optical emission spectra can be utilized for the detection and determination of all members of the rare-earth group at either the trace or major constituent level" (p. 597). The author of the above quoted statement warns against errors in tests for traces on account of line misidentifications in the *M.I.T. Wavelength Tables* (John Wiley & Sons, 1939), but he fails to mention the more modern tables of Gatterer and Junkes (*Spektren der seltenen Erden,* Vatican City Press, 1945) which contain, for rare earths, nearly 10 000 more spectral lines and far fewer misidentifications than the *M.I.T. Wavelength Tables.*

The Rare Earths is certainly a most opportune and valuable source book of information about rare earths and associated elements; it should appeal strongly to chemists, physicists, crystallographers, metallurgists, and graduate students. Indeed, it is indispensable to anyone interested in the exciting possibilities presented to science, technology, and education by the sudden appearance of 16 essentially new metals. Rarely, in the history of science, has there been such a bonanza for chemical and physical study and research or for technological development.

Principles of Cyclic Particle Accelerators. By John J. Livingood. 392 pp. D. Van Nostrand Co., Inc., Princeton, N. J., 1961. $10.75. *Reviewed by Theodore F. Zipf, Lawrence Radiation Laboratory, Berkeley.*

SINCE 1945, the technique of accelerating charged particles to high energies has advanced tremendously. To the reviewer's knowledge, this book is the most comprehensive elementary treatise available on the subject. Needless to say, the need for such a book has grown as rapidly as the subject which it treats.

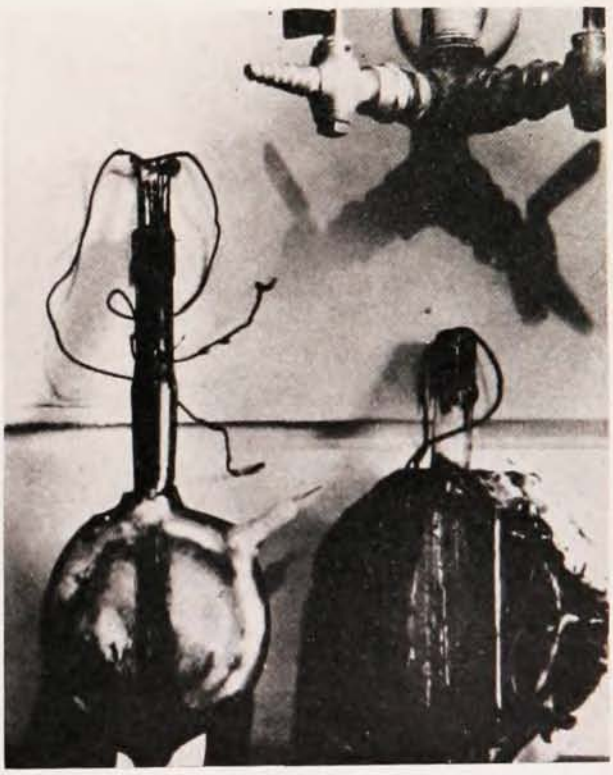
It is the author's stated intent that the book be a relatively self-contained introduction to the field, suitable for the novice. Thus the first six chapters are devoted to a description of the basic principles involved in accelerator design. Chapter 1 contains historical background, a brief description of the various common types of accelerators, and a simple treatment of the pertinent kinematics. The next five chapters cover orbital stability, weak focussing, resonances, and phase stability. Each of these subjects is treated in detail and useful calculational methods are introduced. Throughout these introductory chapters one finds, at strategic locations, pertinent comments on the application of these basic principles to actual accelerator design problems.

In the chapters which follow, each of the various types of accelerators is described in detail. Many machines which have either been built or are in the advanced planning stages are discussed. Obviously a great deal of research has gone into this part of the book. The author's many years of experience in the accelerator field are of special value here. He has selected only relevant facts and has avoided consuming a large amount of space with inconsequential information. Rather lengthy chapters are devoted to fixed-frequency cyclotrons, weak-focusing synchrotrons, alternating-gradient synchrotrons, FFAG machines, and linear acclerators. Synchrocyclotrons, betatrons, and microtrons are described in relatively short chapters. One entire chapter discusses quadrupole lenses and the final chapter gives a brief introduction to stochastic accelerators.

