SCIENCE

14 May 1965
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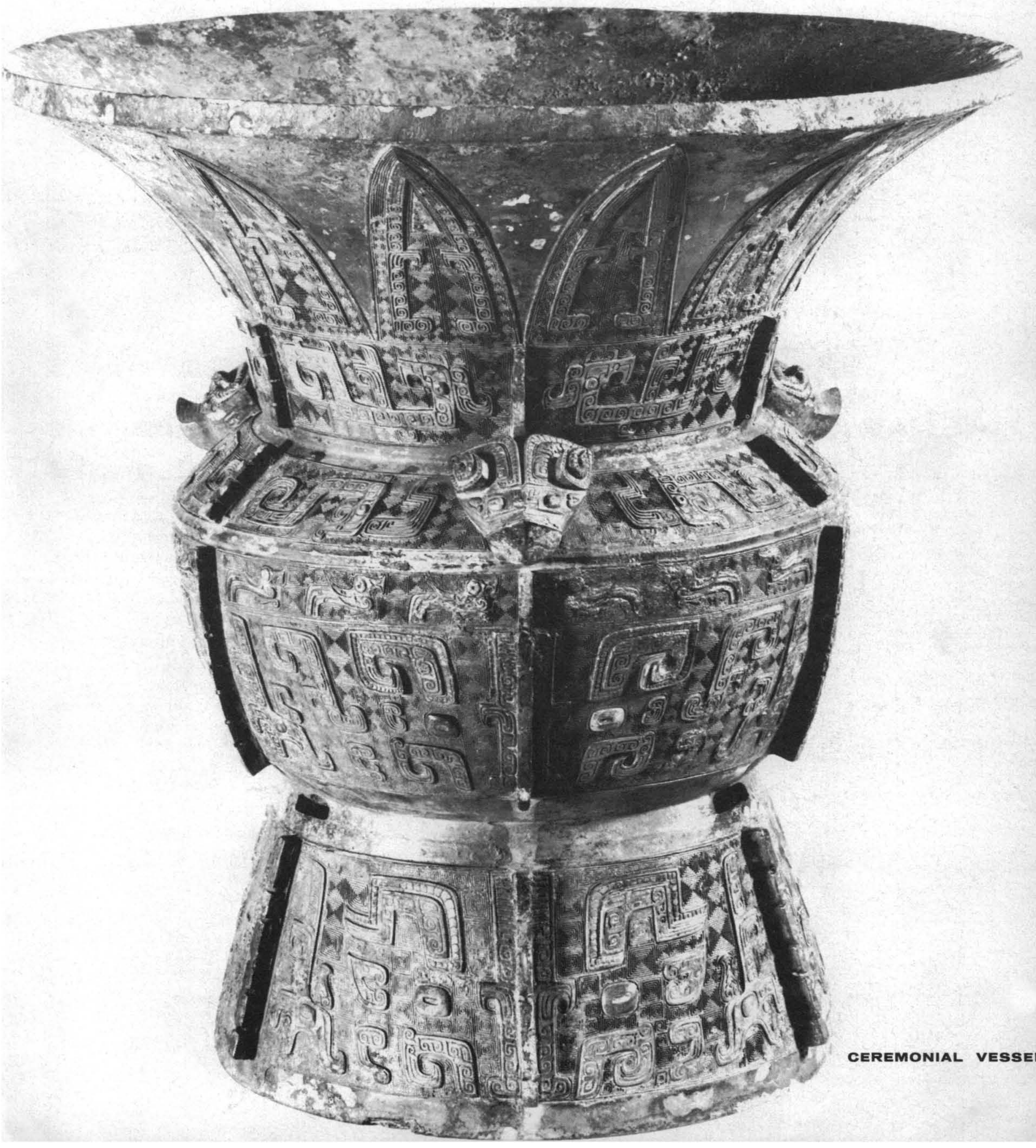
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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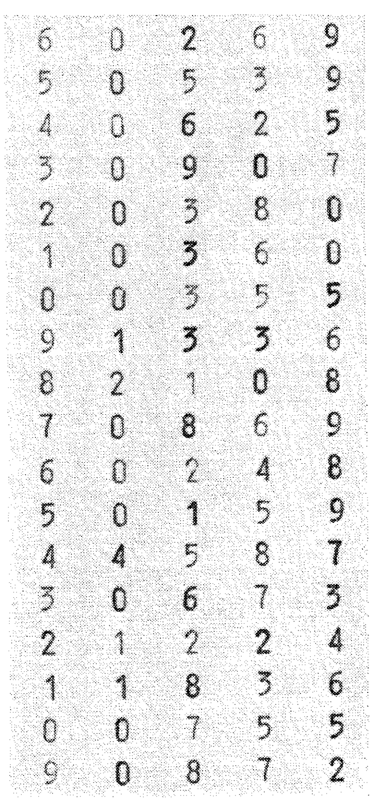

