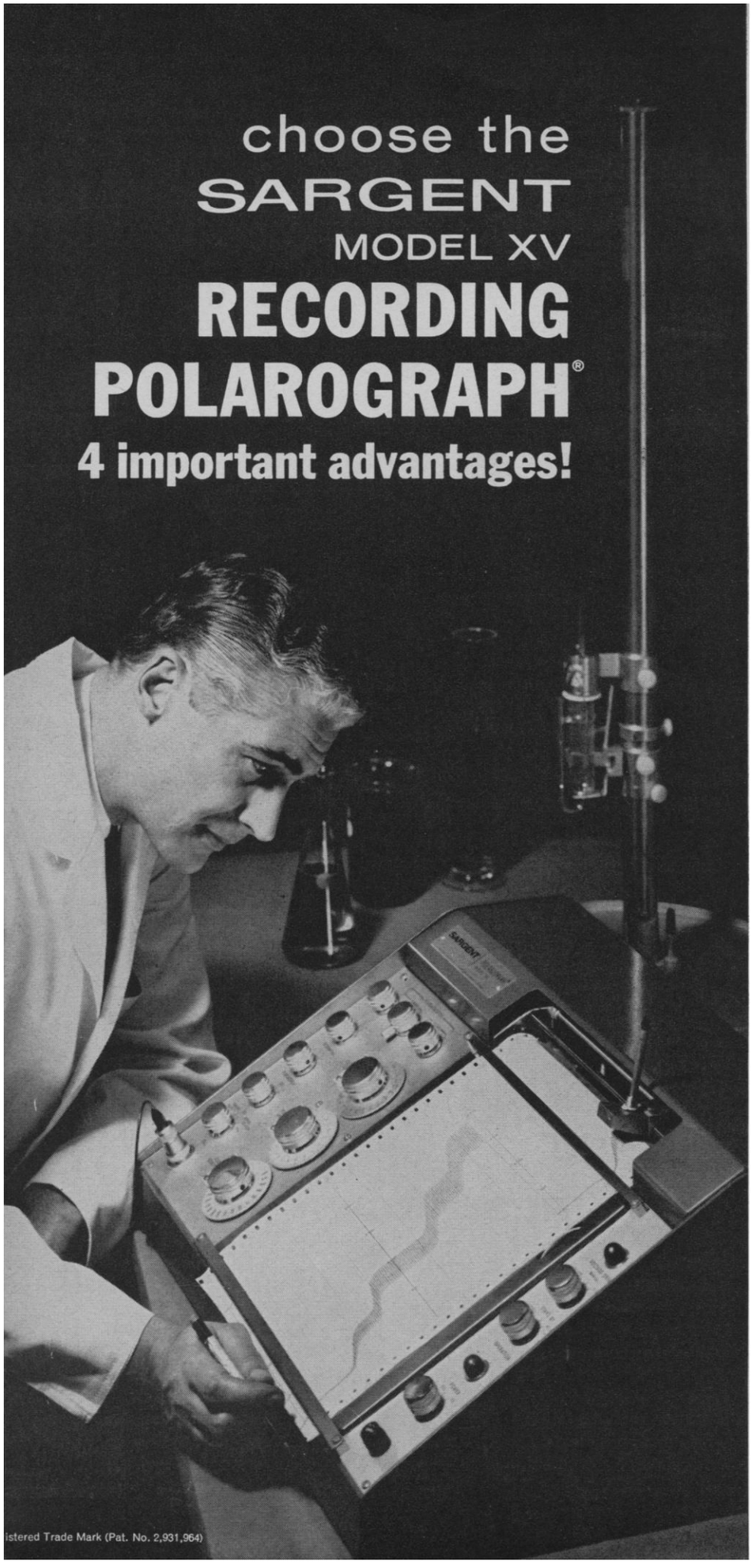

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Those who introduced the medical research bill had to make a hard decision not to accept a compromise of the original specifications, including an amendment which would have put its administration into the Department of Agriculture. The original bill finally passed both chambers, with overwhelming support. The Governor signed it into law on 4 April.

The outstanding lesson of the effort to enact this bill was that, when there is adequate public discussion of the issues, an informed electorate can convince legislators that the use of animals in medical research is essential and should be supported. Similar legislation in other states would make completely unnecessary any additional federal legislation restricting the use of animals in research.

MICHAEL HUME
Yale University School of Medicine,
333 Cedar Street,
New Haven, Connecticut

Revision of the Copyright Law

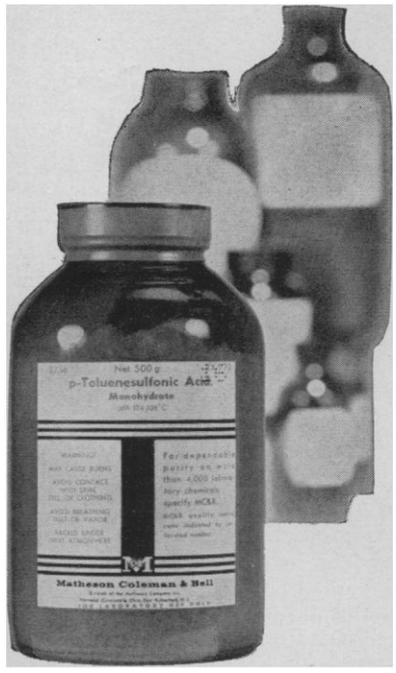
Under the caption of "Copyrights, royalties, reprints, and scholarly interests" [*Science* **141**, 483 (9 August 1963)] appeared a letter by Franklin Folsom, and a reply by Hayward Cirker to which I would like to add some details.

Folsom advocates support for a revision of the copyright law that would increase the maximum duration of a copyright from 56 years to 76 years. Concerning the present maximum of 56 years he says: "Laws about such publicly useful property as real estate, oil wells, factories, and others do not normally place such severe limits on private ownership." This comparison would be more appropriate if it referred to the common law copyright which lasts as long as the author keeps his writing privately in his possession, but is lost as soon as he gives it to the public through publication. The comparison is not appropriate when made with reference to the federal copyright law which does not limit an existing right but creates a new one—the right to prohibit others from doing something they would otherwise be free to do, the right to prohibit them from copying and distributing material which has been published.

A patent constitutes a truer analogy. In common law, if an invention can be used and still kept secret by the inventor, it is protected against theft, but after it has been disclosed to the public, others can copy it. The federal patent law, like the federal copyright law, creates a new right, the right to prohibit others from making, using, or selling counterparts of the patented invention. (Under the patent law the prohibition will apply even to others who may make the same invention independently, while under the copyright law the prohibition does not apply to others who may write the same thing independently.)

The requirements for issue of a patent by the Patent Office are, however, far more exacting than those of the Copyright Office for issue of a "Certificate of Registration of a Claim to Copyright" (notice the word "Claim"). The invention must, with some exceptions, be new and useful, whereas literary matter need only be "original" (meaning only that the writer did not copy it from someone else, although the same thing may have previously been written by others and may be in the public domain). The scope of the claims for an invention—its novelty and usefulness—must be clearly specified and delineated. The original material on which a copyright is claimed does not have to be specified: original and non-original material; and material on which a copyright has expired, can be combined to give the misleading appearance that a copyright is claimed on the aggregate and to complicate litigation. A patent application is scientifically examined by experts in the Patent Office for novelty and usefulness, but no examination is made or could be made for originality of literary material in the Copyright Office; in fact the Copyright Office does not necessarily retain a copy of all material filed with it, but may discard such material even before expiration of the copyright period. In other words, a patent represents a finding that the invention is a substantial advance over the prior art, but a certificate of registration of a claim to copyright does not represent a finding that a writing is creative or even that it is "original." Yet the potential life of a copyright is already more than three times as long as the life of a patent: an initial term of 28 years plus a renewal term of 28 years, or a total of 56 years, as against 17 years for a patent.

Cirker remarks that extension of the life of copyrights to 76 years is being promoted by a small, special-interest



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group and that such extension is not in public interest or in the interest of scientists. In support of this contention the following observations may be made. Anyone can claim a copyright on almost any arrangement of words and bring a charge of infringement against anyone who uses a similar arrangement, even though it is original with the latter person or was taken from the public domain. Since the first test of the validity of a copyright must be made in court, the threat of litigation, especially by one with greater financial resources, and the difficulties of proving originality by the accused as compared with the ease of showing similarity by the accuser put a powerful weapon in the hands of the accuser. With the accelerating rate of publications, more similarities among original writings are bound to result, and thus more charges of infringement where none has occurred. Also, a copyright may be misused to try to prevent the free flow of ideas, although an idea cannot be copyrighted. Hence there seem good reasons for not enlarging the privilege of copyright. With respect to scientists in particular, the extension of the life of a copyright would bring no benefit, for the accelerating rate of scientific developments makes it most unlikely that a scientific writing will command royalties or be in demand after 56 years. Scientists and the general public would be better served by a revision of the copyright law requiring a specification of the portions on which copyright is claimed, where it is not all original or where a copyright has expired on part of it—under penalty of voiding the copyright on the whole thing if a false claim is made.

PAUL L. LATHAM

371 Blythe Road, Riverside, Illinois

Overhead and Research Grants

The recent AIBS predicament [*Science* **139**, 317, 392 (1963)] put the spotlight on the rapidly growing, cancerous, "overhead" situation in U.S. science. It seems timely for someone who is not dependent on this source of income to point out what is happening.

"Overhead" of some sort is a justified feature of applied science contracts, where the government, or an industrial concern, requires that certain work be done and must bid in the open market for the services of an institution with the necessary facilities and capacity to do the work, or build its own facilities with this capacity. This kind of science, if it can really be called science, does not differ from any other sort of commerical or economic activity. Whether the compensation is called "overhead" or "commission," it is essentially a cost-plus arrangement, and the amount of compensation is determined by the state of the market.

Fundamental science, formerly called "pure science," has come to be subject to the same profit motives. Research was once considered to be one of the normal functions of universities, museums, institutes, academies, and other intellectually oriented organizations. The authorities of such institutions were more than happy when their scientists were able to get grants-in-aid to enable them to carry on this function and considered it a normal part of their own duties to take care of the bookkeeping. We were outraged when we heard of a tight-fisted university administration demanding a 7½ or 10 percent "overhead" to cover the cost of these services.

