SCIENCE

21 February 1964

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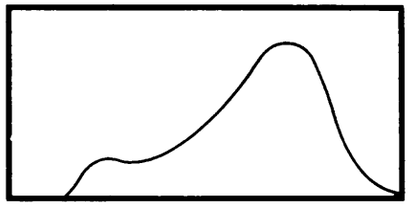
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SITE OF KAGOSHIMA SPACE CENTER

The Analytical Ultracentrifuge... *a review of some exciting new measurements*

The Analytical Ultracentrifuge has come a long way from its early days of simply photographing molecules as they sediment in high force fields. It now provides many of the highly sophisticated measurements needed in such rapidly advancing disciplines as biochemistry, biophysics, genetics and polymer chemistry. Three measurement areas are particularly active.

Interacting Systems The analysis of systems containing interacting components is the focus of considerable theoretical interest. An important contribution has been Gilbert's theory for reversibly interacting systems involving a single component. Systems of two components which react to form a complex also have been studied in detail. Bethune and

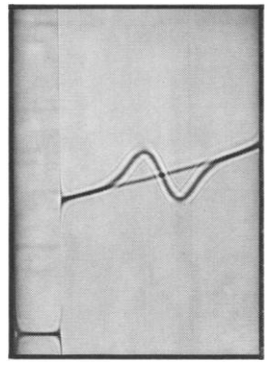


Monomer-Trimer Equilibrium Forms Two Boundaries

Kegeles have applied a computer to analyze these systems as well as systems involving polymerization. Townend, Timasheff and co-workers have studied molecules which associate in aggregates as large as pentamers, and dissociate into sub-units. Others have examined isomerizing systems in which molecular interactions occur at speeds comparable to the time of separation of the molecular species. Both sedimentation and electrophoresis have provided important measurements in these studies.

Density Gradients Now established as a powerful and sensitive method to study nucleic acids, equilibrium sedimentation in a density gradient is rapidly finding other uses. Ifft and Vinograd have

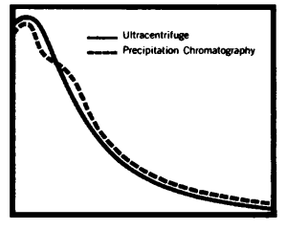
Schlieren Pattern of BMA at Sedimentation Equilibrium in a Density Gradient



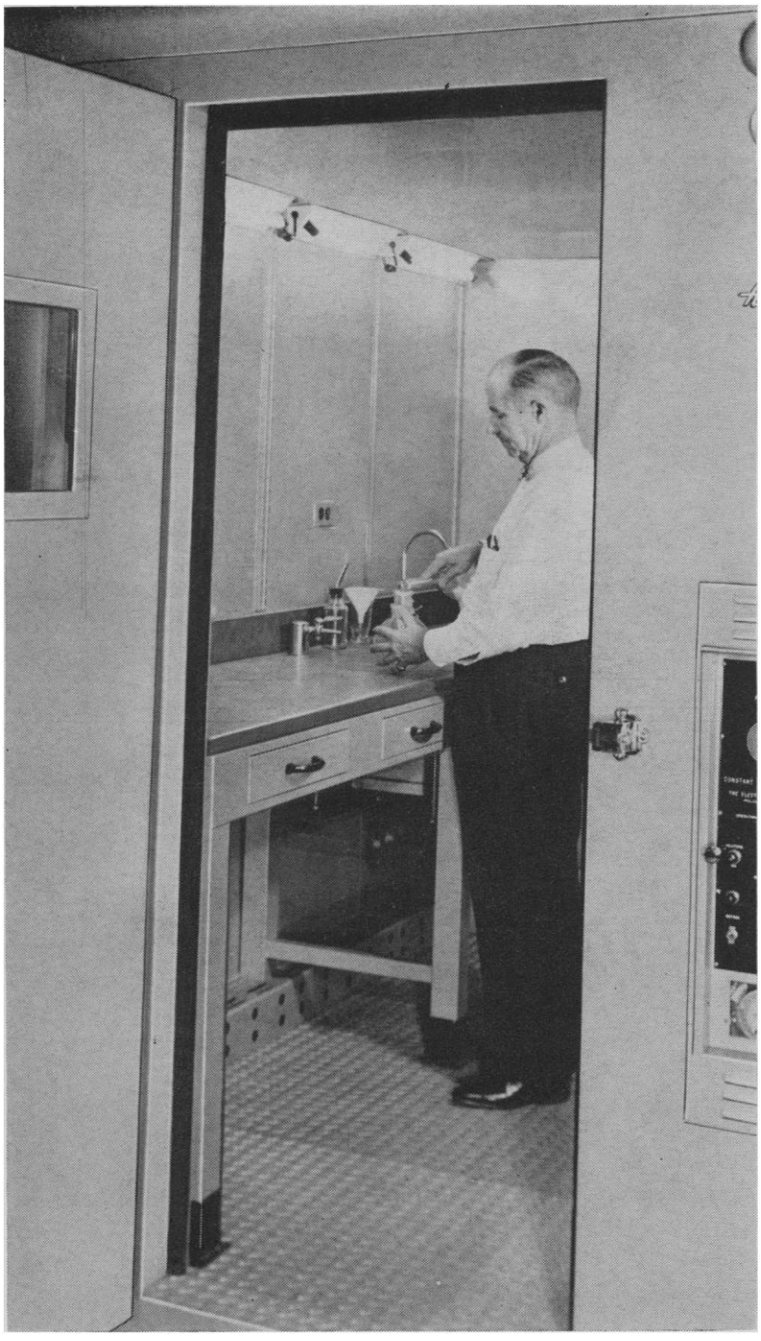
used density gradients to calculate molecular weights for solvated macromolecules, and have studied in detail the behavior of a protein of known molecular weight in a density gradient. Hu, Bock and Halvorson through use of stable isotopes have distinguished between newly synthesized and pre-existing proteins in a cell-free system. Wales has used density gradients of organic solvents to study extremely small quantities of various synthetic polymers, and Hermans has used density gradients to analyze for molecular weight distribution and density distribution of polymers. Both the analytical ultracentrifuge with ultraviolet and schlieren optics, and the preparative unit with swinging bucket rotors are widely used in density gradient centrifugation.

Synthetic Polymers The two density gradient studies noted above are only part of the recent surge of research using the ultracentrifuge to study synthetic polymers in organic solvents. Important papers have been published by investigators at the National Bureau of Standards,

Comparison of Data for Molecular Weight Distribution of Polystyrene



Esso, Shell Development, Dow, and Chemstrand. Their work covers linear polyethylene, polystyrene, Hevea rubber, and cis-1, 4-polyisoprene. A particularly significant example is the study by Wales and Rehfeld showing excellent results in measuring molecular weight distributions from sedimentation velocity data, and demonstrating clearly that their method did not require calibration with fractions of known molecular weight.



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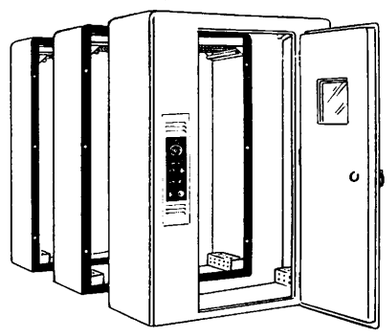

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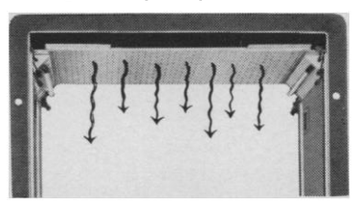

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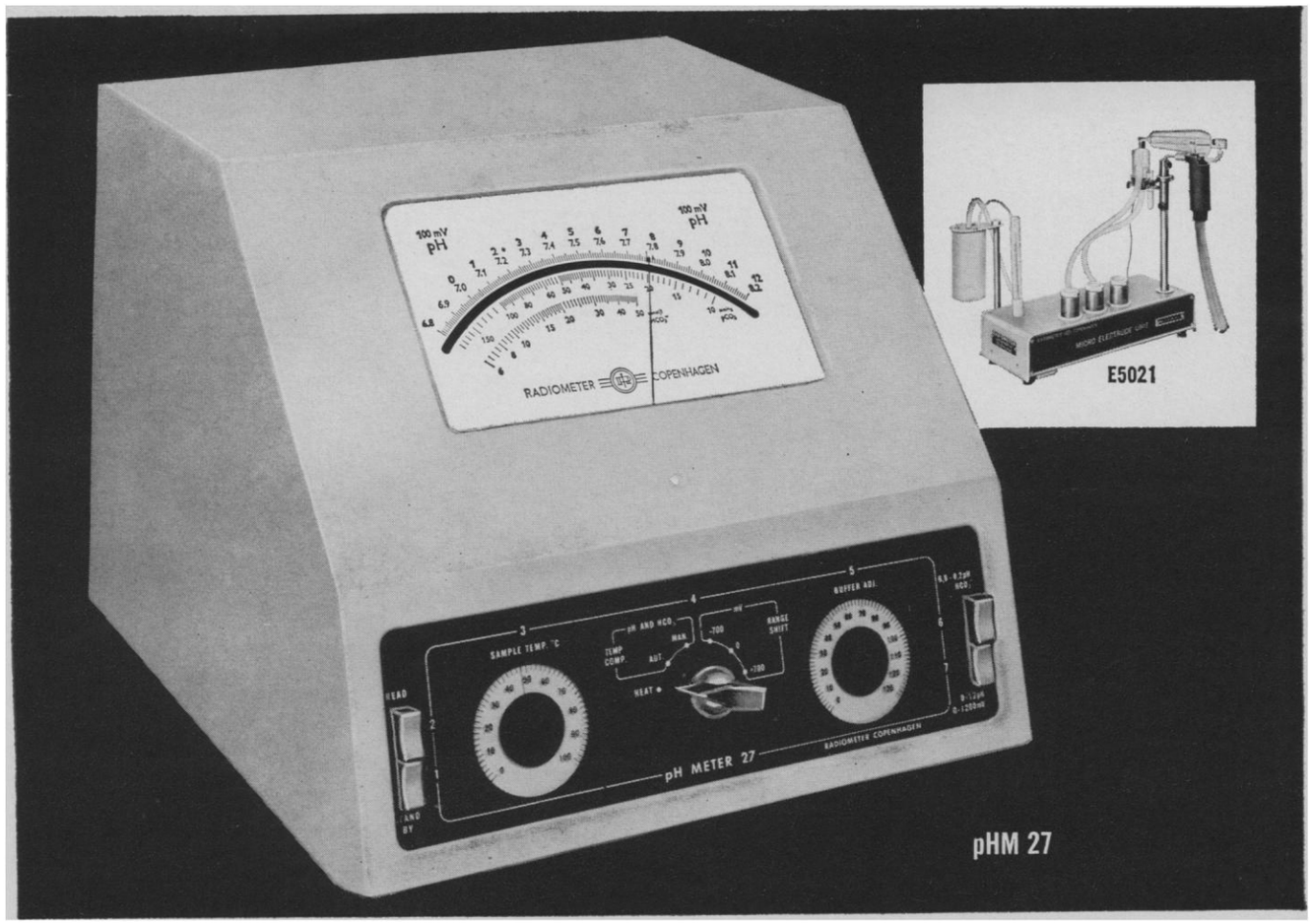
COVER

Japanese space research facilities have recently been moved to a new site facing the Pacific Ocean. This location, on Kyushu Island, affords a maximum rocket firing range. Four centers — instrumentation, rocket launching, telemetry, and controls— are located at tip of peaks (center foreground). See pages 777 and 778.



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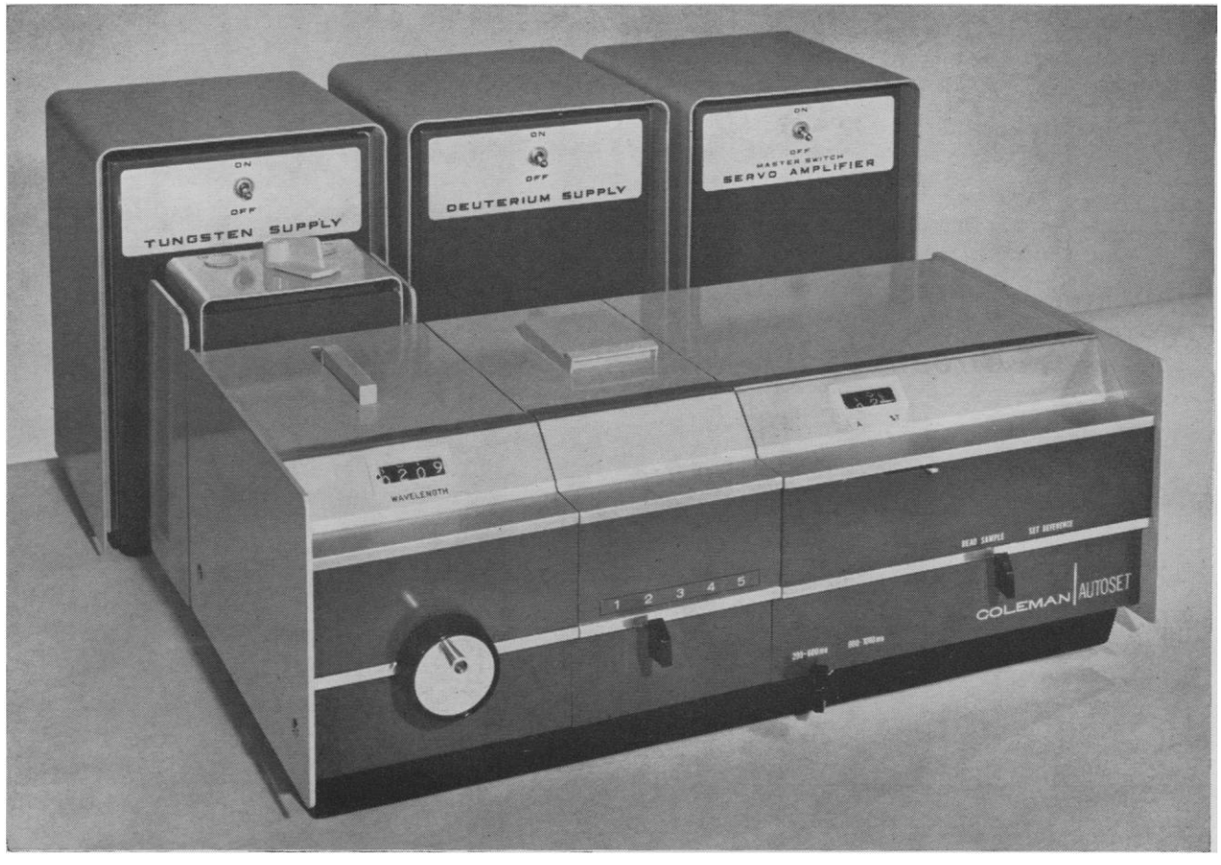

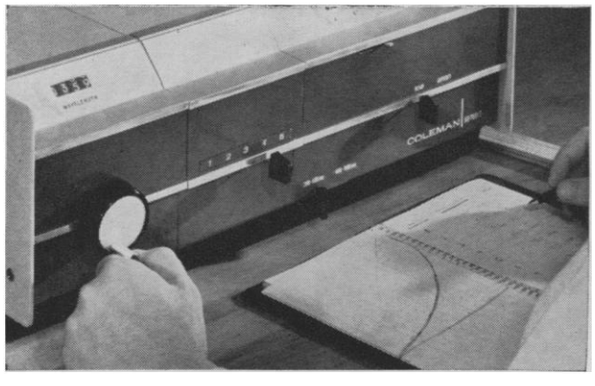

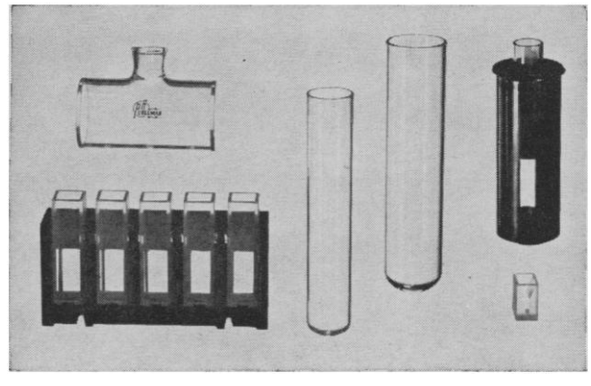

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Automated reference setting, the AUTOSET provision, ends the need for multiple manipulations ordinarily required for making a spectrophotometer reference setting. With AUTOSET, the value is achieved in seconds—*automatically*—by positioning a single control.

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Simplified controls and AUTOSET eliminate critical, time-consuming adjustments and the need for nulling meters.

Sample versatility

General purpose and special cuvettes extend the scope of the instrument to meet widely-varying sample requirements. The instrument's sample compartment is designed for efficient use of a full range of cuvettes—ultramicro, long light path, and round test tube types as well as the highly-accurate standard square cuvettes with parallel optical faces.

