The book focuses on the mathematical treatment of boundary layers and begins by introducing the continuity and momentum equations and the velocity law of the wall for boundary layers both without and with streamwise pressure gradient (Chapters 1 and 2). Later (Chapters 11 and 12), equivalent equations are derived for thermal boundary layers. Chapters 3–5 deal with the turbulence structure; the equations governing the turbulent kinetic energy, E, and the Reynolds stresses are derived, and model assumptions are introduced for the diffusion, dissipation and pressure-strain terms, based mainly on dimensional arguments applied to the law of the wall region. The assumptions made are quite unorthodox: the diffusion flux of E is not, as usual, assumed proportional to $\partial E/\partial y$ but to $\sqrt{(|\partial E/\partial y)}(\partial E/\partial y)$ which yields a variation of E as $(\ln y^+)^5$ in agreement with Klebanoff's measurements; the dissipation terms in the individual stress equations are made proportional to the stresses, in conflict with the concept of local isotropy; and the pressure-strain term is assumed proportional to the production of turbulence energy, with different constants for the different components. Adjusting the constants gives agreement with measured stress distributions in the log-law region. Application to boundary layers near separation yields a variation of the energy components proportional to $y^{1/3}$, again in agreement with experiments. The model is also applied to homogeneous shear flow and to grid turbulence relaxing after a contraction; but now different constants are required for each case.

Chapter 6 introduces the mixing-length distribution used in all the analysis which follows, namely: $l = \kappa y e^{-y/(\delta m)}$, with $m = 0.6$ as empirical constant. This relation is close to the 'ramp' function used extensively by Spalding and his co-workers. Together with Van Driest's damping law, it covers the whole boundary layer. An equivalent relation for calculating the heat flux is introduced in Chapter 13. The consequences of Van Driest's law for the sublayer profiles and the kinetic-energy balance in the sublayer are discussed for boundary layers with zero and finite streamwise pressure gradient in Chapter 7. The above mixing-length distribution is used to derive velocity-defect and drag-coefficient laws for the flat boundary layer in Chapter 8, and equivalent laws for the temperature defect and Stanton number are given in Chapter 14. Approximate schemes for calculating nearly self-preserving boundary layers are presented in Chapter 9 for velocity and in Chapter 15 for thermal boundary layers: to evaluate the convection terms in the momentum and temperature equations, the law-of-the-wall distribution for velocity and temperature is assumed to hold over the whole fully turbulent layer. The closed-form solutions are compared with experiments of Clauser, Herring and Norbury, and Stratford and show fairly good agreement. Chapter 10 presents empirical eddy-viscosity formulae for developed pipe/channel and Couette flow (different for the two cases) and applies them to obtain velocity profiles and friction laws; the topics of roughness and thick sublayers are also discussed. The final chapter gives a short introduction to the subject of spectral distribution of turbulence energy and shear stress.

The literature references quoted in the book lack many of the more recent, important publications on the subject; for example the 1968 AFOSR-IFP Stanford Conference is not mentioned, and a comparison of the author's model suggestions with published models for the diffusion, dissipation and pressure-strain terms in the Reynolds-stress equations would have been appropriate. The author's view that the differences between the fluctuating velocity components in the log-law region can be explained via the pressure-diffusion term is, in the opinion of the reviewer, incorrect: these differences are due to the wall effect on the pressure-strain terms. The recommended use of mixing-length theory to calculate the heat flux is problematic; the author should have included a warning that this theory does not work when there is a finite heat flux at points of zero velocity gradient.

The purpose of the book and the audience for which the book is intended are not quite clear to the reviewer (and are not stated by the author). Unlike other books available in the German language, the present volume is not suitable as an introduction to turbulent boundary layers since it gives very little physical explanation. Also, the reading is in parts quite arduous because all the derivations are included in the main text; and they are sometimes fairly long-winded. The book is also of limited value to researchers or designers who have to solve boundary-layer problems; the author states correctly that boundary-layer calculations are usually carried out with the aid of finite difference methods; hence his rather cumbersome approximate schemes can hardly be in great demand. Further, the book is restricted to a few basic boundary-layer situations and does not discuss the effects of wall curvature, blowing or suction, or free-stream turbulence. The model for the turbulence structure in the law of the wall region is also of little interest because, due to the dimensional analysis used, it is geared to this region and cannot be extended to a general model. This book does however contain a great many useful basic relations; and it may come as a consolation to workers who do not have access to a computer.