However, the pattern was set by the contracts for "testing," "research and development," and other applied activities that required the services of scientists or technicians, and the demand for a cut of the pie spread to contracts and grants for strictly fundamental research—research which the scientists wanted to do because of their own intellectual interests. As granting agencies grew to handle the awarding of the increasing government support to pure science, they tended to be staffed by professional scientific administrators, often coming from the agencies that had handled defense and other applied contracts. The idea of overhead was not new to them, and they had also brought with them the businessman's distrust of the people with whom he deals. They were not any more willing to trust the scientist grantee to handle his own grant than they had been to trust the commercial chemist who had been employed to develop a new pesticide or the engineering company that had built a missile. They demanded the assurance provided by an institution that the scientist would not abscond with the money, spend it on wild parties, or take his family on a vacation. The

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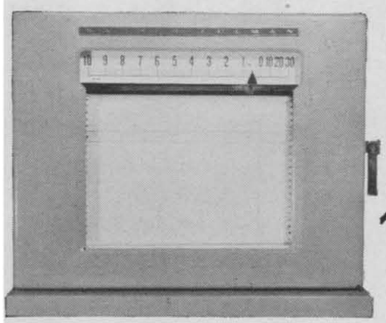

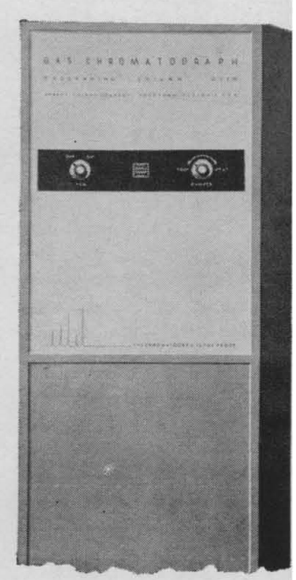

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fact that the value of the work they were supporting depended entirely on the same man's honesty was apparently never given a thought. For the assurance of financial responsibility they were willing to pay an appreciable percentage of the total funds available for their grants.

The fiscal authorities of the universities were not slow in seeing the possibilities in this situation. They began to scrutinize their own operations for "indirect costs." These commenced to mount with no relation at all to any change in the work performed by their bookkeepers. The contrast between the 10 to 15 percent overhead allowed by the pure science granting agencies and the 50 to 120 percent allowed on applied science contracts became evident, resulting in pressure, on the one hand, on their scientists to work on "useful" projects, and on the other, on the agencies financing fundamental research for higher overhead. It was inevitable that the possibilities in the use of "overhead" for purposes for which it was never intended would be discovered. An early one, and certainly not an undesirable one, was the attempt by certain universities to build up a fund to provide continued employment between contracts for the professional staff hired for contract work. Such foresight was never widespread and was soon discouraged by higher authorities controlling these institutions themselves, who could not tolerate the idea of this money lying unused. The practice of using the overhead money to finance scientific or other activities which were outside any approved program of the granting agencies was not long in following. The AIBS, admittedly one of the guilty ones, happened to be the one that got caught and made an example of.

I think that it is time to look into the whole overhead situation in pure science grants. NSF officials readily admit that the number of meritorious proposals submitted exceeds their capacity to finance them. They have to reject, because of lack of funds, projects they would otherwise be glad to support. If overhead did not eat up 20 percent of the available funds, 20 percent more work could be supported. The man-hours that go into the preparation of these lost proposals are both a source of frustration and a dead economic loss. In addition to this, another sinister factor has crept into the situation. Panels of scientists, who are supposedly evaluating proposals on their scientific merits, are allowing the size of the overhead demanded by an institution, what is known of its use of the overhead money, and whether or not the institution normally supports a particular kind of work, all to influence their decisions about the relative merits of the proposals they are judging. This can be described in no other terms than as a perversion of the function of these panels.

The practice of allowing overhead on scientific grants and contracts, except those of a strictly commercial nature, should be abandoned. Abandonment would make at least 20 percent more money available to support meritorious projects. It would, at one stroke, eliminate proposals that are developed because of pressure from administrative authorities rather than because of interest by the scientists themselves. And it would bring out into the open the financial problems of worth-while scientific institutions. The legitimate administrative expenses of these institutions would have to be obtained by the same kind of procedures as the funds for scientific work, would be subjected to the same sort of scrutiny as that given to the scientific budgets, and would have to be justified in the same ways. Such administrative expenses would doubtless decrease materially. We might even be treated to the phenomenon of an administrator not having as many secretaries and clerks as he needed, because he could not afford them. This has long been a common situation with scientists. If the so-called indirect costs were real and legitimate, they could and would be met by appropriate grants. Equally, the costs of maintenance and care of collections, libraries, natural areas, and other facilities for scientific work could be honestly appraised and provided for. If the government is in the business of supporting scientific research, as it obviously is, this should be admitted. The support should be adequate; opportunity for control over the directions pure science may take should be minimized; and the processes of empire-building should at least be brought out into the open, so the empires would stand or fall on their merits, rather than be allowed to take place back in the shadows where funds can be manipulated and things may not be what they seem.

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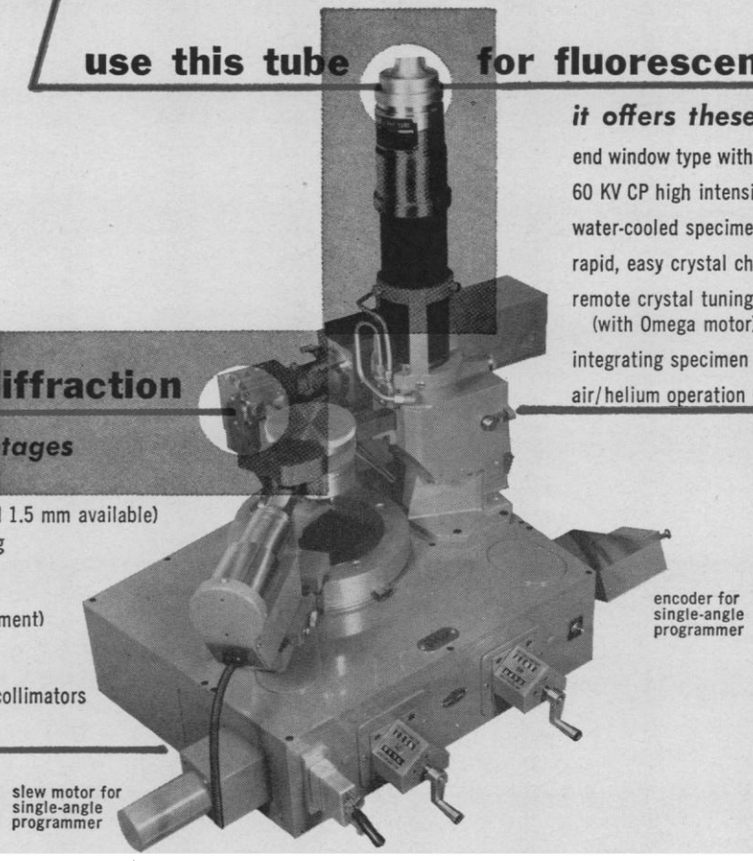

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Equal Opportunity

A tremendous amount of money has been and is currently being expended in an attempt to improve the scientific capabilities of American youth. Yet, do all youth receive an equal opportunity to benefit from this expenditure? Are these funds, many of which are derived from current taxes, actually being used to increase the subject-matter competency of future college science students within particular disciplines rather than to increase the scientific literacy of all youth as citizen-consumers? It would seem that a far greater number will become consumers rather than scientists.

During the past 10 years much has been said about the failure of elementary and secondary schools to provide adequate instruction in the sciences. Much has also been said to encourage these same schools to give students a better understanding of the relationships which exist between 20th century technology and modern social institutions. An ever-increasing emphasis seems to be placed upon the need for public and private elementary and secondary school teachers to acquire new factual information for dissemination to their students. However, it is extremely difficult to find publications concerning the degree to which the newly acquired information is communicated to and learned by high school students.

School administrators have been asked to indicate the necessary qualifications for secondary school science teachers. Is the science teacher unable to indicate the deficiencies which exist in his own subject-matter preparation? Further, to what degree does competent supervision exist in the public schools in general and, more specifically, within the sciences, when the administrator is likely to be less adequately prepared in them than the science teacher he supervises? This may be particularly true of smaller schools, but the debility appears to be general.

Is the college science teacher also shirking responsibility? Do those of us who work with science teachers in training attempt to determine the problems encountered by those working in the smaller schools? Do the present course-improvement programs involve a thorough analysis of the ways in which the discipline can be learned by high school students? Little evidence would indicate an affirmative answer.

While substantiating evidence is lacking, are institute participants selected on the basis of their previous college marks? Are some participants being selected because they teach in a particular community? It would seem that many people who are less well prepared academically, both in terms of marks and the number of science courses completed, should be the first to be invited to participate in an institute. Such teachers still remain in the classroom, while others have attended as many as 8 or more institutes.

In essence, while a large number of us welcome the opportunity to obtain grants, is there an abrogation of responsibility on our part? We apparently fail to investigate any values which may accrue from such expenditure in terms of an increase in the scientific literacy of high school students. If we are evaluating outcomes of institutes course-improvement programs, and the many other existing attempts to improve scientific literacy, then our failure to communicate and publicize our findings is also an abrogation of responsibility.

DAVID W. PIERSON
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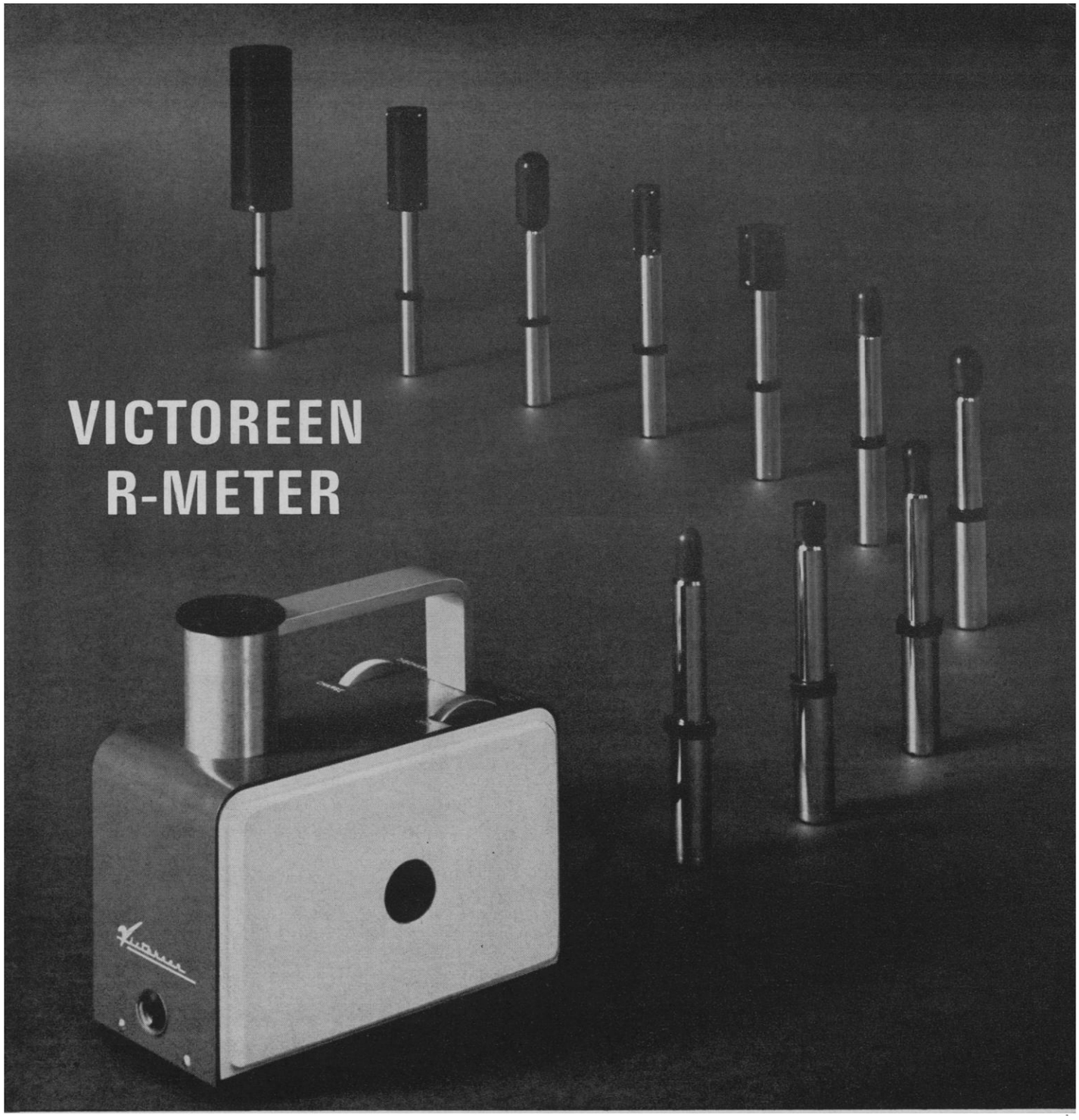
Critical Evaluation of Reviews