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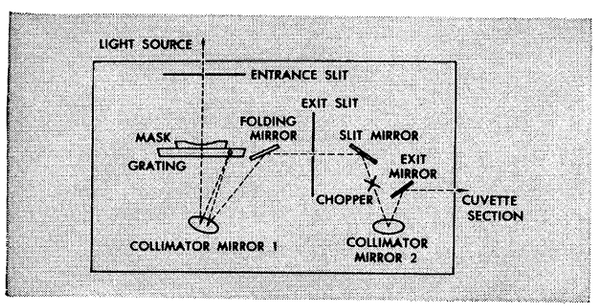
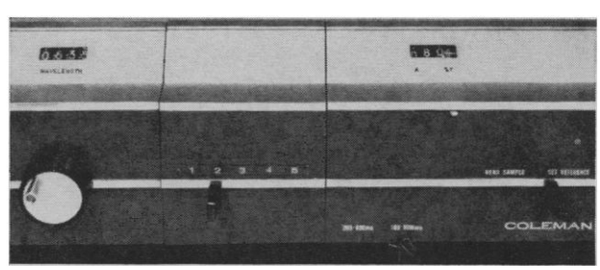


Bipartite diffraction grating optics

The Coleman AUTOSET Spectrophotometer provides the laboratory with the practical advantage of a working instrument with the analytical range of a specialized research equipment. A bipartite diffraction grating, dual light source, and dual phototubes provide high levels of energy throughout the 200-1000mμ spectrum. The bipartite grating produces a straight and linear spectrum which provides constant band width at all wavelengths, with fixed optical slits. Constant band width insures maximum reproducibility.



Error elimination

Reading information in numerical form is twice as fast and three times as accurate as reading the same information from dials. In the AUTOSET Spectrophotometer, all data is presented in unmistakable numerical form.

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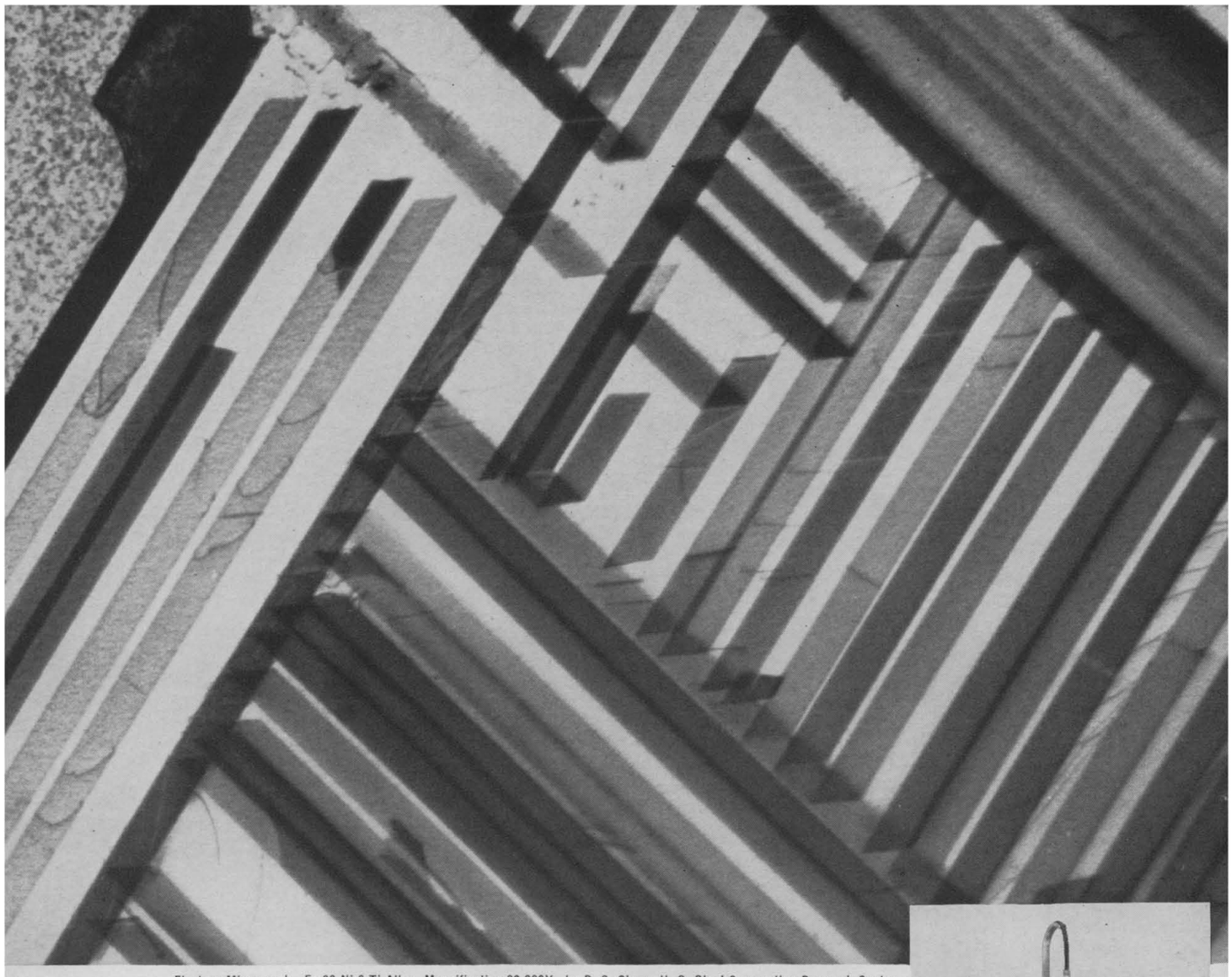
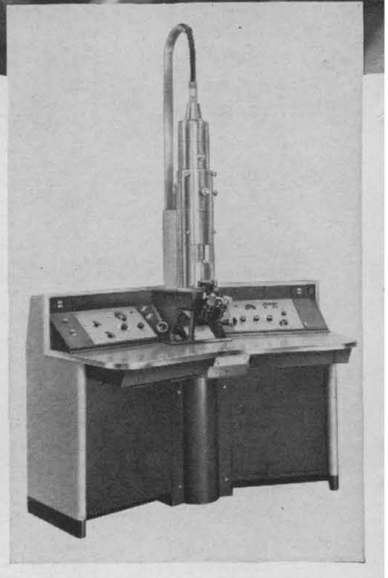


Electron Micrograph—Fe 30 Ni 6 Ti Alloy, Magnification 32,000X—by R. C. Glenn, U. S. Steel Corporation Research Center

AT U.S. STEEL CORPORATION RESEARCH CENTER

RCA Electron Microscope reveals the lamellar structure of Austenitic Fe 30 Ni 6 Ti Alloy



Micrographs, such as the one above, demonstrate the value of the electron microscope in metallurgical research. Of all such instruments, none offers greater versatility than the RCA EMU-3G. Its new universal chamber provides two extra access ports, eight electrical feed-throughs, and up to ten times more space for specimen manipulation than do conventional chambers. Hot, cold and tilt stages are also available.

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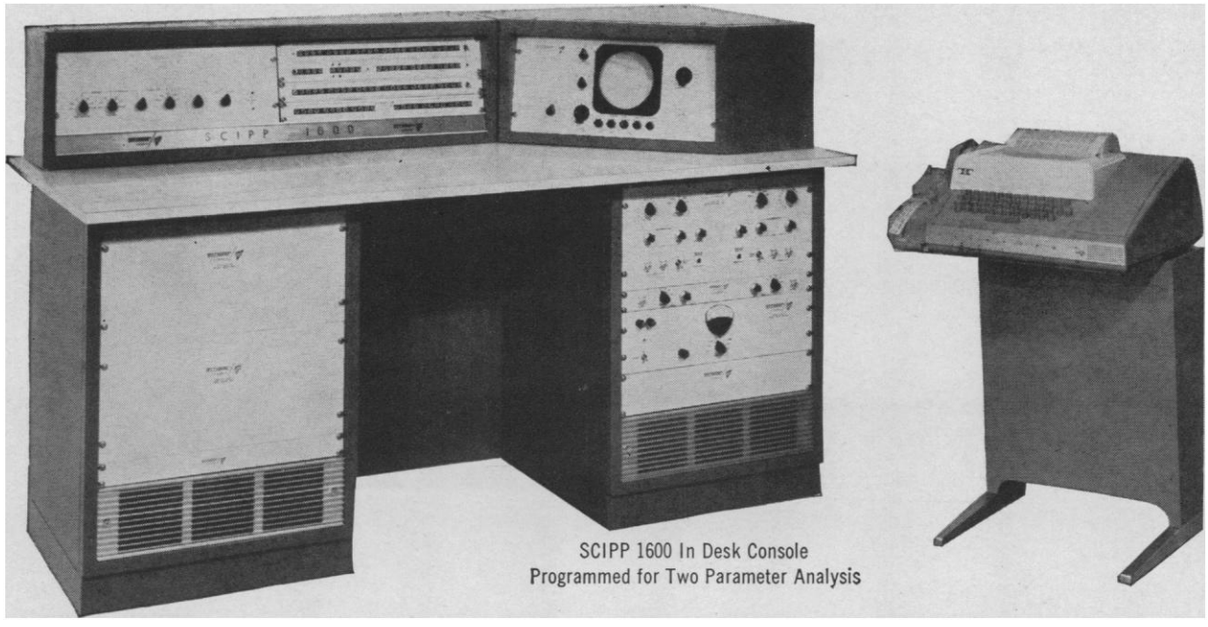

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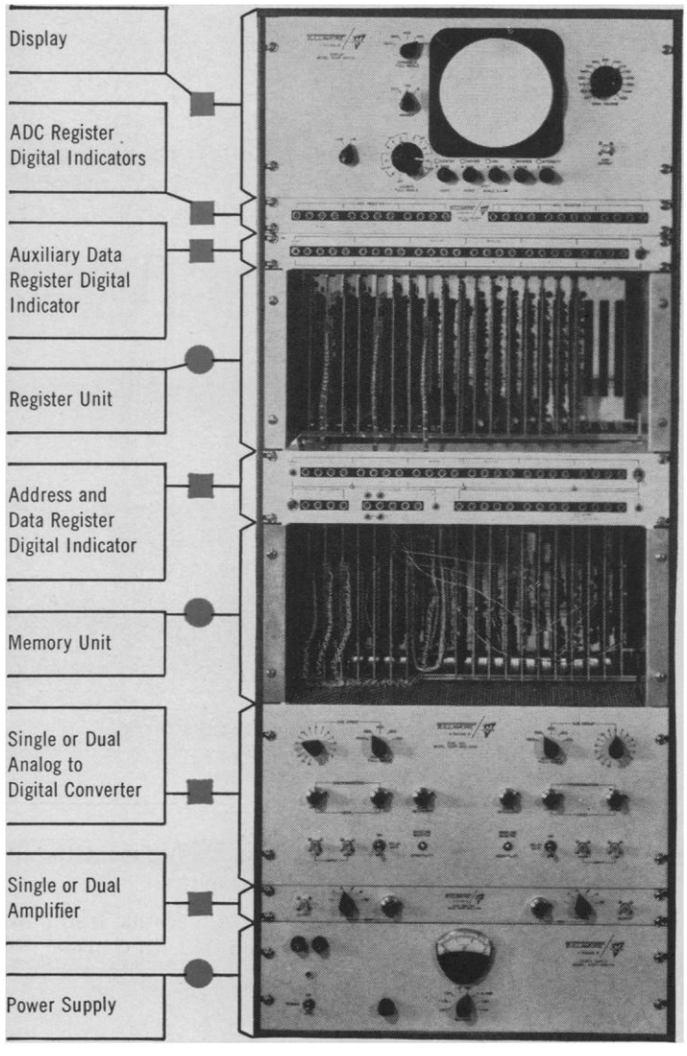

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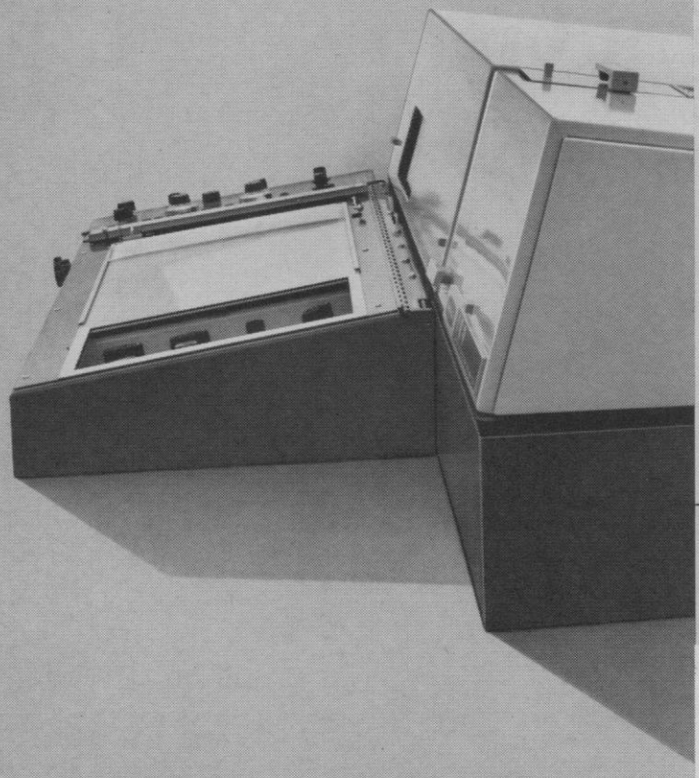
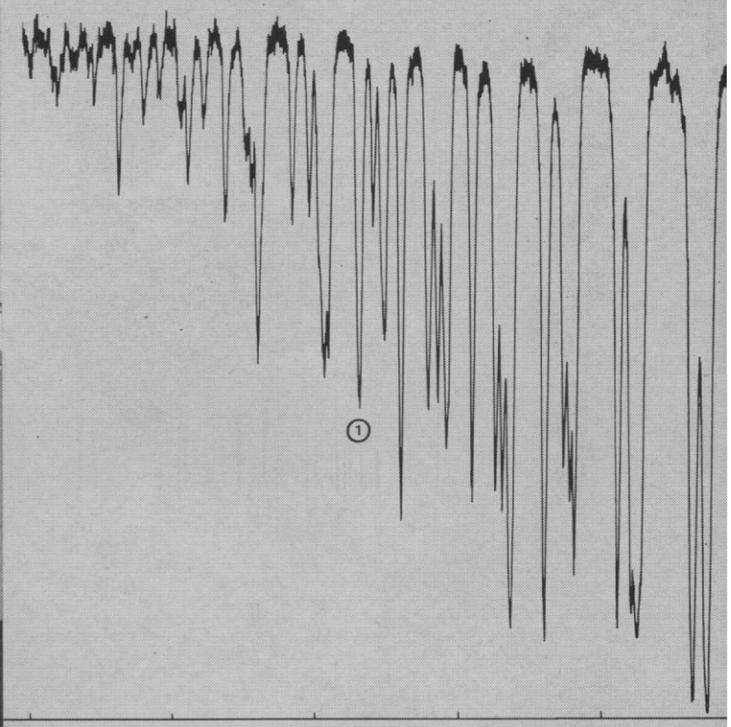
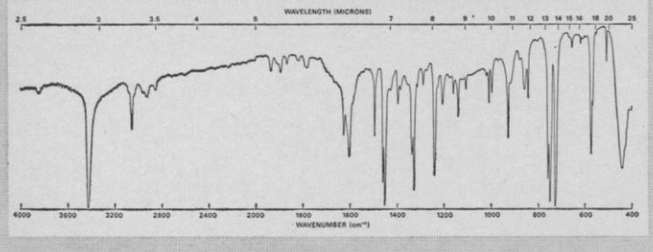


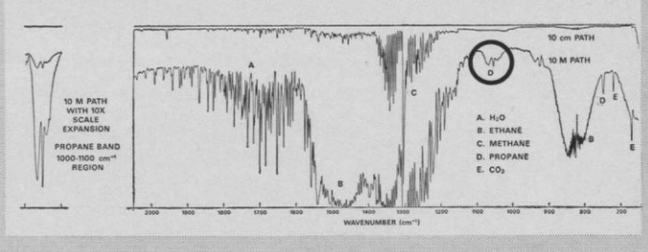


YIELDING THE HIGHEST RESOLUTION of any commercial infrared spectrophotometer, the IR-9 recorded this scan of 60 mm of methane in a 10 cm cell in the region 1220 to 1390 cm^{-1}. Spectral

that you can convert to energy for studies like these

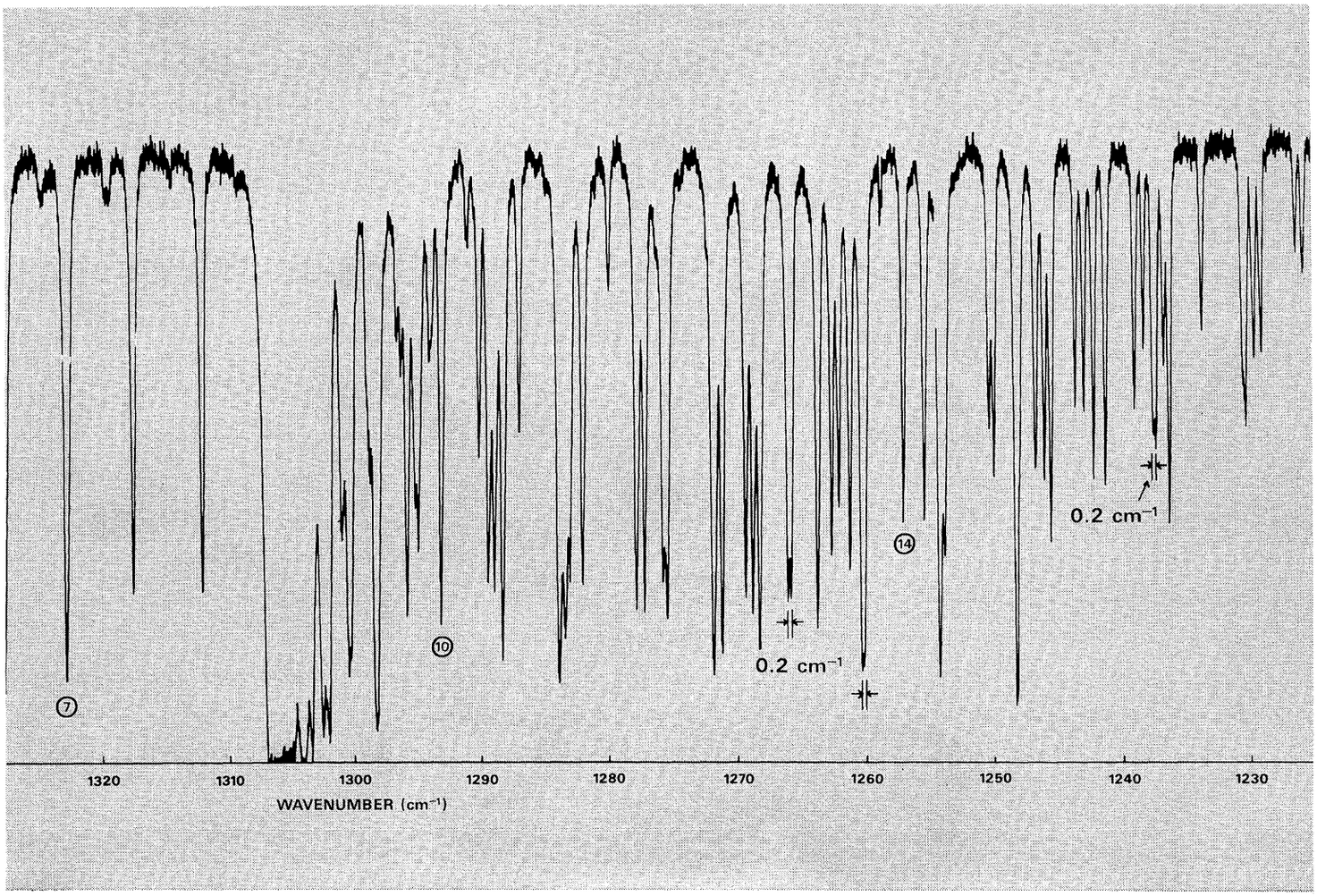


MICRO STUDY of 9 micrograms of carbazole was obtained in routine fashion on a 1 x 1 mm KBr pellet utilizing the Beckman Beam Condenser and Micro Pellet Holder. The energy lost because of the use of beam condensing optics and sample beam masking is readily regained at only a slight loss in resolution by operating the instrument at a slightly wider slit program. Even greater sensitivity can be obtained with the use of ordinate scale expansion; samples as small as 0.4 micrograms are examined in this manner.



