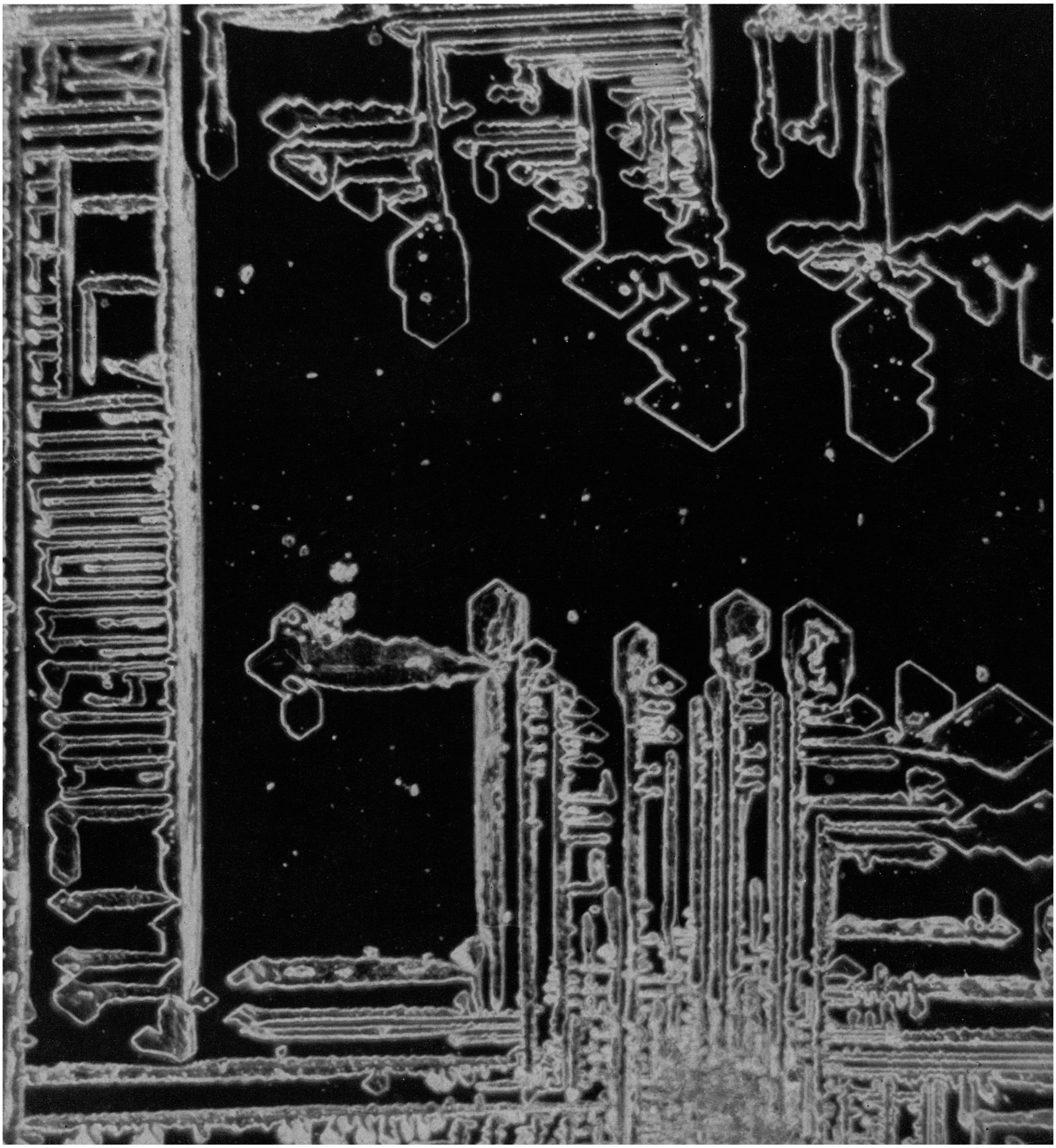
SCIENCE

9 September 1960

Vol. 132, No. 3428

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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Chloride	10 μl	1%
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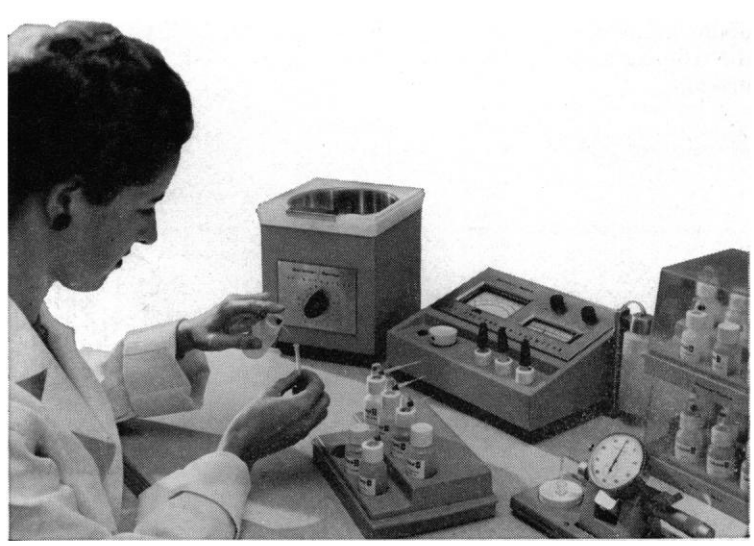
Creatinine	20 μl	3%
Glucose	10 μl	1%
Phosphorus	20 μl	1%
Proteins Total	10 μl	1%
Albumin	20 μl	2%
Urea Nitrogen	10 μl	1%
Uric Acid	20 μl	3%



