

"Reproduction" of the Ciliata "is mainly by conjugation; asexual reproduction by binary fission occurs"; and in the definition of the reservoir host as "a host harboring parasites which may be transferred from man to domestic animals", a statement which is inadequate even in the restricted field of veterinary protozoology.

Criticisms of this kind do not, however, apply to the greater part of the book, which gives a detailed and valuable account of the Protozoa that cause diseases of farm stock, and of the symptoms, diagnosis and treatment of these diseases. The hosts considered in turn are horses, cattle, sheep and goats, swine, dogs, cats and the 'fur-bearers', namely, the fox, rabbit and mink. *Trichomonas fetus* and the disease it causes receive considerable attention, and there is, at the end of the book, a diagram of a plan for hygienic breeding designed to eradicate bovine trichomoniasis and also, in the useful section of the book on diagnosis of protozoal infections, a large plate of diagrams of Protozoa likely to be encountered when trichomoniasis is being diagnosed. Another plate illustrates the not very complex instruments used by the authors for diagnostic work. Some of the space given to these plates might well have been given to structures, such as seeds and fragments of various kinds of foods, which may resemble coccidian oocysts and dying or degenerate Protozoa in the faeces. Even a reduction in size of the figures would have made this possible.

Workers who have difficulty in obtaining the literature of this subject will find a good summary of it in this book, and also a bibliography, extending to 18 pages, which includes important books, a list of the circulars and bulletins on protozoal diseases issued by the United States Bureau of Animal Industry and Department of Agriculture respectively, as well as references to 309 research papers. There are also useful host-parasite lists, schedules of treatment and a brief article on the International Rules of Zoological Nomenclature.

G. LAPAGE

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## NON-LINEAR WAVE MOTION

### Supersonic Flow and Shock Waves

By R. Courant and K. O. Friedrichs. (Pure and Applied Mathematics, a Series of Texts and Monographs, Vol. 1.) Pp. xvi+464. (New York and London: Interscience Publishers, Inc., 1948.) 42s.

**T**WENTY-FIVE years ago what was known on the dynamics of gases, if acoustics and the study of steady motion at speeds small compared with that of sound (when the flow resembles that of a liquid) be omitted, could have been expounded in a few dozen pages. Since then, and more rapidly since 1943, the subject has grown into one which no single book can describe in its entirety. The primary stimulus was the increase in aircraft speeds; but a secondary stimulus, the belated realization of workers in pure science that the phenomena show fascinating differences from those of classical physics, has become equally important.

Profs. R. Courant and K. O. Friedrichs have not sought to cram into their review of progress in this field a vast mass of detail in an attempt to be comprehensive. They have chosen rather to present certain parts of gas dynamics, in a leisurely style, so as to make the result essentially a study in non-linear wave motion and the propagation of waves of

discontinuity; there are appendixes on analogous physical problems, including waves in elastic-plastic materials. Engineers can go elsewhere for rule-of-thumb procedures, for accounts of experimental methods, or for the very extensive and valuable linearized theory of supersonic flow. The man of pure science may regret, however, the almost complete absence of reference to viscosity as an important property of gases.

Prof. Courant is the author of the celebrated "Methoden der mathematischen Physik", Vol. 2, which includes, in a precise and unified whole, a very large mass of general theory relating to partial differential equations. The present book incorporates from that work much of the theory of the quasi-linear hyperbolic problem. The preface regrets that a similar unification and completeness are impossible throughout the present subject, still in its infancy. The reader must rejoice, however, that the authors have not excluded special, more involved, methods which are as yet imperfectly known, since the frontiers of science are often thus isolated, and the interest of the fighting scientific worker lies mostly in such regions. In much of this we see the pen of Prof. Friedrichs, a doughty explorer of new paths.

The book is discursive, and aims principally at communicating the type of mathematical and physical behaviour encountered. It is not a reference work, so it should be read straight through, perhaps fairly fast. The clever student who does this, fresh from an undergraduate course of classical (linear) mathematical physics, will be led safely into a clear understanding of what is now known on the non-linear wave problems involved. Some of the ideas are complicated, and the pages of 'talk', free from formulæ, will be found among the most useful.

Unsteady rectilinear motion is covered very thoroughly, more so than in any previous book, and much of the critical work is done here, since the equations are fairly tractable in terms of Riemann's variables, while the deduced behaviour can mostly be taken over into more complicated systems. This work includes an extensive section on flame propagation.

Plane steady supersonic flow is then treated more briefly; its behaviour is qualitatively almost identical with the unsteady rectilinear motion if the second spatial dimension is equated to the time. The 'limit line' is put firmly in its place (below the importance attributed to it by some); its connexion with the hodograph transformation is displayed, though otherwise the latter is developed only for the purpose of finding simple exact solutions and for the graphical method of Prandtl and Busemann.

Shock reflexion is treated thoroughly. To reconcile theory and experiment on 'Mach reflexion' various postulates put forward include an expansion wave centred at the three-shock intersection. The Laval nozzle is discussed in detail, and it is shown what a variety of shock configurations are possible therein as explanations of phenomena observed in choking and otherwise. A short section on axi-symmetrical flow and spherical waves, 198 references and an index conclude the book.

The book, compiled and improved over a number of years, and given limited circulation in an earlier, shorter form during the War, is most careful and accurate in its statements. However, in Fig. 41 the rear shock should curve in the opposite sense.

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