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SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

e American Association for the Advancement of Science was founded in 1848 and incorporated in 74. Its objects are to further the work of scientists, to facilitate cooperation among them, to prove the effectiveness of science in the promotion of human welfare, and to increase public under- anding and appreciation of the importance and promise of the methods of science in human progress.

COVER

Chinese bronze vessel of the type Tsun, Shang Dynasty. Decorations are cast in high and low relief. Patination ranges from dark green to grey with patches of cuprite. Height, 37 centimeters. See page 908. [Freer Gallery, Washington, D.C.]

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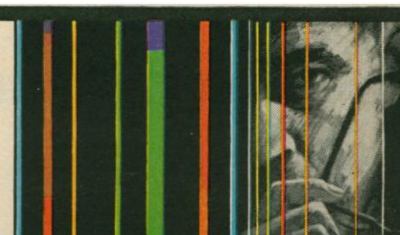

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CHARGED PARTICLES

Extending the capabilities of research equipment

Results from Tandem Research Program

The Tandem Research Group has made notable progress in the past year. Significant experimental results from the program are:

1. 250 mA high-brightness positive ion beam from an expanded-plasma source operating at 38 kv.

2. 270 μA analyzed beam of H_1^+ ions out of the Research Tandem with 320 μA H^- injection and water-vapor stripping.

3. 2.0 μA analyzed dc beam of He^- ions. The previous maximum current routinely available has been 0.1 μA with the EN source.

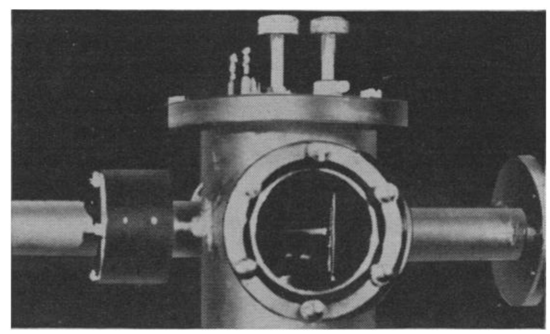
Doubly Charged Helium Ions

Components are now available for converting 3, 4 and 5 MeV machines to produce He^{++} ions at higher energies. Specifications: 30 μA at 5.0 MeV; 10 μA at 7.0 MeV; 5 μA at 10.3 MeV. More than double this current performance has been demonstrated but with some loss in stability and reliability. Multiple-charge states (2, 3 and 4) of neon, oxygen and nitrogen have also been produced with the new kit installed in a 3 MeV Van de Graaff. Beam energies from 50.4 MeV to 9.8 MeV and beam currents from 0.1 to 10 μA were observed. For details on the new HE^{++} kit and experimental results, write for Technical Note #13.

Optical Spectroscopy of Excited Atomic States

When an energetic beam of ions is passed through a thin foil, the charge state of the ion may change, either up or down. The emitted particles may be left in states of electronic excitation from which visible light is subsequently emitted during de-excitation. The emitted light spectrum is characteristic of the excited ion. When particle beams of approximately 0.4 μA or more are used, the light is sufficiently intense for spectroscopic analysis.

The refinement and application of this technique promises to be of major importance in the theory of atomic structure, in measuring hot plasma temperatures, and in acting for the means of energy loss in fast fission fragments in an absorber. Perhaps most importantly, it will help determine the relative abundance of the elements in the sun and other stars, which is the basis for theory of stellar evolution, the origin of the chemical elements, the age of astronomical objects and the nature of the stellar energy. For further details, ask for Technical Note #10.