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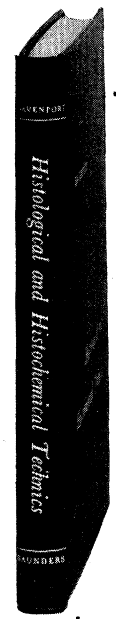

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Designed to create an enlightened approach to processing plant and animal tissue for microscopic study, this clearly written and concise text ideally meets the needs of undergraduate courses in microtechnic or histological technic. Fundamental information is provided the student on the nature of tissues, the technics of fixation, washing, dehydrating, clearing, embedding, sectioning, mounting and staining. Staining methods, staining solutions and fixing fluids are fully presented. Technics to determine inorganic and organic constituents of tissues and enzymes are described. A complete chapter is devoted to applications of *Schiff's Reagent.* Throughout the book procedures and results of 119 histological and histochemical methods are detailed.

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This valuable new text solidly covers comparative vertebrate embryology at the undergraduate level. Dr. Balinsky, well known authority in the field, uniquely shows the embryonic development of vertebrates by *processes and the development of organ systems.* He cites and explains experimental evidence for the interpretation of developmental and growth processes, emphasizing the physiology of development. Embryology is interpreted in a broad sense as a science dealing with ontogenetic development of animals. The author fully describes such topics as post-embryonic development, regeneration, metamorphosis, asexual reproduction, connection between inheritance and development. Students will appreciate the 291 line drawings and photographs. Most of the line drawings were done by Dr. Balinsky for this text.

By B. I. BALINSKY, Dr. Biol.Sc., Professor of Zoology, University of the Witwaterstrand, Johannesburg, South Africa. 562 pages, 6" x 9¼", with 291 illustrations. $7.75. *New!*

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Here is a different kind of embryology laboratory manual. It includes much more than mere directions for microscopic examination of serial sections of progressive stages in the development of the chick and pig embryos. Unlike other manuals, it presents extensive discussions of the *causes* of the observed development. These discussions, called *Physiology of Development,* are presented with admirable care and clarity, interspersed among the nine laboratory exercises. The author describes many significant experimental studies in embryology that students do not have an opportunity to perform in the laboratory. He discusses basic principles such as the organizer, for the light they throw upon the nature and causes of normal development. Thus, the manual stimulates interest in observations students are making.

By WILLIAM W. NEWBY, Ph.D., Division of Biological Sciences, University of Utah. 217 pages, 8½"x11", illustrated. $4.00. *New!*

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This helpful manual describes with pin-point precision step-by-step procedures for 186 experiments in biochemistry. Additional explanations, illustrations and charts are given where needed to increase clarity. Each experiment is followed by study questions to quicken the student's observation. The authors cover preparation, qualitative and quantitative examinations of important biochemical substances. Extensively revised and simplified for this *New (5th) Edition,* the experiments in the manual now require less laboratory supervision by the instructor. New experiments include: use of a circular filter paper chromatography of amino acids; preparation of a crystalline protein, ferritin; estimation of succinic acid dehydrogenase; use of the Beckman DU spectrophotometer. This manual can be used successfully with any standard biochemistry textbook.

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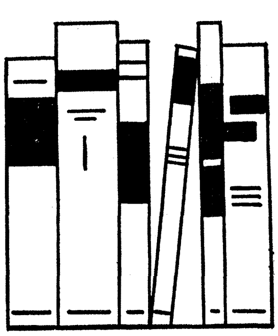
Gladly sent to college teachers for consideration as texts



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West Washington Square
Philadelphia 5, Pa.

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9 September 1960, Volume 132, Number 3428

SCIENCE

APPLICATION FOR HOTEL RESERVATIONS
127th AAAS MEETING
New York, 26-31 December 1960

The five hotels for the AAAS New York meeting have established special, **low, flat rates** and have reserved appropriately large blocks of rooms for this meeting. Thus everyone making room reservations for the AAAS meeting is assured substantial savings.

The list of hotels and the reservation coupons below are for your convenience in making your hotel reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

For a list of the headquarters of each participating society and section, see page 230, *Science*, 22 July. Both the Commodore and the Biltmore are AAAS headquarters hotels.

Flat Rates for Rooms with Bath*

Hotel	Single	Double Bed	Twin Beds	Suites
Commodore	$ 8.50	$14.00	$15.50	$21.00 to $52.50
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Roosevelt	8.50	14.00	15.50	39.00 to 43.00
Belmont Plaza	8.50	14.00	15.50	30.00 and up
Waldorf-Astoria	10.00	16.00	18.00	45.00 and up

* All rates are subject to a 5% New York City tax on hotel room occupancy.

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Please reserve the following accommodations for the 127th Meeting of the AAAS in New York, 26–31 December 1960:

TYPE OF ACCOMMODATION DESIRED

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Suite .... Desired Rate...................... Maximum Rate ....

(Desired rate and maximum rate apply only to suites)

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(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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First Choice Hotel .... **Second Choice Hotel** .... **Third Choice Hotel** ....

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NAME ....

