# SCIENCE

6 March 1959

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# Letters

## Protein Behavior

In a recent article [*Science* **128**, 815 (1958)], I. M. Klotz admirably points up the fact that electrostatic interactions involving proteins and small ions have generally had to be treated in an oversimplified way, and he calls attention to the many observations which would suggest that the properties of the water in the immediate vicinity of the protein molecule may be rather different from those of the water in the bulk solvent. His proposal regarding the effect of an ice structure would explain the greater difficulty of protonation of an $—N(CH_3)_2$ group but, it appears, would still not solve the problem of reduced reactivity of the —SH group with $Ag^+$, with which he initiated the discussion. In this case, of course, there would be no change in the charge to modify the structure of the ice lattice.

The proposal seems even more troublesome when one considers the —COOH groups in the protein. In this case a charge appears on the group when the hydrogen ion is lost. Consequently, the loss of the proton would be hindered, and the apparent $pK$ should be increased as compared with the expected intrinsic $pK$. There seems to be little evidence for any considerable number of —COOH groups with unexpectedly high $pK$'s in proteins.

The lack of any evidence for electrostatic effects on the titration curve of the azomercurial would still be disturbing, however—unless one assumes that the reaction with hydrogen ion is leading to displacement of the azomercurial. If this were true, there would be no change in the charge, and one would not anticipate an electrostatic effect. Such a displacement of methylmercury would have been anticipated on the basis of the results of Hughes [*Cold Spring Harbor Symposia Quant. Biol.* **14**, 79 (1949)].

JOHN W. MEHL
*University of Southern California, Los Angeles*

Each of the three paragraphs of Mehl's letter raises essentially one question. The responses may be grouped, therefore, into the same arrangement.

1) "Maskedness" in the behavior of —SH groups, as Mehl would undoubtedly agree, is a problem of rates rather than equilibria. For example, $Ag^+$ is usually taken up even by masked —SH groups of proteins if we wait long enough. In terms of my model, the explanation (clearly implied if not explicitly stated in the article) is that $Ag^+$ would diffuse through "ice" much more slowly than through liquid water. While no actual data are available for diffusion of $Ag^+$ in ice, measurements with a similar monovalent ion, $Li^+$ [M. Eigen and L. DeMaeyer, *Proc. Roy. Soc.* (*London*) **247A**, 505 (1958)], certainly bear this point out.

2) The most careful theoretical analyses of the titration curves of a protein with, for example, 100 carboxyl groups have limited themselves to a single intrinsic dissociation constant. The spread of the titration curves has been accounted for by the assumption that there is a variable electrostatic factor, plus necessary additional assumptions in specific cases. Clearly, if deviations from ideality are attributed to these additional factors, and if we permit the possibility of only a single intrinsic constant, we cannot possibly find more than one intrinsic constant. As I have emphasized, however, the titration curves can also be accounted for by the assumption that there is a broad spectrum of $pK$'s for the carboxyl groups.

3) The explanation suggested by Mehl is not really tenable. We have not studied the titration curve by some general method which follows gross $H^+$ ion uptake but rather by a special spectrophotometric method which reveals specifically the uptake of $H^+$ by the $(CH_3)_2N—$ group of the dye, not by the mercaptide group of the protein. It is the unusual $pK$ and the unexpected shape of the curve for the optical titration of this particular $(CH_3)_2N—$ group which must be interpreted; a displacement mechanism postulates changes in state of a different group at the opposite end of the molecule. Furthermore, one should also recall that if the dye had been displaced from the mercaptide linkage, no optical titration could have been obtained in the first place, for as we have mentioned previously [*Arch. Biochem. Biophys.* **63**, 77 (1956)], the dye is essentially insoluble in water alone.

I. M. KLOTZ
*Northwestern University, Evanston, Illinois*

## On Eschewing Teleology

A. J. Bernatowicz' stern admonitions [*Science* **128**, 1402 (1958)] to his biological colleagues and to all other scientists to eschew anthropomorphism and avoid even the appearance of teleological thinking (lest their students be not saved from corruption) confuses me. He wants mechanism, and thus also surely determinism, recognized as the language of science, and he wants the teacher of science not to depart from it. Does he mean *never*? Not with the student at the luncheon table? Not with his wife at the breakfast table? How rigorously must righteousness be applied? And must all scientists observe the canon? I think

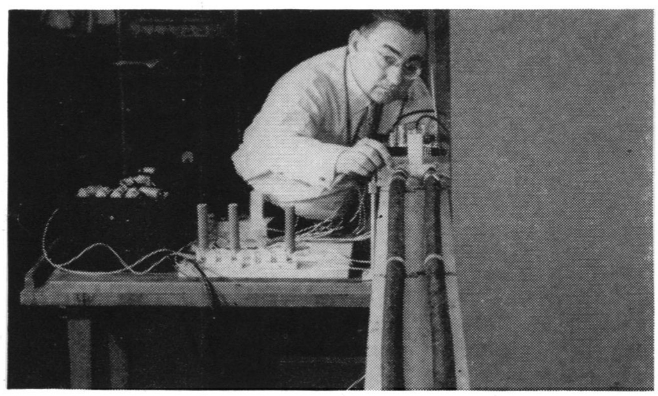
# THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

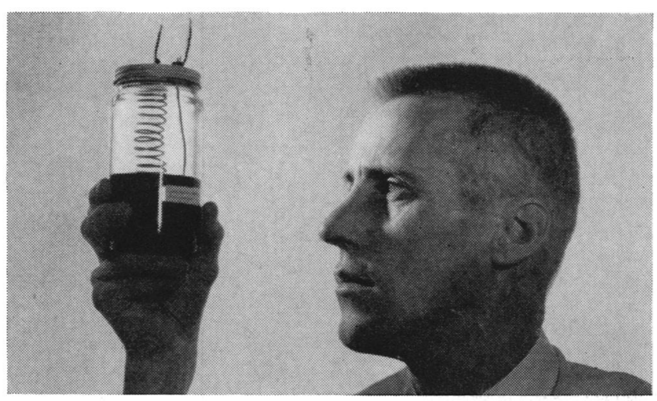
Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.



Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

**BELL TELEPHONE LABORATORIES**

WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

Bernatowicz does believe just this, and I suspect that he also thinks that the scientific view of the world is the true view and that he who departs from proper deterministic language is dealing lightly with truth.