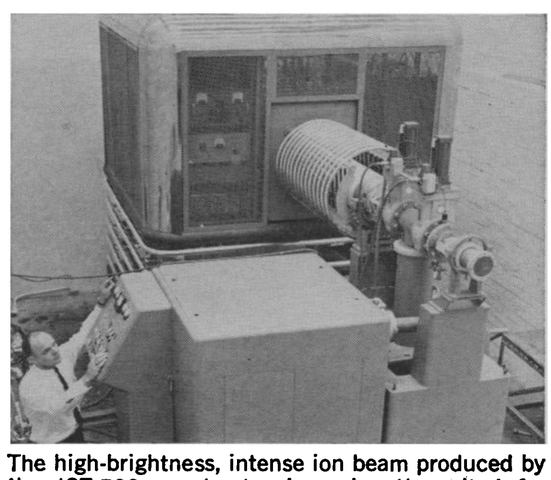


A nitrogen beam, 0.8 μA at 2 MeV, passes from right to left through a carbon foil approximately 9μg/cm² thick.

Intense Ion Beams at 500 kv

The ICT-500 keV positive ion accelerator now being built by High Voltage Engineering operates at energies from 100 to 500 keV dc and pulsed. In performance tests, the machine has produced analyzed ion beam currents from 4 mA at 100 keV to 10 mA from 300 to 500 keV. 10 mA dc positive ion beam currents of H^1, H^2, and D^1 have been produced at a target located 6 feet from the end of the acceleration tube. Beam diameter is 15 millimeters maximum for all particles over the entire energy range. Previous experience with a similar machine of 300 keV maximum energy showed 15 mA of d_2^+ and a 3 centimeter beam diameter. The ICT-500 positive ion accelerator is designed for dc and pulsed operation in the nanosecond and microsecond range with a minimum pulse length of 2 nsec. at a repetition rate of 2.5 Mc/s. Pulse content is 1 mA protons and 0.7 mA deutrons.

The particle source utilized with the ICT-500 positive ion accelerator is an expanded plasma type which has produced 70 mA total beam at 500 kv.



The high-brightness, intense ion beam produced by the ICT-500 accelerator is eminently suited for laboratory production of 14 MeV neutrons for cross-section measurements, dosimetry studies, weapons-effect simulation and special low-density target experiments.

For detailed information, write to Technical Sales, High Voltage Engineering Corp., Burlington, Mass. or HVE (Europa) N.V. Amersfoort, The Netherlands. Subsidiaries: Electronized Chemicals Corporation, Ion Physics Corporation.

HIGH VOLTAGE ENGINEERING

14 May 1965, Volume 148, Number 3672

SCIENCE

Basic Research and National Goals

During the past 2 years the National Academy of Sciences has been increasingly active in exploring policy questions relevant to science. A major instrument for this effort has been a Committee on Science and Public Policy, of which the chairman is George B. Kistiakowsky. This committee in 1964 issued a useful report entitled, "Federal Support of Basic Research in Institutions of Higher Learning." Panels appointed by the committee have studied opportunities and needs in several subjects. An excellent report on ground-based astronomy already has been issued. Another group, a panel on Basic Research and National Goals, has issued its report recently (*Science*, 30 April). This was prepared in response to two extremely difficult questions posed by the Committee on Science and Astronautics of the House of Representatives.

1) What level of Federal support is needed to maintain for the United States a position of leadership through basic research in the advancement of science and technology and their economic, cultural, and military applications?

2) What judgment can be reached on the balance of support now being given by the Federal Government to various fields of scientific endeavor, and on adjustments that should be considered, either within existing levels of overall support or under conditions of increased or decreased overall support?

Most scientists faced with two such riddles are reminded of the good old days when problems were simpler; for example, "How many angels can dance on the head of a pin?" Nevertheless, the two questions are of a kind that Congress frequently faces.