Margaret Mead has raised an important issue in her letter concerning "literary" versus "scientific" book reviews [*Science* **141**, 312 (26 July 1963)]. There is a vast difference between a literary work—which is evaluated by the reviewer on the basis of emotional impact, craftsmanship, persuasiveness, or even the reviewer's personal opinion of the author and what he may be trying to say—and a serious book on some scientific specialty that has become of interest to a literary review journal.

The critical evaluation of the work of one professional scientist by another is based on the assumption that both author and reviewer are engaged in a common enterprise: the search for scientific truth. This is not the situation between the author of a novel and its reviewer. Thus when the scientific work seems to contain erroneous logic, insufficient supporting evidence, or unjustified conclusions, the reviewer should point this out—and the author's reply should also be printed. Many times the critic aids the author by pinpointing weaknesses in logic (or even arithmetic) and science benefits.



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It does not matter where the review appears. When a scientific work is appraised for its content by another scientist, the "scientific reviewing ethic" must govern. For when one scientist criticizes the work of another, the fact that he stakes his reputation in public, keeping in mind the possibility of a sharp rejoinder, serves to maintain responsible discussion. As Arthur Freeman pointed out in the letter printed below Mead's, a reviewer can do himself discredit, as well as the author, if he is inaccurate or hypercritical. The possibility of an immediate rejoinder thus serves the community well.

RAPHAEL G. KAZMANN
Stuttgart, Arkansas

Is not Margaret Mead's "mare" actually a swarm of hornets [*Science* **141**, 312 (26 July 1963)]?

T. H. JUKES
Bonner Laboratory, University of California, Berkeley

Identity of Organized Elements in Carbonaceous Chondrites

A recent report in *Science* (*1*) highlighted the present controversy about the identity of organized elements found in carbonaceous chondrites. In this regard, it may be observed that none of the reported organized elements appear to be from "out of this world" in terms of morphology, structures, and reaction to stains (*2*). This can be seen by the presence of pores, spines, processes, ornamentation, protist size, canals, plates, necks, collars, tissues, walls, acid-resistant pellicles, apparent pectic substances in some walls, ribs or thickenings, reactions to a broad band of biological stains (*2*, Table 1). At the New York Academy of Sciences Conference on Fossil and Recent Protobionta last spring, I recall a conversation with Bourrelly in which he expressed surprise that many of the organized elements were reminiscent of terrestrial chrysophytes (which are his specialty) (*3*).

It follows that for such organized objects, an equivalent biochemistry to that known on earth is indicated. Thus, we may assume that all such objects are carbon-based, that nucleic material compares with that of similar terrestrial objects, that reproduction (fission and copulation) may closely resemble that of terrestrial equivalents (*2*, Fig. 6a).

This complete terrestriality of the organized elements places a sharp focus on a possible explanation. Either we are dealing with an example of extraterrestrial homeomorphy with terrestrial protists or the terrestrial aspect of the organized elements arises because they are, in fact, terrestrial contaminants (*1*). The latter explanation, being simplest, has first claim on our attention.

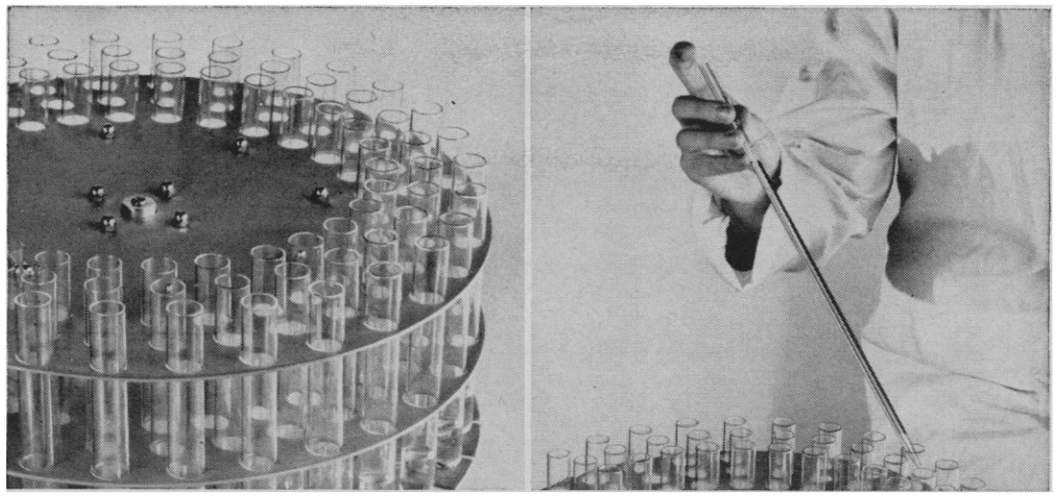
1) *Possibility of terrestrial contamination.* Claus *et al.* (*2*, Table 2) recently provided a valuable reference to the biological material found in soil and rock samples in the Orgueil impact area. These objects included various chrysophytes and in one rock fragment from a quarry (location not indicated on map), a fragment of an armored dinoflagellate, *Peridinium*. In addition, there was a varied suite of other protists, pollens, and other organic items.

The new data on the microbiology of the impact area becomes important when viewed in the light of observations of the organized elements made by several specialists. Claus, Bourrelly, and others have noted that several of the organized elements resemble chrysophytes. Staplin, Ross, and others have noted that some of the organized elements suggest hystrichosphaeres, dinoflagellate cysts, or dinoflagellate structures. Clearly, some chrysophytes and dinoflagellates are available in the impact area today (*2*, Fig. 9a-b). If a chondrite impacted in the Orgueil area today, one might reasonably expect incorporation of some of these forms and others listed in Claus's Table 2.

Claus *et al.* (*2*) cited Bourrelly and noted that the present soil microbiota in the impact area should be similar to that of 1864. Hence, we may conclude that such protists were available in the Orgueil area in 1864 at the time of impact. However, none of the organized elements were found to be "identical" with elements of the existing microbiota of the area. Does that close the case for contamination at the time of impact? I do not think so.

Almost a century has elapsed since the original fall in the Orgueil area and some changes in the biota might have occurred. As the next point to be discussed will show, based on the data of Claus, *et al.*, some changes apparently did occur.

2) *Aquatic contaminants in Anders's sample of the Orgueil chondrite.* Having recently processed a sample of the Orgueil meteorite provided by Anders (*4*), I was surprised



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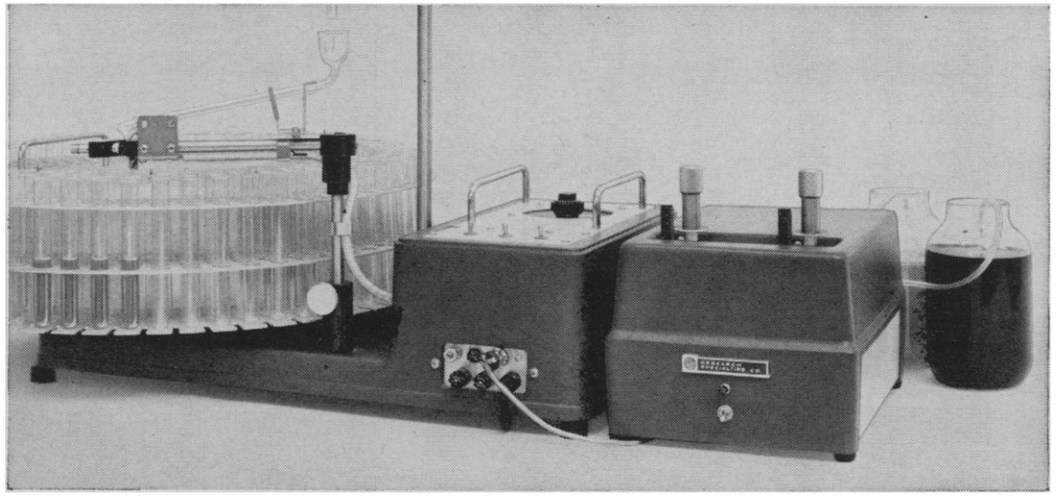

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to learn that Claus *et al.* (*2*, p. 602) found, in another of Anders's samples, the following items: fragments of *Compsopogan* filament (Rhodophyta), individuals of *Chlorella*, a rare species of *Nägeliella*, cladoceran antennae, and so forth. These authors observed that "although the organized elements were clearly visible, the presence of aquatic contaminants suggested a more recent sediment than that of a carbonaceous meteorite."

The contaminants, with special reference to the cladocerans, clearly occupied a small aquatic situation, perhaps on an alluvial floodplain in the area of impact. This is suggested by the map of the area (*2*, Fig. 14). If not, then they probably represent post-impact contaminants acquired during handling or museum storage. Since *Chlorella* species were also reported in the list of biological specimens found in the surface soil of the impact area at the present time, it is reasonable to conclude that the other aquatic objects found in Anders's specimen also were present in the impact area in 1864. However, according to Claus's Table 2, these other forms are not present in the Orgueil area today.

We may thus infer that some degree of change in the microbiota has occurred in the impact area since 1864. If cladocerans, *Compsopogan*, and others were once in the impact area, why could not other forms belonging to aquatic biotas also have been in the area and since have disappeared?