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EXAMPLE

Determination of the Spin-Lattice Relaxation Time (T_1) of F Centers in KCl

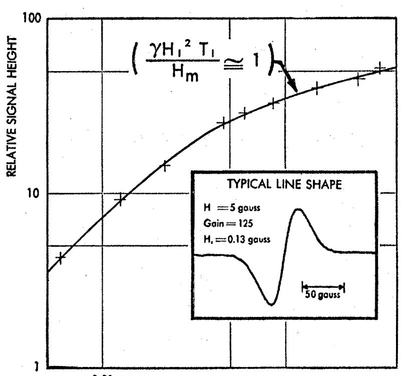

Figure A

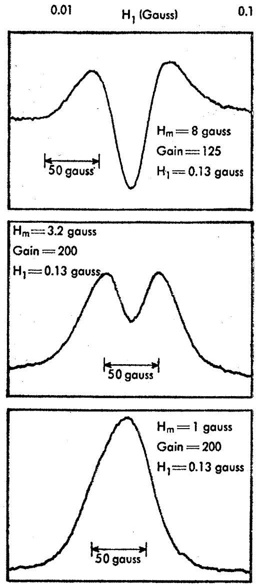

Figure B

Structure defects involving unpaired electrons in crystalline solids generally exhibit a resonance response characteristic of spins immersed in a continuous distribution of magnetic fields. Each electron spin interacts with many neighboring nuclei. The orientation of the nuclear magnetic moments with or against the electron spin, together with the strength of the interactions, determines the local magnetic field, which will be different for every electron. The F center in an alkali halide (an electron occupying a vacant halogen ion site) is a prototype of such a system. In KCl the electron interacts with its nearest neighbor, potassium nuclei, as well as with more distant nuclei to give a line of Gaussian shape of 50 gauss width with no observable structure.

In such a system, with about 10^{17} centers per cc, dipole-dipole interaction is weak and the corresponding relaxation time, T_2, is replaced with T_1 in theoretical treatments. Portis investigated the saturation response of this system* and determined T_1 at room temperature using a spectrometer employing amplitude modulation of the klystron output. He found that the observed EPR absorption signal $\chi'' H_1$ became independent of the microwave field amplitude, H_1, at saturation, and found a value for T_1 of 8×10^{-6} sec. at room temperature.

We were interested in studying the saturation behavior of this system with the Varian EPR spectrometer employing field modulation at a frequency $\omega m = 2\pi \times 10^5$. If $\omega m\, T_1$ is greater than 1, the modulation amplitude, H_m, appears in the saturation parameter. Saturation was expected to occur when $\frac{\gamma H_1^2 T_1}{H_m} \cong 1$. Figure A shows an experimental saturation curve, in which the amplitude of the absorption $\chi'' H_1$, is plotted vs H_1. It is possible to produce a theory to account for the observed behavior, but the break at saturation is not sharp and at best many measurements are required to determine T_1.

One may obtain a value of T_1 much more quickly by observing the dispersion (χ'). Upon saturation, the line shape passes from the typical derivative of the dispersion to the rapid passage shape observed in inhomogeneous systems.** This line shape is the actual distribution of spins in the local magnetic fields. It arises from a summation of the rapid passage responses of the spin packets which compose the line as the modulation field sweeps back and forth sinusoidally. One may vary either H_1 or H_m to bring about saturation; Figure B shows three curves obtained by varying only the modulation amplitude H_m. They illustrate intermediate cases as one is passing into the saturation region. If one solves for T_1 for those values of H_m and H_1 which produce the central curve shown, one obtains a value of 1×10^{-5} sec., which is in good agreement with the value obtained by Portis.

*A. M. Portis, *Phys. Rev.* **91**, 1071 (1953), *Phys. Rev.* **104**, 584 (1956).
**J. S. Hyde, *Phys. Rev.* (to be published).

For literature which fully explains the 100 kc EPR Spectrometer and its application to basic and applied research in physics, chemistry, biology and medical research, write the Instrument Division

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9 September 1960, Volume 132, Number 3428

SCIENCE

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. The joint journal is published in the SCIENCE format. SCIENCE is indexed in the *Reader's Guide to Periodical Literature.*

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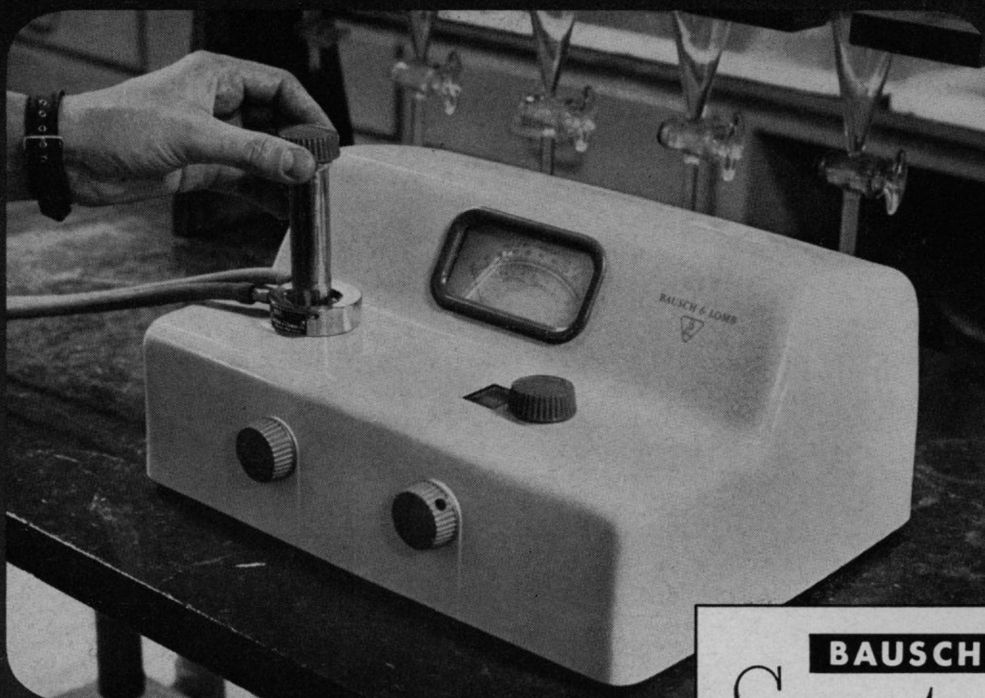
What We Know and Don't Know