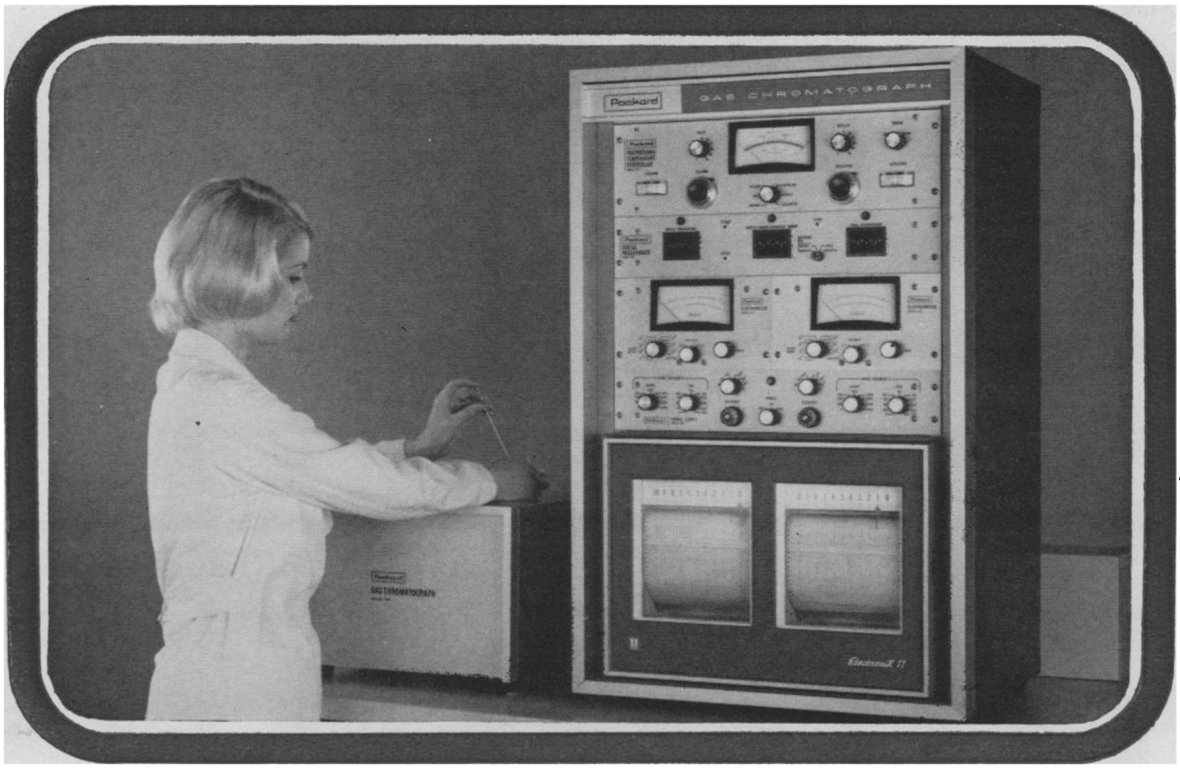
The panel responded to the questions in a manner which was almost unprecedented in Washington. Usually when scientists address themselves to political problems their performance is that of inexperienced politicians. They place a higher value on a consensus than on unearthing the facts, and their report represents only a fraction of the ideas of the group.

In the present instance the approach was different. A panel was constructed whose members held diverse views. Instead of a single report, there were in effect 15. As a consequence, there was much good thinking on the broad problems of basic research and national goals. Scientists generally will find the report interesting and thought-provoking. Congressmen may not find it so valuable; only by interpreting the contents of the 336 pages will they obtain advice.

Nevertheless, a politician can find an answer to the first question. Some panelists advocate an increase of 15 percent per year in the support of basic research. Others do not call for an increase. Few of the panelists make a convincing case that major opportunities are being neglected. A politician may well conclude that an increase of no more than 0 to 15 percent is justifiable.

The report is weak in dealing with question 2. Yet it is in the area of allocation of funds among fields that Congress most needs advice. The report points out that of $1.6 billion devoted to basic research, half goes to space research. We know that another sizable chunk goes to high-energy physics. Not much over $600 million a year goes to areas that are likely to produce substantial benefits for society. In the disposition of the sum remaining there are further inequities. Chemistry, a major source of our industrial strength, gets a tiny fraction. Ultimately we must find better means of allocating research funds.