Well, the language of science is descriptive and not purposive. I am wholly in accord with Bernatowicz on that point. But, if we are talking science, I go farther where he stops short, for I note—remaining descriptive because I am being scientific—that we have here a case of one organism attacking others because these others behave differently from the one. Scientifically, all we have is a case description of an idiosyncratic organism, Bernatowicz, which does not, on the showing of his paper, represent the species but a departure from it. Is this organism quieted by this description of his behavior, or do his words suddenly seem to carry an anthropomorphic meaning? Do they say that his purpose was to convince others of his own rightness, thus ruling him out of the class of scientific organisms because he speaks in terms of purpose? If Bernatowicz wants rigor and the scientific attitude all the time, let him, a biologist, include his own conduct under the scientific rules. Was he or was he not being purposive? I think he was.

For myself, I take the use of the scientific language more lightly, less rigorously, and I am glad that most of my colleagues do too. J. J. Thomson said that a scientific activity is a policy, and he might have made his comment broader to say that all scientific activity is a policy to be accepted when it works and changed when it does not. I do not pretend to be a scientist in all my speech, nor do I want students to be. I want them to have values and purposes, to know when to escape the scientific strait jacket and also when to get a new strait jacket. There should be nothing so inflexible about science or scientific conduct or scientific language. What we want for scientists is wisdom, good judgment, the ability to speak and write English delicately and significantly, enough wisdom to break any rule when a good purpose will be supported thereby.

Urbanity never hurt a scientist yet. Using English with skill, relying on the connotations to work as they should, is less secure than the rigor of mathematics but an art capable of much greater refinement. I find in none of Bernatowicz' examples the sort of thing that should be changed if it is given in a proper scientific context. A strict adherence to his rule would eliminate entirely from scientific speech the phrase *in order that*, and that seems to me to be a preposterous suggestion. The Darwinian theory was a way of changing purposive events into descriptive, and for me (and I should hope for most students) the context of most of these disapproved sentences would be the nonpurposive, descriptive concept of natural selection.

In any event—say I, anthropomorphically purposive, and purposively anthropomorphic—let us not warp our young scientists by rigid rules. Always remembering that we do not wish for all to be alike, let us cultivate urbanity, wisdom, and flexibility. Let us help them to learn to speak and write well, clearly, freely, attractively, and differently from one another. Let us hope they can learn to think of science as a happy way of life, not as a harsh taskmaster with a code of morals dangling at his belt.

EDWIN G. BORING
*Harvard University,*
*Cambridge, Massachusetts*

In the interests of clear thinking one should certainly be wary of any statements that are unjustifiably teleological, as A. J. Bernatowicz has pointed out. Judging from his conclusions, however, I suspect that he would prefer to leave out the word *unjustifiably* in my first sentence, as would many other scientists, although not all. [See L. K. Frank, G. E. Hutchinson, W. K. Livingston, W. S. McCulloch, N. Weiner, *Ann. N.Y. Acad. Sci.* **50**, 187 (1948)].

Let me make plain at the beginning that I would agree that in many circumstances teleological language is inappropriate, implying the existence of agencies beyond our ability to observe directly. The examples quoted by Bernatowicz, I would judge, all demonstrate misapplication of teleological concepts. However, not all of them are inherently unsuited to such treatment.

What do we mean when we say that a statement is "teleological"? Do we not mean that it implies some directing or governing factor which by its nature "causes" events to follow certain observed courses? Certainly in this sense the idea of "force" or "gravitation" or "field" is, or can easily be seen as, teleological, invoking the presence of an agency which we can observe only by inference. But if we are careful to note that, for example, a "field" is a map of what we might expect to observe, then we can still use the concept of "field" at one level of explanation, without implying the existence of any incompletely defined agency.

There is a more important area of teleological thinking, however, in which the above "way out" is of no use. This is the area of biology, physiology, psychology, and other sciences of life. Let me emphasize that when one approaches these disciplines in an attempt to imitate the (in principle) rigorous methods of physics, then any use of teleological thinking is bound to go astray. But if one approaches living entities from the sys-

(*Continued on page 671*)

**Statistics in Chemistry and Chemical Engineering**

Richard J. DeGray, *chairman*
George E. P. Box, *vice chairman*

*24 Aug.* John C. Whitwell, *chairman*: Frank S. Riordan, Jr., "Evolutionary operations." Ralph A. Bradley, *chairman*: Hubert M. Hill, "Designs to compensate for trends in time."

*25 Aug.* Henry Scheffe, *chairman*: Otto Dykstra, Jr., "Partial duplication of factorials." Frank W. Wehrfritz, *chairman*: H. C. Hamaker, "On multiple-regression analysis."

*26 Aug.* Mavis B. Carroll, *chairman*: George E. P. Box, "Nonlinear estimation." Harry Smith, Jr., *chairman*: Gabriel Kron, "Multidimensional curve fitting with irregular polyhedrons."

*27 Aug.* Martin Wilk, *chairman*: James L. Dolby, "Random balance." S. Lee Crump, *chairman*: Carl A. Bennett, "Fixed, mixed, and random models."

*28 Aug.* Hale Sweeny, *chairman*: H. L. Lucas, "Change-over trials."

**Adhesion**

Alan A. Marra, *chairman*
Harold F. Wakefield, *vice chairman*

*31 Aug.* R. Oriani, "Surface behavior as affected by internal organization of solids"; B. G. Ranby, "Adhesion characteristics of cellulosic materials."

*1 Sept.* J. E. Rutzler, "Surface properties and types of bonds involved"; W. E. Holland and J. D. Haygood, "High temperature creep measurements as a means of estimating surface free-energy."

*2 Sept.* R. L. Patrick, C. A. Kumins, and M. Gottlieb, "Molecular interactions with the surfaces of solids"; R. R. Stromberg, "Adsorption of polymers."

*3 Sept.* F. J. McGarry, "Factors affecting adhesion of epoxy and polyester systems to glass"; C. G. Caldwell, "Adhesion properties of carbohydrate systems."

*4 Sept.* Mechanics of adhesive bonds: A. F. Martin, "Influence of adhesive physical properties on bonded-joint behavior"; D. K. Kaelble, "A general theory of peel adhesion."

## Kimball Union Academy

**Lipid Metabolism**

Donald B. Zilversmit, *chairman*
Carleton R. Treadwell, *vice chairman*

*15 June. Blood coagulation*: T. H. Spaet, "The role of lipids in blood coagulation"; A. J. Marcus, "Studies on blood platelet phosphatides"; G. Rouser, "The isolation and characterization of phosphatidyl ethanolamine and its effect on blood coagulation"; J. R. O'Brien, "Lipids in coagulation phenomena in vitro and in thrombosis"; R. L. Swank, "The relation of transport of fats to their physical state in blood."