An embarrassing proportion of key decisions in the government, from the negotiation of treaties to the management of resources, are made on the basis of insufficient information and unproved assumptions. And this is not so different from the way we conduct our private affairs. We do not know what lies beyond the horizon, and science can only map the boundaries of our ignorance. But since science is in part responsible for some of the greatest ills that now beset us, there is a feeling that it can also help us effect their cure. The government has been acquiring scientific advisory bodies, and the belief that the public is entitled to its own counsel from an independent source is gaining adherents. One move to provide such counsel is to be found in the proposals offered recently by the AAAS Committee on Science in the Promotion of Human Welfare.

In the 8 July issue of this journal the committee speaks of bringing together appropriate technical experts to discuss certain problems, and of reporting the results of such deliberations to the scientific community. The results would also be reported to the general public, in a form not only digestible but palatable. The range of topics is broadly conceived, but some of the reports would analyze the benefits and hazards of scientific and technological advances and thus provide a basis for intelligent appraisal by scientist and layman. The committee does not explore in detail suitable problems for such analyses, but it does offer a few examples of what it has in mind. These range from the more specific, such as methods to prevent air pollution resulting from car exhaust, to the more general, such as the implications of the "new capabilities for direct control of social and economic processes" resulting from "progress in the science of cybernetics and the development of automation techniques."

An article on radioactive fallout which appeared early this year in the New York *Times* magazine was given the subtitle "What We Know and Don't Know." And perhaps reports analyzing the social effects of scientific developments might also appropriately be so subtitled. The relative proportion of material in the two categories would differ for different problems. For one problem, much might be known, and the needed research, once public interest was alerted to dangers, might consist only in finding the most economical method for manufacturing some device. For another problem, so little might be known that it would be difficult to state just how investigators would go about finding a scientific basis for possible public action.

The success of the projected program of analyses will depend in part on the care with which the first problems for study are selected. It goes without saying that a problem chosen for study should concern a matter of some urgency. But in the early stages of a new program, when there are no models to follow and it is important to gain widespread support, there is another factor to consider. A report with a solid amount of information to convey is going to be less difficult to prepare, and is going to impress the scientific community and the general public more favorably, than a report that must, out of ignorance, be an extended plea for more research.—J.T.



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Meetings

Forthcoming Events

October

6–8. Society of Experimental Test Pilots, annual symp., Los Angeles, Calif. (SETP, 44919 N. Cedar Ave., Lancaster, Calif.)

6–10. American Assoc. of Textile Chemists and Colorists, natl. conf., Philadelphia, Pa. (G. P. Paine, AATCC, P.O. Box 28, Lowell, Mass.)

8. Helminthological Soc. of Washington, 50th, College Park, Md. (Publicity Committee, HSW, Animal Disease and Parasite Research Branch, ARS, U.S. Department of Agriculture, Beltsville, Md.)

9–13. Electrochemical Soc., Houston, Tex. (Electrochemical Soc., 216 W. 102 St., New York 25)

9–14. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 15 Second St., S.W., Rochester, Minn.)

10–12. Human Factors and Bioastronautics, conf., Dayton, Ohio. (J. J. Harford, American Rocket Soc., 500 Fifth Ave., New York 36)

10–12. Industrial Health, cong., Charlotte, N.C. (Council on Occupational Health, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

10–12. National Electronics, conf., Chicago, Ill. (T. F. Jones, Jr., School of EE, Purdue Univ., Lafayette, Ind.)

10–12. Operations Research Soc. of America, natl., Detroit, Mich. (H. J. Miser, ORSA, Research Triangle Inst., 505 W. Chapel Hill St., Durham, N.C.)

10–14. American College of Surgeons, San Francisco, Calif. (W. E. Adams, 40 E. Erie St., Chicago 11, Ill.)

10–14. American Soc. of Civil Engineers, Boston, Mass. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18)

11–13. Applications of Nuclear Energy, conf., Karlsruhe, Germany. (Ing. Küpfmüller, Deutsches Atomforum, Friedrichstr. 2 III, Düsseldorf, Germany)

11–13. Synthetic Rubber, 2nd intern. symp., London, England. (Rubber and Plastics Age, Gaywood House, Great Peter St., London, S.W.1)

11–14. Audio Engineering Soc., 12th annual conv., New York, N.Y. (H. F. Olson, RCA Laboratories, Princeton, N.J.)