The report, though uneven, is an important contribution to what is likely to be a continuing dialogue. The panel and its chairman merit our gratitude.—PHILIP H. ABELSON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GAS CHROMATOGRAPH

stressed the unique qualifications of the light microscopist in the interpretation of problems, since, as McCrone stated, "the microscope is the only research tool not adaptable to routine operation by a technician, and the experience of the microscopist is a necessity in sample preparation and interpretation of results." He also proposed a new definition of the term microscopy—as the "study of the composition and behavior of matter on a small scale"—to cover the broad application of the essential tools of the skilled microscopist.

In the session on fibers and polymers, three of the speakers discussed various approaches to the study of the internal structure of fibers. The nature of voids and variations in fiber density was demonstrated by Frederick Morehead (American Viscose) using a double sectioning and embedding technique, involving longitudinal sectioning of viscose rayon. Robert Scott (DuPont), after a brief review of the fundamentals of interferometry, described the combination of this technique with x-ray diffraction and density studies to obtain information about the nature of microvoids and the uniformity of density. Both speakers emphasized the value of birefringence measurements, made with the polarizing microscope, in understanding orientation and density of fibers. Marion Rhodes (University of Massachusetts) described a method of obtaining structural information by mathematical evaluation of low-angle light-scattering patterns of polymers. A polarizing microscope equipped with a Bertrand lens was found most convenient when correlating such patterns with the morphology of the polymers. The size of the lobes of the scattering patterns was related to the average dimension of the spherulites, and this average value gave a more accurate representation of the polymer morphology than could be obtained by direct measurement, which would have been hampered by the presence of background spherulites as well as intergrown material which would be difficult or impossible to measure directly.

Illustrations were presented of these applications and of the changes occurring in polymers during thermal treatment. The surface topography of fibers was explored by Joseph Bloxsom, who described how the Tolansky light-profile technique could be used to make quantitative measurements of height-depth variations. This method involves the projection of a reticle in the object plane of a microscope. Quantitative measurements are made by observing the displacement of the ghost reticle in a previously calibrated system. The technique may be used on solid or liquid surfaces and does not require that they be highly reflective. It may be used to determine thickness and refractive index of transparent films and, being nondestructive, is of value in studying time-dependent behavior.

The proceedings of this meeting will be published and are expected to be available next fall at $5 per copy through the New York Microscopical Society, located at the Museum of Natural History, 79th Street and Central Park West, New York, N.Y.

MARIE JONES
Bristol-Myers Company,
Hillside, New Jersey

The Electron Microscope and Its Future Development

The first successful operation of an electron microscope in North America was announced in 1939 (*1*). Many of the formidable technical obstacles that lay in the way of obtaining electron optical images at high magnification were overcome in the encouraging atmosphere of E. F. Burton's laboratory at the University of Toronto. Accordingly, to commemorate the anniversary of the announcement, the Burton Society of Electron Microscopists held a special meeting at the university on 16 January 1965. The work of Burton's talented group of students (which included Cecil Hall, J. Hillier, W. A. Ladd, and A. F. Prebus) was described by Hillier (now at RCA, Princeton). The achievement of Hillier and co-workers in rapidly making a modified version of the Toronto microscope commercially available to biologists and physicists considerably influenced the pace of development of ultrastructural investigations.

J. H. Reisner (RCA, Camden) discussed the possibilities of viewing the electron optical image by an image intensifier–television system. It was pointed out that image intensifiers allow electron microscope images to be seen comfortably in a bright room, while the illuminating beam is actually reduced below normal operating intensity. Methods of recording images on video tape and of analyzing the image were discussed. A method of analyzing the final image by means of a pulse-height analyzer system was described. Each line of the TV scan can be separately analyzed to show the number and density of objects in this part of the image. R. K. Ham (McMaster University) reviewed some recent developments in the transmission electron microscopy of thin crystalline films, especially metals, and gave an outline of the principles of diffraction contrast and the use of selected area electron diffraction. R. D. Heidenreich (Bell Telephone Laboratories) discussed the resolution and contrast limitations in imaging single atoms. He used a wave optical approach, based on reconstruction of the diffraction image present in the back focal plane of the objective lens, to show the limitation in resolution due to the spherical aberration of the objective lens. Deterioration of the image due to inclusion of inelastically scattered electrons was also discussed. D. F. Parsons (University of Toronto) discussed biological applications of electron diffraction and, in particular, recent work on the configuration of polyamino acids in very thin, oriented films.