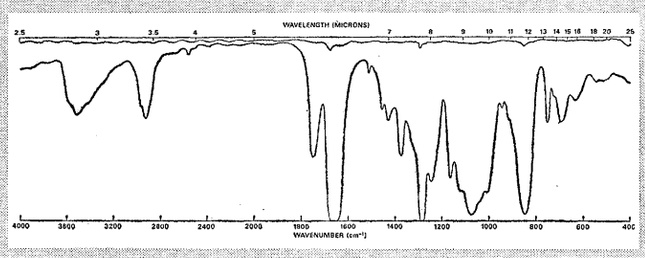
TRACE GAS STUDY of 40 mm of natural gas utilizes the Variable Path Gas Cell. Only methane is observed at a path length of 10 cm (top curve). Lower concentration components appear when path length is increased to 10 meters (bottom curve). One band of propane near 1050 cm^{-1} is shown at the left, scale expanded 10 times at a high signal-to-noise ratio allowing even more precise measurement. Often, in strongly absorbing trace gases, sensitivity in the hundredths of a part per million range is realized.

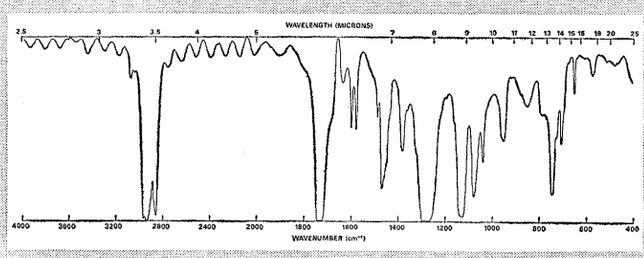
The Beckman IR-9 offers you the highest resolution of any commercial infrared spectrophotometer. However, many analyses do not require full utilization of this capability. Sample characteristics or the method of investigation may dictate the need for a higher level of energy. That is when you can trade the IR-9's exceptionally high resolution for increased energy. The IR-9 provides the best possible compromise between resolution and energy for any study. For information, contact your Beckman Sales Engineer or write for Data File LIR-38-264.



slit width is estimated to be 0.2 cm^{-1} or less as judged from the spacing of the doublets at 1237, 1260 and 1266 cm^{-1}. This run also illustrates the high frequency accuracy capabilities of the IR-9.

Bands labelled 1, 7, 10 and 14 on this scan agree without prior instrument calibration to within 0.4 cm^{-1} of the accepted values similarly identified and published by IUPAC(1).





DIFFERENTIAL STUDY illustrates the ability of the IR-9 infrared spectrophotometer to compensate for tremendous variations in reference beam energy. A sample of di-octyl phthalate deposited on a cellulose nitrate-acetate membrane filter is examined by compensating for the filter material's absorption spectrum. This is accomplished by placing a matching thickness of filter in the reference beam (2). The bottom curve on the scan at the left is that of a 25 micron thickness of the filter. The top curve is the background obtained when matching filters are placed in both sample and reference beams. The filters are retained in both beams to obtain the actual differential scan at the right, showing the spectra of 3 microliters of ester deposited on filter in the sample beam. Differential work is done simply and conveniently with the use of Automatic Slit Control, an exclusive Beckman feature providing an automatic means for obtaining an optimum preset compromise between resolution and energy throughout the entire scan.

(1) International Union of Pure and Applied Chemistry, Commission on Molecular Structure and Spectroscopy, "Tables of Wavenumbers for the Calibration of Infrared Spectrometers," pp. 586, 587, Butterworth, Inc., Washington, 1961.

(2) Sloane, H.J., *Anal. Chem.*, **35**, 1556 (1963).

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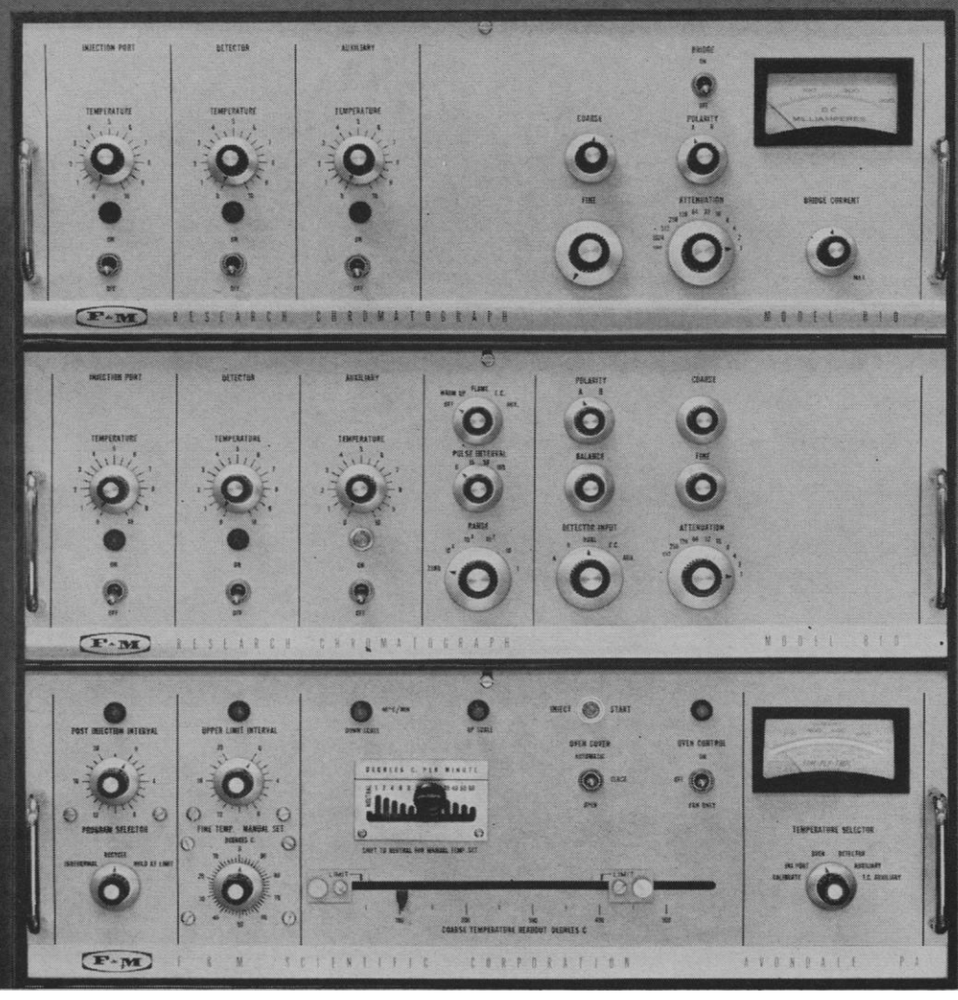

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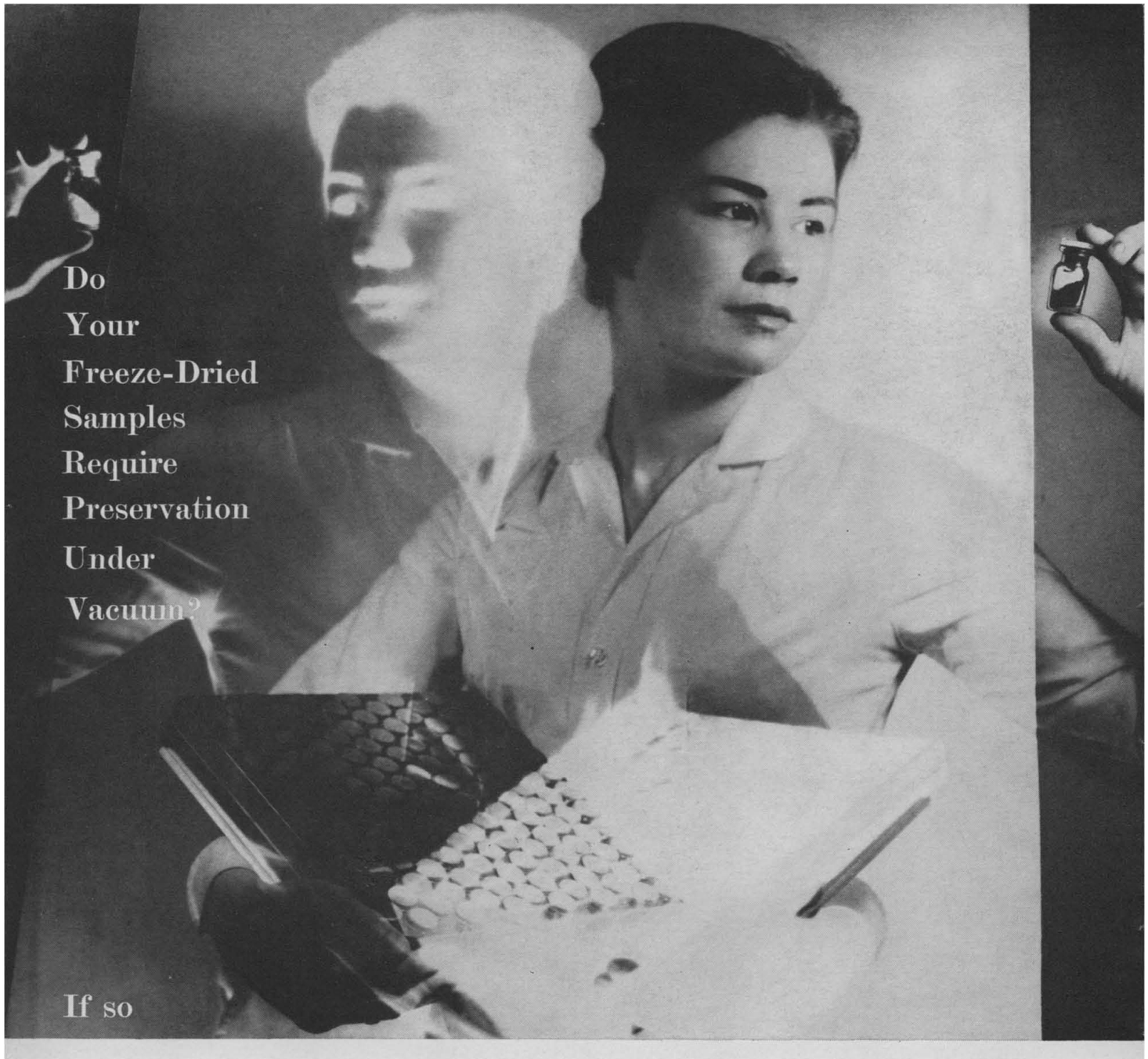

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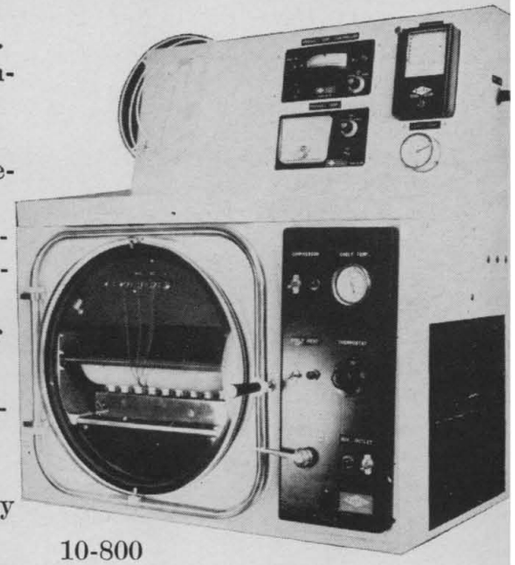

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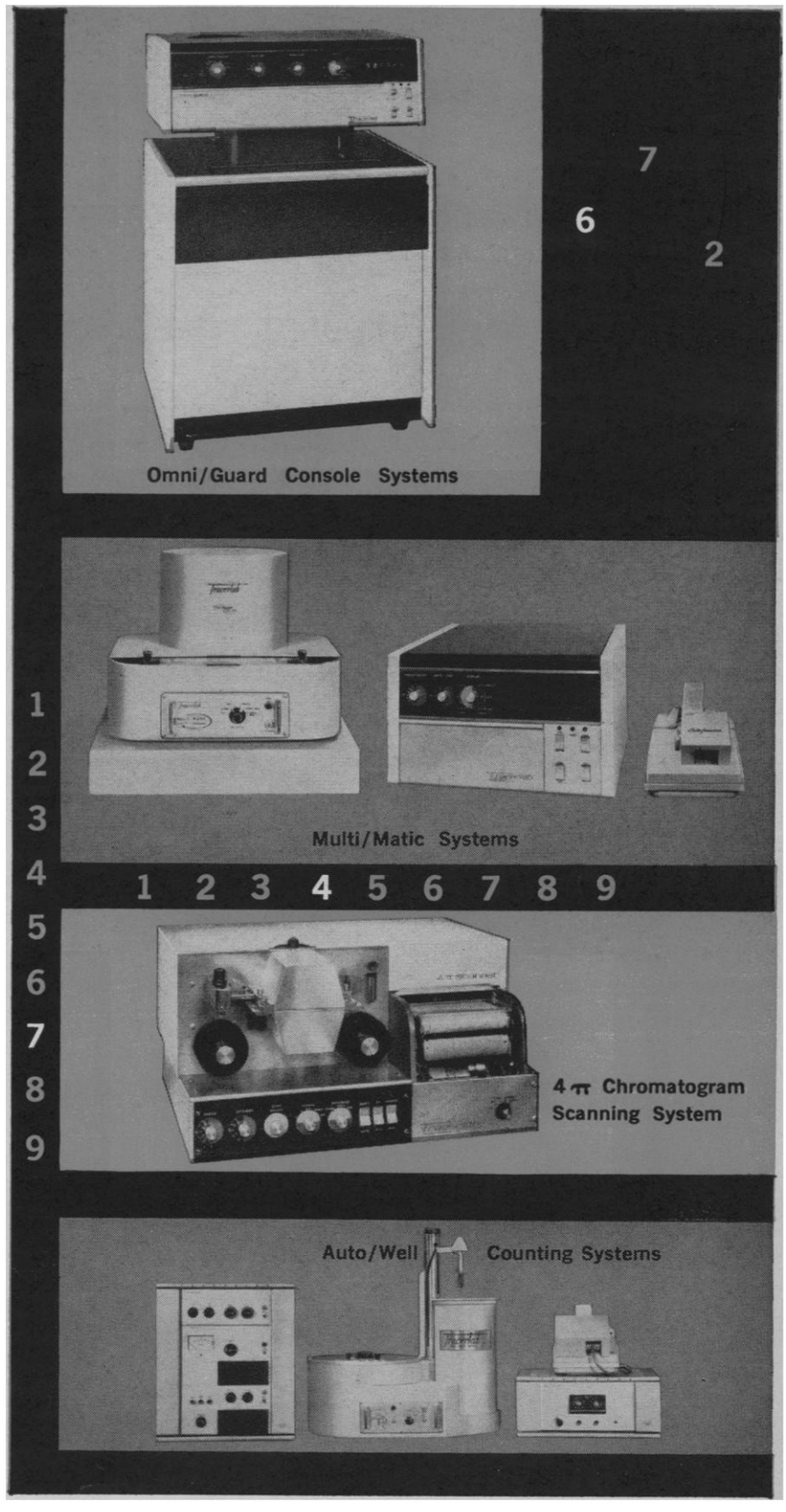