11–14. Inelastic Scattering of Neutrons in Solids and Liquids, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

12–13. American Vacuum Soc., 7th natl. symp., Cleveland, Ohio. (AVS, Box 1281, Boston 9, Mass.)

12–14. Astronautics, 3rd annual symp., Los Angeles, Calif. (Maj. G. Colchagoff, Propulsion Div., Air Force Office of Scientific Research, Washington 25)

12–14. Gaseous Electronics, 13th annual conf., Monterey, Calif. (N. L. Oleson, U.S. Naval Postgraduate School, Monterey)

12–14. Nuclear Reactor Chemistry, conf., Gatlinburg, Tenn. (C. D. Susano, Oak Ridge National Lab., P.O. Box Y, Oak Ridge, Tenn.)

13–15. Academy of Psychosomatic Medicine, Philadelphia, Pa. (B. B. Moss, 55 E. Washington, Chicago 2, Ill.)

13–14. Engineering Writing and Speech, natl. symp., Chicago, Ill. (M. Whitmer, Admiral Corp., 3800 W. Cortland St., Chicago 47)

13–15. Optical Soc. of America, Boston, Mass. (M. E. Warga, OSA, 1155 16 St., N.W., Washington 6)

14–15. Society of Photographic Scientists and Engineers, symp., Washington, D.C. (F. M. Brown, Photomechanisms, Inc., Box 67, Huntington Station, N.Y.)

15. American Soc. of Safety Engineers, annual, Chicago, Ill. (A. C. Blackman, ASSE, 5 N. Wabash Ave., Chicago 2)

15–16. American Acad. of Psychotherapists, 5th annual conf., Cleveland, Ohio. (B. J. Barkley, 1856 Coventry Rd., Cleveland Heights 18, Ohio)

16. American College of Dentists, Los Angeles, Calif. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis 8, Mo.)

16–22. High-Speed Photography, 5th intern. cong., Washington, D.C. (V. H. Allen, Soc. of Motion Picture and Television Engineers, 55 W. 42 St., New York 36)

16–22. Society of Motion Picture and Television Engineers, semi-annual conv., Washington, D.C. (C. S. Stodter, SMPTE, 55 W. 42 St., New York 36)

17–18. Basic Science in France and the

United States, symp., New York, N. Y. (S. Roth, Office of Research Services, New York Univ., Washington Square Center, New York 3)

17–19. Adaptive Control Systems, symp., New York, N.Y. (H. Levenstein, W. L. Maxon Corp., 260 W. 34 St., New York)

17–19. American Oil Chemists' Soc., fall, New York, N.Y. (W. C. Ault, U.S. Dept. of Agriculture, Philadelphia 18, Pa.)

17–20. American Acad. of Pediatrics, Chicago, Ill. (E. H. Christopherson, 1801 Hinman Ave., Evanston, Ill.)

17–20. American Dental Assoc., Los Angeles, Calif. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago, Ill.)

17–21. Neutron Pile Research, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

17–22. Diagnosis and Treatment of Acute Radiation Injury, Geneva, Switzerland. (World Health Organization, Palais de Nations, Geneva)

17–26. Plastics Processing, intern. cong. and exhibition, Amsterdam and Utrecht, Netherlands. (Secretariat, c/o N. V. 't Raedthuys, Tesselschadestraat 5, Amsterdam-W, Netherlands)

18. Oak Ridge Inst. of Nuclear Studies, Oak Ridge, Tenn. (W. G. Pollard, Box 117, Oak Ridge)

18–20. Mathematical Optimization Techniques, symp., Berkeley, Calif. (R. M. Oliver, Dept. of Industrial Engineering, Univ. of California, Berkeley 4)

18–21. American Dietetic Assoc., 43rd annual, Cleveland, Ohio. (M. L. Ross, Simmons College, The Fenway, Boston 15, Mass.)

19–20. American Geophysical Union, Moscow, Idaho. (A. N. Sayre, U.S. Geological Survey, Washington 25, D.C.)

19–21. Design of Experiments, 6th conf. (by invitation only), Aberdeen Proving Ground, Md. (F. G. Dressel, Office of Ordnance Research, Box CM, Duke Station, Durham, N.C.)

19–21. Space Navigation, symp., Columbus, Ohio. (Institute of Radio Engineers, 1 E. 79 St., New York 21)

19–26. Measuring Techniques and Automation, 2nd intern. cong., Düsseldorf, Germany. (Nordwestdeutsche Ausstellungs-Gesellschaft, Ehrenhof 4, Düsseldorf)

20–21. Hypervelocity, symp., Denver, Colo. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

20–22. Acoustical Soc. of America, San Francisco, Calif. (V. Salmon, Stanford Research Inst., Menlo Park, Calif.)

20–22. Institute of Management Sciences, 7th intern., New York, N.Y. (J. Townsend, IMS, 30 E. 42 St., New York 17)

21–22. Association of Midwestern College Biology Teachers, 4th annual, Mankato, Minn. (L. Zell, Mankato State College, Mankato, Minn.)