These lectures were followed by a panel discussion about future development of the electron microscope. Possible ways of enhancing electron optical contrast in order to avoid the use of heavy metal stains for biological materials were discussed. J. H. Reisner indicated that most microscopes in present use are not adjusted for maximum contrast. It is possible to find, for a given microscope, accelerating voltage, focal length for the objective lens, and size and position for the objective aperture which will give optimum contrast. Reisner pointed out that all the information necessary for making these adjustments has been published but has never been summarized in a convenient form for the electron microscopist.

Members of the panel agreed that the best approach to increased electron optical contrast was by use of in-focus phase contrast. This appeared more satisfactory than the low accelerating voltage approach, since there would be less damage to the specimen being examined. In fact, it appears desirable to increase the accelerating voltage above present levels (40 to 100 kv) in order to reduce such damage. Ham indicated that an extra-high-voltage electron microscope would enable thicker and more representative metal specimens to be examined with less loss of contrast due to inelastically scattered electrons. Possible methods of achieving phase contrast were discussed by Heidenreich, Hillier, A. F. Howatson (University of Toronto), and Reisner. Reisner considered that since the deposition of contamination (a layer of carbon formed by breakdown of hydrocarbon vapor) on objects in the beam can be minimized by surrounding them with a cooled metal surface, it is now more feasible to maintain a quarter wavelength phase plate in operating condition for a practical length of time. However, considerable technical difficulties in the manufacture of phase plates and in protecting them from damage by the electron beam have to be faced. F. W. C. Boswell (Waterloo University) considered that an improvement in contrast would be useful also, for inorganic specimens, in detecting vacancies and small dislocations in crystalline substances.

Hillier prefaced a discussion on improving the resolution beyond the present 5 Å for nonperiodic structures by asking whether such an improvement could be justified in terms of available specimens. At this level of resolution, the specimen would need to be very much thinner than the present minimum 50- to 200-Å thickness. A clear picture of molecular structure or individual atoms can only be obtained if the film is a few atoms or molecules thick. This would preclude the use of the relatively thick conventional Formvar or carbon support films and would require a different way of mounting the specimen. At present there appear to be more possibilities for improving the resolution of the microscope than for improving techniques for the preparation of specimens. Improvements in the objective lens design were discussed by Boswell, Heidenreich, Hillier, Reisner, and B. W. Schumacher (Ontario Research Foundation). The advantages of superconducting magnet lenses were described. With the use of such a lens, using a few turns of wire, it should be possible to make a dimensionally "thin lens" with the spherical aberration reduced to one-half or one-third of usual values. The high magnetic stability of such lenses was emphasized. Schumacher asked whether a mathematical analysis of strong magnetic and electrostatic lenses with intercombined fields should not be made in the hope of finding systems of smaller overall spherical aberration but still having rotational symmetry.

The early studies of Gabor along these lines were restricted to weak lenses and limited by the fact that computers were not then available. Hillier then brought up the possibility of obtaining a negative spherical aberration lens, suggesting that one type of negative correcting lens (having a very thin charged membrane across the aperture) should be reconsidered now that contamination can be reduced to small proportions. Heidenreich pointed out the necessity for filtering out inelastically scattered electrons. These electrons contain no determinate information about the structure of the object and only cause deterioration in resolution and contrast. However, Schumacher suggested that energy loss contrast is worth investigation where contrast, rather than the resolution, is the limiting factor. The intermediate or final image can be subjected to energy loss analysis in order to accentuate this type of contrast. Reisner pointed out that loss of resolution may also occur due to charging of the specimen. He suggested that a conducting type of resin might be advantageous for reducing charging over thin sections of tissue. More use might be made of thin carbon films evaporated over the specimen. Reisner considered that it would be difficult to neutralize the charges on the specimen with a low-voltage electron gun since the gun itself might cause the specimen to charge up. R. G. E. Murray (University of Western Ontario) indicated that a number of features of present-day microscopes could be improved; for instance, a more efficient phosphor for the viewing screen might be found and a better method of comparing exactly the dimensions of two specimens (or one specimen and a magnification standard) might be devised. There was also some discussion of the difficulties currently experienced by some electron microscopists in preventing significant etching of biological specimens while using cooled-surface, anticontamination devices.