3) *Organized elements in mineral grains in chondrites.* Some organized elements have been found in mineral grains which suggests that they are indigenous and were not added at impact or subsequently. Brian Mason (*5*) has pointed out that the "environment can affect the 'organized elements' " in various ways, among others, in the amount of bound water in magnesium sulphate in the chondrites. Now, it seems desirable to reconcile these two observations.

If one grants that a given organized element incorporated in a chondrite mineral grain represents a once-living individual, then it becomes important to know about all possible environmental and diagenetic effects on mineral grains in carbonaceous chondrites. Specifically, to advance the argument, if one assumes that a given organized element embedded in a mineral is a terrestrial contaminant, then a plausible explanation is needed for the steps leading to its incorporation. One might even ask whether it is possible to *deliberately* incorporate one or more such contaminants in mineral grains of such chondrites under the prevailing temperature conditions in soil or museum air, or during the preparation of thin sections?

The terrestriality of the organized elements is their most distinctive general characteristic. Either homeomorphy (the least likely possibility) or terrestrial contamination (the most likely possibility) can account for it. Only a vigorous and healthy scepticism about *every detail* of published reports (pro and con) can help to resolve the matter.

PAUL TASCH
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2. G. Claus *et al.*, *Ann. N.Y. Acad. Sci.*, **108**, 580 (1963).
3. P. Bourrelly, *Revue Algologique, Mémoire Hors-Série No. 1* (Muséum National d'Histoire Naturelle, Paris, 1957).
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5. B. Mason, *ibid.*, **108**, 615 (1963).

Science in the Humanities

Comments such as those made by Marcel Roche in "The humanities in the scientific curriculum" (*Science* **141**, 698 (23 July 1963)], distract interested observers from the true problem. Scientists *do* know about the humanities, and they understand them, appreciate them, and participate in them. The degree may be less than perfect but it certainly is not zero, as is the case with regard to the comprehension and understanding of science by the nonscientific community—the major portion of our population.

These people are proud of their ignorance! How often one hears a comment such as, "Oh, that's mathematical; I never was any good at figures."

Ask any nonscientific man-in-the-street to explain, even in a rudimentary sense, why an iron gets hot but a refrigerator gets cold when both are plugged into the same outlet; or how a TV set functions or why a satellite stays in orbit. Their ignorance is abysmal.

What *is* needed, desperately, is science in the humanities curriculum—not further additions to the converse.

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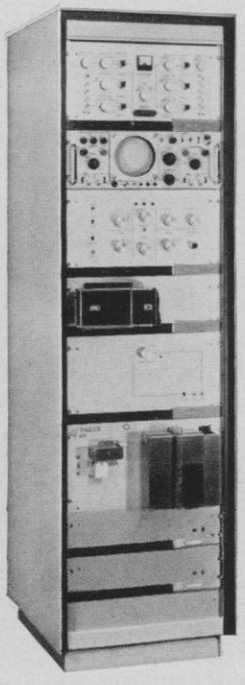

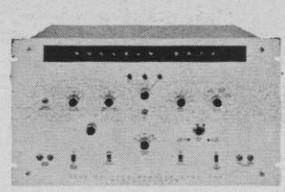

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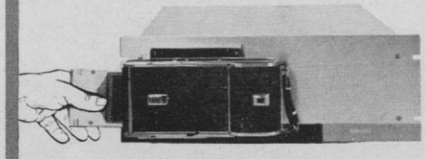

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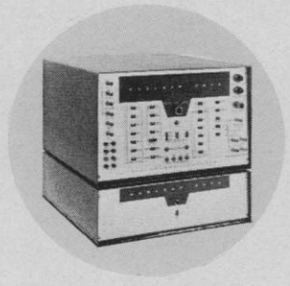

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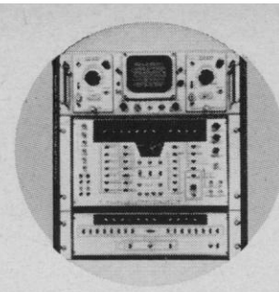

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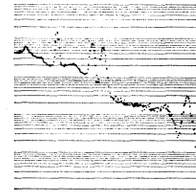

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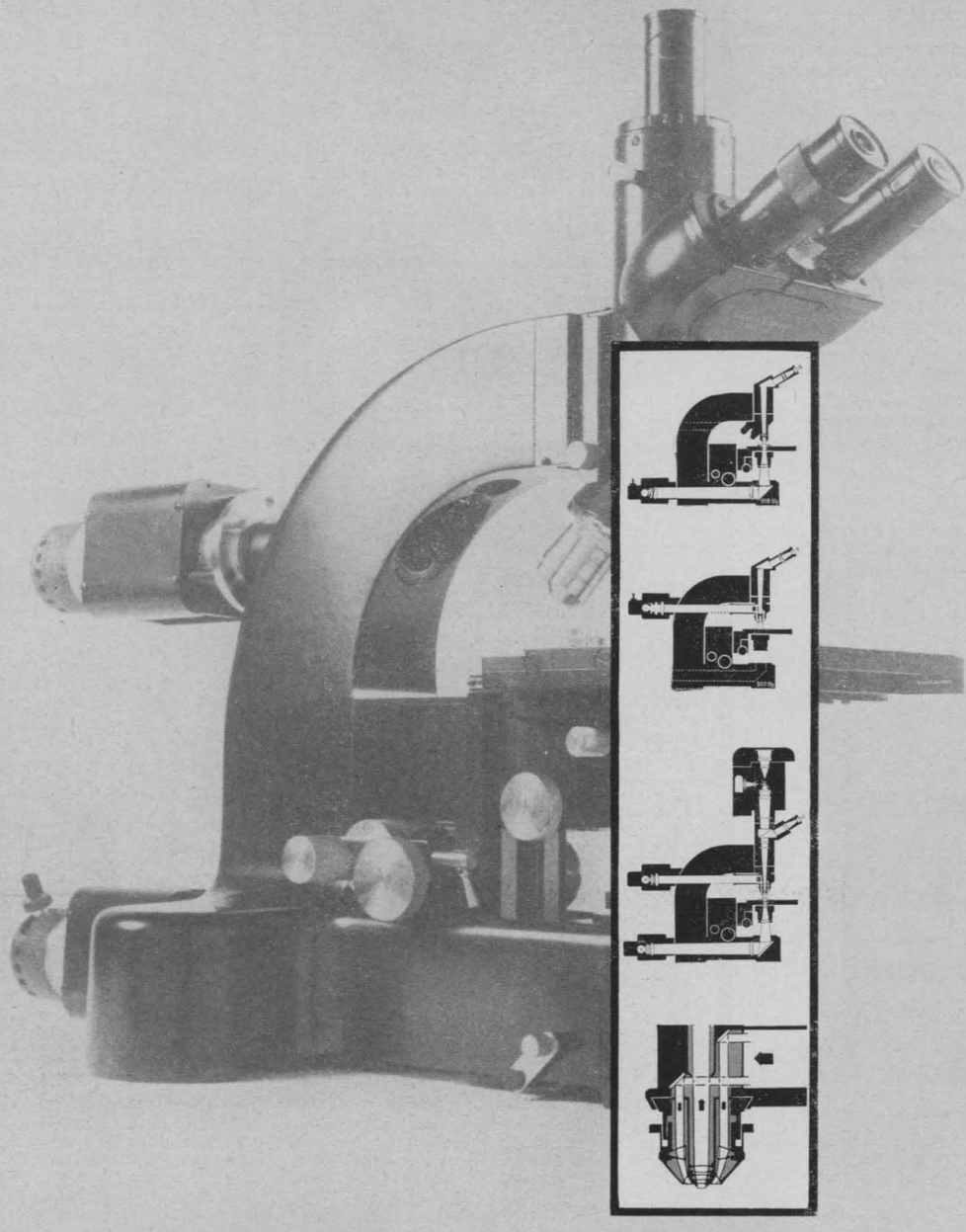

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11 October, 1963, Volume 142, Number 3589 **SCIENCE**

Instrumentation Creates New Opportunities

One of the principal avenues to scientific progress is the development of new means of probing nature. In an earlier day it was possible to make experiments with simple tools in many areas of inquiry. Gradually, however, most of the great questions that could be answered by simple procedures in virtually every area of science were examined. During the last decade the increased funds available through government support of research would not have been so useful had it not been for what has amounted to a revolution in instrumentation. This was financed to a considerable extent from funds in the hands of investigators who were searching for new approaches. Developments in instrumentation have affected the conduct of research in almost all areas of science.

In astronomy many of the recent advances are connected with new instruments and techniques—radio and radar astronomy—or with improvement in the measuring capacity of existing observatories through the development of more sophisticated devices—infrared detection, for instance. In space research all the new findings have involved the use of recently invented equipment, whether it be the launch vehicles, the satellites themselves, or the instrument packages. In nuclear physics most of the new discoveries are dependent on instrumentation—either the accelerators or the detectors, such as bubble chambers or spark chambers. Chemistry has become increasingly dependent on instrumentation for further progress. Recording infrared spectrometers are routinely used tools. In some laboratories whole programs are built around the use of gas-liquid chromatography. In others, mass spectrometry plays an important role. Studies of natural products are being greatly aided by new equipment for measuring optical rotary dispersion. Most organic chemical research laboratories employ nuclear magnetic resonance, which permits unique assignments of structure of complicated compounds. Perhaps nowhere has the impact of instrumentation been greater than in biochemistry and molecular biology. Many of the important advances of the past few years have stemmed from the use of column chromatography, the analytical ultracentrifuge, radioactive tracers, or the amino acid analyzer. The impact of new equipment has extended to the behavioral sciences. Today some psychology departments use more electronic equipment than most physics departments used a decade or two ago.

Instrumentation has an impact that shapes the course of research. The drudgery of many routine measurements has been eliminated by means of automatic equipment. Still more important, some of the new apparatus opens up new experimental capabilities. For instance, gas-liquid chromatography permits effortless identification and measurement of 20 or more substances present in a microgram or less of sample. In an earlier day, to get comparable information might have required kilograms of material and days of work. Similarly, in countless ways the computer saves human effort and permits detailed calculation and correlation which previously were impractical.

As with any useful development there is a danger of misuse. With powerful new gadgets available, some individuals are tempted to ask for each new item as it is developed and to treat it as a new toy. To others, the appeal is the possibility of amassing vast amounts of data. But the greatest importance of the new equipment lies in its usefulness in opening research frontiers which could not be explored in any other way. The potential of the new instrumentation will be developed only insofar as the instruments are used thoughtfully in efforts to answer meaningful questions.—P.H.A.

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lation. In another example, computer simulation has been applied to human handwriting. Reading and understanding speech were found closely related to the physiology of handwriting. Equivalent current generators have been found to simulate successfully the heart as current source.