21–22. Research Approaches to Psychiatric Problems, symp., Galesburg, Ill. (T. T. Tourlentes, Galesburg State Research Hospital, Galesburg)

21–25. American Heart Assoc., annual, St. Louis, Mo. (AHA, 44 E. 23 St., New York 10)

(See issue of 19 August for comprehensive list.)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ DIGITAL PRESSURE GENERATOR provides selectable pneumatic pressure outputs said to be accurate to ±0.05 percent. To obtain a desired output, a selector switch is turned that activates a precise oscillator. The difference between the reference frequency thus selected and the frequency output of a pressure pickup furnishes an error signal that is used to actuate valves to adjust manifold pressure. Pressure ranges from 0 to 5 to 0 to 1000 lb/in.^{2} with incremental steps of either 10 or 25 percent of range are available. Intermediate pressures can be obtained by plugging in an external oscillator. (Wiancko Engineering Co., Dept. Sci726A, 255 N. Halstead Ave., Pasadena, Calif.)

■ EXPLOSIVE-ACTUATED VALVE for liquids or gases is insensitive to back pressure by virtue of balanced piston design. The normally closed valve is rated at 4200 lb/in.^{2} and operating temperature range −65 to +160°F. Flow passage is 5/32 in. and weight is 2.6 oz. (Pyronetics, Dept. Sci727A, 11973 E. Slanson, Santa Fe Springs, Calif.)

■ PUNCHED-TAPE PROGRAMMER uses 2-in.-wide tape with 1 in. for punched information and 1 in. for corresponding printed information. A bidirectional drive system employs detent action for positioning tape. Contacts are spring-loaded, gold-plated pins. A 1-in. section within 250 ft. of stored tape is read at each position. Storage reels are self-contained. (Electronic Engineering Co. of California, Dept. Sci756, 1601 E. Chestnut Ave., Santa Ana, Calif.)

■ CATHODE FOLLOWER has a frequency range of 0.02 cy to 1 Mcy/sec. Input impedance is 5000 megohms, and output resistance is 290 ohms. Gain is 0.98, and output noise level 75 μv. The unit is capable of reproducing a 25-volt pulse with 0.4 μsec rise time and 1.0 μsec decay time. (Columbia Research Laboratories, Dept. Sci772, MacDade Blvd. and Bullens Lane, Woodlyne, Pa.)

■ EXPLOSION TEST CHAMBER is designed for temperature operation to +200°F and altitudes to 10^5 ft. The explosive atmosphere is propane gas or gasoline. Operating pressure is 300 lb/in.^{2} A sampling chamber permits check of the explosiveness of the fuel mixture prior to test. (Itemco Inc., Dept. Sci776, 18 Beechwood Drive, Port Washington, N.Y.)

■ VACUUM GAGE reads pressure automatically and displays digital values as illustrated numerals with decimal automatically placed. Response time is less than 2 sec. Five ranges from 0.01 to 900.0 μ-Hg are covered. Should pressure exceed the range of the instrument, a warning light flashes on and the display numerals go off. A cold-cathode ionization gage calibrated for dry air is supplied. Calibration for other gases is available. (Nuclear Metallurgical Enterprises, Dept. Sci773, 1004 United Office Bldg., Niagara Falls, N.Y.)

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JOSHUA STERN

National Bureau of Standards, Washington, D.C.

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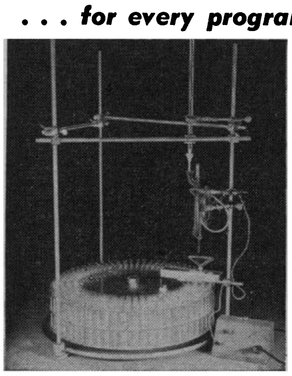

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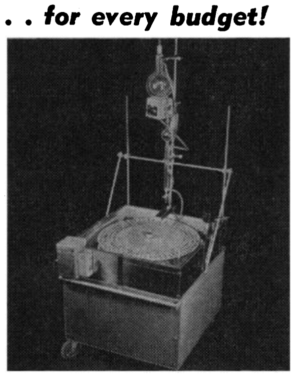

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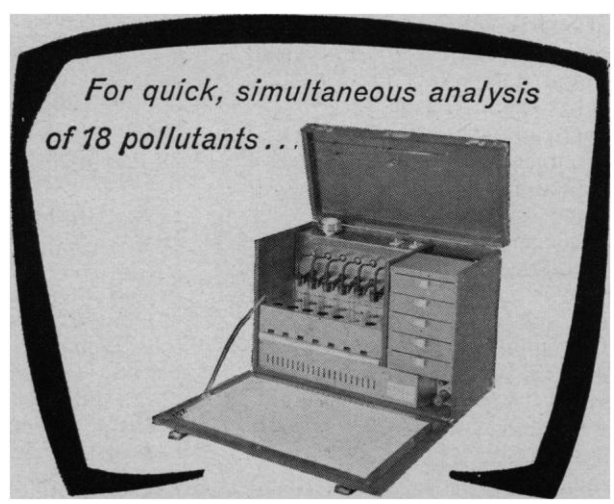

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Letters

On Un-American Science Reporting

The views expressed by your contributors are, of course, their own, and hence, in a given reader's opinion, may be biased or inaccurate or both. This is the essence of free speech. But one has the right, I believe, to expect factual material to be reported truthfully and objectively, without sneers and without slanting. Such is not the case in the news article published in the 1 July issue [*Science* **132**, 24 (1960)] entitled "Un-American Science." The facts as stated are false and misleading. Richard Arens, staff director of the House Committee on Un-American Activities, is reported as having "enemies" who seem to be making progress in getting his job. The reason for this happy situation, as your reporter sees it, is that Arens has been helping W. P. Draper, a New York millionaire, make certain grants, the purpose of which is to prove the Negro mentally inferior to the white, and eventually to work out a plan to send American Negroes back to Africa. Your reporter asserts with poorly concealed glee, that although Representative Walter is, for some reason, not greatly excited, Speaker Rayburn "appeared" to be "extremely upset" by Arens' activities in behalf of "un-American science" and that "it is believed that Arens will no longer be staff director when the next Congress convenes."