W. Rodi

D. J. Tritten, **Physical Fluid Dynamics.** Van Nostrand–Reinhold, New York (1977).

"Physical Fluid Dynamics" is written by a physicist who had 'final-year physics students particularly in mind'. This reviewer is in a mechanical engineering department and so has mechanical engineering students in mind.

Books on fluid mechanics by engineers in academic departments, written for undergraduates, rarely break new ground, though frequently their publishers if not the authors claim novelty of presentation. A claim to be oriented towards practical applications often means only the presentation of much arithmetic calculation; and a claim to present fundamentals often means only the laying out of a lot of algebraic manipulation associated with three-dimensional field theory. In both types of book skilled use of words, sentences, paragraphs (i.e. the content of discursive prose), is often at a disappointingly poor level; it is flat and dull as if only algebraic symbols or numerical magnitudes matter. (And yet academics are primarily talkers!) This present book makes handsome amends.

In his Preface the author quickly disposes of the need to classify his book as "pure or applied", "theoretical or experimental": he categorises it by treating fluid mechanics as a branch of physics. This offers him a unifying idea and allows him to be theoretical or experimental as needed and, most importantly, to weld the two approaches together, so displaying yet another example of how progress in the physical sciences is made. The author writes about his material in prose which, sentence by sentence is full of content; he can develop arguments in most illuminating ways; and he moves smoothly amongst a mixture of prose (mainly), algebra and numbers. He has also rediscovered the use and immense value of parenthetical comment. For too many authors, comment in parenthesis is merely comment which cannot be made to fit into the main sentence structure; here the author uses parenthetical comment most exactly: for, just when a nagging question arises in the reader's mind regarding perhaps the restrictions under which an argument is developing, the question is answered precisely and briefly, in parenthesis.

The author sets out to capture the reader's attention in Chapters 2–4 by describing what one can see, measure and hope to explain in Pipe and Channel Flow, Flow past cylinders, Convection in Horizontal Layers. In each case he finds a descriptive style which allows him to discuss the great variety of flow phenomena which occur in those situations without drawing on analytical knowledge that the student at this stage does not possess. His description of transition to turbulent flow within the context of his examples is one of the best I have read. An engineering student reading these chapters would realise what he is missing in his more conventional reading; and he would be keen to learn what can be done to explain this exciting variety of phonemena.

For the engineering student the book will fall into two parts. If he is not specialising in fluid mechanics, chapters 17–22 dealing with turbulent flow will be too detailed, requiring more of his time than he can give. If, however, he is taking a special course in fluid mechanics (not fluid machinery), he will have in these chapters one of the most lucid accounts of Stability, Transition and Turbulence that is at present available to the perceptive and able undergraduate. For a postgraduate student these chapters would form an admirable preparation for more specialised reading.

The book has many incidental pleasures. Diagrams and photographs are especially well chosen and almost all serve other purposes in addition to the one which is their main reason for display. The Bibliography is classified in a helpful way to the learner and the Reference section is exceptionally full. The collection of 75 problems following the text will be challenging to an engineering student.

In a second edition of the book, there is one clear improvement which could be made. Throughout the book much use is made of forward and backward referencing; so it would be of great help to the reader if the page headings, which carry the chapter titles, could also carry the section numbers appearing on that page. It is a tedious process looking through the pages of the text to find the required item.

R. G. TAYLOR

Measurement of Unsteady Fluid Dynamic Phenomena. edited by B. E. RICHARDS Hemisphere/McGraw-Hill, New York (1977). Price $35.00.