Of particular—and from a humane standpoint urgent—interest is a development ultimately meant to make the blind man's fingers "see." An electronic environment sensor transduces optical information into types of sensory information accessible to a blind person, such as pressure outputs which can be fed to the pressure receptors of the human hand as the person moves around.

No biomedical instrumentation symposium in our time could possibly ignore outer space. Applications to space travel and outer space research were presented in many of the sessions, culminating in a program solely devoted to bioinstrumentation in the aerospace age. The status of the art of monitoring chimpanzee and man during space travel was surveyed and included a system for measuring effects of environmental variables on physiological stress. Even though man has made successful space flights, it is still important to conduct further research on both man and animal in their orbital flights.

An instrumentation system using implanted arterial and venous catheters obtains cardiac output, arterial and venous blood pressure, blood protein, and electrocardiograms. Other projects are devoted to the environment of outer space and the environment of the space capsule. A photometric scanning and telemetering device, though still in the developmental stage, has shown wide application in the realms of exobiology and telemetered biomedical responses. Potentially, it could become a valuable tool for man on interplanetary missions and similar explorations of long duration. The paucity of knowledge of major and trace gases inside the manned space vehicle points to an area urgently awaiting further concentrated efforts by the biomedical engineer. This important life support aspect might well determine the duration of the space mission and also, if not adequately monitored, cause the mission to be aborted. Conventional laboratory instrumentation employing gas chromatography, optical absorption, or mass spectrometry offers some potential.

Numerous modifications, however, must be made in the transition from laboratory to space qualified hardware.

Still on telemetering of physiological data of humans in flight—though much closer to earth than outer space—one paper dealt with parachute jumping. Interesting results were obtained from a telemetry system using RF transmission techniques. Head accelerations, for instance, were +6 to +8 G vertically, +9.6 to −9.6 G laterally, and +3.8 to −12 G horizontally; heart rate, 180 prior to jump, decreased to 156 during free fall, returned to 180 at ground impact. Similar variation in breathing rate was 40 to 55 to 48 breaths per minute.

A session on spectroscopy showed the variety of research programs for which one single method can be successfully used. Of immediate medical interest is the infrared determination of protein structure and its application to the clinical analysis of calculi and gallstones.

Advantages, problems, and different methods of automation in hospitals and medical laboratories were noted. The presentations surveyed excellently current developments throughout the country and showed examples of effective uses of automation.

Other new developments covered at the meeting included new methods of monitoring air pollution, and its effect on human health and plant life; the great strides in automation and data processing in clinical pathology, pathologic anatomy, and clinical chemistry (a punch card system in operation was described and illustrated for the latter application); and finally, the impressive developments and the impatiently hoped for progress in the field of artificial organs. Scientists are still working on artificial intracorporeal hearts (32 hours in a live dog are now reported) and on improving the artificial kidney (by bacteria removal through filtering), and have developed an artificial "gastrointestinal pacemaker" whose use in the treatment of paralytic ileus was reported successful in over 60 patients.

After a review of some of the recent advances of the biomedical instrumentation engineer, this man himself and his problems were considered. Three sessions were devoted to questions of how to educate him and how to put him to work. It was also noted that two more schools, Wake Forest College and the University of Florida, have joined the number of those which are offering now, or planning for future

addition, curricula in interdisciplinary biomedical engineering education.

On the question of organizing effective engineering support to life science research and hospitals, it became apparent that the concept of centralized engineering facilities, rather than the reliance on individual engineers assigned to individual research projects, is slowly proving its value and gaining ever increasing recognition. Pioneered years ago for the intramural research program of the National Institutes of Health, the centralization system has been adopted recently by several other research organizations. Central support facilities represented at the symposium —among speakers and audience—included such newcomers as the Eastern and Western Research Support Centers of the Veterans Administration, the engineering center at the Bowman Gray School of Medicine, and the new Center for Computer Technology under the auspices of the Massachusetts Institute of Technology. The operation of two other biomedical engineering support centers at the University of Oregon and the University of California was described.

The meeting was sponsored by the Instrument Society of America with three cooperating societies—American Society of Clinical Pathology, National Society for Medical Research, and Society for Applied Spectroscopy. The full text of the papers will be published in book form by Plenum Press, New York City.

Appreciation of the help of the following in summarizing the contents of the 20 sessions and over 80 papers is noted: H. S. Dordick, C. D. Ferris, R. Jonnard, R. I. Larsen, L. L. May, H. V. Pipberger, J. C. Roberts, G. H. Sullivan, T. B. Weber, and G. Z. Williams.

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Cell Division and Cancer

The hypothesis that cancer involves an abnormality in the control of cell division was the major theme at an international symposium on the control of cell division and the induction of cancer held 1–7 July at Lima, Peru, and Cali, Colombia.

The organizers brought two groups of individuals together, those interested in the control of cell division, and those interested in the induction of

cancer. The assumption was made that viruses, radiations, chemicals, and all other carcinogenic situations cause cancer by altering the mechanisms that control somatic cell mitosis.

Both Arthur Pardee (Princeton) and Herman Kalckar (Boston) discussed the idea that the point of action or final expression of the carcinogenic agents might be on the surface properties of the cell. Pardee reviewed known surface changes in malignant cells and suggested that control by growth-inhibiting factors from adjacent cells was lacking. Kalckar extended this concept with the terms "ectobiology" and "ectobiochemistry," defining the latter as involving the receptor sites for surfaces of antigens and the existence of histocompatibility factors. The biochemical entities that Kalckar described were the polysaccharides, which he thought subserved the "social functions" of the cell. He pointed out further that the lack of particular antigens on cell surfaces may be related to an epimerase defect. The Leloir equilibrium is disturbed in tumors and epimerase is the rate-limiting enzyme in them. Measurements on HeLa and L cells, Erlich ascites tumor, and mammary carcinoma support this point of view.

The more frequently considered approach to control of cell division through understanding DNA and RNA synthesis was presented by Eduardo de Robertis (Buenos Aires), D. M. Prescott (Oak Ridge), and Robert P. Perry (Philadelphia). De Robertis reviewed the electron microscopy of the nucleus and emphasized that the basic unit of the chromosome is a filamentous, macromolecular component or microfibrill which may be a single nucleoprotein molecule. Prescott continued the theme, stating that the cell life cycle is a DNA cycle with all events subserving DNA. He felt the question should be asked, "What controls initiation of DNA synthesis?" This presumably is the point at which carcinogens act or alter DNA in a way that results in cancer. The interrelations of DNA, RNA, and protein synthesis describe the major events of the cell cycle, but Prescott thinks control for DNA synthesis might reside within each gene itself. Chromosomes do not all begin DNA synthesis at once, and the X-chromosome is especially known as a late replicator.

Perry developed the idea that the nucleolus is a prominent RNA-containing organelle intimately associated

with specific chromosomal loci, and whose function is a prerequisite for cell division. From Perry's ideas one could make the thesis that carcinogens upset the usual control of cell division by interfering with the normal function of the nucleolus.

The evolutionary point of view about control of cell division was discussed by both Prescott and Pardee. They pointed to the lack of control of cell division in single-celled organisms, such as bacteria and protozoa. They suggested that control of cell division was acquired late in evolution and was inevitably associated with the presence of differentiation in multicellular organisms. In their view, one could ask what mechanisms that stop cell division appeared during evolution.

A different line of discussion during the conference was the consideration of specific examples of metabolic control mechanisms in cells. Daniel Mazia (Berkeley) mentioned two classes—those that operate by modulating existing cell machinery and those that create new cell machinery. The first class was essentially equivalent to examples of feedback inhibition of enzyme synthesis illustrated by Pardee. He included in his discussion the two-site model for control of the enzyme, and emphasized that a special site designed for control of the enzyme was present which had nothing to do with the site concerned with the function of the enzyme. Mazia's other class in illustrating enzyme induction had been considered by Pardee who pointed out in addition the basic concepts of gene function learned from the study of bacteria. The discovery that repressor genes control operator gene function (being able to turn a gene on or off for an extended period) could simulate a mutation in some circumstances.

Major interest at nearly all cancer meetings centers around the role viruses play in inducing or perpetuating malignant disease. S. E. Luria (Cambridge, Massachusetts), and Stanfield Rogers (Knoxville) dealt exclusively with the actions of viruses on different kinds of systems; the subject was also considered at length by other participants directly concerned with radiation-induced cancer. Luria reviewed functional alterations in cells caused by viruses, showing how they may produce permanent changes by initiating new synthetic processes directed by viral genes or by establishing new regulatory controls on the function of cellular genes. Modifications induced by the host cell on the virus can also be demonstrated in bacteria. Findings of special interest mentioned by Luria were that a virus can bring a large amount of information to a cell and viruses are capable of mass repression of gene action. They can turn off entire blocks of host genes. Viruses can also specify bacterial cell antigens. The concept of helper viruses that complete the action of a defective virus, such as that seen with the Rous sarcoma, was described by Luria as a potentially significant aspect of tumor viruses.

Rogers presented in detail his work on the Shope papilloma virus. Here the virus brings new antigens to the papilloma, and, in addition, new metabolic information in the form of a unique papilloma arginase. He speculated that one approach to the therapy of a genetically determined human disease with loss of an enzyme would be to find a human virus that might transfer the information for producing the enzyme back into the genome.

Since the control of cell division and the induction of cancer must ultimately

involve the cells from which the cancer arises, several significant studies on stem cells were presented by C. P. Leblond (Montreal), Joan Wright Goodman (Oak Ridge), G. S. Hodgson (Santiago), and L. F. Lamerton (London). Leblond reviewed the general theory of stem cells and developed the concept of static, expanding, and renewal cell populations encompassing all cells in an individual. Tumors, to a significant extent, resemble expanding and renewal cell populations without the appropriate mechanisms for eliminating the new cells produced. Goodman reported her work on stem cells of the hemopoietic and lymphatic tissues, which, she pointed out, could easily be removed from the animal for study or manipulation in vitro, a feature not readily visualized for stem cells of most organ systems. Transplantation studies revealed the presence of hemopoietic and lymphatic tissue stem cells in bone marrow, blood, and peritoneal fluid, whereas lymphatic tissues contained only stem cells for lymphatic tissue replacement, not those of the hemopoietic system.

Hodgson considered the erythropoietic stem cells a specially advantageous model to study control of cell division since proliferation of these elements can be controlled more or less at will by manipulating endogenous or exogenous erythropoietin. Not only can cell division be initiated by the action of this substance, but it can be stopped by its withdrawal.

Lamerton's work on the ability of stem cells from various cell renewal systems to proliferate under continuous irradiation demonstrates the great variability in resistance to injury of mechanisms that control cell division. Presumably, this includes the initiation of DNA synthesis. C. Pavan (São Paulo), however, presented evidence that in some Diptera, where DNA synthesis occurs without cell division, irradiation may actually stimulate DNA synthesis. Others felt Pavan's data reflected a reduction in the pool of endogenous thymidine. Of the systems he studied, Lamerton found the stem cells of the lining of the small intestine most resistant and the testis most sensitive to continuous irradiation. Other cell renewal systems, such as bone marrow, lie between these two extremes.