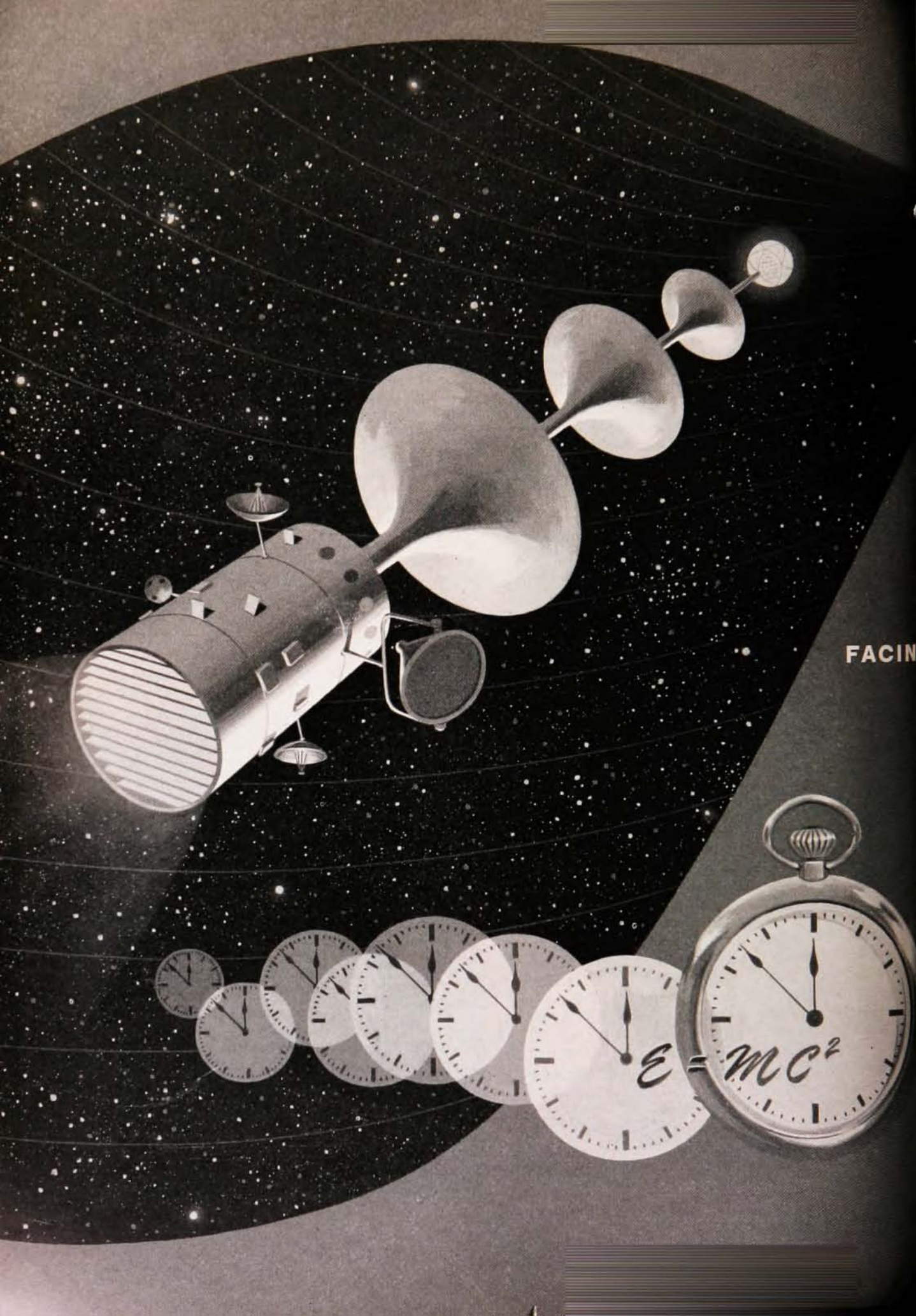
The book is well illustrated with many diagrams and photographs. One of the most valuable features is the annotated bibliography of published literature on accelerators which appears at the end of the book. References are listed according to the type of accelerator and are in chronological order.

One criticism is that the author does not introduce the principle of strong focussing in detail early in the book. The introduction, which is given in the first section of the chapter on alternating-gradient synchrotrons, may prove to be too abstract for the uninitiated. It should be pointed out, however, that any reluctance on the part of the reader to accept the principle will probably be removed by the chapter on quadrupole lenses. This criticism should not be taken too seriously since it does not detract from the over-all value of the book.

This book is certainly a worthwhile and welcome addition to the literature on particle accelerators. It is to



Prototype cyclotron: glass flasks for vacuum chambers with dees of silver coating as used by Lawrence and Edlefsen in 1930 (from the book *Principles of Cyclic Particle Accelerators*).


FACIN
E = MC²

HE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles & Space Company, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Company in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24I, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.

LOCKHEED MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS programs. Other current programs include SAINT, ADVENT and such NASA projects as OGO, OAO, ECHO, and NIMBUS.

