

Le Grand Carnot, Engineer and Scientist

Lazare Carnot, Savant

By C. C. Gillispie

359 pp. Princeton U. P.,
Princeton, N. J., 1971. \$17.50

Reviewed by Robert E. Schofield

Lazare Carnot (1753–1823) is chiefly known as “le Grand Carnot,” the military engineer whose tough-minded grasp of political realities carried him to membership in the powerful Committee of Public Safety and whose restructuring of French Revolutionary armies during the crucial winter of 1793–94 justly earned him the title, “Organizer of Victory.” In *Lazare Carnot, Savant* Charles Gillispie, long-time student of French science during the revolutionary period, attempts to redress the balance. Prompted by the discovery of original Carnot manuscripts relating to mechanics and mathematics, Gillispie, with the aid of A. P. Youschkevitch, historian and philosopher of mathematics, concentrates on Carnot the engineer-scientist and argues that his writings helped to define the scientific character of early 19th-century French engineering and significantly influenced the thermodynamic studies of his famous son, Sadi Carnot.

The short contribution by Youschkevitch begins with an analysis of an essay on the theory of the infinite in mathematics submitted unsuccessfully by Lazare in 1786 for a prize competition of the Berlin Academy of Sciences. Youschkevitch traces the development of Carnot's ideas into the *Reflexions sur la metaphysique du calcul infinitesimal*, his most popular work published first in 1797, and shows that the basic concept—validation of the use of the calculus by demonstration of necessarily compensating errors—is an ingenious variation on a characteristic 18th-century approach to mathematical analysis.

The remainder of the text is essentially devoted to Gillispie's treatment of Lazare's work on machines. Although a biographical chapter places Lazare in his political and socio-scientific setting and another chapter analyzes Carnot's published writings on al-



Lazare-Nicolas-Marguerite Carnot while War Minister of France (1793–1795). This engraving is from a book on the life of Napoleon by William M. Sloane published by Princeton University Press in 1886.

gebra, trigonometry, and the theory of transversals, the core of the work is to be found in three chapters on his theory of machines, its reception, and its influence on Sadi Carnot's *Reflexions sur la puissance motrice du feu*. Here

the discussion again begins with an essay, submitted in two versions of 1778 and 1780, for a prize contest of the Paris Academy of Sciences on the theory of simple machines with regard to friction. Neither version won the

Chromabeam dye laser

1050

CONTINUOUSLY
TUNABLE FROM
4300Å to 6500Å
AT $\frac{1}{2}$ MEGAWATT
PER PULSE

PRICE: \$2595.



SYNERGETICS
RESEARCH INC

princeton n.j.
609 452-8980

Circle No. 21 on Reader Service Card

High Voltage Gate Generator Image Intensifier Test Set



- PRF to 10 KHz ■ Max. Pulse Amplitude...3000 v P/P
- 55 ns rise and fall times ■ Completely solid state
- Output gate can be floated to ± 25 KV
- Pulse Width Adj. from 0.5 μ sec. to 100 msec.
- Pulse Delay Adj. from 0.3 μ sec. to 50 μ sec.

APPLICATIONS:

- QC inspection/test ■ laboratory simulation ■ high speed shutter for image intensifier tube ■ automatic exposure control for intensifier tube or photomultiplier
- LIDAR range gate ■ direct viewing image intensifiers
- vidicon coupled image intensifiers

Send for the NEW Venus Catalog featuring
many High Voltage Power Supplies as off the shelf items

Venus Scientific Inc.

399 Smith Street, Farmingdale, N.Y. 11735
Telephone (516) 293-4100 - TWX 510-224-6492

Circle No. 22 on Reader Service Card

prize, but a rewritten version was published in 1783 as *Essai sur les machines en general*, with a second edition of 1786, and that *Essai* was again rewritten to be published in 1803 as *Principes fondamentaux de l'équilibre et du mouvement*.

There seems little doubt but that Lazare's scientific work was scarcely recognized during his lifetime. Though he served as an officer of the scientific branch of the Institut de France, his membership of the Institut was a consequence of political position, not scientific accomplishment. His analysis of machines began to attract some attention during the early decades of the 19th century, particularly among the young fellow students of Sadi Carnot, at the Ecole Polytechnique, but the significance of the mode of analysis was recognized only after the principles had become commonplace and the methods transcended in the work of others. The final justification for the detailed and elaborate presentation given Lazare's work here must, therefore, ultimately lie in the connection between it and the work of Sadi.

Gillispie's analysis of Carnot's work is a necessary but not an easy guide to an idiosyncratic approach to machines. Lazare characteristically developed mechanics as an engineering science, not in the form of a practical handbook nor as mathematical analysis. His work is abstract, but verbal, generalizing all machines as the means of continuous transmission of power. To outflank the problem of apparent discontinuity of change of motion in hard bodies, Lazare develops the concept of work and its equivalence to *vis viva* (defined as kinetic energy) and introduces a concept of "geometrical motions"—that is, those in which possible or actual displacements can occur without work being done within the system. These are the major characteristics that Gillispie finds transmitted, as a Carnot family style, into the work of Sadi: reversible processes, formally equivalent to geometric motions, permitting a comparison of initial and final states without concern for internal energy; a similarity between Lazare's hydraulic machines and Sadi's fluid-of-heat engines, and a strong similarity in the rigorous but verbal style of generalization from mechanics to design of machinery.