Radiation-induced cancer was more thoroughly covered at the conference than any other type of induced cancer. H. S. Kaplan (Palo Alto), A. C. Upton (Oak Ridge), Miriam P. Finkel

(Argonne), and R. H. Mole (Harwell), respectively, took up the problems of radiation-induced thymic lymphosarcoma, myeloid leukemia, osteogenic sarcoma, and tumors in general, in the mouse. Michael Court Brown (Edinburgh) discussed radiation-induced leukemia in man.

Kaplan pointed out there were two paths the investigator could follow. He could describe the intracellular events essential to the malignant transformation or he could follow the approach Kaplan himself took of defining the pathogenesis by giving the conditions for induction of the neoplasm under study. All five investigators followed the latter course for the most part. Both Upton and Kaplan, however, gave progress reports on their studies with filterable agents probably released by radiation, thus causing leukemia through intracellular events in which a virus might conceivably be incorporated into the genome of the target stem cell. Upton described very rapid myeloid leukemia induction with cell-free preparations obtained with the Anderson zonal ultracentrifuge. Kaplan, trying to cope with the variability in assay results that plague work with new leukemia viruses, pointed out the desirability of using a 1-week interval between x-ray exposure and administering the filtrate preparation to the test host.

Finkel suggested in her introductory remarks, before defining the conditions under which radionuclides induce osteogenic sarcoma in mice, that this lesion might turn out to be virus mediated. Mole was chiefly concerned with complexities in dose-response relations as influenced by the dose rate.

The problem of leukemia in man was described by Court Brown. A total of 13,000 persons with spondylitis who were irradiated in 32 British radiation centers have been studied for induction of leukemia, and many for radiation-induced chromosome abnormalities. In the chronic myeloid leukemia cases Court Brown investigated, 95 percent showed the Philadelphia chromosome, and a few cases did not. This nearly pathognomonic myeloid leukemia chromosome is not present in other tissues such as fibroblasts. Sixty-five percent of the myeloid leukemia cases show no other chromosome abnormality, but 35 percent have other lesions of the karyotype. Erythrocyte, megakaryocyte, and granulocyte precursors all show the Philadelphia chromosome. There is no difference between the

radiation- and nonradiation-induced chromosome lesion. Normal cells are present in a dormant state since they return during remission. During the transition of chronic myeloid into acute leukemia, the positive cells of the Philadelphia chromosome increase in numbers. The same chromosomal lesion can presumably be produced by two or more agents. Viruses, such as measles and yellow fever, can cause extensive chromosome breaks in vivo and in white blood cell tissue cultures, respectively. Direct preparations of the African Burkitt's lymphoma show chromosome changes. Study of the spondylitis cases revealed stable and unstable abnormalities in the chromosome karyotype. The stable abnormalities persisted for as long as 20 years. What was the significance of the chromosome lesions for the leukemia problem? No clone formation was detected and unstable lines did not persist. Upton pointed out that studies he and Niel Wald were doing on transmitted myeloid leukemia in mice revealed a typical extra chromosome in all the instances so far examined. This included cases transmitted with cell-free supernatant fluid. Luria remarked in the discussion that there may be a gene function that keeps chromosomes intact and which may be unrelated to proliferation.

Other speakers at this conference included H. L. Stewart (Bethesda), Pablo Mori-Chavez (Lima), Albert Tannenbaum (Chicago), C. C Congdon (Oak Ridge), and Alexander Hollaender (Oak Ridge). Stewart quoted the definition of geographic pathology —"Who has what, when, where, and why." He pointed out that less than 1 percent of cancer in man has a known etiology and gave examples of how geographic pathology dealt with the extrinsic factors in the etiology of scurvy, pellagra, beri beri, and yellow fever. He suggested that geographic differences in cancer incidence might similarly provide clues as to the pathogenesis of the tumors in question.

Other researchers found that cancer induction and metastasis of cancer at high altitude differed from those at sea level and that cancer occurred in man at high altitudes in Peru (Mori-Chavez and Arias Stella, Lima).

Tannenbaum demonstrated the multiple carcinogenicity of urethane and noted how it produces many different kinds of tumors besides the well-studied pulmonary adenoma. He then asked if all carcinogens were not mul-

tipotential. The data presented showed this to be true. In addition, the same tumor (for example, mammary tumors in rats) could be produced by several different chemical carcinogens. In Tannenbaum's view, carcinogenesis is an augmentation of spontaneous neoplasia.

Not taken up specifically at this conference, although mentioned in the discussion, was the possibility that chemical carcinogens release tumor viruses. William Hueper (Bethesda) also mentioned some aspects of chemical carcinogenesis in his report on tumor induction by polymers.

In summation, Congdon suggested that gene control of somatic cell division needs to be considered from the point of view of cancer induction. Little is known about specific loci that produce some abnormality in the cell division process. One could think of the problem in terms of many specific genes operating to initiate cell division and to determine its features, or, in the sense mentioned by Prescott, that each gene has at least one pleiotropic effect in determining its own replication.

Congdon also discussed what he called the three basic long-established principles in the theory of cancer in relation to the idea that all cancer is caused by viruses. The first principle, that the carcinogenic agents are adventitious stimuli which do not specify the kind of cancer produced, is no longer valid if viruses bring new specific information to the host cell genome. The second, that the host cell determines the nature of the tumor, is also probably invalidated if a virus brings new information to the host cell genome. The extreme position that all cancer is caused by viruses is a difficult one in view of the third basic principle, which relates the biological phenomenon of cancer to normal growth and development through a series of imperceptible gradations including the congenital and acquired tissue malformations. This position would also suggest that viruses, or some other similar phenomena, are the cause of normal growth and development and tissue malformations.

Hollaender, in an unusual impromptu session in Lima, described some of the schemes now being considered for stimulating international cooperation in science and mentioned the establishment of international research institutes to help solve urgent major biological and medical problems, such as

those taken up at this conference. He also encouraged Latin-American scientists to participate in these efforts.

The major sponsor of the symposium in Lima was Universidad Peruana de Ciencias Médicas y Biológicas, and in Cali, Universidad del Valle. Pablo Mori-Chavez was general secretary for the organizing committee.

Substantial financial assistance was also provided by the following organizations: Pan American Union, Damon Runyon Memorial Fund, Rockefeller Foundation, Anna Fuller Fund, The Jane Coffin Childs Memorial Fund for Medical Research, the United States Atomic Energy Commission, National Cancer Institute, National Science Foundation, International Atomic Energy Agency, the British Council, and numerous commercial firms in Lima and Cali.

The U.S. National Academy of Sciences–National Research Council also sponsored the meeting and encouraged the development of this series of symposia in Latin America. The first one was held in Santiago, Chile, in 1961 on "Tissue transplantation"; the second, in 1962, took place in São Paulo and Rio de Janeiro with two programs, "Mammalian tissue culture and cytology" and "Specific topics in radiobiology"; and a fourth symposium is being organized in Buenos Aires in 1964 on "Genes and chromosomes—structure and function." Publication of the proceedings of this year's conference, as a monograph from the National Cancer Institute, is anticipated.

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Free Radicals

Free radicals, particularly when trapped in solid materials at low temperatures, were the topics of discussion at the sixth international symposium on free radicals which took place 2–5 July 1963 at Cambridge, England. The total attendance was about 260, with the host (United Kingdom) delegation numbering almost as many as the representatives from all other countries combined.

R. G. W. Norrish (University of Cambridge), organizer of the symposium, gave an introductory lecture which dealt with studies of free radicals in the gaseous state and showed the transient nature of such radicals as

intermediate species and the ubiquitous role of chain reactions. Under these conditions, free radicals bore the status of some postulated entities necessary for the logic of reaction kinetics but were hardly "real" enough for direct and on-the-spot inspection. It was G. N. Lewis who in 1942 first achieved stabilization of the radicals by trapping them in the frozen state, thus obviating difficulties due to very short life times. But the principal job of direct and specific inspection of trapped species had to wait for the introduction, after the end of the Second World War, of a technique known as electron spin resonance (ESR). Since then, the rapid adoption of the ESR technique for the study of free radicals has been most phenomenal. Whereas there was only one paper on ESR in the first international symposium on free radicals (Quebec, Canada, 1956) 27 of the 39 papers presented at this symposium dealt with this method.

Free radicals can be produced and trapped in solids in a variety of ways. In some experiments radicals were generated in an electric discharge and were condensed, along with other discharge products, on a cold target. In a majority of cases, however, they were generated by irradiating the solid sample at a low temperature with ultraviolet light or γ-rays (occasionally x-rays). Results obtained by using electron beam bombardment were not materially different from those using x- or γ-rays because radical production was most probably accomplished by secondary electrons in either case.

The stabilization of free radicals in solid media or on solid surfaces is not very well understood. It is hard to understand, for instance, that hydrogen atoms are not stable in irradiated ice at liquid nitrogen temperature whereas they are quite stable in certain irradiated frozen acids at the same temperature. J. Weiss (New Castle) raised questions of this kind and speculated about the nature of the trapping sites. If, according to one suggestion, the hydrogen atoms could only be stabilized at certain trapping sites, then with a limited site density the radical concentration ought to reach a saturation value after prolonged irradiation. There is as yet no experimental verification of this suggestion. In another direction, V. B. Kasanskii and G. B. Pariiskii (Moscow) studied the problem of stabilization of free radicals on solid surfaces. They found, for instance, that

hydrogen atoms could be stabilized on the surface of a silica gel (an insulator) up to about 170°K. On the other hand, hydrogen atoms or any other free radicals could not be stabilized at all on the surface of a semiconductor or conductor. Theories postulating a one-electron bond between a radical and an insulator or a two-electron bond between a radical and a semiconductor (or conductor) may well explain the above-mentioned phenomena but they are so far only qualitative.

In the field of radical identification by ESR technique, many successful examples exist. However, there is also a case of considerable confusion that is concerned with the problem of identifying free radical species in a solid hydrogen-oxygen system (H_2O, H_2O_2, or mixture) when one of several radical production methods (frozen discharge product, uv, x-ray, γ-ray, or electron bombardment) is used. For a number of years various groups of workers all over the world (American, Russian, English, and French) have put forth their claims of identification (such as OH, HO_2, and so forth) with rather different kinds of ESR data and quite dissimilar interpretations. More recently, Siegel, Baum, Sholnik, and Flournoy (Aerojet Corp., California) observed a doublet ESR spectrum in γ-irradiated ice and interpreted this as due to the OH radical. The results of Kroh, Green, and Spinks (University of Saskatchewan) with partially tritiated ice strongly supported this identification.