*16 June. Metabolism of adipose tissue*: D. W. Fawcett, "Observations on the submicroscopic structure and metabolic responses of brown adipose tissue"; R. A. Liebelt, "Growth characteristics and lipid deposition in adipose tissue of mice"; B. Shapiro, "The mechanism of fat transport in adipose tissue and liver"; K. Bernhard, "Some aspects of the behavior of the polyenic fatty acids in the animal body"; J. F. Mead, "Hydrogenation of polyunsaturated fatty acids in biological systems."

*17 June. Role of lipids in enzyme activity*: D. E. Green, "The role of lipids in mitochondrial function"; F. L. Crane, "The function of coenzyme Q and other lipids in electron transport"; A. Nason, "The role of lipids in electron transport: tocopherol at the enzymatic level"; S. J. Wakil, "The mechanism of fatty acid biosynthesis"; D. D. Feller, "Incorporation of low-molecular-weight metabolites into lipids by slices of adipose tissue."

*18 June. Mechanisms of fat transport*: V. P. Dole, "The role of nonesterified fatty acids in fatty acid transport"; D. S. Fredrickson, "The in vivo metabolism of plasma UFA as determined by tracer experiments"; J. J. Spitzer, "Hormonal effects on release and uptake of UFA"; C. M. Radding, "In vitro synthesis of liver lipoprotein"; M. Rodbell, "The nature and metabolism of chylomicron proteins."

*19 June. Mechanisms of fat transport*: R. P. Geyer, "Utilization of emulsified lipids in vivo and in vitro"; J. Seifter, "The action of the lipid-mobilizing factor."

### Physical Metallurgy

Thomas A. Read, *chairman*
Robert L. Fullman, *vice chairman*

*Phase Transformations*

*22–26 June*. J. W. Christian, "Martensitic transformations"; T. B. Massalski, "Certain features of transformations that resemble both the martensitic and the nucleation and growth types"; H. W. Paxton, "Interface-controlled transformations in solids"; J. W. Cahn, "The role of diffuse interfaces in transformation kinetics"; R. J. Weiss, "Relation of electron properties of $\alpha$- and $\gamma$-iron to transformation behavior"; Larry Kaufman, "Lattice stability of metals"; Gilbert Speich, "Bainitic growth rates"; C. S. Smith, "Transformation and deformation in metals under explosive shock loading"; V. F. Zackay and J. C. Shyne, "Plastic properties of martensitic steels formed from cold-worked austenite"; W. W. Mullins, "An analysis of the linear cooperative problem as a mark-off process"; P. A. Flinn and G. McManus, "A Monte Carlo calculation of the order-disorder transformation in the body-centered cubic structure"; S. L. Quimby, "Ordering and disordering processes in $Cu_3Au$"; J. L. Walter, "Surface energy

## GORDON RESEARCH CONFERENCES

***Request for Application Forms***

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Gordon Research Conferences
Department of Chemistry
University of Rhode Island
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Please send me application forms for attendance at the Gordon Research Conference on

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mechanism for secondary recrystallization"; J. W. Rutter and K. T. Aust, "Grain boundary migration in high-purity metals"; A. G. Tweet, "Supersaturation effects in precipitation in semiconductors"; J. Mitchell, "Precipitation processes in crystals of silver halides"; Brian Berry, "Internal friction studies of precipitation"; L. S. Darken, "Interaction of interstitials with dislocations"; D. Turnbull, "Kinetics of clustering and Guinier-Preston zone formation in alloys"; H. S. Rosenbaum, "The role of dislocation loops in the precipitation of silicon from aluminum"; Mats Hillert, "Some viewpoints on the transformation of austenite."

**Nuclear Chemistry**

Morris L. Perlman, *chairman*
John O. Rassmussen, *vice chairman*

*29 June–3 July.* Survey of current problems in the study of nuclear reactions (low-energy region; high-energy region). The initial interaction: experimental evidence for compound nucleus formation and for direct interaction; theory and comparison with experimental results. Decay of compound system. High energy interactions. Heavy ion reactions. Fission.

**Solid State Studies in Ceramics**

W. D. Kingery, *chairman*

*6 July.* J. J. Gilman, "Dislocations and mechanical properties of nonmetal crystals"; S. Amelinckx, "Dislocation structure in nonmetal crystals."

*7 July.* R. J. Stokes, "The mechanical properties of MgO crystals"; G. R. Pulliam, "The influence of environment on flow and fracture of single crystals."

*8 July.* J. B. Wachtman, Jr., "Damping capacity of polycrystalline ceramics"; R. M. Fulrath, "Polycrystalline and polyphase ceramics"; J. Selsing, "Fracture in polyphase ceramics."

*9 July.* G. R. Eusner, "Mechanical properties of basic brick"; W. J. Young, "Research studies on art forgeries."

*10 July.* C. C. Evans, "Mechanical properties of nonmetal whiskers." Discussion leaders: I. B. Cutler, P. Gibbs, A. E. Gorum, J. Gurland, M. L. Kronberg, T. S. Shevlin, T. L. Johnston, J. W. Mitchell, P. L. Pratt, R. Bacon, E. Ruh.

**Chemistry, Physiology, and Structure of Bones and Teeth**

W. D. Armstrong, *chairman*
B. B. Migicovsky, *vice chairman*

*13 July. Invited short communications* (Felix Bronner, *chairman*). *Bone as a mechanical tissue* (Jonathan Cohen, *chairman*): G. H. Bell, "Bone as a problem in mechanical engineering."

*14 July.* F. G. Evans, "The relation of the microscopic structure of bone to its strength characteristics and other physical properties"; H. Hollingshaus, "Mechanical properties of bone from radiumpoisoned dogs"; W. T. Dempster, "The distribution of osseous material in the mandible and humerus, and its mechanical importance"; M. G. Hardinge, "The transmission of weight through the knee joint." *Fluoride metabolism* (Harold C. Hodge, *chairman*): D. A. Greenwood, "Broad aspects of fluoride metabolism"; Yngve Ericsson, "Radiofluoride studies."

*15 July.* P. H. Phillips, "Bone retention of fluoride"; C. S. Hobbs, "Radiofluoride distribution in animals under chronic fluoride exposure"; E. J. Largent, "Urinary fluoride levels in relation to change in osseous radiopacity"; F. J. McClure, "Fluoride content and the chemistry of human skeletal tissue"; C. H. Carlson, "Mechanisms of renal excretion of fluoride determined with radiofluoride"; Leon Singer, "Plasma fluoride concentrations in relation to fluoride intake." *New developments in methodology in study of calcified tissues* (D. Dziewiatkowski, *chairman*): Diego Carlström, "Some new aspects of ultrastructure of bone."