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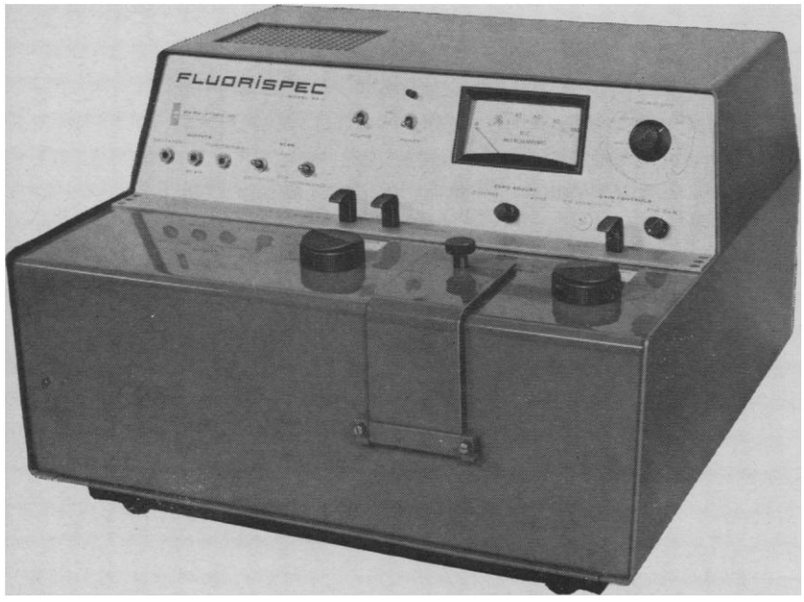

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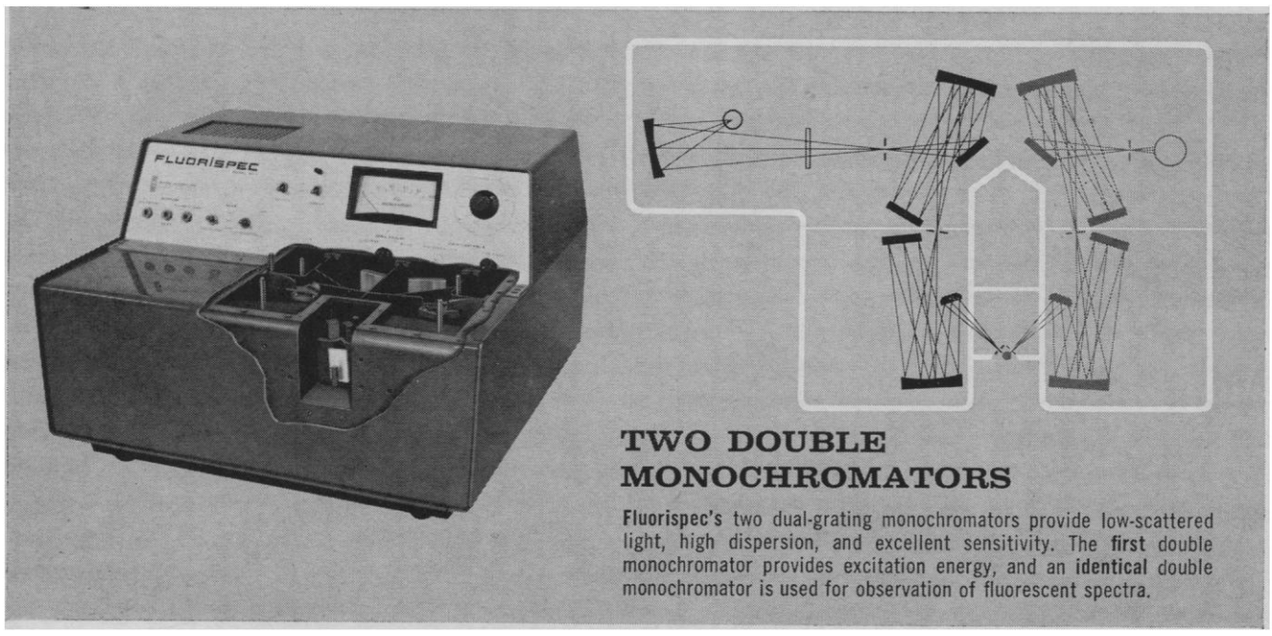

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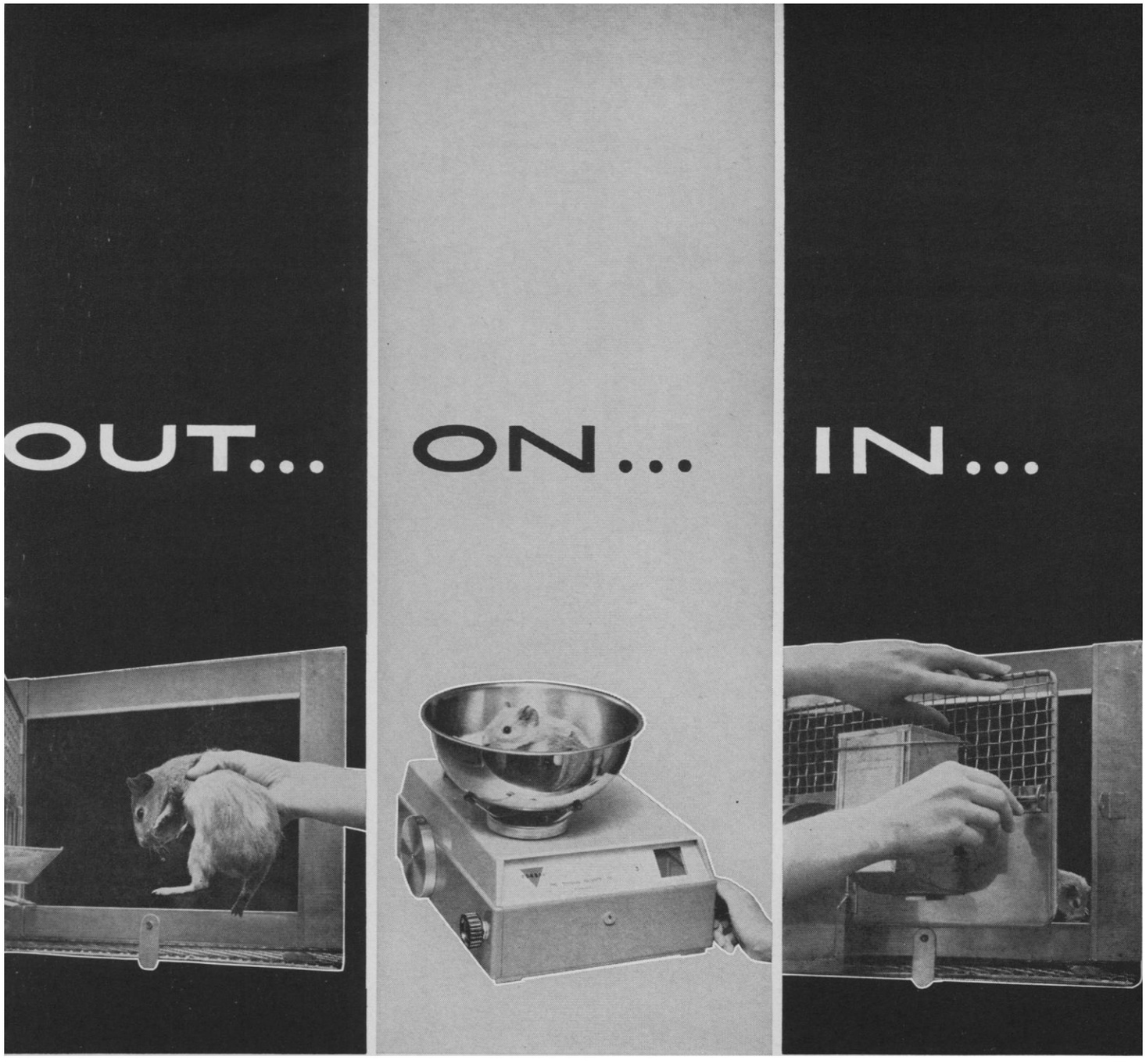

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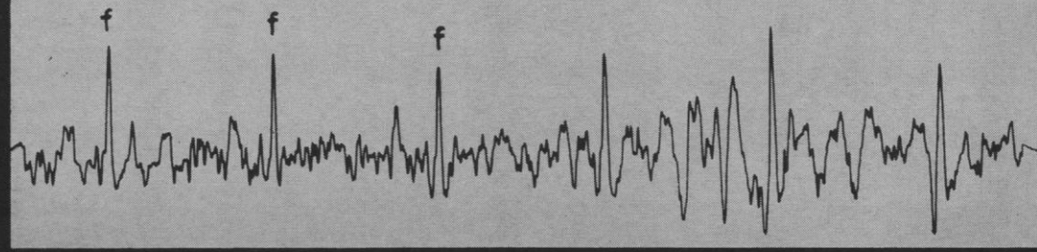
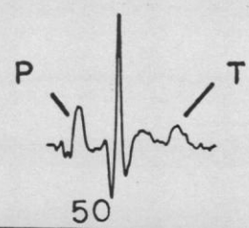
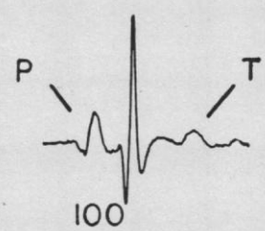
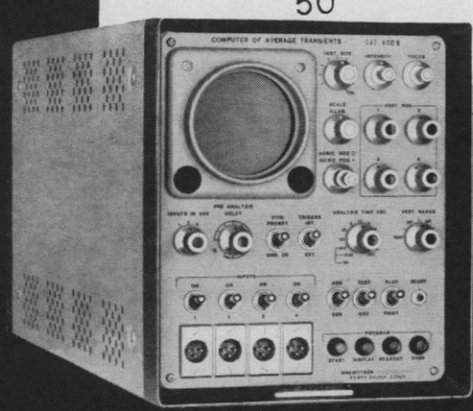


AND GIVE YOU THIS







FOR THE FIRST TIME, CLEAR DEFINITION OF A FETAL ECG HAS BEEN OBTAINED

The figures above illustrate CAT application in Fetal ECG analysis.[1,2] The upper portion, taken directly from a plotting device, is a waveshape recorded from the fetal scalp with concurrent noise components, before being applied to the CAT 400B. The lower portions indicate the same ECG signals summed 50 and 100 times. Note the clear definition of the signal under investigation and the gradual dissipation of the background noise.

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1. E.H. HON, S.T. LEE, Paper presented at the Fifth International Conference on Medical Electronics, July 1963, Liège, Belgium.
2. E.H. HON, S.T. LEE, "Noise Reduction in Electrocardiography", American Journal of Obstetrics and Gynecology (In press).

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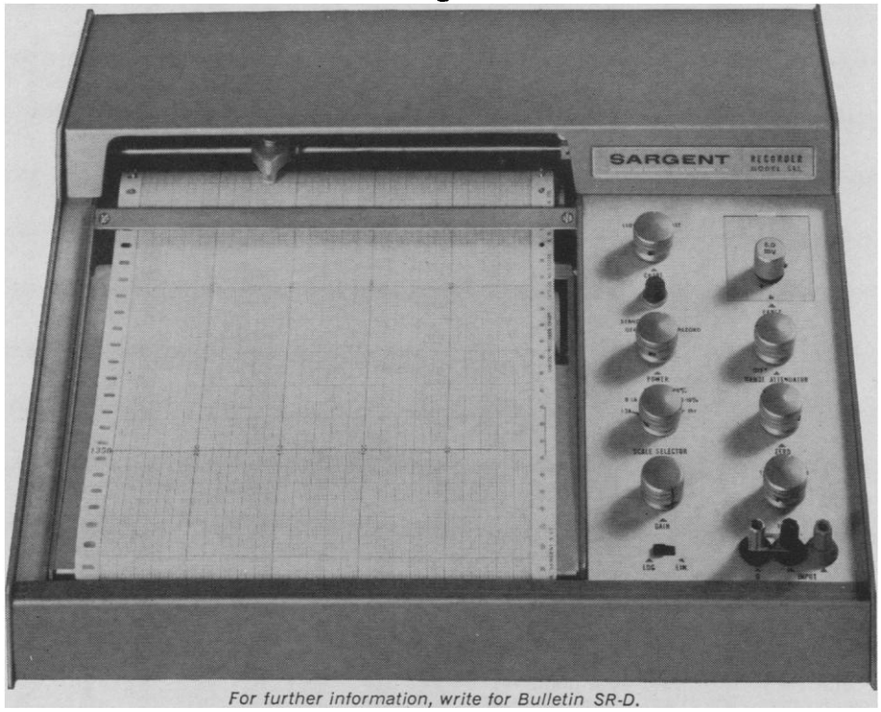

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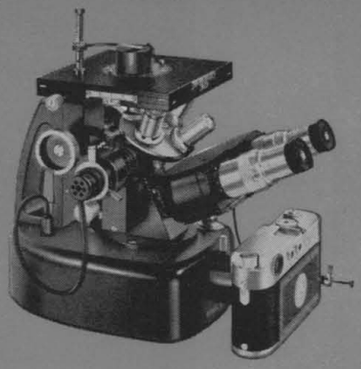

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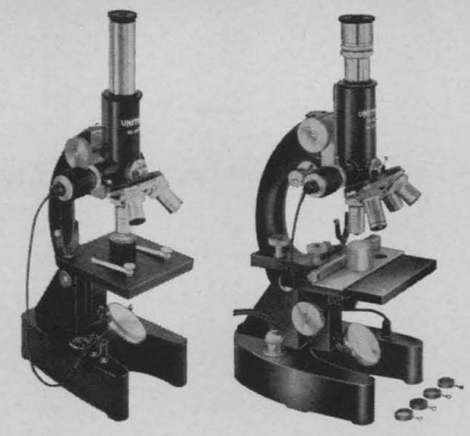

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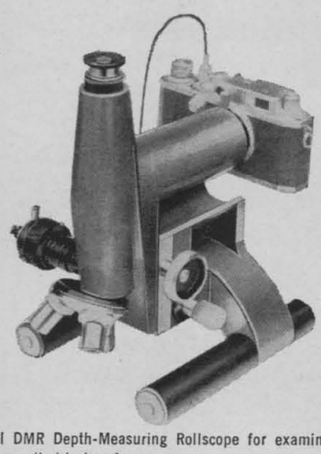

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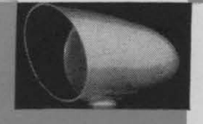

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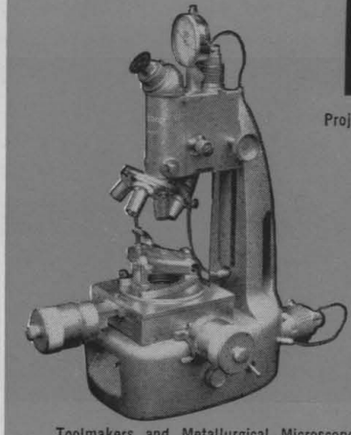

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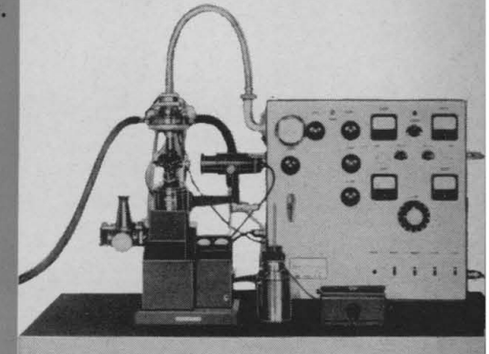

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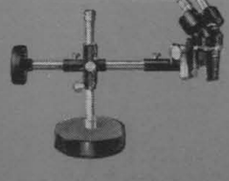

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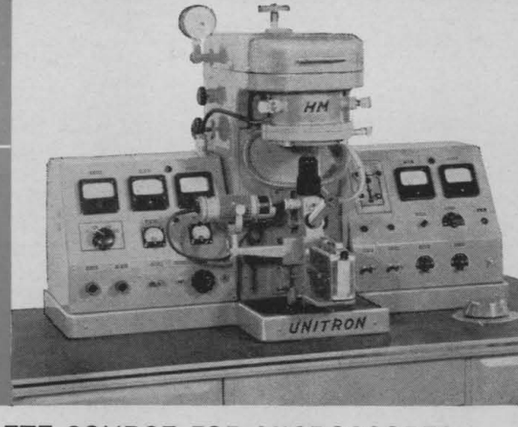

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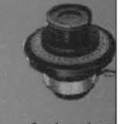