Now this stuff is a queer mixture of truth and falsehood. It is true that Arens has enemies, as has every patriotic American who comes out publicly and courageously against subversion, even when found in high places. It is also true that Representative Walter is not concerned about Arens' connection with Draper. It is false that Speaker Rayburn is greatly "upset"; and unfortunately for your reporter's peace of mind, it appears as though Arens will continue as staff director of the Un-American Activities Committee for some time to come.

Your reporter's story is even more reprehensible in its references to W. P. Draper. Draper *is* interested in racial differences, and he would like to see our present immigration laws remain on the books. He is not interested in "proving" the Negro mentally inferior to the white, and he has never proposed a plan for sending Negroes back to Africa nor does he advocate such a scheme.

Draper has made several grants for research in the general area of race relations. His reasons are twofold. First, he believes that objective, unbiased work on racial matters is impossible in those university departments where the equalitarian dogma has been accepted as a basic premise. And secondly, he believes that young men of independent mind hesitate to publish results showing racial differences for fear of reprisal from the almost fanatic believers in racial equality. To those who have experienced the vaunted "tolerance" of the dedicated "liberal," neither of these propositions will seem to be extreme. Grants for research have been made and work is in progress. In no case have any strings been tied to these grants with respect either to method or results. I know this to be true, as I have placed several grants myself.

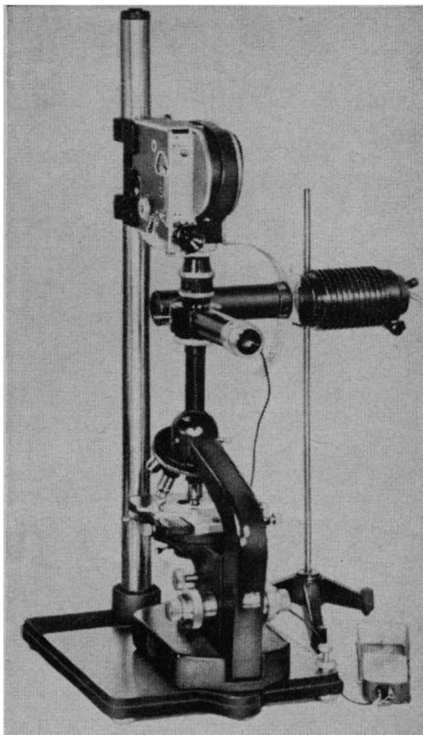
Apparently, your reporter took the "facts" for his story from a news item published some months ago in a Midwestern newspaper by a feature writer who wanted to discredit the Un-American Activities Committee. No attempt, obviously, was made to check the accuracy of these scurrilous statements. As a result, his article is a snide affair in which the editors of *Science* can take little satisfaction.

HENRY E. GARRETT
1872 Winston Road,
Charlottesville, Virginia

Education and Research

It seems to me that Sander Rubin [*Science* **132**, 46 (1 July 1960)] has inadvertently put his finger on the crux of the problem with his statement: "The primary mission of a college is to educate its students, not to conduct research." This is a distinction that is all too frequently made and one that is, in my opinion, false. Certainly in the physical sciences (the only area in which I can claim special competence) one of the things that every student should learn is that the sciences are not a static thing to be learned once and for all, but a continuously growing thing in which new developments require periodic major overhauls of our ways of looking at, and understanding, the universe around us. One of the most important things that a young person can learn in school is the necessity of keeping up with his field, and probably the most important things that such a young person can learn in school are the methods of study and the habit of study which make it possible for him to do so. These are things that, I think, can be really learned only in an atmosphere in which some research is actually going on.

Although I can personally certify to the necessity of these lessons only in the physical sciences, I strongly suspect that it would do no harm for the liberal arts majors to learn them too, at least in the areas of economics and po-



litical science. It has become almost a platitude that the physical sciences have progressed, in recent years, at a rate astronomically greater than the rate of progress shown by the economic and political sciences. I believe one reason for this may be that the nonphysical sciences are too often taught as immutable truths, not subject to continuous re-examination and re-evaluation as a result of experimental tests—that is, research.

CHARLES F. ROBINSON
Consolidated Electrodynamics Corporation, Pasadena, California

May I comment on the statement of Sander Rubin about my "position" in the matter of teaching and research? He stated only half of it—and half a position is worse than none—when he noted that I claimed "any scholar not doing research simply cannot be a fully effective teacher." I also claimed—and neither half is complete in itself—that any scholar not immersed in teaching may have great difficulty in being a fully effective research worker. The point of my letter was not to take sides or to state an ideal but to propose that side-taking in this issue is tantamount to missing the point.

Some scholars prefer teaching, others research; some cannot make a sensible dichotomy. Whatever the case, to prefer one to the *exclusion* of the other may turn one aspect of scholarly activity into a mere technical competence like watchmaking or ghostwriting.