*16 July.* James Irving, "Histochemical changes at sites of calcification"; Richard Gruelich, "High-resolution microradiography"; Harold Schraer, "Quantitative determination of bone mineral content and bone density in vivo from standardized roentgenograms." *Pathological physiology of bone and calcium metabolism* (Franklin C. McLean, *chairman*): G. Fanconi, "Idiopathic hypercalcemia."

*17 July.* Albert Dorfman, "Studies on acid mucopolysaccharides (Hurler's syndrome)"; Donald Fraser, "Hypophosphatasia"; Karl M. Wilbur, "Mechanisms of mineralization in mollusks."

**Cell Structure and Metabolism**

A. K. Solomon, *chairman*
Alan J. Hodge, *vice chairman*

*Biological Membranes*

*20 July. Structure and cellular aspects of membranes*: George E. Palade; Heinz Holter; Manfred L. Karnovsky.

*21 July. Molecular architecture of the membranes*: F. O. Schmitt; J. B. Finean; W. Stoeckenius: J. Lawrence Oncley; J. D. Robertson.

*22 July. Transport across cellular membranes*: Hans H. Ussing; John R. Pappenheimer A. K. Solomon; Paul Lefevre; Alan Hodgkin and Richard Keynes.

*23 July. Physics and chemistry of membranes*: George Scatchard; Torsten Teorell; R. Schlögl; Theodore Shedlovsky.

*24 July. Metabolic functions of membranes*: Albert L. Lehninger; Eric G. Ball; Philip Siekevitz.

A grant from the Muscular Dystrophy Associations of America and the Muscular Dystrophy Association of Canada has provided support for the travel of the foreign scientists.

**Chemistry at Interfaces**

Norman Hackerman, *chairman*
Herman E. Ries, *vice chairman*

*27 July. Metal-solution interfaces* (R. S. Hansen, *chairman*): R. S. Hansen, "Relaxation phenomena in the double layer"; Norman Hackerman, "The electrical double layer at solid metal-solution interfaces"; J. O'M. Bockris, "Adsorption of nonelectrolytes of metal-solution interfaces."

*28 July. Dispersions* (F. R. Eirich, *chairman*): E. Matijewic, "Formation of solid phases in electrolyte solutions"; J. J. Chessick, "Stability of dispersions in nonaqueous media"; A. J. Rutgers, "Ionic hydration in aqueous solutions."

*29 July. Adsorption* (R. A. Beebe, *chairman*): H. S. Taylor, "Aspects of chemisorption and catalysis"; G. H. Young, "Chemisorption studies from fuel cell potentials (applications of a new tool in chemisorption studies)"; D. H. Everett, "Adsorption hysteresis."

*30 July. Adsorption* (continued) (A. C. Zettlemoyer, *chairman*): J. R. Zimmerman, "Water vapor adsorption on silica gel by nmr techniques"; J. G. Aston, "Adsorption studies by nmr."

*31 July. Monolayers on liquids* (H. W. Fox, *chairman*): L. Jarvis, "Monolayers on nonaqueous substrates."

### Biochemistry and Agriculture

George L. McNew and Robert S. Bandurski, *cochairmen*

*3 Aug. The biochemical basis of ecological response* (Hubert Martin, *chairman*): Z. A. Patrick, "Root diffusates and decomposition products of plant residues as factors in crop ecology"; David Gottlieb, "The role of symbiosis and antibiosis in the soil community"; P. W. Brian, "Biochemical basis of microbial antagonisms in soil"; E. E. Smissman and S. D. Beck, "Biochemical basis of pathogenesis"; R. A. Ludwig, "The function of biologically active compounds in the growing plant in pathogenesis and defense mechanisms."

*4 Aug. Phosphorus in plant nutrition* (G. C. Bridger, *chairman*): D. R. Bouldin, "Chemical behavior and plant availability of phosphorus sources in relation to soil and fertilizer properties"; A. J. Ohlrogge, "Plant-nutrient uptake from fertilizer bands"; C. V. Cole, "Distribution of phosphorus in plants." *Metabolism of adenyl anhydrides* (Robert S. Bandurski, *chairman*): G. C. Webster, "Amino acid activation and protein synthesis"; R. S. Bandurski, "Sulfate activation and reduction."

*5 Aug. Chemistry and metabolism of nucleic acids* (Paul O. P. Ts'o, *chairman*): J. Herbert Taylor, "DNA and RNA synthesis"; Paul O. P. Ts'o, "Structure and properties of microsomal particles and their RNA"; P. C. Cheo, "Physical-chemical properties and infectivity of tobacco mosaic virus RNA"; K. K. Reddi, "Studies on tobacco mosaic virus nucleic acid." *Uridine diphosphate sugars and polysaccharide synthesis* (W. Z. Hassid, *chairman*): E. Neufeld, "Mechanism of sugar nucleotide synthesis in higher plants"; L. Glaser, "Polysaccharide synthesis from uridine linked sugars."

*6 Aug. The inhibition of metabolic functions by synthetic chemicals* (H. P. Burchfield, *chairman*): Paul H. Schuldt, "Activation of cyclic sulfones by dehydrochlorination"; Donald E. Moreland, "Biochemistry of herbicidal action including effects on the Hill reaction"; R. D. O'Brien, "Mechanism and significance of esterase inhibition by phosphates and carbamates." *Special conference addresses on the regulation of plant growth* (A. G. Norman, *chairman*): T. A. Bennet-Clark, "Possible mechanisms of plant growth regulation"; R. L. Wain, "Some chemical aspects of plant growth regulation."

*7 Aug. Effect of ionizing radiation on biochemical processes* (James L. Liverman, *chairman*): B. S. Schweigert, "Biochemical aspects for the radiation preservation of food"; Charles O. Doudney, "Macromolecular synthesis in the mutagenic and lethal effects of radiation in bacteria"; Henry Quastler, "Comparative radiosensitivity of living organisms."

**Toxicology and Safety Evaluations**

Don D. Irish, *chairman*

David W. Fassett, *vice chairman*

*10 Aug.* David W. Fassett, *chairman*: Irvin Blank, "Basic mechanisms of percutaneous absorption"; Albert A. Kondritzer, "Physical-chemical factors in the development of barrier materials"; Leonard J. Vinson, discussion. John A. Zapp, Jr., *chairman*: G. W. H. Schepers, "Pulmonary tissue changes induced by inhaled industrial dust."