The meeting was adjourned with the resolve to hold further discussions in the near future in Toronto on electron microscope development.

D. F. PARSONS

Department of Medical Biophysics, University of Toronto, Toronto 5, Canada

Reference

1. A. Prebus and J. Hillier, *Can. J. Research* **A17**, 49 (1939); E. F. Burton, J. Hillier, A. Prebus, *Phys. Rev.* **56**, 1171 (1939).

Forthcoming Events

May

20–21. **Fiber** Soc., Atlanta, Ga. (L. Rebenfeld, Box 625, Princeton, N.J.)

20–21. Medical Diagnostic Applications of **Ultrasound**, conf., Pittsburgh, Pa. (C. Moses, Univ. of Pittsburgh School of Medicine, Pittsburgh 15213)

20–22. American **Cleft Palate** Assoc., annual, New York, N.Y. (C. O. Wells, Parker Hall, Columbia, Mo.)

20–22. **Diabetology**, Paris, France. (M. Rathery, Hôtel-Dieu, 1, Pl. du Parvis Nôtre-Dame, Paris 4ᵉ)

20–22. American **Gynecological** Soc., New York, N.Y. (C. J. Lund, 260 Crittenden Blvd., Rochester 20, N.Y.)

20–25. **Intersexuality in Fishes**, Sarasota, Fla. (E. Clark, Cape Haze Marine Laboratory, 9501 Blind Pass Rd., Sarasota)

21–22. **Surface Physics**, 3rd annual symp., Pullman, Wash. (E. E. Donaldson, Dept. of Physics, Washington State Univ., Pullman)

21–22. **Women of Science**, symp., Bennington, Vt. (H. W. Toolan, Putnam Memorial Hospital Inst. for Medical Research, Bennington)

21–23. **Exfoliative Cytology**, 2nd intern. congr., Paris, France. (Intern. Acad. of Cytology, 5841 Maryland Ave., Chicago, Ill. 60637)

23–24. American **Laryngological** Assoc., annual, Colorado Springs, Colo. (L. G. Richards, 12 Clovelly Rd., Wellesley Hills 82, Mass.)

23–26. **Administrative Management** Soc., 46th intern. conf., Minneapolis, Minn. (R. C. Walter, 32 W. 40 St., New York 10018)

23–26. **Radiation Research**, 13th annual, Philadelphia, Pa. (A. C. Upton, Biology Div., Oak Ridge Natl. Laboratory, Oak Ridge, Tenn.)

23–26. **Social Medicine**, intern. conf., Berlin, Germany. (Secretariat, Deutsche Gesellschaft für Sozialmedizin, Alsterglacis 3, Hamburg 13, Germany)

24–26. **Hygiene and Preventive Medicine**, 4th intern. congr., Vienna, Austria. (Vienna Acad. of Medicine, Alserstr. 4, Vienna 9)

24–26. **Standardization of Pharmaceutical Preparations**, 2nd intern. congr., Leipzig, East Germany. (J. Richter, Deutsches Inst. für Arzneimittelwesen, Grosse Seestr. 4, Berlin-Weissensee, East Germany)

24–27. **Thyroid**, 5th intern. conf., Rome, Italy. (T. Winship, American Thyroid Assoc., 110 Irving St., NW, Washington, D.C. 20010)

24–28. Australian Inst. of **Metals**, annual conf., Brisbane. (Secretary, AIM, P.O. Box 107, North Quay, Brisbane)

