REVIEWS

The Dynamics of Real Gases. By J. F. CLARKE and M. McCHESNEY. Butterworths, 1964. 419 pp. 90*s*.

Teachers of fluid mechanics who have tried to keep up with the explosive growth of the subject during the last decade have long felt the need for a book giving the necessary physical background for a study of that part of the subject where the fluid behaves as what is loosely called a 'real gas'. They have had to refer students to a number of texts not specially written for fluid mechanicists, and have found it difficult to limit the material to what could reasonably be absorbed in the time available.

The authors of this book have therefore set out to fill a real gap in the literature. At the same time they have demonstrated that this is a tremendously difficult task.

The first four chapters review in quick succession the subjects of quantum theory, macroscopic thermodynamics, statistical mechanics and chemical reactions. To do this in 120 pages is no mean feat, and obviously much has been left out and many ideas are only briefly mentioned. Nevertheless, accepting that only limited space was available, the choice of material seems sound, and the newcomer will get a good background for the further reading to which he is guided by references to more comprehensive texts. He will, however, be left wondering what it is all about, and feel the need for an introduction which could have outlined the relationship between modern high-speed fluid mechanics and ideas long familiar to the physical chemist. People active in the field are aware of the revolution in high-speed fluid mechanics and the need for bringing in more and more of the knowledge and techniques of neighbouring subjects, but the student can hardly be expected to know the history of his subject before he embarks on his studies.

There follows a brief chapter entitled 'Non-equilibrium theory' but concerned more with near-equilibrium phenomena. This again shows a well-balanced choice of material.

Chapters 6 (100 pages) and 7 (150 pages) are entitled 'Theoretical gas dynamics' and 'The physics of gas dynamics'.

Chapter 6 deals with certain aspects of flows involving high-temperature effects, with emphasis on one-dimensional and linearized flows. Notable omissions are boundary layers and blunt-body flows. This chapter can be read with the background given in the preceding chapters and some elementary knowledge of fluid mechanics.

Chapter 7 starts with a discussion of elastic and inelastic collisions and scattering theories. This is followed by detailed treatments of vibrational relaxation, dissociation and recombination, and a brief survey of radiation phenomena and spectra. This chapter will definitely be beyond the reader whose knowledge of quantum mechanics is limited to the material set out in the introductory chapter. It is a useful guide to the present state of knowledge for the more advanced reader. In places the going is quite heavy and the reading is made more difficult, not only by the continual reference to the literature for details of derivations, but also by a peculiar habit of the authors of referring the reader to later sections in the chapter for definitions and results needed in the discussions.

The book contains a wealth of information and will undoubtedly be widely used by students at all levels. Unfortunately, the text displays a remarkable lack of care in the preparation. I did not make any attempt to check the equations quoted from the literature, but nevertheless found well over one hundred points needing correction. They range from minor typographical errors over confusing misprints, omissions and inconsistencies to quite serious errors. One wonders if the text was ever proof-read. This, of course, greatly reduces the value of the book as a reference text.

A second (corrected) edition might perhaps include at least some mention of ionization and the flow of rarefied gases. A useful addition would be a few tables giving standard physical constants and characteristic properties of the common gases.

N. H. JOHANNESEN

Internationale Bibliographie der Strömungstechnik 1959–1962. Compiled by W. RICHTER, J. BURCKHARDT and B. TEICHERT. Berlin: Verlag Technik, 1963. 479 pp.

The compilers have listed and classified about four years' research papers, books and dissertations, mainly on basic fluid mechanics, but with an eye to research on engineering applications as well. Further issues at intervals of several years are planned.

The result is an extensive bibliography set out in better perspective than can easily be found elsewhere. On some topics the coverage of German and East European sources appears likely to repay consultation by readers who are not very familiar with them.

Titles are given in the original language and also, where necessary, translated into German. The format is well designed to allow easy scanning of the German titles. This feature goes a long way towards offsetting deficiencies in the classification arising from employment of the U.D.C. system, which proves rather a clumsy tool here.

E. P. SUTTON

Linearized Analysis of One-Dimensional Magnetohydrodynamic Flows. By R. M. GUNDERSON. Springer-Verlag, 1964. 119 pp. DM 22.

A number of results relating to the propagation of shock waves and simple waves along channels of varying cross-section are reconsidered for a gas which is perfectly conducting and subject to a transverse magnetic field.

The analysis is suspect at several points. In particular the variations in cross-section are assumed to modify only the equation of continuity. In magnetohydrodynamics, however, there are equally significant modifications of the other basic equations. This can be demonstrated by expressing the equations in a form appropriate for flow with (say) cylindrical symmetry.

The electromagnetic boundary conditions to be satisfied at the walls of the channel are not discussed.

Magnetohydrodynamics apart, the analysis and the results for the piston-driven shock waves are not convincing. An exponent for the singularity in the strength of the collapsing shock is obtained which differs from that calculated by Guderley—a surprising result if correct. Nor do the results agree with the known exact solution for the shock wave produced by a cylinder expanding uniformly from zero radius (from similarity considerations the shock wave here is of uniform strength).

W. CHESTER

Dynamics of Charged Particles. By BO LEHNERT. North-Holland, 1964. 300 pp. 65*s*. or $9.10.