*11 Aug.* Kingsley Kay, *chairman*: speaker and subject to be announced; Henry F. Smyth, "Deriving tentative threshold limits from experimental data." Charles R. Williams, *chairman*: Charles Kensler, "Quantitative aspects of chemical carcinogenesis"; Miriam P. Finkel, "Quantitative aspects of radioisotope carcinogenesis."

*12 Aug.* Eugene H. Krackow, *chairman*: Eugene H. Krackow, "Extension of laboratory toxicological data to the field of industrial medicine"; C. Boyd Shaffer, "Prospectively"; W. Clark Cooper, "Retrospectively." Norton Nelson, *chairman*: George M. Knauf, "Biological effects of microwave energy." Film, "Medical aspects of missile operations."

*13 Aug.* Horace Gerarde, *chairman*: Joseph H. Gast, "The biological effects of chemical agents on in vitro systems." Bernard L. Oser, *chairman*: H. van Genderen, "Interpretation of toxicological data in animals for the determination of acceptable levels for intake in man."

*14 Aug.* Geoffrey Woodward, *chairman*: Frederick S. Phillips and Stephen S. Sternberg, "Experimental and clinical toxicity of cancer chemotherapeutic agents"; William Layton, "Some problems in evaluation of the safety of drugs."

**Chemistry and Physics of Metals**

George H. Vineyard, *chairman*

Warren DeSorbo, *vice chairman*

*Lattice Dynamics*

*17 Aug.* P. M. Marcus, "Specific heats and vibration spectra"; J. A. Morrison, "Present status of low-temperature specific-heat measurements"; J. A. Krumhansl, "Microscopic theories of elasticity as tested in anisotropic substances—graphite."

*18 Aug.* B. N. Brockhouse, "Inelastic neutron scattering—Chalk River results"; H. Palevsky, "Inelastic neutron scattering—Brookhaven results"; M. Lax, "Long-range forces and lattice vibrations in germanium"; E. Burstein, "Infrared observations and lattice dynamics."

*19 Aug.* H. B. Rosenstock, "Far-infrared lattice absorption"; W. C. Overton, Jr., "Vibration spectra and critical points in F.C.C. lattices with nearest and next-nearest neighbor interactions"; J. DeLaunay, "Vibration spectrum calculations"; A. Maradudin, "Effects of defects and disorder on vibrational properties of crystals."

*20 Aug.* G. Leibfried, "Recent developments in the theory of anharmonic effects"; M. Blackman, "Thermal expansion"; R. W. Morse, "Acoustic observations of phonon-electron interactions."

*21 Aug.* C. Herring, "Phonon-drag effects"; M. Walsh, "Spin-phonon interactions."

**Photonuclear Reactions**

Peter Axel and

A. O. Hanson, *cochairmen*

*24–28 Aug.* E. G. Fuller and R. B. Duffield, "Systematics of photonuclear reactions." Current experimental programs. M. Danos, D. H. Wilkinson, "Theory of photonuclear reactions." Energy levels in light nuclei. Theoretical interpretation of light nuclei. Bremsstrahlung and non-nuclear gamma ray interactions. Photonuclear and inverse reactions (experimental). Theoretical interpretation of inverse reactions. Remaining uncertainties and controversies.

### Molten Salts

B. R. Sundheim, *chairman*
Dieter Gruen, *vice chairman*

*31 Aug.* H. Flood, M. Blander, "Activity"; F. R. Duke, "Kinetics."

*1 Sept.* J. O'M. Bockris, "Transport properties"; B. R. Sundheim, "Transference."

*2 Sept.* D. M. Gruen, "Spectrophotometry"; G. Janz, "Raman spectra x-ray."

*3 Sept.* D. D. Cubicciotti and M. Bredig, "Metals in molten salts."

*4 Sept.* L. Brewer and R. Porter, "High-temperature chemistry."

## Forthcoming Events

### April

*2–3.* Electrical Applications for the Textile Industry, AIEE conf., Atlanta, Ga. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

*2–3.* Radioisotopes in Agriculture, 4th conf., Stillwater, Okla. (J. H. Jensen, Associated Midwest Universities, Iowa State College, Ames.)

*3–4.* Marine Biology, 20th annual, Corvallis, Ore. (J. E. McCauley, Dept. of Zoology, Oregon State College, Corvallis.)

*5–9.* International Acad. of Proctology, 11th annual, New York, N.Y. (A. J. Cantor, IAP, 147–41 Sanford Ave., Flushing 55, N.Y.)

*5–10.* American Chemical Soc., 135th, Boston, Mass. (M. A. H. Emery, 18th and K St., NW, Washington, D.C.)

*5–10.* Nuclear Congress, Cleveland, Ohio. (S. Baron, Burns & Roe, Inc., 160 West Broadway, New York 13.)

*6.* Paleontological Research Institution, Ithaca, N.Y. (R. Harris, 109 Dearborn Rd., Ithaca.)

*6–7.* Chemical and Petroleum Instrumentation, 2nd natl. symp., St. Louis, Mo. (H. S. Kindler, Director of Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

*6–8.* American Radium Soc., Hot Springs, Va. (R. L. Brown, Robert Winship Clinic, Emory Univ., Atlanta 22, Ga.)

*6–8.* National Open Hearth Steel Furnace, Coke Oven and Raw Materials Conf., St. Louis, Mo. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

*6–9.* American Acad. of General Practice, San Francisco, Calif. (M. F. Cahal, Volker Blvd. at Brookside, Kansas City 12, Mo.)

*6–11.* Coordination Chemistry, intern. conf., London, England. (Chemical Soc., Burlington House, London, W.1.)

*8.* Evolution of Cell Populations, conf. (by invitation), Atlantic City, N.J. (D. C. Hetherington, Dept. of Anatomy, Duke Univ. School of Medicine, Durham, N.C.)

*8–9.* Tissue Culture Assoc., 10th annual, Atlantic City, N.J. (D. C. Hetherington, Dept. of Anatomy, Duke Univ. School of Medicine, Durham, N.C.)

*10–11.* Society for the Scientific Study of Religion, Chicago, Ill. (W. H. Clark, SSSR, Hartford Seminary Foundation, Hartford 5, Conn.)

*10–16.* Mental Health, 2nd Caribbean conf., St. Thomas, Virgin Islands. (Mrs. E. L. M. Shulterbrandt, Bureau of Mental Health, St. Thomas, V.I.)