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

be recommended not only to engineers and physicists interested in learning the principles of accelerators per se but also to research scientists planning to participate in that nuclear physics research which requires the use of these machines.

Essay on Atomism. From Democritus to 1960. By Lancelot Law Whyte. 108 pp. Wesleyan U. Press, Middletown, Conn., 1961. $2.95. *Reviewed by Cyril Stanley Smith, Massachusetts Institute of Technology.*

THIS book is a good introduction to the idea of atomism, stressing the variety of concepts and the transformation from the initial Democritan division of occupied and void space to our present belief that particles are in some measure a function of their environment. A central part of the book is the chronological table which provides pegs for various discourses. The persisting problem of discreteness *vs.* continuity in knowledge generally is treated with a brevity unusual for a philosopher.

Not all physicists will like *Essay on Atomism* but it is recommended reading for graduate students because of its discussion of how traditional ideas have always carried with them a block against more fruitful alternate patterns of thinking. Perhaps, says the author, "the obstructive element in current theory may conceivably be a persisting excessive reliance on symmetry and invariance." Anyone hoping to make a contribution of fundamental importance who encounters this book will pause before doing the next obviously valuable experiment or theoretical analysis, to seek qualitatively the kind of thought that is needed in physics.

Techniques of High-Energy Physics. David M. Ritson, ed. Vol. 5 of Monographs and Texts in Physics and Astronomy, edited by R. E. Marshak. 540 pp. Interscience Publishers, Inc., New York, 1961. $16.75. *Reviewed by Herman Yagoda, Air Force Cambridge Research Laboratories.*

THIS volume presents an excellent summary of the techniques employed in the detection and measurement of high-energy particles as produced in beam form by accelerators and occurring as a sparse flux in the cosmic radiation. It is devoted largely to methods of estimating the mass, charge, kinetic energy and momenta of the nucleons and associated fundamental particles. David M. Ritson introduces the subject with a chapter on the general properties of particles and radiation whose fundamental tenets are applicable to the diverse detectors of increasing stopping power. About one third of the book is devoted to the construction and operation of diffusion cloud chambers, liquid bubble chambers and the nuclear emulsion. These abound in details of the plumbing essential to their proper operation. The section on nuclear emulsions has scored a first in being the only review that does not exhibit photographs of tracks produced by ionizing particles. This may be taken as a tacit acknowledgement that this detector has definitely arrived.

The prodigious accumulation of information by these devices and related ionization chambers, scintillation and Čerenkov counters, and transistors of which the book treats, necessitates a chapter on the use of digital computers to expedite the flow of data. The volume also treats of beam optics and target preparation and has several valuable appendices, in one of which the diverse techniques are compared with regard to the accuracy of measurements attainable.

Theoretical Aspects of Very High-Energy Phenomena, IUPAP Conf. Proc. (CERN, Geneva, June 1961). J. S. Bell, F. Cerulus, T. Ericson, J. Nilsson, H. Rollnik, eds. 426 pp. CERN, Geneva, 1961. Paperbound. *Reviewed by D. Keefe, Lawrence Radiation Laboratory, Berkeley.*

THE spectacularly successful construction and operation of strong-focusing accelerators in the 30-Bev range at CERN and Brookhaven has raised the problem of what the next step should be in the high-energy field. In the past year three groups—one in Europe, two in this country—have met to discuss the future of high-energy accelerators. Various energies, ranging from 100 Bev to 1000 Bev, have been suggested as possible goals for which to aim. In general, the terms of reference for any preliminary study of such a new machine reduce to three questions:

> Can it be built and made to work?
> Will transport and detection techniques be adequate for successful experimentation in the new energy region?
> Are there experiments which can only be done at such an accelerator and are they sufficient in number and importance fully to warrant its construction?

To provide answers several years in advance can involve at best only an educated guess. Almost all experts agree that the answer to the first two is a simple affirmative; the third question is the one that involves the most crystal-gazing and is illuminated best in this CERN conference report.

One summary paper, by A. Schoch, on the likely design parameters for a high-energy AGS and two short reports on the Stanford and Frascati colliding electron-beam projects complete the contributions concerning accelerators. One session was devoted to the experimental results of high-energy interaction studies using the CERN Proton-Synchrotron and emulsion work on "jets" by the Bristol and Cracow groups. By far the greater fraction of time was devoted to theoretical papers on weak and electromagnetic interactions, the statistical model, diffraction theory, peripheral collisions, and dispersion relations. In each of these fields there are many exciting predictions which can only be checked by experiments at sufficiently high energies. For example, the weak interactions grow enormously in strength, and many