However, one would hardly get this feeling of surety if he had listened to some of the researchers who dealt with this same general subject. After studying radicals produced in frozen H_2O_2-H_2O solutions by ultraviolet and ionizing radiations, S. J. Wyard and R. C. Smith (Guy's Hospital, London) concluded that one of five observed spectra could most probably be assigned to HO_2 but none could reasonably be assigned to OH. Other experiments with ultraviolet-irradiated, frozen H_2O_2-H_2O solution led to the belief that the observed spectra were due to a mixture of OH and HO_2 radicals, according to B. C. Green and J. W. T. Spinks (University of Saskatchewan).

R. Marx, S. Leach, and M. Horani (University of Paris) studied the condensed product (at 77°K) of water vapor bombarded by low energy electrons and interpreted their observed spectra as due to HO_2 and one other complicated radical. Experiments by R. Livingston (Oak Ridge National

Laboratory) with frozen discharge products of water vapor and γ-irradiated ice and solid hydrogen peroxide (both single- and polycrystalline) revealed five different types of ESR spectra, two of which could be assigned as triplet state systems. Of the three remaining spectra, two were regarded as unknown and the last one may possibly be assigned to OH. Livingston further conjectured that the triplet state species may be thought of as two OH molecules coupled in a hydrogen-oxygen complex. In summary, the problem of identifying free radicals in a hydrogen-oxygen system is still unresolved.

The electronic structure of free radicals by ESR analysis was investigated by F. J. Adrian, E. L. Cochran, and V. A. Bowers (Applied Physics Laboratory, Johns Hopkins University) in their studies of the HC=R type of free radicals. Here the unpaired electron occupies a σ-orbital which, unlike a π-orbital, has very rarely been treated experimentally or theoretically. They observed the hyperfine splittings for formyl (HC=O) and vinyl ($HC=CH_2$) radicals and were able to assign the observed splittings for the vinyl radical to its α and two β protons. Their theoretical investigations on the basis of a valence bond model gave results which were in good agreement with the experimental values and, in addition, spelled out the specific splittings for the two non-equivalent β protons. In another work, R. J. Cook, J. R. Rowlands, and D. H. Whiffen (National Physical Laboratory, Teddington) observed the ESR spectrum of frozen furoic acid (C_3H_3OCOOH) after x-ray irradiation. Free radicals were known to be formed by the addition of a hydrogen atom to the aromatic molecule. The problem for these investigations was to determine at which position around the aromatic ring the hydrogen atom was added. With a molecular orbital approach they concluded, from calculations, that the hydrogen atom was added at position 5, with oxygen at position 1, and COOH at position 2.

A different type of electronic structure problem is that of a triplet state molecule. This area of research, which was initiated several years ago by C. A. Hutchison, Jr. (University of Chicago), was discussed by W. A. Yager, R. W. Murray, G. Smolinsky, A. M. Trozzolo, and E. Wasserman (Bell Telephone Laboratories, Murray Hill). They observed a number of stable triplet state molecules in rigid glasses when certain organic compounds were decomposed

by ultraviolet light. They found that a divalent carbon species (methylenes) and a monovalent nitrogen species (nitrenes) represented two classes of triplet state molecules which had the stable characteristics of being in the ground state.

Some ingenious experimental methods were presented for the study of radical reactions and intermediate radical species. A new technique was introduced by J. E. Bennett and A. Thomas ("Shell" Research, England) who used a rotating cryostat for direct measurement of rates of radical-molecule reactions. The rotating cryostat served as a "conveyer belt" on which radicals were first frozen and then bombarded by molecules for specific reactions. The reaction products were then examined by an ERS spectrometer. Another new technique was initiated by P. L. Kolker, T. J. Stone, and W. A. Waters (Oxford University) for the study of transient free radicals involved in oxidation and reduction processes. By appropriately injecting the reactants, they were able to observe intermediate radical species when the reaction products passed through the ESR spectrometer at a very high flow rate. It was possible to establish whether the observed species were the primary or secondary products of a reaction sequence. The information on the identity of transient radicals should throw light on the mechanism of chemical reactions and the nature of electron transfer for oxidation and reduction processes.

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Spectrophotofluorometry: Biological Techniques

The initial extramural activity of the new Instituto Di Ricerche Farmacologiche "Mario Negri" in Milan, Italy, was the organization of lectures and demonstrations on spectrophotofluorometric techniques in biology, given by an invited international staff and 110 participants from 19 countries. A NATO grant aided in the financing, and the institute provided the fine facilities of its laboratories and lecture hall now being completed in Milan. The institute, directed by Silvio Garrattini, was founded by a bequest of Mario Negri, a Milanese philanthropist.

The program was organized as a survey course. Practical experience and

demonstrations were offered on American and European instruments loaned for the occasion. Theoretical and practical considerations determining the design and use of currently available instruments were reviewed and demonstrated by Bowman (National Institutes of Health, Bethesda, Md.) and Howerton (American Instrument Company, Silver Spring, Md.). They pointed out the possibilities of increasing sensitivity by utilizing the options offered by the instruments available. The use of mercury xenon sources, specially blazed gratings, and photomultipliers with optimal spectral characteristics, as well as micro cells or phosphorescence attachments, was discussed and demonstrated. The high sensitivity, rivaling that of bioassay, the specificity afforded by the activation and excitation spectra, and the fact that radioactive labels and counting are not necessary make the method attractive.

Details of the various commercial instruments illustrate the compromises in spectral resolution and photometric accuracy which are made in the interest of obtaining high sensitivity. The advantages of the use of spectra in identifying sources of blank emission, second-order scatter peaks and Raman lines that overlap the region of emission, and the ability to select working wavelengths that eliminate these were demonstrated in the laboratory sessions. Once these working areas are selected a simple filter instrument probably can be more sensitive if similar conditions are preserved.

The fluorescence of several homologous series of derivatives of indoles, sulfonamides, pyridoxines, and related compounds was analyzed over a range of hydrogen ion concentration by Williams (St. Mary's Hospital Medical School, London). He showed how electronegativity or positivity of substituent groups at various positions on the aromatic ring can be used to predict whether a new member of the series will be fluorescent or not. James (St. Mary's) described several methods for measuring plasma and urinary steroids in man which provide the basis for clinical research, diagnostic tests, and control of therapy. The methods for plasma generally involved simple extraction and assay on a filter fluorometer, but urinary tests had to be run on a spectrophotofluorometer to obtain the necessary specificity.

Corticosteroid and estrogen methods are applicable to normal levels in plasma and urine by nature of the submicrogram sensitivity of the fluorescence assay. Separation on paper or columns is necessary to identify specific estrogens. It was pointed out that there is a method for converting nonfluorescent androgens to fluorescent estradiol by the use of a placental enzyme to introduce the hydroxy and aromatize the "A" ring. The resultant product in ethanol and concentrated sulfuric acid is fluorescent enough to measure 0.1 microgram per 100 milliliters.

With simple solvent extraction and measurement in ethanol–H_2SO_4, cortisol output in urine can be measured when Dexamethasone, a synthetic nonfluorescent steroid, is given to suppress cortisol secretion. Tests of pituitary response, adrenal response, and hepatic function in clearing the plasma were described, and their potentialities in diagnosis and therapy were pointed out.

Several methods for enzyme assay based on the release of a fluorescent product from a suitable synthetic substrate were reviewed by Roth (Hôpital Cantonal, Geneva). The method for determining trypsin with an arginine β-naphthylamide substrate was described as a clinical procedure applicable to the assay of trypsin in pancreatic juices. Another procedure also releasing the highly fluorescent β-naphthylamine utilizes leucine naphthylamide for plasma peptidases and may

be of value in the diagnosis of liver or pancreatic disease. Other synthetic substrate systems with fluorescent products and a method of coupling a dye to the product for histochemical localization of enzymes were reviewed.

Falck (University of Lund, Sweden) showed some of his remarkable fluorescence photomicrographs of the monoamines in adrenergic tissue. With this method it is possible to produce clear pictures of the amines stored in the adrenergic nerve endings. When the tissue is prepared by freeze-drying and then is exposed to dry formaldehyde gas, a highly fluorescent product is formed with green fluorescence from noradrenaline and dopamine and yellow-green fluorescence from serotonin. Reserpine depletion experiments and assay by other techniques have confirmed the specificity and resolution of the method. In ganglia, the terminations of adrenergic fibers on cell bodies showed up as sharply defined regions surrounding the relatively clear cell bodies of the neurons.

The value of fluorescence and phosphorescence methods in determining molecular structure was illustrated by Parker (Admiralty Materials Laboratory, Poole, England). He pointed out the possibility of converting fluorescence to phosphorescence and utilizing energy transfer systems for selective quenching of interfering substances. Emphasis was placed on the quenching effect of oxygen and the greater effect for longer duration of the excited state, Schwartz (Hoffman-LaRoche, Basle) reviewed methods involving dehydrogenation of tetrahydroisoquinolines to form fluorescent products by treatment with mercuric acetate-acetic acid reagent for the determination of several important alkaloids in tissues. Van-Duuren (New York University Medical Center) analyzed curves showing how the ratio of dye to nucleic acid can affect the wavelength of the fluorescent peaks of the dye and thus indicate the form of the aggregation of the dye on the nucleic acids. He also showed how fluorescence spectra of polycyclic aromatics could be obtained from material incorporated into potassium bromide pellets. Spectra of charge transfer complexes that may be useful in the study of the carcinogenic activity of these substances were obtained by this method.

The details and practical suggestions for the assay of tissues for catecholamines and related compounds were presented by Magnusson (Gôteborg, Swe-

den), and the chemistry of the compounds was discussed by Werdinius (Gôteborg). The method requires great care, and various laboratories find different modifications necessary for optimal results. R. L. Smith (St. Mary's) presented the modifications necessary for application to adipose tissue.

In a review of the pharmacology of the catecholamines, Costa (National Institutes of Health) presented a working theory of the interaction of the mediators, monoamine oxidase, the inhibitors, reserpine, and other drugs. The theory provides a good picture of the current state of the art. Spectrofluorometric techniques are used in much of this work.

Bowman concluded the lecture sessions with some discussion of new techniques utilizing low-energy electrons to excite fluorescence and suggested that new advances in fluorescence techniques are just as likely to develop from experimentation as from analysis of the complex theoretical possibilities.

The institute is now examining the possibilities of holding another session within the year for the more than 100 qualified applicants who could not be accommodated in this session.

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High Magnetic Fields: Production and Application

In the evolution of research, cross divisions of science sometimes arise which are based on specialized objectives or experimental techniques. Such research areas cut across the time-honored, historic, or pedagogic divisions of science and are often reabsorbed into these after a more or less brief period of vigorous progress and cross-fertilization. The field of low-temperature physics has enjoyed such a transient existence during the past decade or two, and high magnetic-field research, a closely related area, appears to be following. The environment of low temperature and high magnetic field actually have a great deal in common. Both are of value largely because they are conducive to minimum entropy, and each environment is helpful, if not necessary, in generating the other. The community of high magnetic-field research had its formal birth at the first international conference, held at Mas-

sachussetts Institute of Technology in November 1961. The second such conference was held at Oxford University 10–12 July 1963, and it appears quite likely that these events will become biennial and follow the pattern of the one in low-temperature physics.