*12–13.* American Soc. for Artificial Internal Organs, Atlantic City, N.J. (C. K. Kirby, ASAIO, 110 Maloney Bldg., University Hospital, 3600 Spruce St., Philadelphia 4, Pa.)

*12–14.* Atomic Mechanisms of Fracture, conf., Cambridge, Mass. (D. K. Felbeck, Natl. Acad. of Sciences–Natl. Research Council, 2101 Constitution Ave., NW, Washington 25.)

*12–15.* Neurosurgery, 8th Latin American cong., Santiago, Chile. (A. Asenjo G., Casilla 70-D, Santiago, Chile.)

*12–16.* American Physiological Soc., Atlantic City, N.J. (R. C. Daggs, 9650 Wisconsin Ave., Washington, D.C.)

*12–16.* Fracture, intern. conf., Cambridge and Dedham, Mass. (Headquarters, Air Force Office of Scientific Research, Washington 25.)

*13.* Biochemical Cytology of Liver (Histochemical Soc.), symp., Atlantic City, N.J. (A. B. Novikoff, Dept. of Pathology, Albert Einstein College of Medicine, Yeshiva Univ., Eastchester Rd. and Morris Ave., New York 61.)

*13–15.* Hydraulics Conf. (American Soc. of Mechanical Engineers), Ann Arbor, Mich. (O. B. Schier, ASME, 29 W. 39 St., New York 18.)

*13–17.* American Assoc. of Immunolo-

gists, Atlantic City, N.J. (C. Howe, 630 W. 168 St., New York 32.)

*13–17.* American Inst. of Nutrition, Atlantic City, N.J. (G. M. Briggs, NIAMD, Room 9D20, Bldg. 10, National Institutes of Health, Bethesda, Md.)

*13–17.* American Soc. for Pharmacology and Experimental Therapeutics, Atlantic City, N.J. (H. Hodge, Univ. of Rochester, Rochester 20, N.Y.)

*13–18.* American Acad. of Neurology, Los Angeles, Calif. (J. M. Foley, Boston City Hospital, Boston, Mass.)

*13–18.* American Soc. of Biological Chemists, Atlantic City, N.J. (F. W. Putnam, Univ. of Florida Medical School, Gainesville.)

*13–18.* American Soc. for Experimental Pathology, Atlantic City, N.J. (J. F. A. McManus, Univ. of Alabama Medical Center, Birmingham 3.)

*14–15.* Electrical Heating Conf. (American Institute of Electrical Engineers), Philadelphia, Pa. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

*14–16.* Faraday Soc. (Energy Transfer), Nottingham, England. (Faraday Soc., 6 Gray's Inn Sq., London, W.C.1, England.)

*14–16.* Life Span of Animals, 5th colloquium on aging, London, England. (Ciba Foundation, 41 Portland Pl., London, W.1.)

*14–16.* Rheology of the Glassy State (British Soc. of Rheology), Sheffield, England. (D. W. Saunders, British Rayon Research Assoc., Heald Green Laboratories, Wythenshawe, Manchester 22, England.)

*15–17.* American Assoc. of Genito-Urinary Surgeons, Absecon, N.J. (W. J. Engel, 2020 E. 93 St., Cleveland 6, Ohio.)

*15–17.* American Surgical Assoc., San Francisco, Calif. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati 29, Ohio.)

*15–17.* Midwest Benthological Soc., annual, Hickory Corners, Mich. (C. M. Fetterolg, Jr., Water Resources Commission, Sta. B, Lansing 13, Mich.)

*16–18.* American Assoc. of Railway Surgeons, Chicago, Ill. (C. C. Guy, 5800 Stony Island Ave., Chicago 37.)

*16–18.* Association of South Eastern Biologists, Knoxville, Tenn. (H. J. Humm, Dept. of Botany, Duke Univ., Durham, N.C.)

*16–18.* Ohio Acad. of Sciences, Columbus. (G. W. Burns, Ohio Wesleyan Univ., Delaware.)

*16–18.* Southern Sociological Soc., 22nd annual, Gatlinburg, Tenn. (S. C. Mayo, North Carolina State College, Raleigh.)

*16–30.* Engineering, Marine, Welding and Nuclear Energy Exhibition, 22nd, Olympia, London. (F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, England.)

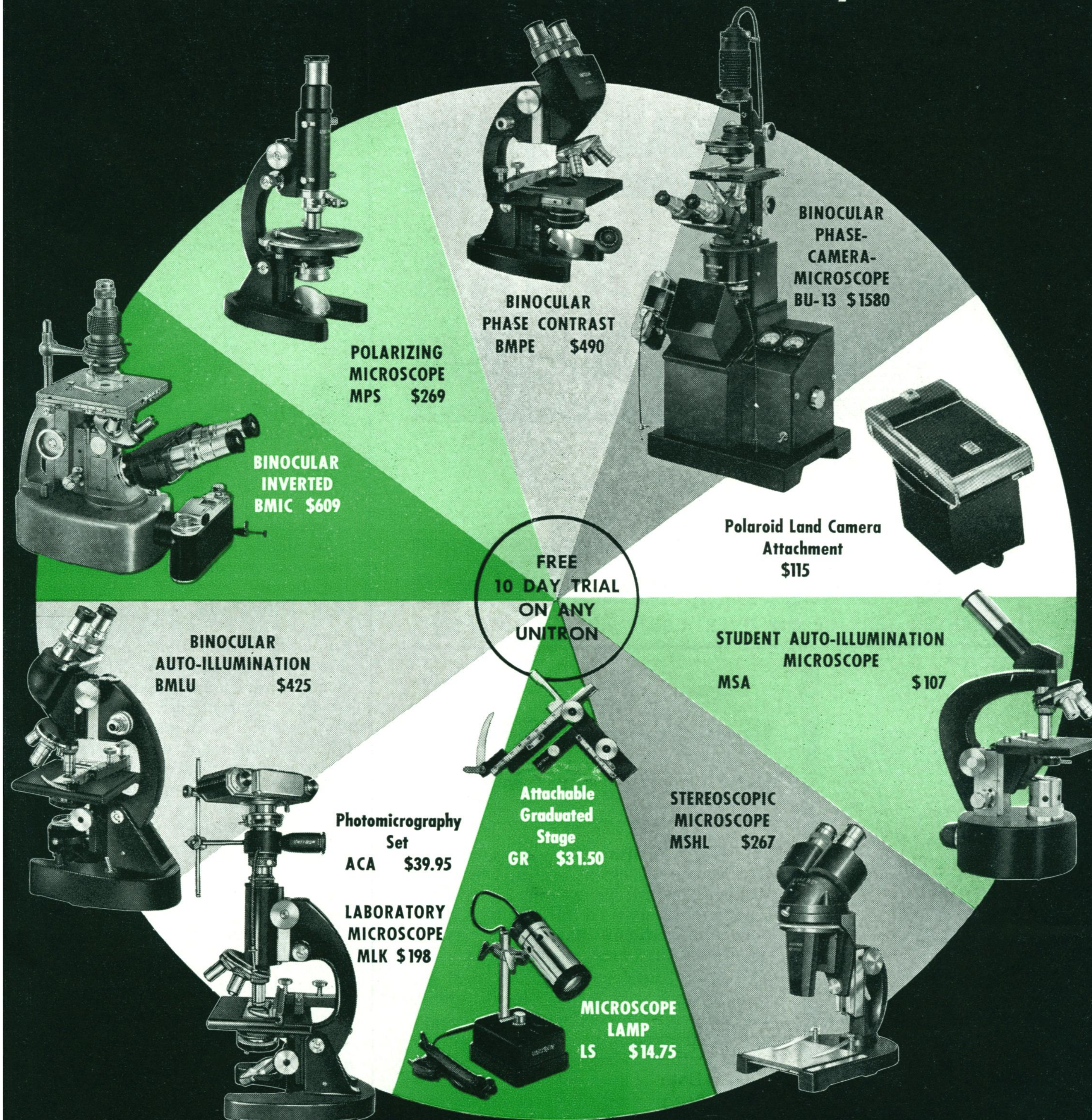
*17.* Current Developments in the Production of High Vacua, symp., London, England. (Institute of Physics, 47 Belgrave Square, London, S.W.1.)