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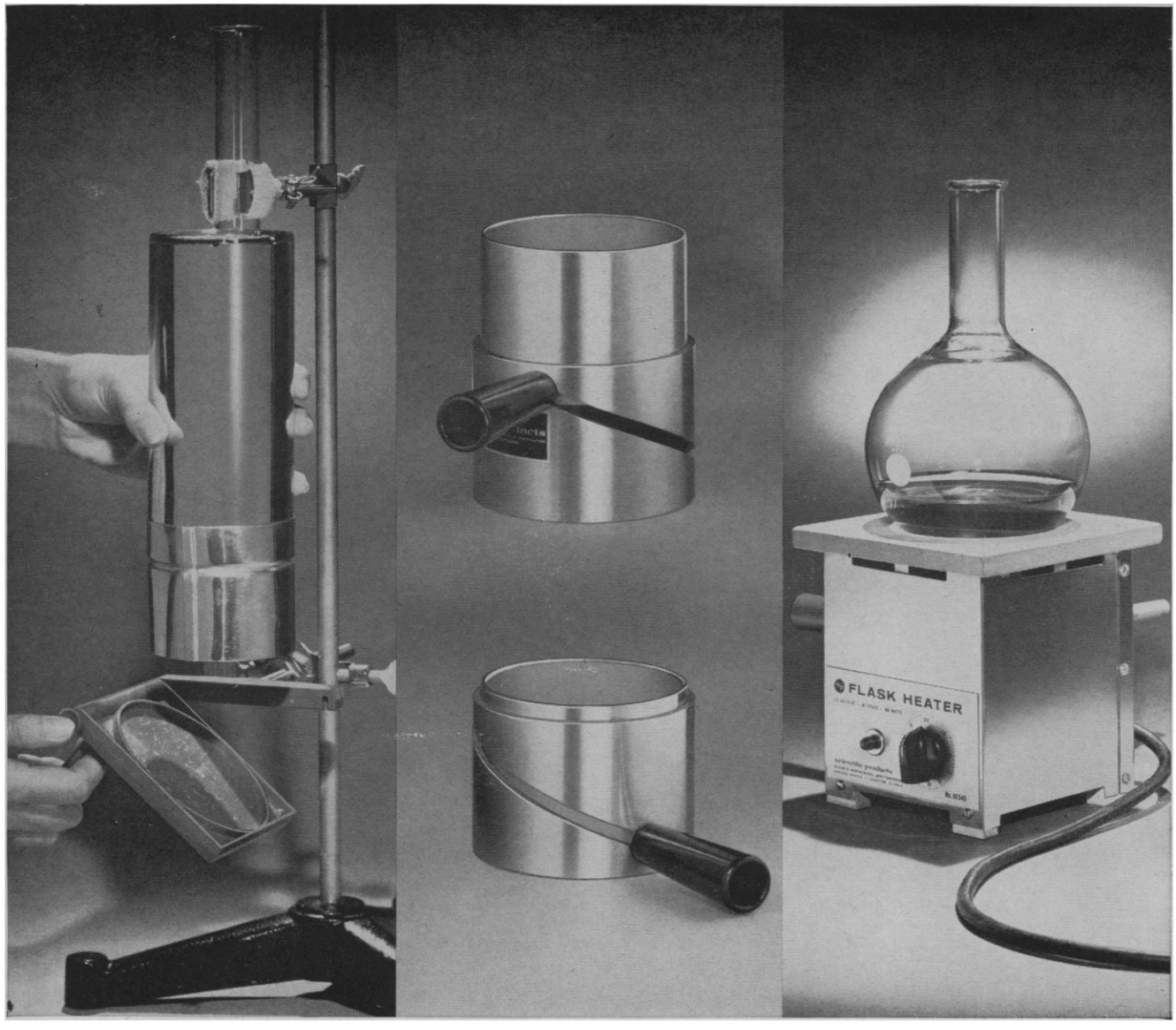

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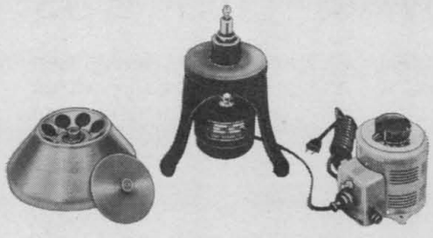

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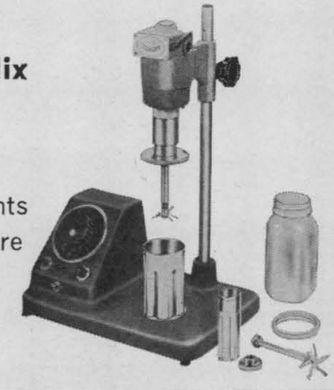

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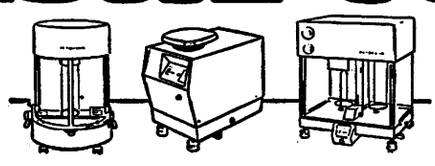

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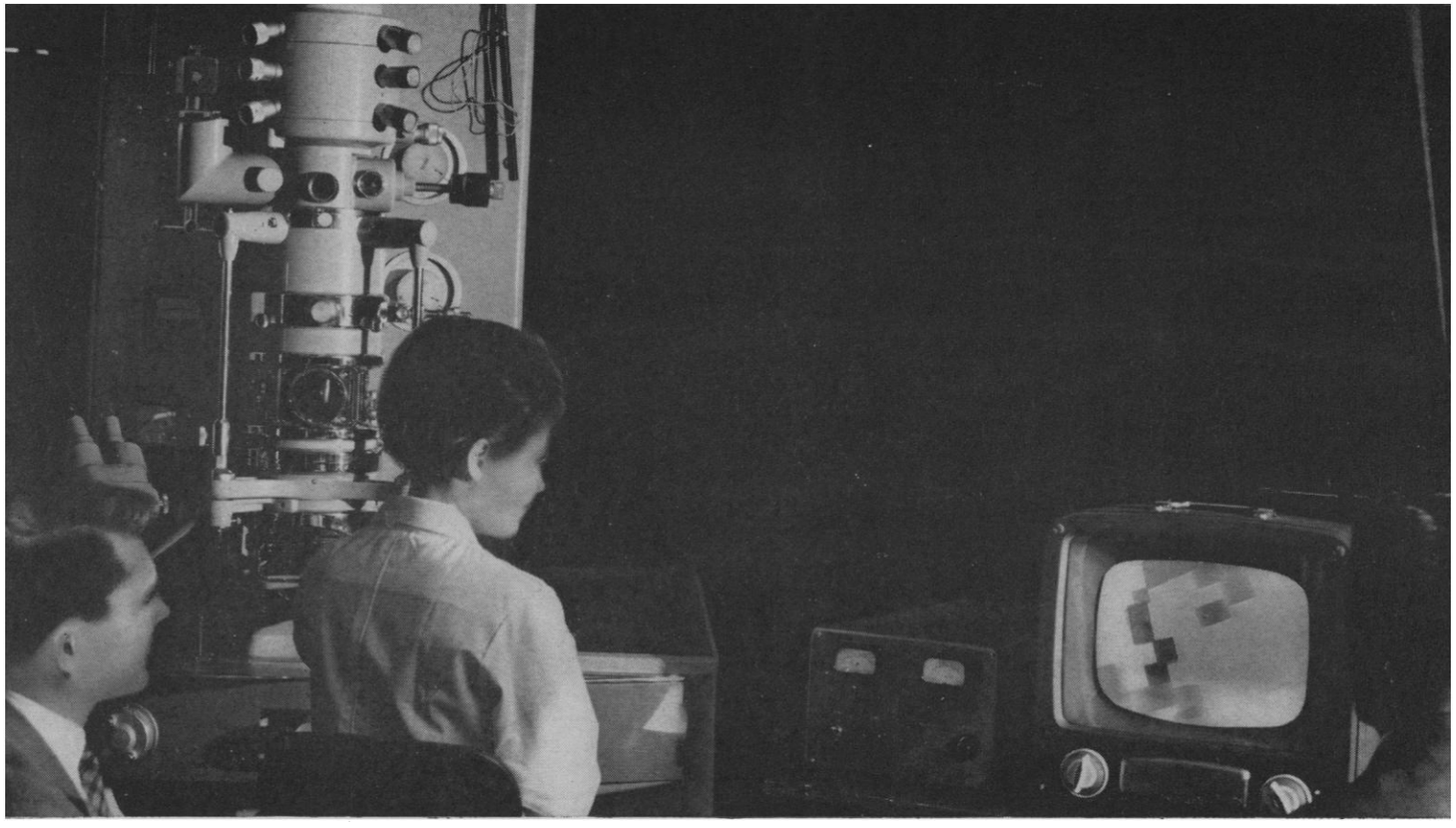

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21 February 1964, Volume 143, Number 3608

SCIENCE

Educational Leadership

The next few years are likely to see a good deal of consideration given to the role and strength of the U.S. Office of Education. Historically it has been a weak agency, and many educators have wanted it that way, preferring that strength be found only in the state departments of education and the professional educational associations. But now, with a proposed budget of $2.15 billion, twice that of the National Institutes of Health and over four times that of the National Science Foundation, the Office of Education has greatly increased fiscal responsibilities. The National Defense Education Act of 1958, the small but growing program of cooperative research grants, the modernized Vocational Education Act of 1963, and the Educational Facilities Act of 1963 have all brought larger funds and greater opportunities.

In some of its functions the Office of Education parallels NIH and NSF. All three support graduate students, make grants for research, allot funds for the construction of educational facilities and the purchase of equipment, collect statistics, and publish reports on trends. As a consequence, all three have opportunities for formulating policy and demonstrating intellectual leadership.

NSF and NIH have been given, and have accepted, this responsibility. The Office of Education has had a more passive role, for it has been less trusted, both by Congress and by its constituency, with the degree of policy-making responsibility given these other agencies. A formula for distributing its funds is often dictated by Congress, and its freedom of action has sometimes been limited to establishing minimum standards for plans developed by the individual states. Behind all this, of course, lies the fear of federal control of education, which is always worth keeping in mind but which in actual practice is more often a red herring than a real danger.

As for the future, the yeast is working throughout the whole educational world. Criticisms and recommendations are legion. The course-content-improvement idea has demonstrated its power in mathematics and the sciences and is spreading to other disciplines. New educational techniques are being extensively tried out. Congress has recognized that the national interest calls for greater national involvement in the whole educational effort. Clearly, major changes lie ahead. As they come, the need for educational statesmanship will increase. There will inevitably continue to be much decentralization of responsibility; our educational system is built that way and will continue to work that way. The few voices that are calling for a "national" system are too far out of tune to be heeded. But the feeling that all educational decisions should be made at the state or local level is equally out of step with current problems and requirements.

To the financial support they have distributed, NIH and NSF have added the stimulating effects of coordinated national planning. Neither has deprived its constituency of freedom to make a variety of choices; in fact both have developed new opportunities and have helped to build many parts into a more effective whole. An Office of Education much stronger than we have traditionally had could be a more helpful partner to these agencies in the fields where they overlap and could be a center of intellectual leadership for the rest of education.—D.W.

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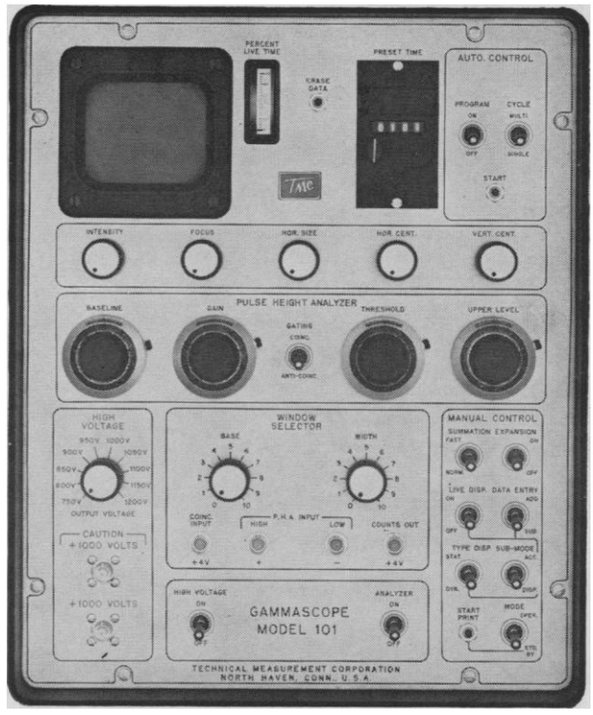

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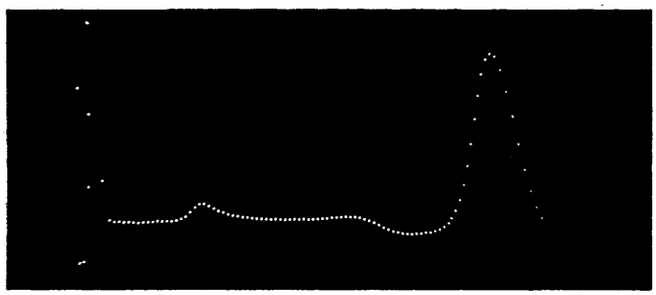

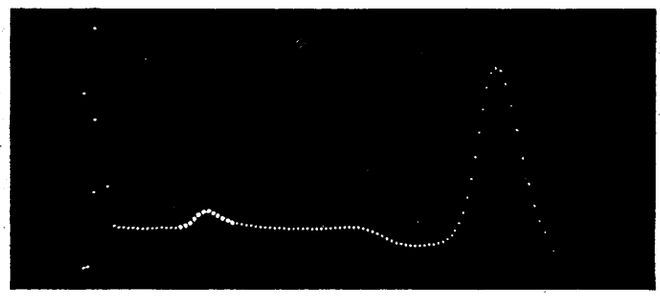

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science) the featured speakers reported on research in two fields of science. Sister M. Angelice Seibert (Ursuline College) discussed her investigation of the interaction of mercury compounds and EDTA, and emphasized the biological importance of the mechanism involved. Agnes Hansen (University of Minnesota) reported on her long-term study of the atmospheric pollen counts in Minnesota. These data have made it possible for her to advise vacationists who were seeking an area free of ragweed pollen during the hay-fever season.

The 1963 recipients of the three Sigma Delta Epsilon grants-in-aid were announced: Amegda Jack Overman (Gulf Coast Experiment Station), Sister M. Angelice Seibert, and Ruth Angelina Walker (Hunter College).

The dinner and Grand Chapter meeting of the fraternity were held in the Lewis Room of the Sheraton-Cleveland Hotel on 29 December. National honorary membership in Sigma Delta Epsilon was awarded to Margaret Mead (American Museum of Natural History), Mary I. Bunting (Radcliffe College), Agnes Chase (Smithsonian Institution), and Zada M. Cooper (Iowa State University).

At the business session which followed, great interest in the affairs of the freternity was demonstrated by suggestions and approved actions relative to membership, awards, communication, district conferences, and national meetings. A workshop, earlier in the day, facilitated the action on the various issues. Finally, the delegates elected the national officers for 1964: Sue C. Stevens, president; Agnes Hansen, 1st vice president; Eltora Schroeder, 2nd vice president; Hazeltene Parmenter, secretary; and Barbara Roth, treasurer.

SUE C. STEVENS, *President*

AAAS Symposia

Committee on Desert and Arid Zones Research

A symposium, "Arid lands of Latin America," provided a wide coverage of arid land problems and various suggestions for solutions. All of the speakers gave evidence of their intimate knowledge of Latin American conditions. The first papers dealt with climate, soils, and vegetation, and provided a background for the following discus-

sions on social and economic aspects. Papers relating to Mexico covered the anthropological background and the recent land reform programs in northwestern Mexico. Discussions on other Latin American areas showed how people in northeastern Brazil have solved some of their own problems, and contrasting views were presented on the possible solution to land use problems in Peru. Also noted were investment criteria for development of arid zones. The meeting was closed by a summary report on the Latin American Arid Lands Meeting held last September in Buenos Aires. It is hoped that the papers can be published in Spanish, but final arrangements have not yet been completed.

W. G. McGINNIES, *Program Chairman*

Radical-Ions and the Excited State

As part of the 1963 AAAS annual meeting in Cleveland, the Chemistry Section presented two symposia, entitled "Chemistry of radical-ions" and "Chemistry of the excited state."

The symposium on Friday (28 Dec.) was concerned with the generation, properties, and reactions of radical-ions, those species possessing both an unpaired electron and a charge. W. F. Libby (U.C.L.A.) discussed some of the properties of $CH_4^{+\cdot}$ generated by ejection of an electron from neutral methane by ionizing radiation. Libby suggested that insight into the chemistry of radical-cations could be obtained by considering them in terms of their isoelectronic counterparts. On this basis, $CH_4^{+\cdot}$ may be compared to the fluorine atom:

$$F\cdot + CH_4 \longrightarrow HF + CH_3\cdot$$

$$CH_4^{+\cdot} + CH_4 \longrightarrow CH_5^{+} + CH_3\cdot$$

Although CH_5^+ was reported by Russian workers in 1952, its existence gained only slow acceptance. Its formation, according to the foregoing equation, is one of the fastest reactions known. There are at least three effects of the positive charge on radicals: (i) Energy enhancement. In the molecule NeH^+ produced from $Ne^{+\cdot} + H_2 \longrightarrow NeH^+ + H\cdot$ the bond strength of the Ne-H bond is approximately 170 kcal. (ii) Polarization attraction. The positive charge induces a dipole in neutral molecules and thereby produces a very high capture cross section and very fast reactions. (iii) Charge exchange bonding. This phenomenon represented by

the reaction $CH_4^{+}\cdot + CH_4 \longrightarrow C_2H_5^{+}\cdot$ requires geometrical identity of the two moieties and can occur only in the condensed phase in molecules of any complexity. In contrast to the sensitivity of aliphatic compounds toward ionizing radiation and the great reactivity of the radical cations so produced, benzene and other aromatic compounds are inert. In $C_6H_6^{+}$ the charge is effectively delocalized. In connection with his work with benzene, Libby reported an impurity of less than 10^{-9} g/g in the preparation of high purity benzene.

Reactions of alkanes at low pressures as observed in a mass spectrometer were described by M. S. B. Munson, J. L. Franklin, and F. H. Field (Humble Oil, Baytown, Texas). The rate constants are independent of temperature, and therefore activation energies are essentially zero. From methane and ethane the protonated species CH_5 and $C_2H_7^{+}$ were observed; however, this did not occur in the case of higher members of the series (propane, butane, and isobutane). The main reactions of the alkanes observed could be considered as hydride-ion abstractions leading to $(C_n\ H_{2n+1})^{+}$ ions.