The conference was opened by Bitter and Montgomery who described the recently dedicated M.I.T. National Magnet Laboratory, sponsored by the U.S. Air Force. The laboratory represents the first cooperative effort in this area of research and is expected to do for various branches of atomic physics what Brookhaven and similar institutions have done for nuclear physics. It will not only provide very high fields as a research environment but will also serve as a center for advancing the art of generating high magnetic fields. This facility is based on a family of high-performance, reinforced copper solenoids, water-cooled, and supplied by an 8-megawatt power plant capable of 32-megawatt overload operation. It is flexibly arranged to accommodate many simultaneous experiments and will supply continuous fields up to 250 kilogauss and 2-second fields up to 400 kilogauss. These reports as well as others from Leiden University, Oxford University, the Royal Radar Establishment, and the Lewis Research Center of NASA in Cleveland indicate that conventional (normal conductor) magnets are still the object of a great deal of sophisticated work and are likely to continue as the principal tool for generating high fields for many years to come.

The science and technology of superconductivity formed at least half of the subject matter of the conference. Compared to other conferences devoted specifically to this topic, emphasis at Oxford was phenomenological. The topic was ably introduced by Berlincourt of Atomics International, who summarized what little progress appears to have been made during the past two years. Composite materials containing niobium-tin as a core or diffusion layer still appear to have the most promising properties, just as they did 3 years ago. However, the technical difficulties involved in reacting these materials at 1000°C *in situ* and subsequently immobilizing them have caused almost universal abandonment of composite materials in favor of the less promising, though less problematic, alloy materials, notably niobium-zirconium. About half a dozen commercial organizations now sell niobium-zirconium alloy, and a comparable number of organizations

are marketing niobium-zirconium solenoids supplying fields of up to 60 or 70 kilogauss. Much has been learned about the motion of magnetic flux through hard or magnetically permeable superconductors to explain many of the originally baffling phenomena. In particular, magnetization measurements have indicated that the instability of the current-carrying state in hard superconductors (the mysterious "coil degradation") is predominantly a thermal effect related to the release of magnetic energy when transport currents destroy magnetization currents.

In the light of some very recent success with composite materials, it appears regrettable that this facet of superconductivity has been virtually abandoned for at least 2 years. It is perhaps one of the adverse effects of modern communication among investigators. The outstanding bit of news at the conference was undoubtedly from the General Electric group which described a niobium-tin solenoid capable of generating 101 kilogauss. This is the first report on such a magnet since the early attempts at Bell Telephone Laboratories and M.I.T. more than 2 years ago. Although little detail concerning the material was given, the work is bound to stimulate workers to give more attention to composite superconductors. Two groups are, in fact, working along similar lines: Saur (University of Giessen, Germany) and collaborators reported systematic studies of vanadium-gallium and silicon systems, and Stauffer (National Research Corporation) reported on a metallurgical process leading to a new composite niobium-tin material. From the viewpoint of high magnetic-field research, superconducting magnets at present appear most promising as supplementary solenoids surrounding conventional magnets. Problems of force containment and heat removal remain to be solved. The former are receiving attention by Wakefield and collaborators at Princeton University and Boom at Atomics International, where a study of force-free structures is being continued. The problem of cooling large structures has thus far received essentially no attention. A feasibility study by Stekly (Avco) indicates that when suitable materials become available, the generation of 500 kilogauss is structurally possible in simple solenoid design. Two methods were described for solving the difficult current supply problems in large superconducting solenoids. Volger and Van Suchtelen (Phillips Research Labora-

tory, Netherlands) described an ingenious superconducting generator without moving parts, and Laquer (Los Alamos) described an electrical-flux pumping method. General progress, trends, and future prospects were discussed in an unusually lively ad hoc session.

Regardless of whether or not superconducting solenoids will ultimately replace normal ones, solid-state research in high magnetic fields continues at an increasing rate.

For the purpose of this conference, solid-state research was divided into two parts: (i) metals and magnetic materials in high magnetic fields and (ii) semiconductors in high magnetic fields. The keynote speech on the first of these subjects was delivered by A. B. Pippard (Cambridge). He discussed in physical and pictorial terms the measurement of conduction electron motion in a magnetic field. Particular emphasis was given to the high field phenomenon of magnetic breakdown, which becomes important when the magnetic energy $\hbar\omega_c$ becomes comparable to the energy band gap E_g. In this limit, the two adjacent energy bands become strongly coupled by the magnetic field. Those electron trajectories corresponding to open orbits can then carry current by transmission through the zone boundaries and, in fact, dominate the conductivity in the high field limit. An experimental illustration of the magnetic breakdown phenomena was presented by J. M. Reynolds (Louisiana State University) in galvanomagnetic measurements on Zn and Sn, materials which have small band gaps.

Considerable progress has been made recently in the application of magnetoresistance experiments and of the De Haas van Alphen effect measurements to study the topology of the Fermi surface of metals. Interesting magnetoresistance results in fields up to 100 kilogauss were reported on the transition metals by Fawcett (Bell Telephone Laboratory). De Hass van Alphen results in the alkali metals were presented by Shoenberg and Stiles (Cambridge University), who used a novel modulation technique, and by Okumura and Templeton (National Research Council, Ottawa). Small departures from a spherical Fermi surface were found for the alkali metals. The possibility of observing the De Haas van Alphen oscillations in alloy systems (Au-Zn) is also quite exciting.

The use of high magnetic fields to study magnetism attracted attention. Wohlfarth (Imperial College, London)

challenged the experimentalists to produce density of state curves for magnetic materials, while Jacobs (General Electric Laboratory, Schenectady) confronted the theoreticians with the intricacies of magnetization studies of several antiferromagnetic systems.

The introductory talk by R. J. Elliott (Oxford) not only summarized high field research in semiconductors but also covered the use of high magnetic fields to study crystals and cooperative magnetism. The contributed papers on semiconductors were largely concerned with magneto-optical measurements and calculations. Optical studies on the metal silver were reported.

The realm of high magnetic-field research, in fact, is by no means limited to solid-state physics. One of the more exotic applications of magnetic fields concerns the search for ferromagnetically trapped Dirac monopoles. None have yet been found by this or other means. Perhaps the next international conference on high fields will feature the finding of both monopoles and megagauss.

The conference was sponsored by the Institute of Physics and the Physical Society (of Great Britain), and organized by a committee comprising Kurti and Bagguley (Oxford University), Chester (Central Electric Research Laboratories, Leatherhead), and Parkison (Royal Radar Establishment, Malvern). Complete proceedings will not be published, but the four invited introductory papers and a summarized report of the conference by M. Lock (Royal Radar Establishment) will appear in the *British Journal of Applied Physics*.

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Forthcoming Events

October

17–18. American Soc. of **Tool and Manufacturing Engineers**, Pittsburgh, Pa. (H. E. Conrad, 10700 Puritan Ave., Detroit, Mich.)

17–19. Society of **Photographic Scientists and Engineers**, Washington, D.C. (E. Ostroff, SPSE, Box 1609, Main Post Office, Washington, D.C.)

17–20. **British Medical Assoc.**, annual clinical meeting, Stoke on Trent, Eng-

land. (D. Gullick, BMA, Tavistock Sq., London W.C.2, England)

17–22. Anglo-American **Aeronautical** Conf., Cambridge, Mass., and Montreal, Canada. (American Inst. of Aeronautics and Astronautics, 500 Fifth Ave., New York, N.Y.)

18–19. American **Physical** Soc., Chicago, Ill. (K. K. Darrow, American Physical Soc., Columbia Univ., New York 27)

18–19. American Soc. of **Opthalmologic and Otolaryngologic Allergy**, New York, N.Y. (J. Hampsey, Grant Bldg., Pittsburgh 19, Pa.)

19. Research in Blindness and Severe **Visual Impairment**, symp., New York, N.Y. (Natl. Committee for Research in Ophthalmology and Blindness, 406-C S. Blvd., Evanston, Ill.)

19–23. **Chemical Engineering** conf., Montreal, P.Q., Canada. (N. E. Cooke, P.O. Box 10, Montreal)

20–23. Society of American **Foresters**, Boston, Mass. (H. Clepper, 704 17th St., NW, Washington, D.C. 20006)

20–25. **Exploration Geophysicists**, 33rd intern., New Orleans, La. (J. S. Johnson, California Company Bldg., New Orleans 12)

20–25. Pan American Congress of **Neurology**, Lima, Peru. (J. O. Trelles, Organizing Committee, Apartado 5117, Lima)

21–23. Direct **Aeronomic Measurements** in the Lower Ionosphere, Urbana, Ill. (S. A. Bowhill, Dept. of Electrical Engineering, Univ. of Illinois, Urbana)

21–23. **Aerospace and Navigational Electronics**, 10th East Coast conf., Baltimore, Md. (R. J. Allen, Research and Advanced Technology Dept., Martin Co., Baltimore 3)

21–23. Pathology of **Laboratory Animals**, New York, N.Y. (Office of Medical Education, New York Acad. of Medicine, 2 E. 103 St., New York 29)

21–25. **Beryllius Oxide**, intern. conf., Lucas Heights, New South Wales, Australia. (Secretary, AAEC, Research Establishment, Private Mail Bag, Sutherland, N.S.W., Australia)

21–25. American Soc. for **Metals**, metals and materials show, Cleveland, Ohio. (ASM, Metals Park, Ohio)

21–25. **Protein Rich Foods** in Developing Areas, intern. conf., Food and Agriculture Organization, United Nations, Rome, Italy. (FAO, Rome)

21–25. Society for **Nondestructive Testing**, 23rd natl., Cleveland, Ohio. (P. D. Johnson, 914 Chicago Ave., Evanston, Ill.)

22–25. Society for **Clinical and Experimental Hypnosis**, New York, N.Y. (SCEH, 200 W. 57 St., New York, N.Y. 10019)

22–28. **Medical Radiation**, seminar, Geneva, Switzerland. (WHO, Palais des Nations, Geneva)

23–24. **Industrial Hygiene** Foundation, 28th annual, Pittsburgh, Pa. (R. T. P. de-Treville, 4400 Fifth Ave., Pittsburgh 13)

23–25. **Design of Experiments** (invitation only), Huntsville, Ala. (F. G. Dressel, Army Research Office, Durham, Box CM, Duke Station, Durham, N.C.)

23–25. **Human Factors** Soc., Palo Alto, Calif. (J. A. Kraft, Bioastronautics Organization, 50-03, Lockheed Missiles and Space Co., Sunnyvale, Calif.)