24–28. International **Planned Parenthood** Federation, Western Pacific regional conf., Seoul, Korea. (T. Katagiri, IPPF Western Pacific Regional Office, No. 2, 1-chome, Sadohara-cho, Ichigaya, Shinjuku, Tokyo, Japan)

24–28. **Radioisotope Sample Measurement Techniques** in Medicine and Biology, intern. symp., Vienna, Austria. (J. H. Kane, Intern. Conferences Branch, Div. of Special Projects, U.S. Atomic Energy Commission, Washington, D.C. 20545)

24–29. International Federation for **Information Processing**, congr., New York, N.Y. (AFIP, 345 E. 47 St., New York 10017)

24–1. **Cloud Physics**, intern. conf., Tokyo and Sapporo, Japan. (H. Hatakeyama, Japan Meteorological Agency, Otemachi Chiyoda-ku, Tokyo)

25. American **Iron and Steel Inst.**, annual, New York, N.Y. (G. S. Rose, 150 E. 42 St., New York 10017)

25–26. American **Otological** Soc., Colorado Springs, Colo. (J. A. Moore, 525 E. 68 St., New York 10021)

25–27. Armed Forces **Communications and Electronics** Assoc., 19th annual conv., Washington, D.C. (AFCEA, 1725 Eye St., NW, Washington 20006)

25–27. American Astronautical Soc./Aerospace Electrical Soc., **Space Electronics** symp., Los Angeles, Calif. (L. T. Isaacs, Douglas Aircraft Corp., Long Beach, Calif.)

25–28. American Assoc. for **Contamination Control**, 4th annual, Miami Beach, Fla. (W. T. Maloney, AACC, 6 Beacon St., Boston, Mass. 02108)

25–29. Structure and Control of the **Melanocyte**, conf., Sofia, Bulgaria. (N. Anchev, c/o Oncological Inst., Sofia)

25–29. American Assoc. on **Mental Deficiency**, 89th annual, Miami Beach, Fla. (J. E. Horner, AAMD, Oregon Fairview Home, 2250 Strong Rd., SE Salem)

26–28. Canadian **Botanical** Assoc., Carleton University, Ottawa, Ont. (R. L. Taylor, Plant Research Inst., C.E.F., Ottawa, Canada)

26–28. **Cineradiography**, 3rd symp., Antwerp, Belgium. (S. Masy, Steenweg op Waver 256, Heverle, Belgium)

26–28. **Peaceful Uses of Space**, 5th natl. conf., St. Louis, Mo. (G. W. Ferguson, Fleishman-Hillard, Inc., 407 N. 8 St., St. Louis 63101)

26–28. **Analysis Instrumentation** and Chemical and Petroleum Instrumentation, 1st ISA intern. symp., Montreal, Quebec, Canada. (E. J. Minnar, ISA, 530 William Penn Pl., Pittsburgh, Pa. 16219)

26–29. Biological Characterization of **Human Tumors**, intern. symp., Abbaye de Royaumont, France. (W. Davis, c/o Chester Beatty Research Inst., Fulham Rd., London, S.W.3, England)

26–29. Electrochemical Aspects of **Molecular Biology**, symp., Jena, East Germany. (H. Berg, Inst. für Mikrobiologie und Experimentelle Therapie, Deutsche Akademie der Wissenschaften zu Berlin, Beuthenbergstr. 11, Jena)

27–29. American **Gastroenterological** Assoc., Montreal, Quebec, Canada. (D. Cayer, 2240 Cloverdale Ave., Winston-Salem, N.C.)

27–29. American **Ophthalmological** Soc., Hot Springs, Va. (S. D. McPherson, Jr., 1110 W. Main St., Durham, N.C.)

27–29. American Assoc. of **Physical Anthropologists**, annual, Pennsylvania State Univ., University Park. (F. E. Johnston, Dept. of Anthropology, Univ. of Pennsylvania, Philadelphia 4)

27–30. **Neuro-Ophthalmology and Neurogenetics**, intern. congr., Albi, France. (M. Amalric, Congrès Intern. de Neuro-Ophthalmologie et Neuro-Génétique, B.P. 79, Albi, Tarn, France)