For configurations with a simple geometry, there exist a number of exact integrals to the equations of motion of a charged particle in a static magnetic field. A knowledge of these integrals obviously helps greatly in understanding the behaviour of the particle. Thus it may turn out that certain parts of space are inaccessible to it. Such information becomes very relevant in a study of, say, the entry of charged particles into the Earth's magnetic field or in an experiment to confine a high temperature laboratory plasma.

In practical cases, however, the geometry of the field is not usually simple enough to permit the setting up of exact integrals of the motion; if the field is not quite static even the energy integral ceases to exist. Nevertheless, it is often still useful to investigate approximate integrals of the motion. These will exist when the linear scale on which the field changes is large compared with the Larmor radius, and when the time scale on which it varies is long compared with the Larmor period. Approximate integrals are often remarkably good and most useful. They are evidently closely connected with the concept of a guiding centre for a charged particle, and with the near constancy of the angular momentum of the particle with respect to that centre. By using such ideas one can visualize much more easily how a plasma behaves, and whether an equilibrium will be stable to certain kinds of disturbances.

Dr Lehnert's book gives an admirable and well-balanced account of these ideas and of their application. He also indicates under what conditions these methods will fail owing to the intervention of other physical effects such as particle-particle interactions, or micro-instabilities. Quite rightly he does not follow these up in detail, since they belong to a different range of ideas. There is, however, one place where he comes across a failure of the approximate integrals not due to any such extraneous cause, but due to a phase relation between the motion of the particle about its guiding centre and the variation of the magnetic field which it sees. This situation can be described mathematically by a Mathieu equation, and the approximate integrals may then not exist. The consequences have given rise to interesting experiments. It would have been worth while to say more about such effects. But this is only a quite minor complaint about an excellent and comprehensive book.

F. D. KAHN

Field-Coupled Surface Waves. By J. R. MELCHER. The M.I.T. Press, 1963. 190 pp. 38*s*. or $5.00.

Not very often do electrical engineers master and contribute to a branch of fluid mechanics. If this book is anything to go by, one wishes it happened more often. The book is an experimental and theoretical treatise on wave motions on fluid surfaces and free jets, subjected to electric or magnetic Maxwell stresses. The duality and anti-duality between the cases is well brought out. Most of the theory is linearized on a small-perturbation basis, but the last two chapters deal with large-amplitude effects and the development of 'shocks' or what one might call generalized hydraulic jumps. Some very elegant experiments are described. These are confined to the electrohydrodynamic cases. Their magnetohydrodynamic duals are hard to realize because they involve surface current sheets and perfect conductivity, whereas—to quote—'one of the virtues of electrohydrodynamics is that a simple idealized model often provides an accurate description of physical reality'.

One gathers from the book that liquid electrohydrodynamics may have some practical applications—the enhancement of boiling heat transfer is mentioned—but one feels that the main justification of this book is its educative value. For the fluid dynamicist it comes as a reminder that modern electrical engineers deploy a formidable array of concepts and analytic techniques, from which he can surely receive stimulus. At the same time most electrical engineers can but benefit from being reminded by a book like this that electromagnetic phenomena are geometrical in essence and that the much favoured 'equivalent-circuit' view of events suppresses this.

In reading the preface one's hopes rise at the author's dictum 'Simplicity is the key to understanding', but the text brings some disappointment. The fluency of the author's deployment of what to him are simple and familiar concepts or techniques makes the book difficult reading for the innocent fluid-dynamicist. But he should persist with it and be educated as his reward.

J. A. SHERCLIFF

Elastic Liquids. By A. S. LODGE. Academic Press, 1964. 389 pp. 75*s*.

This is an introduction to phenomenological theories of rubber-like polymers. By an elastic liquid the author means a material in which the stress eventually becomes purely hydrostatic under constant strain and/or in which flow does not immediately cease when the stress is made hydrostatic. Phenomena of principal interest are large elastic recovery or recoil, stress relaxation, and normal stress differences in shearing. The formulation of invariant constitutive laws with memory functions is the basic task in the analysis. The whole account is a nice blend of theory and experiment, authoritatively presented well and documented, and the book is very welcome as the first venture of its kind in finite strain rheology.

For the most part the analysis is deliberately restricted to uniform states and is developed from scratch in considerable detail (a little too much, perhaps, to some tastes). Embedded co-ordinates are, very properly, given prominence and experimentalists should find the book particularly helpful in this respect. A useful collection of exercises with fully worked solutions is included, so that the book should also be accessible to students. Tensors are necessarily used, but not so named until the final chapter on non-uniform states. This will be found hard-going by comparison, and possibly even obscure, through the author's pedantic adoption of the language and viewpoint of a pure mathematician (e.g. isomorphisms, field transfer between manifolds, and the like).

Some minor blemishes have slipped in where the author strays outside his field of specialism. (i) Hyperelastic does *not* mean 'less than elastic' (p. 156). (ii) The theory of plasticity is *not* 'based on the idea that a material may behave like an elastic solid at low stresses and a viscous liquid at high stresses' (p. 182). Neither is it necessarily relevant to modern 'plastics' but primarily to metals, in which connexion the word plastic was coined at least a century ago. (iii) Despite statements in the literature quoted by the author (p. 182), viscoelastic or hypoelastic theories do *not* lead to results significantly similar to those of plasticity theory.

R. HILL