T. F. Williams (University of Tennessee) noted the effect of radical-ions in polymerization reactions in the condensed phase. Cyclopentadiene, which undergoes a conventional acid-catalyzed polymerization, also polymerizes on irradiation with cobalt-60 γ-rays at −78°C. The presence of a suitable base (for example, NH_3) to the extent of 0.01 percent (mole) reduces the polymer yield by over a hundred fold. The effect is attributed to neutralization of the growing polymer chain.

A detailed study indicated a low efficiency in the yield of ions responsible for initiation. These were characterized as positive radical-ions separated from their conjugate electrons beyond the range (200 Å) where the electrostatic attraction exceeds kT. The lifetime of polymerizing species are deduced to be about 10^{-3} sec implying rate constants for polymerization of 10^{7} liters mole^{-1} sec^{-1}. Because radical cations may be regarded as protonated radicals, for example, $CH_3\cdot + H^{+} \longrightarrow CH_4^{+}\cdot$, it was suggested that neutral free radicals generated by conventional chemical methods might display enhanced reactivity in very acidic media.

The radical-cations discussed previously are of short life. In contrast, radical-anions derived by electron transfer from an alkali metal atom to an aro-

matic olefin are stable almost indefinitely. M. Szwarc (State University, Syracuse) described such adducts from styrene, α-methylstyrene, and 1,1-diphenylethylene. The initially formed anion $M^{-}\cdot$, may dimerize to the dianion, $^{-}MM^{-}$, or react with monomer forming the dimeric radical-ion, $^{-}MM\cdot$. Various techniques were described which permitted study of the kinetics and equilibria in the two processes. These involved exchange between deuterated and nondeuterated dimers, exchange between a dimer and its radioactive monomer, and electron transfer from dimer to aromatic hydrocarbons such as anthracene or pyrene.

From naphthalene-alkali metal adducts D. Lipkin (Washington University, St. Louis) described new synthetic applications. Reaction with 1,4-dichloroalkanes yielded ring systems at the 1,2 and 1,4 positions of the naphthalene. New polycyclic structures are thus available by this method.

S. Weissman (Washington University, St. Louis) noted important data concerning radical-anions obtained from magnetic resonance spectroscopy: (i) average spin distributions, (ii) rates of intramolecular electron migrations, (iii) rates of intermolecular processes, and (iv) rates and equilibria of ion pairing.

Spectroscopic evidence for the formation of radical-ions by adsorption onto surfaces of heterogeneous catalysts (for example, silica-alumina) was reviewed by H. P. Leftin (M. W. Kellogg Co., Jersey City).

The symposium held on Monday (30 Dec.) reflected a renewed interest in photochemistry and emphasized chemistry of the excited state. G. Porter (Sheffield University), the keynote speaker, stressed the contribution of new experimental techniques. Matrix stabilization methods eliminate bimolecular reactions, such as radiationless processes, and true unimolecular decay rates can be obtained. Flash photolysis permits observation of primary products; over 100 different radicals have been observed by this technique which also permits the observation of triplet-triplet absorption. The lifetime of the triplet state is on the order of 200–300 μ sec. The flash photolysis technique permits a determination whether the reaction mechanism involves triplet or singlet states. Where the triplet itself cannot be observed, provision for energy transfer to an acceptor molecule, which has a lower-lying triplet but a much higher singlet, may be made. The

singlet state is much more reactive and shorter-lived than the triplet. In the n-π^* transition, polarization is responsible for the high reactivity of the resulting singlet state; this is in contrast to the π-π^* transition which does not result in polarization. Most bond dissociations are of the singlet type. The weakest bond of a polyatomic molecule will generally be broken in the gas phase; this is not the case in the condensed phase because of the cage effect. Here, the bond having the lowest activation energy for rupture is most likely to be dissociated. In concluding Porter pointed out that most chemistry to date represents that of the one-ground state; in contrast, with several excited states available, a much vaster field has been opened by excited state chemistry.

N. C. Yang (University of Chicago) discussed the photochemistry of carbonyl compounds involving intramolecular reactions. Singlet-state processes are best studied in this way because the singlets are short-lived states and because rates are not diffusion controlled for intramolecular reactions. Ultraviolet irradiation of ketones at appropriate wavelength causes $n \longrightarrow \pi^*$ transitions; the oxygen atom becomes more positive in the process and may abstract a hydrogen atom, thus forming a cyclic compound. The fact that the reaction is not an entirely concerted mechanism is shown by two facts: (i) When the carbon atom γ to the carbonyl is optically active, only about 15 to 20 percent of the optical activity is retained in the product. (ii) When the γ position permits allylic isomerization, both 4- and 6-membered ring products are formed.

The *cis-trans* photoisomerization of stilbene was discussed by J. Saltiel and G. Hammond (California Institute of Technology). The reaction occurred in the presence of an added sensitizer (with appropriate filters) which produces a high yield of triplet whereby energy transfer took place from the sensitizer triplet state (donor) to the stilbene ground state (acceptor). With a variety of sensitizers, whenever the ground-state singlet to triplet transition of the sensitizer was higher than the energy of the corresponding transitions of either the *cis* or *trans* isomers, the same *cis*-to-*trans* ratio was obtained in the photostationary state. With sensitizers of lower excitation energies the *cis*-to-*trans* ratio was a complex function of the energy and could be varied greatly.

IRVING MADOR, *Program Chairman*

Degenerate Stars

Properties of degenerate stars were discussed in a symposium as a part of the annual AAAS meeting held in Cleveland Ohio, 26–31 December. This symposium was organized and chaired by Hong-Yee Chiu (Goddard Institute for Space Studies) at the request of Frank B. Wood (secretary of Section D; University of Pennsylvania).

Charles W. Misner (University of Maryland) first summarized the theoretical aspects. Degenerate stars are cold stars in which the pressure is entirely due to degenerate electrons or neutrons and hyperons. It is well known that a mass limit, the Chandrasekhar critical mass (about 1.4 solar mass), exists for nonrelativistic degenerate stars. No equilibrium configurations exist when the mass exceeds this limit. White dwarf stars are one type of degenerate star in which the pressure is entirely due to the electron gas. The density is around 10^6 g/cm^3. However, if the density is increased to around 10^9 g/cm^3 (which is possible during the collapse of a star) inverse beta reactions will drastically reduce the number of electrons; as a result all nuclei dissolve into free neutrons. Because the inverse beta reaction induces an instability, no star exists with a density from 10^8 to 10^{13} g/cm^3. At a density of 10^{14} g/cm^3, inverse beta reaction is complete and a stable region is obtained. However, at this density the mass concentration is so high that general relativistic effects should be included in the study of the theoretical structure. The significant contribution is that the pressure (stress energy) now also contributes to the energy, which is the source of the gravitational field. The critical mass is now reduced to around 0.7 solar mass. H. Zapolsky's recent work indicates that the most extreme assumptions on the equation of state (postulated to increase the pressure) only decreases this critical mass limit to 0.3 solar mass.

A. G. W. Cameron (Goddard Institute for Space Studies) discussed the composition of matter at extreme densities. Almost all hyperons are produced in an equilibrium state. Recent results from nuclear many-body theory were used to obtain an equation of state. The limiting mass does not seem to change by much. He also discussed the possible surface composition (collaborator, Miss S. Tsuruta) at somewhat lower densities (about 10^9 g/cm^3 or less). Two groups of elements ap-

pear to be stable; one is the iron group elements (mass number A about 56) and the other is the neutron-rich group elements (A about 80). The surface of a neutron star is thought to be composed of these two groups of elements.

The two theoretical papers, which dealt mainly with neutron stars because the internal structure of the ordinary white dwarf star is well understood, were followed by two papers on the observational aspects of white dwarf stars. Neutron stars are expected to radiate mainly in the x-ray band. Recent rocket x-ray experiments by Friedman (Naval Research Laboratory) indicated that there are discrete x-ray sources coincident with known supernova remnants. The source might be neutron stars. V. Weidemann (Physikalisch-Technische Bundesanstalt) discussed the structure of white dwarf atmospheres. The atmosphere of a white dwarf star is only 100 meters thick, with a surface gravity of 10^8 cm/sec^2. The lines are extremely broadened by high gravity and density. The width of these lines is around 100 Å (as compared to the gravitational red shift which is of the order of 10 Å). In general, one can divide white dwarf stars into two groups, the hydrogen-rich and hydrogen-poor atmospheres. In one type of white dwarf star (DC) no line is observed. In the determination of the color of the star (and hence its surface temperature) the great variation of surface composition must be taken into account. In general, the white dwarf radiation more closely resembles black body radiation than that from an ordinary star.

J. B. Oke (Mt. Wilson and Palomar observatories) reported on the observational aspects of white dwarf stars. Most of the earlier work was done by J. Greenstein (Palomar Observatory). White dwarf stars are intrinsically fainter than the sun by a factor of 10^3 or more. The brightest white dwarf star (the companion of Sirius A) has a magnitude of 10. Usually one has to work with white dwarfs of magnitude +15 and at this brightness it is not possible to use high dispersion spectra graph. On the other hand, the spectra lines are usually broadened and do not contain any finer detail. With a 200-inch telescope, the limiting distance is around 100 parsecs. Photomultiplier devices are now used in the study of white dwarf spectra and give higher sensitivity and better signal-to-noise ratio than photographic plates.

In the future it is hoped that an array of 50 photomultipliers may be used, with each recording a part of the spectra. This will drastically reduce the observation time. From the observations and theoretical interpretation of white dwarf stars, one can obtain vital information regarding the mass, density, surface temperature, and eventually, evolution track. Most white dwarf stars have a surface gravity of 10^8 cm/sec^2. From this and the theoretical radius-mass relation, one can conclude that the average mass is 0.5 solar mass and the radius about 1/70 of the radius of the sun. Although it is not possible to determine the mean molecular weight accurately at present, results indicate this may be achieved with better observational equipment and with better model atmospheres for white dwarfs.

HONG-YEE CHIU, *Program Arranger*

Growth and Development of the Face, Teeth, and Jaws

The growth and development of the face, teeth, and jaws and future research in this field were the subjects of a four-session symposium sponsored jointly by the Dentistry Section (Nd) and the Section on Anthropology (H) at the annual meeting of the AAAS in Cleveland, Ohio (26–27 December).

Paul E. Boyle (chairman of Section Nd) opened the sessions and welcomed the audience. Albert A. Dahlberg (University of Chicago) emphasized the variations in types and sizes of dento-facial structures and noted the processes involved in evolutionary change. In a discussion on normal variations in dento-facial growth, Coenraad Moorrees (Forsyth Dental Center) stressed the importance of directing future research toward a better understanding of factors that contribute to individual differences (source of variants).

More emphasis than ever before was placed on the extent of genetical involvement in dental facial growth, and the discussions to a degree were far removed from conventional, historical analyses. Harold O. Goodman (Bowman Gray School of Medicine, Winston-Salem) carefully scrutinized the present literature and indicated that much past information on the inheritance of dental and facial parameters, and in particular, modes of inheritance of specific dental defects need more adequate testing, and in many cases,

confirmation. Uwe Stave (Fels Research Institute) detailed the interaction of genetic and environmental factors in dental and facial malformation, and noted the extent to which susceptibilities to environmental insults were, in part, genetically determined. Developmental defects with associated facial disturbances were discussed by Frederic N. Silverman (Children's Hospital Research Foundation, Cincinnati). He also presented an illustrated series of cases, including arrhinencephaly and trigonocephaly.

Discussions by M. Michael Cohen and R. A. Winer (Tufts), Tatsuo Fukahara (University of Chicago and Tokyo University School of Dentistry), and Robert J. Gorlin (University of Minnesota) indicated the increasing evidence for dental and facial defects in chromosomal abberations, deletions, reduplications, and translocations. In particular, Gorlin traced changes in palatal height and arch width from the (naploid) XO (Turner's syndrome), the XX, the XXX, the XXY, the XXXY, and so forth. Reacting as if a timing mechanism were involved, palatal height and arch breadth alter with the amount of X chromosomal material held in common. Fukahara noted the extent to which siblings of children afflicted with cleft palate were characterized by minor cephalo-facial disturbances; this fact is clearly suggestive of the carrier state and was originally suggested by Neel (Volume 1, Number 1, *American Journal of Human Genetics*). In this connection also, Daris R. Swindler and Harriet Ann McCoy (Medical College of South Carolina, Charleston) demonstrated that the type of polymorphism in tooth sequence existing in colony-reared rhesus monkeys was the same as that found in family studies of normal children from southwestern Ohio. From this and other observations it was suggested that primates as a group (specific primate species and sub-species) possess many genes in common that affect dental and facial development.

Discussions in the final session extended many of the ideas presented in previous sessions and also suggested new lines and directions of research. Panel members (Richard C. Greulich, University of California; Jerry D. Niswander, National Institute of Dental Research; Wilton M. Krogman, University of Pennsylvania; Edward E. Hunt, Jr., Harvard University; and Robert E. Moyers, University of Mich-

igan) generally agreed that there must be a critical reexamination of old and prevailing concepts; exploration of new concepts of control mechanisms of growth, with particular regard to aspects of canalization or buffering of growth; additional studies at the molecular level. Also emphasized was that advances in knowledge of malformations and normal growth, while dependent upon a better understanding of molecular genetics, can be furthered by explaining the complicated interactions between environmental agents and associated complex, multiple, hereditary factors. In addition, there is great need for further defining the factors with the capacity for controlling cell proliferation and differentiation.

Publication of the proceedings of this conference will be aided by a grant from the National Institutes of Dental Health and will be distributed as a special supplement to the *Journal of Dental Research*; it will include contributions from E. Holly Broadbent, Carl J. Witkop, and Seymour Kreshover. The arrangers for the overall program were Stanley M. Garn and Sholom Pearlman (American Dental Association) and the sponsors included the AAAS section on Anthropology (H), American Dental Association, International Association for Dental Research (North American Division), and the American College of Dentists.

SEYMOUR J. KRESHOVER, *Secretary*
STANLEY M. GARN, *Program Arranger*

Science Research Planning: Instruments and Equipment Use

The programs of the conference were jointly sponsored by the Office of Economic and Statistical Studies of the National Science Foundation and by the Industrial Science Section (P). The morning session was concerned with the role of instrumentation and equipment use in science research program planning; the afternoon session was more broadly oriented to the planning and management of science research programs.

The introductory paper by Zola Bronson (National Science Foundation) addressed itself to two major aspects of the role of instruments and equipment use in science research program planning—development of a preliminary estimate of present R&D dollar expenditures for instrumentation in

support of R&D programs and the nontechnical impacts of instrumentation on R&D planning and management, largely due to the cost, complexity, and associated characteristics of instrumentation. These impacts are seldom consciously recognized by R&D planners and managers.

For 1963, a variety of data resources cited suggests an expenditure on the order of $4- to $4.25-billion for instrumentation acquisition and use out of an estimated $16-billion R&D expenditure. This includes instruments themselves and all other devices, components, materials, and supplies which will help make up an operative instrument system, including electronic computers. Further, as the result of a variety of management policies and practices now operating in the R&D laboratory, an estimated total of $25- to $30-billion of instrumentation materials, based on original acquisition costs, may be on hand in the nation's laboratories despite noticeably low use level for much of the available instrumentation. Increased annual expenditures are anticipated so long as total R&D expenditures continue to rise. A leveling off of R&D expenditures, with an overall tightening of available funds, however, could be accomplished by a sharper drop in the level of instrumentation expenditures. Further, the normal tooling up characteristics of instrumentation and the existing excess capacity of many facilities could contribute to a reduced expenditure ratio in the future.

Preliminary studies show that freedom of research for both the researcher and management is impaired by the decision to exclude from formal consideration those research projects believed to involve significant expenditures for instrumentation or where ready access to instrumentation is uncertain. Although instrumentation of R&D, in the aggregate, may generate increased overall manpower requirements, intermediate phases of technological displacement and obsolescence of scientists, engineers, and technicians also exist; this situation is comparable to the impact of automation on the production work force. The low levels of instrumentation use in the laboratory, concurrent with the acquistion of additional units of identical or comparable R&D instrumentation resources, require re-examination by R&D planning and management. The urgency of this issue is underlined by the huge in-

ventory of instrumentation facilities now on hand in the nation's laboratories, the increasing concern about the rising cost of R&D, and the view that researchers need to be humored and allowed to be possessive about instrumentation supplied to them. The extent to which these conditions are a measure of R&D affluence and the American's proclivity for gadgets is also at issue.

Optimization of the promise of R&D instrumentation for catalyzing the researcher's creativity, as well as his productivity, is another planning and management responsibility. The hazards of producing overwhelming burdens of data, impeding research productivity, and drowning potential creativity in the absence of specially qualified supporting manpower to assure effective instrumentation utilization are included with a number of other nontechnical aspects of R&D instrumentation for which more thoughtful research program planning and management is required. Before more effective performance by the latter can be anticipated, however, better record-keeping on instrumentation acquisition costs, use levels, manpower impacts, and associated issues is essential.

Despite the significantly increased costs for certain categories of R&D instrumentation, Winston E. Kock (Benedix Corporation) expressed the view that without this instrumentation, costs of research would be even higher, if not completely unattainable. This relatively lower cost, of course, is due to the increased productivity attained and to this extent is bridging the manpower shortage gap. Unfortunately, the manpower shortages and limitations are so great that even more extensive development and use of newer and better instrumentation are essential. As a result of this inter-linkage, Kock is of the opinion that future research growth will become increasingly dependent upon more and better instrumentation; and significant incremental increases in creativity due to improved instrumentation are anticipated. The latter will be due to the resulting reduction in time required for investigations, permitting more ideas to be conceived and explored.