The deeper question is whether we want our universities and colleges (unlike our secondary and preparatory schools) manned by scholars or by Mr. Chipses. The original editorial and my letter [*Science* **131**, 71, 1282 (1960)] came down firmly on the side of scholars. The ultimate question may be whether a university should "give" an education by "good teaching" or create the kind of place in which an education is available to those who have sufficient interest and intelligence to take it.

PAUL BOHANNAN
Northwestern University, Evanston, Illinois

Shatter Cones and Their Origin

The shatter cones in fine-grained limestones and dolomites, described by Dietz [*Science* **131**, 1781 (1960)] are merely a much-magnified version of the cones of percussion well known to archeologists. It is this conical or conchoidal fracture in flints and cherts that made flint-working possible and started mankind on the technological exploitation of his environment.

Miniature cones of this kind are perhaps best seen in plate-glass doors and windows, where they have been produced by the impact of pebbles thrown up by passing cars, or bullets from air rifles or .22's in the hands of teen-agers. The apical angles of these cones are much blunter than in those shown by Dietz—well over 90° in all I have seen. This is presumably because of the lower impact velocity or lower energy of the pebbles, relative to that of a meteorite.

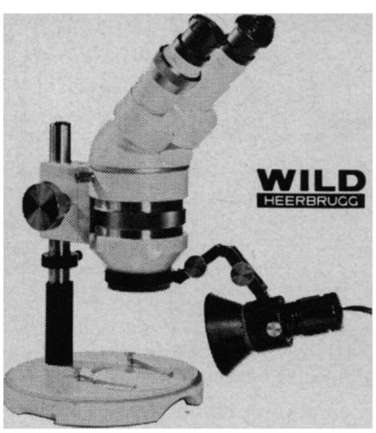
Cones of this perfection rarely if ever appear in worked flint, probably because man had no use for them. The impact of his hammerstone or flaking punch was deliberately localized near the edge of the flint block, so that a flake of controlled size and shape could be split off.

Surely somebody must have worked out the mathematical theory of shock waves in extended solids, such as a thick stratum of stone. Empirically, it can be seen that a greater impact produces sharper cones, that the conical wave penetrates deeper before being damped, and that at high velocities and energies the irregularities in the medium become a less controlling factor. Dietz speaks of shatter cones which have penetrated more than 12 meters in shale, a laminated stone, whereas impact cones are usually stopped by the layer of plastic in safety glass. Nevertheless, the phenomenon of conical fracture in stone cannot be considered one of great energies or velocities, except in so far as the size of the cone is concerned.

I do not recall having seen parasitic coning in flake surfaces in chipped flint. However, this is perhaps because of the distortion of the conical wave form and the different order of magnitude of the energies produced by a blow of a hammerstone and the impact of a meteorite.

The apex of the cone is ordinarily at the point of impact, and this cannot be the case with the parasitic cones. I presume that they develop where the main shock wave strikes some structural discontinuity in the stone, which initiates a new wave at that point. This suggests that where the apices of the presumed master cones are found below the surface of the rock strata, they may themselves be parasitic to a much larger cone with its apex at the surface, produced by the impact. Perhaps more logically, they may have been initiated at points along the front of some sort of spherical shock wave, if such forms exist.

I question Dietz' conclusion that volcanic explosions cannot initiate shatter cones, though they may not be able to produce cones as large or as sharp as those in his illustrations. In any case, cones of volcanic origin should be produced with their apices pointed



downward, or at least toward the focus of volcanic shock, and not toward the surface. Dietz does not specify whether this was the case with the cones at the site of the underground nuclear bomb test.

P. Schuyler Miller
Allegheny Chapter, Society for Pennsylvania Archaeology, Pittsburgh

Formation of cones is a well-known common mode of failure both by percussion and by static loading. The point I make is that shatter cones are a *distinctive* type of percussion cone apparently related in nature to hypervelocity meteorite impact and a subsequent engulfment of the rock by an intense shock wave.

Conchoidal coning is *another* distinctive mode of coning. It is typical of glassy and isotropic cryptocrystalline solids. As the name implies, it is characterized by horizontal shell-like ribbing. Prehistoric man, and convicts working on the stone piles at Sing Sing for that matter, have produced uncounted millions of conchoidal fractures but never a shatter cone.

As I mentioned, artificial shatter cones are produced by nuclear detonations and high-*brisance* explosives. Just recently I have received from E. M. Shoemaker and D. Gault a plaster cast of the target crater produced in Kaibab limestone by a 3/16-in. glass pellet fired at 18,000 ft/sec at the Moffet Field laboratory of the National Aeronautics and Space Administration. At ground zero there is a beautiful nest of minute shatter cones.

The apex of a shatter cone is not the point of impact; rather, shatter cones are formed by the spherically spreading shock wave when it strikes some lithologic discontinuity. The spreading of the fracture is then limited by the next lithologic discontinuity, so that the cone may be either 1 centimeter long or many meters. The apex of the cone points toward the advancing shock-wave front. At the nuclear detonation site mentioned, jumbled and caved rocks had fallen into the explosion cavity. It was not possible to reconstruct the original orientation of the shatter-coned rock.

Shatter cones have never been reported from volcanic explosion sites. I don't believe they exist. Discovery there would be a simple and sufficient disproof of my thesis that shatter cones are a distinctive criterion for hypervelocity meteorite impact. I urge volcanologists to search for them. Science progresses not only by the discovery of new truths but also by discarding erroneous hypotheses.

Robert S. Dietz
U.S. Navy Electronics Laboratory, San Diego, California