THIS book is based on notes from a Von Karman Institute lecture series with the same title, held in January 1975. The 13 contributors have written 12 chapters on experimental techniques, with, in some cases, an introduction to the physics of the phenomena to be measured. Techniques for measurement of force, velocity, heat transfer, temperature, density and pressure are described, necessarily in the context of particular applications. The main applications are to shock-tunnel flows and turbulence studies, and in the latter case the rather specialised data-reduction procedures and results of space–time correlation and conditional sampling are discussed in some detail. It is a pity that room could not be found for a chapter on measurement of unsteady flows over aerofoils or behind bluff bodies; the techniques used have something in common with shock-tunnel practice while the data processsing has affinities with conditional sampling. However almost any reader with an unsteady-flow problem would be able to find techniques of value to him, though only someone wishing to use hot-wire and laser anemometry for conditional sampling of turbulent combustion in a shock tunnel would benefit equally from all the chapters! Most of the shock-tunnel chapters have been written by authors from VKI and most of the turbulence chapters by the Lyon group, but there are contributions from several other universities and the treatment is by no means parochial.

The book is generally of high quality. This reviewer found the two chapters on data handling somewhat unsatisfying and a better treatment might have been achieved if the authors had collaborated on one long chapter. Of course, most of the chapter topics could be, and have been, treated at book or monograph length: however the compact treatment given in the present volume is ideal for the beginner, and has the further advantage of introducing shock-tunnel and turbulence experts to each others' problems and solutions. The references are extensive and, as of 1975, up-to-date.

The editing and production of the book are both good. The topics are sufficiently self-contained that extensive cross-referencing is not necessary, although a little more tidying up would have been helpful (for instance one author refers to "Raman scattering", another to "Raman spectroscopy", and the index refers to both; they are of course the same thing in this context). The text has been typeset—as distinct from the prevalent "instant book" technique of offsetting from unjustified typewriter scripts—and the only blemish is the presence of hand-drawn diagrams in one or two of the chapters.

The highest compliment one can pay the editor, contributors and publishers, and the most useful guidance one can give the prospective reader, is to say that the book's origin as lecture course notes is not apparent from the text: it is a well-planned and well-executed review of an important and rapidly-developing field.

P. BRADSHAW

Two-phase Steam Flow in Turbines and Separation. Edited by M. J. Moore and C. H. Sieverding Hemisphere McGraw Hill, New York (1976).

HEAT-TRANSFER specialists are much concerned with two-phase flows of steam and water; but, for the most part, their attention is concentrated upon flows internal and external to pipes, in apparatus in which the change of phase is desired, and essential. It is therefore interesting to observe the same subject from the different point of view of the contributors to the present volume; for they, for the most part, wish that they had only single-phase flow to deal with; and when two-phase mixtures do appear, they try to separate them.

In steam turbines, two-phase phenomena arise from expansion to pressures permitting condensation. Heat-transfer phenomena play a part; but those of nucleation, friction and relative motion between the phases, and impingement on solid surfaces, dominate the scene. In separators, the inability of the droplets to follow the strongly curved streamlines of the vapour phase is relied upon by the designer; and thermal effects can be neglected in comparison with fluid-mechanical ones.

This handsomely produced volume is the outcome of a course of lectures at the Von Karman Institute for Fluid Dynamics. The contributors are:

- G. Gyarmathy, with 58 pages on Basic Notions:
- M. J. Moore, the Course Director, with 68 pages on Gas Dynamics of Wet Stream and Energy Losses in Wet-Steam Turbines;
- G. Gyarmathy, with 64 pages on Condensation in Flowing Steam;
- M. J. Moore and A. Ederhof, with 70 pages on Instrumentation for Wet Steam;
- A. Smith, with 30 pages on Experimental Development of Wet-Steam Turbines;
- W. Engelke, with 28 pages on Operating Experience of Wet-Steam Turbines; and
- G. C. Gardner, R. L. Coit, P. D. Ritland, T. F. Rakas and P. W. Viscovich, with 54 pages on External Water Separators.

Judged from the viewpoint of one concerned with advancing the development and application of heat-transfer science to engineering problems, what impression does the volume give?

First, it is that the authors know what they are talking about, and have taken the trouble to present their knowledge in an understandable and attractive manner. There is a certain amount of over-lapping between the contributions; but it is not excessive; and the editors have been successful in giving coherence to the collection of individual lectures.

Secondly, the standard of application of science to the engineering problems appears to be high, a conclusion that is not always apparent in areas of technology which, like this one, have a long history.

Thirdly, however, it can be deduced that recent advances in two-phase flow analysis, particularly by numerical methods, have not yet penetrated to specialists in this area. For example, about corrugated-plate separators, it is stated: "there is no theory completely describing the separating