The pervasiveness of increasing complexity of instrumentation has not, however, entirely eliminated the beeswax and string scientist. The moral to be learned from the latter, according to Kock, is the beneficial ingenuity of

the experimental design which sparing access to instrumentation makes possible. Continued performance under these conditions often further enhances the researcher's ingenuity. Also, the unplanned and unmanaged use of extensive instrumentation impairs the development of the researcher's ingenuity and the law of experimental simplicity, thus making the experimentalist a less effective idea man.

Discussing instrumentation acquisition and use policies from an industry point of view, John Grebe (The Dow Chemical Company) expressed the opinion that broad policies for the acquisition and use of instrumentation in new laboratories today, as contrasted with 10 years ago, is roughly the same in all sectors. The differences are primarily in the replacement and rejuvenation policies. With reference to the expenditure requirements for laboratory instrumentation, Grebe pointed out that whereas in the process industries control instrumentation accounts for approximately 20 percent of the total capital expenditures, in the modern laboratory it is more nearly a 1 to 1 ratio. Large as this may seem, Grebe is of the opinion that it is small to those who know how much more could be accomplished if still further instrumentation is applied.

A significant difference in laboratory operations, particularly as regards instrumentation acquisition and use in government compared to industry, is attributed to antiquated government regulations and specifications which permit or encourage older methods to persist. Wherever government specifications are followed, one cannot help but recognize long lags between the initiation and standardization of technology. It becomes so difficult to make changes and corrections or to go to very new systems of detection or control. Comparable conditions were found in the universities, because of the difficulty of getting funds for new facilities. The resultant lag in the teaching of undergraduates of as much as 20 to 30 years, leaves an imprint on their mental attitude that is hard to erase when they get into positions of authority.

In the concluding paper, Otto Schmitt (University of Minnesota) observed that the insidious changes in the nature of R&D instrumentation during the past decade have left a national pattern of policies with respect to development of new instrumentation ac-

quisition and utilization that is at best a patchwork of well-intentioned efforts to stimulate the present rapid advance of science and at the same time to demonstrate concern with fiscal and scientific responsibility. A higher rate of scientific growth and productivity could be achieved at a lower cost in dollars, elapsed time, and frustration, if key policies are reframed to conform to the real human needs of the individuals and organizations involved. Policy changes to meet future instrumentation impacts include: (i) anticipating, at least in general outline, the way that instrumentation will go over the next few years and establishing a policy that will be appropriate when it goes into operation; (ii) developing inter-compatible instrumentation, because we cannot afford the engineering costs of a special instrumental development for each need; and (iii) modification of instrumentation acquisition policy to conform to the systems concept instead of its present focus on the instrument component.

Schmitt pleaded for as much managerial concern over the efficiency of idea production and use as is currently exhibited with regard to the more material and tangible inputs in research. Regarding the existing low use level of instrumentation, he proposed that idea-generating experimental scientists be pampered with instrumentation that will be used only occasionally and with personal and departmental computers that will be idle 80 to 90 percent of the time, as are their corresponding personal and departmental libraries and shops. Investment in additional instrumentation available to a smaller, select group of experimental scientists is considered likely to be more productive of useful ideas than more staff employed at the expense of instrumentation acquisition. The large inventory and existing high levels of fund expenditures for R&D instrumentation is believed to be due at least in part to two operating policies. First is the ever-recurring complaint over the length of time required to negotiate approval of proposed instrumentation purchase and the consequent practice of acquiring devices before actually needed or before the specific capabilities have been adequately identified. Second is the hesitancy on the part of federal agencies particularly, to reclaim semi-obsolescent instruments, especially if the ill will of an investigator may be incurred in the process. Conversely, the

experimental investigator encounters endless difficulty in trying to dispose of unneeded instruments. J. F. Reintjes (M.I.T.) served as chairman.

The papers presented at the session on the planning and management of science research programs, consisting of two each from the respective sectors of government, industry, and the university, were concerned with the factors affecting the optimum utilization of human and material resources in the performance of science research. Despite the different orientation of the respective sectors, the papers demonstrated an underlying identity of responsibility for basic issues. Perhaps most significant, however, were the contrasting policies and practices with regard to the basic issues, as expressed by the representatives from the same sector. These differing viewpoints underscore the importance of recognizing that in the non-technical areas of science research planning and management, identical issues may be subject to equally satisfactory solution in more than one way. The critical consideration is that any proposed guiding policy or operating procedure be based on an accurate identification of the essential elements in the issue to be resolved.

Ralph A. Sawyer (University of Michigan) viewed the campus research administrator's basic responsibility as one of helping establish policies concerning research, monitoring research to assure conformance with policy, and providing support services to research directors. Project research justification, planning, staffing, and management are viewed as concerns and responsibilities of the research sponsor and the officers and committees that guide the programs of the various university departments.

In the paper prepared by John R. Dunning (Columbia University), and read in his absence by Lawrence H. O'Neill, the university was called upon to accept responsibility and leadership in dropping the false dichotomy between the teaching and research functions. This dichotomy is charged with serving as an excuse for avoiding the big and speculative research in favor of cautious projects more certain to result in publications. The latter does not have the boldness of conception expected in the free environment of the universities.

Erwin G. Somogyi (Somogyi Associates), representing industry, identified the rapidly changing research picture

as the cause of the difficulties in increasing the yield from the present industrial research effort. To resolve this condition. Somagyi emphasized the need to base the management approach, at least in part, on unchanging factors. These are the human aspects which involve a process of motivation and consist of three major steps: (i) Setting goals and standards, (ii) management and evaluation of performance, and (iii) response to the performer.

William B. Reynolds (General Mills) emphasized the profit requirement as the dominant concern of the industrial sector in R&D. Accordingly, industrial research planning and management must give priority consideration to product marketing factors. Further, consumer-oriented research involves factors of corporate relations not usually involved in process research or in the development of industrial end items. This necessitates a finely balanced cooperation between research and marketing management, since both are responsible for the ultimate success of the research effort. The research administrator in this industry group must organize the research functions so that product concepts flow from technology itself, requiring the creation of an environment in the research organization where all echelons are highly motivated to product innovation.

In discussing the planning and management of research from the viewpoint of the government sector, Nicholas E. Golovin (Office of the Science Advisor to the President) focused his attention on basic research. He believes that pressures for the detailed planning of research will continue despite the fact that basic research particularly, does not readily lend itself to conventional planning techniques, except in very transient and trivial ways. At the same time, the researcher, as a matter of self interest, needs to facilitate a broad understanding of the nature and methods of science and technology and their roles in society. Golovin suggests emphasis on procedures which will produce coordination and integration before agency plans and budgets are formulated, depending on systematic and detailed information exchanges between agencies having R&D efforts in the same or related fields. Making government employment more attractive for outstanding scientists and engineers will help reduce existing obstacles to "coordination." Additionally the availability of scientists and engi-

neers within the legislative and executive branches of government would facilitate the optimum exploitation of science and technology for social progress. A first and major step towards significant progress to the problem of coordinating R&D at the national level was described as the abandonment of the futile search for general solutions and the substitution of gradual, gently directed evolutionary efforts.

In the concluding paper, T. C. Byerly (U.S. Department of Agriculture) observed that the purpose of science administration and management in the executive agencies is to maximize the quantity, relevance, and rate of research productivity of federal funds appropriated for research. Further, because the faith of American scientists in research management is thin, they subscribe to the proposition that all management and administration are nuisances. Tradition, however, has always required that the science manager be a scientist, and this raises the question whether this is the best use of the scientist's time. Byerly questions whether "amateurs in management," (for example, scientists turned managers) provide sounder judgments than professionals in management. Likewise, he is uncertain that the use of panels of scientists meets the existing needs and he wonders about the number of scientists who now serve on panels to review project proposals. The latter raises the further question of whether the advisory service of the panel members is more valuable than what they would accomplish with the same hours in actual research in their own laboratories. In this regard and related matters, Byerly questioned the validity of the manpower shortage appraisals.

In conclusion, Byerly noted that research management is necessary to maintain quantity, relevance, and rate of research productivity. Government research laboratories should operate either in conjunction with universities or be of sufficient size to assure continuing communication with the scientific community on a reciprocal basis. Freedom of research choice varies more within universities, industry, and government than it does among these three groups. Non-scientist administrators have difficulty gaining the cooperation of research personnel largely due to communication failure and prejudice on both sides. Jacob Perlman (National Science Foundation) served as chairman.

ZOLA BRONSON, *Program Arranger*

Forthcoming Events

February

26–28. **Biophysical** Soc., Chicago, Ill. (W. Sleator, Jr., Washington Univ. Medical School, 660 Kingshighway, St. Louis 10, Mo.)

26–28. **Scintillation and Semiconductor** symp., Washington, D.C. (G. A. Morton, RCA Laboratories, Princeton, N.J.)

27–28. Cellular Basis for the Action of **Cardiac Drugs**, Philadelphia, Pa. (Heart Assoc. of Southeastern Pa., 318 S. 19 St., Philadelphia 3)

27–28. National Assoc. for **Mental Health**, annual conf., London, England. (General Secty., 39 Queen Anne St., London, W.C.1)

27–29. American Acad. of **Forensic Sciences**, Chicago, Ill. (W. J. R. Camp, 1853 W. Polk St., Chicago 12)

27–29. American **Physical** Soc., Tucson, Ariz. (K. K. Darrow, American Physical Soc., Columbia Univ., New York, N.Y.)

March

1–4. Canadian Assoc. of **Radiologists**, annual, Vancouver, B.C. (A. I. Ekstrand, 1555 Summerhill Ave., Montreal 25, P.Q., Canada)

2–4. Fundamental **Cancer Research**, 18th annual symp., Houston, Tex. (R. J. Shalek, Dept. of Physics, Univ. of Texas, Houston)

2–6. **Analytical Chemistry** and Applied Spectroscopy, Pittsburgh, Pa. (R. B. Fricioni, Allegheny Ludlum Steel Corp., Research Center, Brackenridge, Pa.)

2–6. Applied **Meteorology**, 5th conf., American Meteorological Soc., Atlantic City, N.J. (A. Hilsenrod, Federal Aviation Agency, Atlantic City)

3–7. Inter-American **Nuclear Energy** Commission, 5th, Valparaiso, Chile.) Pan American Union, Constitution Ave., NW, Washington, D.C. 20006)

3–21. World **Health** Assembly, 17th annual, Geneva, Switzerland. (WHO, Palais des Nations, Geneva)

4–6. **Thermal Radiation** of Solids. symp., San Francisco, Calif. (W. D. Harris, Engineering and Sciences Extension, Univ. of California, Berkeley 4)

4–7. **Psychoanalysis**, first Pan-American congr., Mexico City, Mexico. (The Congress, Insurgentes 421 "C"-108, Mexico 11, D.F.)

5–6. Theoretical and Applied **Mechanics**, southeastern meeting, Atlanta, Ga. (Dept. of Short Courses and Conferences, Georgia Inst. of Technology, Atlanta 30332)

5–7. Evaluation and Mechanisms of **Drug Toxicity**, conf., New York, N.Y. (New York Acad. of Sciences, 2 E. 63 St., New York 21)

5–7. **Macromolecular** Colloquium, Freiburg im Breisgau, Germany. (Institut für Makromolekulare Chemie, Univ. Freiburg, Stefan-Meier-Str. 31, 78 Freiburg im Breisgau)

5–7. Pacific **Sociological** Assoc., Coronado, Calif. (S. M. Dornbusch, Stanford Univ., Stanford, Calif.)

6–8. Society of **Nuclear Medicine**, southwestern chapter, Houston, Tex. (S. N. Turiel, SNM, 333 North Michigan Ave., Chicago 1, Ill.)

6–8. National **Wildlife** Federation, 28th annual, Las Vegas, Nev. (NWF, 1412 16th St., NW, Washington, D.C. 20036)

7–12. **Proctology**, 16th teaching seminar, Miami Beach, Fla. (J. Reichert, 147-41 Sanford Ave., Flushing, N.Y. 11355)

8–12. **Water Resources** Engineering, conf., Mobile, Ala. (American Soc. of Civil Engineers, 345 E. 47 St., New York 10017)

8–15. North American **Clinical Dermatologic Soc.**, Mexico City, Mexico. (E. F. Finnerty, 510 Commonwealth Ave., Boston, Mass.)

9–10. **Aerodynamic Testing** Conf., American Inst. of Aeronautics and Astronautics, Washington, D.C. (J. N. Fresh, David Taylor Model Basin, Code 630, U.S. Navy, Washington, D.C.)

9–11. **Computers in Education**, conf., Eugene, Ore. (J. W. Loughary, School of Education, Univ. of Oregon, Eugene)

9–11. North American **Wildlife and Natural Resources** conf., Las Vegas, Nev. (Wildlife Management Inst., 709 Wire Bldg., Washington 5)

9–11. Society of **Toxicology**, annual, Williamsburg, Va. (C. S. Weil, Mellon Inst., 4400 Fifth Ave., Pittsburgh, Pa. 15213)

9–13. National Assoc. of **Corrosion Engineers**, 20th conf., Chicago, Ill. (W. H. Schultz, Dearborn Chemical Corp., Chicago, Ill.)

9–13. Peaceful Applications of **Nuclear Energy**, 5th inter-American symp., Valparaiso, Chile. (J. D. Perkinson, Inter-American Nuclear Energy Commission, Pan American Union, Washington, D.C.)

10. **Wildlife Telemetry**, annual, Las Vegas, Nev. (L. Adams, Univ. of California, Carmel Valley)

10–12. **Exploding Conductor** Phenomena, 3rd conf., Boston, Mass. (W. G. Chace, Air Force Cambridge Research Laboratories, Hanscom Field, Bedford, Mass.)

10–13. **Raman** Colloquium, Freudenstadt/Schwarzwald, Germany. (J. Gobeau, Dept. of Chemistry, Technische Hochschule Stuttgart, 7 Stuttgart, Germany)

10–14. American Inst. of **Chemical Engineers**, New Orleans, La. (AIChE, 345 E. 47 St., New York 17)

11–12. Instrument Soc. of America, 14th conf. on **instrumentation** for the iron and steel industry, Pittsburgh, Pa. (N. F. Simcic, Research Laboratory, Jones and Laughlin Steel Corp., 900 Agnew Rd., Pittsburgh 30)

12. **Interplanetary Monitoring Platform** Experiments, symp., Greenbelt, Md. (C. P. Boyle, Code 207, Goddard Space Flight Center, Greenbelt, Md. 20771)

12–13. **Information** Organization, New Brunswick, N.J. (S. Artandi, Graduate School of Library Service, Rutgers Univ., New Brunswick)

13–14. **Louisiana Acad.** of Sciences, Baton Rouge. (H. J. Bennett, Dept. of Zoology, Louisiana State Univ., Baton Rouge)

13–14. Institute of **Management** Sciences. 11th intern., Pittsburgh, Pa. (IMS, Box 273, Pleasantville, N.Y.)

13–14. Effects of **Shock and Vibration** on the human body, Denver, Colo. (A. E. Paige, Dept. of Electrical Engineering, University of Denver, Denver)

14–15. **Endocrinology**, 2nd annual symp., Salisbury, N.C. (H. Nushan, Medical Service, Veterans Administration Hospital, Salisbury)

14–19. American Assoc. of **Psychiatric Clinics for Children**, annual, Chicago, Ill. (AAPCC, 250 W. 57 St., New York 19)

15–19. **Microcirculation**, 3rd European conf., Jerusalem, Israel. (E. Davis, Capillary Research Laboratory, Hadassah Univ. Hospital, P.O. Box 499, Jerusalem)

15–21. American Soc. of **Photogrammetry**, congr. on surveying and mapping. Washington, D.C. (American Soc. of Photogrammetry, 44 Leesburg Pike, Falls Church, Va.)

17–18. **Hypervelocity Flight** Techniques, symp., Denver, Colo. (W. G. Howell Denver Research Inst., Univ. of Denver, Denver, Colo. 80210)

17–19. Society for **Nondestructive Testing**, Los Angeles, Calif. (D. E. O'Halloran, Northrop Corp., 1001 E. Broadway, Hawthorne, Calif.)

17–19. Statistical Assoc. Methods for **Mechanized Documentation**, symp., Washington, D.C. (M. E. Stevens, Natl. Bureau of Standards, Washington, D.C. 20234)

17–20. Society of **Biological Chemistry**, Paris, France. (P. Malangeau, Executive Committee, 4, Avenue de l'Observatoire, Paris 6°)

18–19. **Mycotoxins in Foodstuffs**, intern. symp., Cambridge, Mass. (G. N. Wogan, Rm 16-210-B, Massachusetts Inst. of Technology, Cambridge 02139)

18–20. **Chemurgic Council**, 28th natl. conf., Philadelphia, Pa. (J. W. Ticknor, Chemurgic Council, 350 Fifth Ave., New York 1)

18–21. Latin **Medical** Union, intern. congr., Rome, Italy. (B. Urso, Policlinico Umberto I, Viale Policlinico, Rome)

18–21. American **Orthopsychiatric** Assoc., Chicago, Ill. (M. F. Langer, 1790 Broadway, New York 19)

20–24. National Assoc. for **Research in Science Teaching**, Chicago, Ill. (G. G. Mallinson, Western Michigan Univ., Kalamazoo)

20–24. National **Science Teachers** Assoc., Chicago, Ill. (R. H. Carleton, 1201 16th St., NW, Washington, D.C.)

21–3. British **Computer** Soc., conf., Edinburgh, Scotland. (Secretariat, I.E.E., Savoy Pl., London, W.C.2, England)

21–23. Asian-Pacific **Dental** Federation, 4th congr., Singapore and Malaya. (B. B. Eraña, Manila Doctors Hospital, Isaac Peral St., P.O. Box 373, Manila, Philippines)

21–24. **Cybernetic Medicine**, 3rd intern. congr., Naples, Italy. (A. DeChiara, 348, Via Roma, Naples)

22–25. American Assoc. of **Dental Schools**, 41st annual, Los Angeles, Calif. (AADS, 840 Lake Shore Dr., Chicago 11, Ill.)