From Lazare's work beginning in 1778, through its successive refinements and into his Institut reports on the heat engines of the Niepce brothers of 1806 and of Cagniard in 1809, to Sadi's work of 1823, is a long and complicated journey. Gillispie presents some persuasive arguments that it is a path worth following for the future understanding of French engineering

science and of the achievement of Sadi. One could wish that the details of the argument had been brought out more clearly and in a less imposing and expensive format. It is, in fact, unfortunate that 1971 does not appear to mark any significant anniversary in the life or career of Lazare, to justify in this volume its characteristic marks of an anniversary memoir. Handsomely designed, more than half its pages consist of photographic reproductions—of the complete text of the manuscript of the Berlin essay and of copious extracts of the theoretical sections from the two Paris contest entries. The volume concludes with a useful bibliography.

* * *

Robert E. Schofield is a Professor of History of Science at Case Western Reserve University, Cleveland, Ohio.

Physics: The Behavior of Particles

By P. Stehle
434 pp. Harper and Row,
New York, 1971. \$10.95

Philip Stehle has written a text to be used in the standard noncalculus physics course. Such a course is attended in the main by lethargic life-science types, a few overeager medical and dental school aspirants, and an occasional stray soul from history or philosophy. To this group Stehle adds the future professional physicist and then sets himself the task of educating the lot without sacrificing their training.

His *idée fixe* is the particle, its varieties, existence and motion through the physical world. This perspective allows much of what has properly passed from the province of physics to the practice of engineering to be ignored. It also emphasizes modern physics, where the single-entity explanation of almost every phenomenon is favored because of its ease of mathematical formulation. This approach is thus both clever and promising.

The organization of the material is rather standard; a definition of physics, the compulsory superficial treatment of vectors, then a headlong plunge into Newtonian mechanics, which starts by stating the three laws and ends with energy and momentum conservation. The Lorentz force is discussed, and then the atom and its nucleus is explored. Relativistic mechanics is called forth, and a couple of denizens of the erstwhile elementary-particle zoo are exhibited. Light, relativity, and the electromagnetic wave

are merged, before chapters on kinetic theory and electrons in solids complete the exposition. The definition of physics is then revisited, and the book trails off with the inevitable tables of physical constants, answers to the odd-numbered problems, and so on.

The author's style is clear, informal and readable, but not exciting. The book itself is mediocre, the graphics unimaginative, the combination of type face and paper tiring to study, and the layout is uninteresting.

In my opinion the chief failure of the text lies with its choice of audience. A text that focuses on topics, examples and problems describing the physics encountered in biological and medical applications would better serve the typical noncalculus physics student. The audience of humanists, now almost a null set, could be expanded and stimulated by a course that dwells on concepts and principles, their philosophy and history, and deletes the details in which physicists delight. It is the student of engineering and natural science who could benefit most from Stehle's particle organization of physics. The gratitude accorded Halliday and Resnick for their fine book has begun to wain, while the over-stimulative efforts of the Feynman and the Berkeley series do not seem to work for the usual class. It is in this niche where the impact of Stehle's interesting organization could be most effective.

W. PETER TROWER
Virginia Polytechnic Institute and
State University
Blacksburg, Virginia

Introduction to the Theory of Solid State Physics

By J. D. Patterson
388 pp. Addison-Wesley, Reading,
Mass., 1971. \$14.50

This book is intended as a text suitable for second-year graduate students. The author, James D. Patterson, is associate professor of physics at the South Dakota School of Mines and Technology. His intention is to "present the fundamental aspects of solid state physics in a somewhat more than superficial way." The level of presentation is intermediate between elementary Kittel (*Introduction to Solid State Physics*) and advanced Kittel (*Quantum Theory of Solids*).

The book begins with a qualitative discussion of crystal structures and binding. A small amount of group theory is presented, and lattice vibrations, the Hartree-Fock approximation, and band theory follow. Many

New Books from North-Holland

Internal Friction of Structural Defects in Crystalline Solids

By R. de Batist, Studiecentrum voor Kernergie, Mol, and University of Antwerp

Defects in Crystalline Solids, Vol. 5

Contents: Structural defects in crystalline solids. Internal friction. Relaxation of point defects. Dislocation damping effects. Two-dimensional defects.

1972, approx. 500 pp., \$39.50

Currents in Hadron Physics

By V. de Alfaro, University of Torino, S. Fubini, M.I.T. and University of Torino, G. Furlan, University of Trieste, and C. Rossetti, University of Torino

Contents: Introduction. Notations and conventions. Introduction to the theory of strong interactions. Weak and electromagnetic currents. Ward identities and low-energy limits. Dispersion sum rules in current algebra. Phenomenological Lagrangians and chiral symmetry. Completeness sum rules from equal-time commutators. The role of Lorentz invariance. The infinite-momentum limit. A new approach to strong interactions: Duality. Open problems and recent developments in the theory of currents. Current commutators on the light cone. References.

1972, approx. 850 pp., in prep.

Paul Ehrenfest

Volume 1: The Making of a Theoretical Physicist

By M.J. Klein, Yale University

"This book . . . is both a fascinating biography and an important contribution to the history of modern physics . . . an extraordinary and almost unique example of a scientist's biography. This book should be read by everyone interested in the history of the development of modern physics . . . I should like to see it also in the hands of many non-physicists . . . an arresting story that will provide a better understanding of the life and work of a scientist and of the sociology of science."

Physics Today

Second printing, 1972, 346 pp., \$9.50

Distributed in the United States and Canada by

American Elsevier
Publishing Company, Inc.
52 Vanderbilt Avenue
New York, N.Y. 10017

Circle No. 23 on Reader Service Card