*17–18.* American Mathematical Soc., Monterey, Calif. (E. G. Begle, Leet Oliver Hall, Yale Univ., New Haven, Conn.)

*17–18.* American Mathematical Soc., Chicago, Ill. (E. G. Begle, Leet Oliver Hall, Yale Univ., New Haven, Conn.)

*(See issue of 20 February for comprehensive list)*

## *In the Laboratory . . . where optical quality counts . . . the trend is to UNITRON Microscopes*

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# Equipment

*The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither* Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed is included in the postcard insert.*

■ VOLTAGE REFERENCE combines a temperature-compensated Zener diode and an amplifying transistor. Combined temperature coefficient may be as low as 0.002 percent/°C over the range −55° to +100°C. (Transitron Electronic Corp., Dept. 663)

■ MAGNETRON TEST KIT can be used in the field to test both X- and C-band, 100- and 400-w magnetrons. The portable unit measures 22 by 15 by 19 in. A power meter and a spectrum analyzer are optional accessories. (Bomac Laboratories, Inc., Dept. 664)

■ FREQUENCY STANDARDS for the range 200 to 10,000 cy/sec are dynamically balanced electromechanical resonators designed to function without frequency or amplitude modulation in severe environments. Accuracy is ±0.01 percent. All circuitry is transistorized. (Gyrex Corp., Dept. 660)

■ BLACK-BODY REFERENCE is a controlled source of infrared radiation. The instrument is constructed as two separate units, a source and a controller. The controller is a closed-loop servo system that maintains the temperature of the source by proportional control. Temperature range is 200° to 600°C. Temperature stability is ±1.5°C for ambient variations from 16° to 38°C and line-voltage variations from 105 to 125 v. The black body consists of an accurate aperture plate behind which is a pure silver core with a conically shaped radiating cavity. The cavity is coated with a black finish of emissivity approaching unity. Cosine radiation distribution is achieved over a 20-deg field for standard apertures 0.040 and 0.015 in. in diameter. (Perkin-Elmer Corp., Dept. 667)

■ POWER GENERATOR for 400-cy/sec power is an integral unit consisting of a motor, inductor alternator, and regulating equipment. Power ratings from 1.5 to 10 kw and a variety of output voltages are available. Voltage is regulated to ±3 percent; ±1 percent regulation can be obtained. Driving motors can be supplied for voltage and phases required by the application. (Safety Industries, Inc., Dept. 668)

■ BAROSTAT operates on dead-weight principle to achieve reproducibility said to be approximately ±0.005 in.-Hg. Weights loaded on a pan are supported by the regulated pressure in a bellows. Another evacuated bellows eliminates atmospheric pressure. When the force due to the pressure exceeds that of the suspended weights, the supporting plate actuates a valve leading to a vacuum pump. Weights are added and removed by an electrically operated cable lift. The change from atmospheric pressure to 3.44 in.-Hg, corresponding to 50,000-ft altitude, can be accomplished in 30 sec. (National Instrument Laboratories, Inc., Dept. 669)

■ MAGNETIC-TAPE-EQUIPMENT TEST SET permits frequency-response measurements of amplifiers; measurement of magnetic-head record and bias current and amplifier input-output levels; calibration of FM record amplifiers; setting up of pulse-density mode recording and equalization of analog reproduce amplifiers. The set includes volt-ohm-milliammeter, audio oscillator, vacuum-tube voltmeter, oscilloscope, and voice amplifier. A patch panel permits various circuit arrangements. (Consolidated Electrodynamics Corp., Dept. 671)

■ GALVANOMETER MASK consists of a block holding adjustable blades that can be lowered to interrupt light from any galvanometers in a multichannel oscillograph. The mask will withstand accelerations in excess of those for which the oscillograph is designed. Up to 52 channels can be masked. (L-W Photo Products, Dept. 673)

■ PRESSURE TESTER balances air pressure against a known weight. Range is 0.20 to 15 lb/in.$^2$ without cylinder or piston change. Increments of 0.1 lb/in.$^2$ can be set. Accuracy is $\pm 0.05$ percent of full scale. A self-contained source supplies filtered compressed air; an external source may also be used. (Dynametrics Corp., Dept. 675)

■ AMPLITUDE MODULATOR provides 100-percent modulation over the range from d-c to 1000 Mcy/sec. Modulation frequency range is 15 cy to 15 kcy/sec. Percentage modulation is continuously variable. Radio-frequency input voltage is up to 2.0 v r.m.s. Input impedance is 50 ohm. Drift is not more than 5 cy/sec in 5 min at normal operating temperature. The modulator is transistorized and powered by mercury batteries. (Kay Electric Co., Dept. 670)

■ OXYGEN ANALYZER is improved by the addition of automatic calibration at predetermined intervals. The calibrator operates with a mixture of gases in which the oxygen content is known within $\pm 0.1$ percent. Calibration frequency can be set for 2-, 4-, 6-, 8-, or 12-hr intervals. The calibrator operates for about 5 min; during this period several adjustments may be made to position pointers correctly. Use of the automatic calibrator is said to eliminate need for thermostating. The instrument may be used in hazardous locations. (Mine Safety Appliance Co., Dept. 672)