23–24. Society for **Economic Botany**, 5th annual, Chapel Hill, N.C. (D. J. Rogers, New York Botanical Garden, Bronx Park, N.Y.)

23–25. Federation of European **Biochemical** Societies, 1st, London, England.

(FEBS, Lister Inst., Chelsea Bridge Rd., London, S.W.1)

23–26. Institute of **Electrical and Electronics Engineers**, intern. conv., New York, N.Y. (IEEE, Box A, Lenox Hill Station, New York 21)

23–26. **Gas Chromatography**, 2nd intern. symp., Houston, Tex. (A. Zlatkis, Dept. of Chemistry, Univ. of Houston, Houston)

23–26. American **Physical** Soc., Philadelphia, Pa. (K. K. Darrow, Columbia Univ., New York 27)

24–26. Physics and Dynamics of **Clouds**, conf., American Meteorological Soc., Chicago, Ill. (Miss D. L. Bradbury, Dept. of Geophysical Sciences, Univ. of Chicago, Chicago)

25–27. **Aerospace Bearings**, USAF-Southwest Research Inst. conf., unclassified, San Antonio, Tex. (P. M. Ku, SwRI, 8500 Culebra Rd., San Antonio)

25–27. **Entomological** Soc. of America, Northcentral branch, Omaha, Neb. (G. E. Guyer, Dept. of Entomology, Michigan State Univ., East Lansing)

26–28. **Michigan Acad.** of Science, Arts and Letters, East Lansing (G. G. Mallinson, Western Michigan Univ., Kalamazoo)

26–28. Southern Soc. for **Philosophy and Psychology**, 56th annual, Lexington, Ky. (D. Calvin, Psychology Dept., Univ. of Kentucky, Lexington)

26–29. International Assoc. for **Dental Research**, 42nd, Los Angeles, Calif. (J. C. Muhler, 1120 W. Michigan St., Indianapolis, Ind. 46202)

27–28. American **Ethnological** Soc., Pittsburgh, Pa., (N. F. S. Woodbury, U.S. National Museum, Smithsonian Institution, Washington, D.C.)

27–28. **Seismological** Soc. of America, annual, Seattle, Wash. (K. V. Steinbrugge, SSA, 465 California St., San Francisco 4, Calif.)

27–29. Society for the Study of **Evolution**, annual, Chapel Hill, N.C. (H. H. Ross, Illinois Natural History Survey, Urbana)

28–30. American Assoc. of Colleges of **Pharmacy**, Detroit, Mich. (C. W. Bliven, 1507 M St., NW, Washington, D.C. 20005)

29–2. Association of American **Geographers**, annual, Syracuse, N.Y. (AAG 1201 16th St., NW, Washington, D.C.)

30–2. American Assoc. of **Junior Colleges**, Bal Harbour, Fla. (W. G. Shannon, AAJC, 1777 Massachusetts Ave., NW, Washington, D.C. 20036)

31–3. American Assoc. of **Anatomists**, Denver, Colo. (L. B. Flexner, Dept. of Anatomy, Univ. of Pennsylvania, Philadelphia 4)

31–3. **Calcified Tissues**, European symp., Liége, Belgium. (L. J. Richelle, 32, Boulevard de la Constitution, Liége)

April

1. **Thermoplastic Materials**, conf., Soc. of Plastics Engineers, Akron, Ohio. (W. H. Nicol, RETEC, Goodyear Tire and Rubber Co., Akron 16)

1–2. **Engineering Aspects of Magnetohydrodynamics**, symp., Cambridge, Mass. (G. S. Janes, Avco Everett Research Laboratories, Everett 49, Mass.)

1–2. Methods for Measurement of **Weak Beta-Emitters**, Karlsruhe-Leopoldshaven, Germany. (Gesellschaft Deutscher Chimiker, Gesellschaftsstelle, Postfach 9075, Frankfurt/Main, Germany)

1–3. **Structures and Materials**, American Inst. of Aeronautics and Astronautics, 5th annual conf., Palm Springs, Calif. (R. R. Dexter, AIAA, 2 E. 64 St., New York, N.Y.)

1–3. **Optical** Soc. of America, spring meeting, Washington, D.C. (M. E. Warga, OSA, 1155 16th St., NW, Washington, D.C. 20036)

1–4. National Soc. for **Programmed Instruction**, annual, San Antonio, Tex. (NSPI Program Committee, Trinity Univ., 715 Stadium Dr., San Antonio, Tex.)

1–5. Latin **Oto-Rhino-Laryngology** Soc., 15th congr., Bologna, Italy. (G. Motta, Via Modica 6, Milan, Italy)

2–3. American Soc. of **Civil Engineers**, Engineering Mechanics Div., spring conf., Boston, Mass. (ASCE, 33 W. 39 St., New York 18)

2–3. Alexander Graham Bell Assoc. for the **Deaf**, southeastern meeting, New Orleans, La. (R. Tegeder, Utah School for the Deaf, 846 20th St., Ogden)

2–3. **Obstetrics and Gynecology**, seminar, Gainesville, Fla. (Mrs. D. Miller, Div. of Postgraduate Education, College of Medicine, Univ. of Florida, Gainesville)

2–3. Industrial Applications of New **Technology**, conf., Atlanta, Ga. (Director, Short Courses and Conferences, Georgia Inst. of Technology, Atlanta, Ga. 30332)

2–4. American Acad. of **Oral Pathology**, Bethesda, Md. (R. J. Gorlin, Univ. of Minnesota, Minneapolis)

2–4. Association of **Surgeons** of Great Britain and Ireland, annual, St. Andrews, Scotland (Secretariat, 47 Lincoln's Inn Fields, London, W.C.2, England)

2–5. British **Medical** Assoc., clinical meeting, Northampton, England. (D. Gullick, Tavistock Sq., London, W.C.1)

3–4. **Biology** colloquium, Corvallis, Ore. (C. M. Gilmour, School of Science, Oregon State Univ., Corvallis)

3–4. Society for **Industrial and Applied Mathematics**, midwest regional meeting, Cedar Rapids, Iowa. (W. J. Jameson, Collins Radio Co., 120–11, Cedar Rapids 52402)

3–5. **Fleming's Lysozyme**, 3rd intern. symp., Milan, Italy. (G. Podio, Museo della Scienza e della Tecnica, Via Modica, 6, Milan)

3–5. American Soc. of **Internal Medicine**, annual, Atlantic City, N.J. (A. V. Whitehall, 3410 Geary Blvd., San Francisco, Calif.)

3–5. American Assoc. of **Pathologists and Bacteriologists**, annual, Chicago, Ill. (E. A. Gall, Dept. of Pathology, Cincinnati General Hospital, Cincinnati 29, Ohio)

4. Arizona Acad. of Science, Tempe. (H. B. Whitehurst, Dept. of Chemistry, Arizona State Univ., Tempe)

4–5. American **Psychosomatic** Soc., San Francisco, Calif. (C. Binger, 265 Nassau Rd., Roosevelt, N.Y.)

4–6. **Neurobiology**, 2nd symp. (by invitation), Phoenix, Ariz. (E. Eidelberg, Barrow Neurological Inst., St. Joseph's Hospital, 350 W. Thomas Rd., Phoenix)

5–8. International Acad. of **Pathology**,

annual, Chicago, Ill. (F. K. Mostofi, Armed Forces Inst. of Pathology, Washington, D.C. 20012)

5–10. American **Chemical Soc.**, 147th natl., Philadelphia, Pa. (A. T. Winstead, 1155 16th St. NW, Washington, D.C.)

5–10. Asia-Pacific Acad. of **Opthalmology**, 2nd congr., Melbourne, Australia. (R. N. Mellor, 82 Collins St., Melbourne C1)

6–8. **Nonlinear Magnetics** Conf., Washington, D.C. (R. C. Barker, Dept. of Engineering and Applied Science, Yale Univ., New Haven, Conn.)

6–8. Association of Schools of **Public Health**, annual, Toronto, Ont., Canada. (R. E. Coker, Jr., Drawer 229, Chapel Hill, N.C. 27515)

6–9. French Soc. of **Biological Chemistry**, 50th, Paris. (P. Malangeau, 4 Avenue de l'Observatoire, Paris 6°)

7–9. **Atomic Energy** Soc. of Japan, Tokyo. (Atomic Energy Research Inst., 1-1, Shiba-tamura-cho, Minato-ku, Tokyo)

7–9. **Chemical Soc.**, Birmingham, England. (General Secretary, Burlington House, London, W.1, England)

7–11. Applied **Mathematics and Mechanics**, Giessen, Germany, (K. Maruhn, Mathematisches Institut, Justus Liebig Univ., Giessen)

8–10. **Textile Research** Inst., 34th, New York, N.Y. (TRI, Princeton, N.J.)

9. **British Cardiac** Soc., annual, London, England. (J. Shillingford, Postgraduate Medical School, Ducane Rd., London, W. 12)

9–11. American Assoc. for **Cancer Research**, annual, Chicago, Ill. (H. J. Creech, AACR, Institute for Cancer Research, Fox Chase, Philadelphia 11, Pa.)

9–11. Association of **Clinical Pathologists**, spring meeting, London, England. (G. Cunningham, Dept. of Pathology, 47 Lincoln's Inn Fields, London, W.C.2)

9–11. **Geological** Soc. of America, southeastern section, Baton Rouge, La. (R. J. Martin, 1426 Harvard Rd., NE, Atlanta, Ga.)

9–11. Southwestern **Psychological** Assoc., annual, San Antonio, Tex. (C. C. Cleland, 2104 Meadowbrook Dr., Austin, Tex. 78703)

9–13. **Roentgen** Congr., German, Wiesbaden, Germany. (H. Lossen, Deutscher Röntgenkongress, Fichterplatz 20 III, Mainz, Germany)

10. **Natural Phenolic Compounds**, symp., Tokyo, Japan. (M. Shimokoriyama, Dept. of Botany, Univ. of Tokyo, Hongo, Tokyo)

10–11. American **Laryngological** Assoc., San Francisco, Calif. (L. G. Richards, 12 Clovelly Rd., Wellesley Hills 82, Mass.)

10–11. Association of **Physicians** of Great Britain and Ireland, annual, Oxford, England. (G. de J. Lee, Dept. of Medicine, Radcliffe Infirmary, Oxford)

11. **Paleontological Research** Inst., Ithaca, N.Y. (R. S. Harris, 109 Dearborn Place, Ithaca)

11–12. **Histochemical Soc.**, 15th annual, Chicago, Ill. (A. D. Deitch, Dept. of Microbiology, Columbia Univ., 630 W. 168 St., New York 32)

12. **Industrial Fibers**, European inst., Milan, Italy. (F. Tommy-Martin, 40 rue du Stand, Geneva, Switzerland)

12–13. American Soc. for **Artificial Internal Organs**, Chicago, Ill. (B. K. Kus-

serow, Dept. of Pathology, Univ. of Vermont College of Medicine, Burlington)

12–17. Federation of American Societies for **Experimental Biology**, Chicago, Ill. (H. B. Lemp, The Federation, 9650 Wisconsin Ave., NW, Washington, D.C. 20014)

12–17. Society of **Motion Picture and Television Engineers**, semiannual technical conf., Los Angeles, Calif. (J. M. Waner, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.)

12–18. Chemistry of **Natural Products**, intern. symp., Kyoto, Japan. (Science Council of Japan, Ueno Park, Tokyo, Japan)

13–15. Institute of **Environmental Sciences**, annual, Philadelphia, Pa. (J. Breen, RCA Bldg., 10-1-2, Camden 2, N.J.)

13–15. **Microelectronics**, 3rd annual symp., St. Louis, Mo. (T. F. Murtha, P.O. Box 4104, St. Louis, Mo. 63136)

13–16. American Acad. of **General Practice**, Atlantic City, N.J. (M. F. Cahal, Volker Blvd. at Brookside, Kansas City 12, Mo.)

13–16. **Industrial Health**, conf., Pittsburgh, Pa. (American Industrial Health Conf., 55 E. Washington St., Chicago, Ill. 60602)

13–16. **Industrial Medical** Assoc. and American Assoc. of **Industrial Nurses**, Pittsburgh, Pa. (C. D. Bridges, 55 E. Washington St., Chicago, Ill. 60602)

13–16. American **Radium** Soc., White Sulphur Springs, W. Va. (J. J. Stein, U.C.L.A. Medical Center, Los Angeles 24, Calif.)

13–17. **Fluid Power**, intern. conf. and exhibition, London, England. (Secretary of the Conference, The Tower, 229-243 Shepherds Bush Rd., Hammersmith, London, W.6)

14–16. **Power** Conf., Chicago, Ill. (W. A. Lewis, Illinois Inst. of Technology, Chicago)

14–18. Primary Disorders of **Heart Muscle** (by invitation), CIBA Foundation symp., London, England (CIBA, 41 Portland Pl., London, W.1)

14–18. **Mathematical Logic**, conf., Oberwolfach, Germany. (M. Barner, Mathematisches Forschungs-institut, Hebelstr. 29, 78 Freiburg im Breisgau, Germany)

15–17. **High Energy Physics**, conf., Chilton, England. (Inst. of Physics and the Physical Soc., 47 Belgrave Sq., London S.W.1, England)

15–17. **Ophthalmological** Soc. of the United Kingdom, annual, Dublin, Ireland. (Secretariat, 47 Lincoln's Inn Fields, London, W.C.2, England)

15–18. British **Paediatric** Assoc., annual, Scarborough, England. (E. W. Hart, Inst. of Child Health, Hospital for Sick Children, Great Ormond St., London, W.C.1)

15–18. American Soc. for **Public Administration**, natl. conf., New York, N.Y. (ASPA, 6042 Kimbark Ave., Chicago, Ill. 60637)

16–17. **Fiber Soc.**, spring meeting, Charlotte, N.C. (I. Rebenfeld, P.O. Box 625, Princeton, N.J.)

16–17. **Textile** Inst., annual conf., Leeds, England (D. B. Moore, 10 Blackfriars St., Manchester 3, England)

16–18. Eastern **Psychological** Assoc., Philadelphia, Pa. (M. A. Iverson, Queens College, Flushing 67, N.Y.)

16–18. Teaching of **Foreign Languages**, 1964 northeastern conf., Washington, D.C. (S. Isaacs, 1110 Patterson Plank Rd., North Bergen, N.J.)

16–18. Western **Psychological** Assoc., annual, Portland, Ore. (J. Matarazzo, Univ. of Oregon Medical School, Portland)

16–19. Cooper **Ornithological** Soc., annual, San Diego, Calif. (C. V. Duff, 2911 Antelo View Dr., Los Angeles 24, Calif.)

17–18. **Arkansas Acad. of Science**, Conway. (R. R. Corey, Dept. of Botany and Bacteriology, Univ. of Arkansas, Fayetteville)

17–18. **Iowa Acad. of Science**, Decorah. (D. C. Foley, Iowa State Univ., Ames)

17–18. **Resonance Physics**, New York State section, American Physical Soc., Corning, N.Y. (J. T. Kerr, Corning Glass Works, Corning)

17–19. Association of Southeastern **Biologists**, 25th annual, Atlanta, Ga. (W. D. Burbanck, Dept. of Biology, Emory Univ., Atlanta)

18–23. American **Ceramic** Soc., 66th annual, Chicago, Ill. (ACeS, 4055 N. High St., Columbus 14, Ohio)

19–21. **Radioisotope** Conf., 2nd annual, Gatlinburg, Tenn. (R. T. Overman, Special Traning Div., Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.)

19–22. American **Oil Chemists'** Soc., 55th spring meeting, New Orleans, La. (AOCS, 35 E. Wacker Dr., Chicago 1, Ill.)

19–24. **Measurements and Instruments**, intern. conf., Stockholm, Sweden. (G. Ljungberg, Royal Swedish Acad. of Engineering Science, Stockholm)

19–25. **Aerospace Electrotechnology**, intern. conf., Phoenix, Ariz. (A. A. Sorensen, Mail 3016, The Martin Co., Baltimore 3, Md.)

20–23. American **Mathematical** Soc., New York, N.Y. (G. L. Walker AMS, 190 Hope St., Providence, R.I.)

20–24. **Medical Radioisotope Scanning**, symp., Athens, Greece. (E. H. Belcher, Div. of Isotopes, IAEA, Kärntnerring 11, Vienna 1, Austria)

20–24. **Research Administration** Inst., American Univ., Washington, D.C. (American Univ. 1901 F St. NW, Washington 6, D.C.)

20–24. Fluid Dynamic Aspects of **Space Flight**, Marseilles, France. (Fluid Dynamics Panel, NATO, 64, rue de Varenne, Paris 7°, France)

20–24. American Soc. of **Tool and Manufacturing Engineers**, annual, Detroit, Mich. (L. S. Fletcher, ASTME, 10700 Puritan Ave., Detroit 38)

20–25. American Acad. of **Neurology**, 16th annual, Denver, Colo. (AAN, 4307 E. 50 St., Minneapolis 17, Minn.)

21. Association for **Symbolic Logic**, New York, N.Y. (Mrs. R. Drew-Bear, Special Projects Dept., American Mathematical Soc., 190 Hope St., Providence, R.I.)

21–23. Joint **Computer** conf., Washington, D.C. (C. S. Jones, 8227 Woodmont Ave., Bethesda 14, Md.)

21–23. **Engineering with Nuclear Explosives**, 3rd "Plowshare" symp., Davis, Calif. (Plowshare Symp. Committee, Lawrence Radiation Laboratory, Bldg.