■ R-I-E METER measures current, resistance, and voltage. Resistance range is $2 \times 10^2$ to $2 \times 10^8$ megohm with limits of error between $\pm 1.7$ and $\pm 6$ percent of reading. Current range is $10^{-12}$ to $5 \times 10^{-6}$ amp with error limits from $\pm 1.5$ to $\pm 3$ percent of full scale. Voltage range is 0.005 to 500 v with error limits between $\pm 0.5$ to $\pm 3$ percent of full scale. A self-contained power pack supplies either 10 or 100 v. (Leeds and Northrup Co., Dept. 676)

■ POWER SUPPLIES employ nickel-cadmium batteries maintained in a fully charged condition at all times by a constant-potential charger. The charger is designed to supply both the external constant load and the trickle charge current. High current peaks are permitted by the low internal resistance of the batteries. A 7 AH cell, for example, will deliver 75 amp. (Gulton Industries, Inc., Dept. 677)

■ OSCILLATOR for the frequency range 0.01 cy to 11.2 kcy/sec uses analog-computer techniques to produce two-phase oscillations. The 360-deg phase shift required for oscillation is achieved by two integrating circuits, each providing a phase shift of 90 deg, and a sign changer circuit. Two outputs 90 deg apart, taken from the integrator circuits, are available at a level of 10 v. Both outputs are directly coupled. Output is constant within $\pm 1$ db over the stated range. (Muirhead & Co., Dept. 678)

■ IMPACT SWITCH possesses a controllable time limit range from 90 to 200 μsec from time of initial impact. Operating temperature range is $-80°$ to $+185°F$. For applications involving radar, the device can be supplied with 95-percent nonmetallic construction materials. (Servonics Engineering Services Co., Inc., Dept. 679)

■ SOLVENTS for chromatography are certified to have mol-percent purity greater than 99 percent. Acetone, benzene, carbon tetrachloride, methyl alcohol, and methylene chloride are available. (Fisher Scientific Co., Dept. 681)

■ DRY-AIR SUPPLY features automatic self-reactivation. Discharge air is supplied at pressure of 30 lb/in.$^2$ and at flow rates to 4 ft$^3$/min. Dew point is stated to be $-100°F$. (Wells Industries Corp., Dept. 683)

JOSHUA STERN
*National Bureau of Standards*
*Washington, D.C.*

*(Continued from page 610)*

tems standpoint, particularly employing even the simpler concepts of feed-back theory, he finds himself tending toward teleological expressions, because they are far more accurate and conservative of words than "mere" statement of relationship among "fundamental" variables. Feed-back systems are best discussed with transitive verbs.

In any case, where a closed chain of cause-effect relationships is known to exist, feed-back exists, by definition, and in living systems this feed-back is often both significant and of the correct sign to qualify as negative feed-back. All negative feed-back systems can properly be thought of as control systems, and all control systems operate to maintain their input signals at some "reference level." The reference level might be set where it is as a result of physical properties of the control-system components, or it might be determined by a signal entering the control system from outside it. This reference level is in all respects a *goal* for the system. The system will (within its limits of complexity) produce whatever outputs are required by the momentary environment to bring its input to this reference level.

In other words, one can say with clear meaning that the *purpose* of the system's behavior is to make its inputs approach some goal state. Many modern psychologists have unfortunately rejected this language for discussing behavior because it is teleological or "anthropomorphic," but one is here properly accused of speaking anthropomorphically only when he tries to describe the goal of a control system in terms appropriate to himself rather than to the control system. To make this clear, let us look at one of Bernatowicz' examples.

"There has to be some sort of mechanism for raising sap [in trees], and energy is lavishly expended in the process." The word *lavishly* aside, this is clearly a hypothesis that a control system exists. But the "goal" of the system has been expressed in the observer's, not the system's, terms: "raising sap" is one event that a human observer might notice, to be sure, but the plant can hardly be suspected of being directly sensitive to the height of the sap column. Rather, we might guess that the presence or absence of sap in critical portions of the tree affects biochemical processes, and some of the products of these processes may well be controlled variables for which specific "reference levels" are determined by the plant's physical properties.

The control system which maintains this kind of variable at a particular level does so by controlling the transfer of energy from storage into work or chemical synthesis; thus, it is quite appropriate to use the transitive verb *expend*.

Teleology and anthropomorphism were

properly rejected when scientists realized that they were projecting their own goals into the systems they were studying. Indeed, lacking the basic concept of feedback system, they could only study scientifically those systems in which "straight-through" space-time relationships were predominant. But when at last scientific thought began to develop in studies of living systems, the lesson had been learned too well, and what proved a crucial advance in the development of physics and chemistry may now turn out to have been in some ways a backward step in the life sciences. The rejection of teleology ultimately enabled students of behavior to develop reliable means for accumulating data, but it may have been that very step which so far has prevented the organization of those mountains of data into comprehensive theories, not only in psychology but in biology, biochemistry, medicine, sociology, and so forth.

If I have succeeded in communicating anything, I hope it is this: teleological concepts can be misused, but the ideas of purpose, goal, or directivity that they denote are both appropriate and proper when one speaks of control systems; I believe at the moment, along with many others, that feed-back control is a pervasive and fundamental feature of living systems. Perhaps it is time that at least the students of living creatures reconsider their goal of rejecting teleological concepts *in toto*. Perhaps in this way we might at last arrive at an "anthropomorphic" theory of human behavior.


William T. Powers

*Veterans Administration Hospital, Chicago, Illinois*


A. J. Bernatowicz says (page 1404), "To the beginner, the idea of natural law presupposes a lawgiver. . . ." Why only to a beginner? Beginner in what? I would say that to any clear thinker the idea of natural law presupposes a lawgiver.

And I fully intend the implication that anyone who succeeds in not drawing this conclusion is not a clear thinker.


Anthony Standen

*Interscience Publishers, New York*


Bernatowicz' rogues' gallery of teleologists may be augmented by one far more important than any he quotes: "What can be more curious than that the hand of man, formed for grasping, that of a mole for digging, the leg of a horse, the paddle of the porpoise, and the wing of the bat, should all be constructed on the same pattern . . ." (*1*).

Not all of Bernatowicz' teleologists, animists, and anthropomorphists are villains. Some are ignorant and some merely careless. The author of my quo-