REVIEWS

Modern Developments in Fluid Dynamics. Edited by S. GOLDSTEIN. Two volumes. Pp. xxiv, 702, with 256 figures and 35 plates. 50s. 1938. (Oxford)

The immense debt which the science of Hydrodynamics owes to Sir Horace Lamb can hardly be overestimated by workers in that field. It is only in the penultimate chapter of his classical volume on fluid motion that the real problems of the present day are approached and of this chapter only a few pages are devoted to turbulence. It will therefore come as no surprise to learn from the Preface that the present work owes its inception to Lamb's suggestion; indeed he was at first the general editor. This arduous office of general editorship was later entrusted to Dr. S. Goldstein, who is to be congratulated on the ability with which he has performed the task of producing these handsome volumes which form a composite work composed by the Fluid Motion Panel of the Aeronautical Research Committee and others. That the task of editing can have been no sinecure is evident from the number of collaborators, the variety of the subject-matter, and the extent of the work.

To judge a book of this kind and to assign it a place in the hierarchy of similar treatises, it is only fair to take into consideration not what the reviewer would like to have seen, but what the avowed intention of the authors may be. This is clearly set out in the Preface as follows: "It makes no attempt to provide an exhaustive account of all modern advances in hydrodynamics, but only to present and summarise methods of experiment and development of theory in certain branches of hydrodynamics of special interest to aeronautical science. The book does not deal with the potential flow of inviscid fluids or with the trailing vortex theory of aerofoils, except to summarise the results of work recorded in other books, nor does it discuss problems of compressibility which have recently become of practical interest to aeronautics. On the other hand, the book is concerned with the laminar and turbulent flow of viscous fluids, particularly near and at the surfaces of solids and in wakes, and with transfer of heat in laminar and turbulent flow. Modern theories of such flow are fully discussed; exact mathematical solutions of particular types of flow are given, when possible, and approximate methods for the solution of more general cases are developed. The experimental results and illustrations of theory are naturally mainly of aerodynamic interest, but technical applications are avoided."

As far as works in English are concerned, it would on the above showing be proper to regard the present work as completing a trinity whose other two members are "Aerodynamic Theory", edited by W F. Durand, and Bulletin No. 84 of the National Research Council, "Report of the Committee on Hydrodynamics," edited by H. Bateman; for the former devotes six volumes to a thorough study of fluid motion in its application to flight, and the latter gives 500 pages to the study of viscous liquids and turbulence, and a further 100 pages to the motion of compressible fluids.

The present book consists of fifteen chapters of which II and IV are devoted to a physical and mathematical description of the boundary layer, V to turbulence and VI to experimental apparatus. These chapters form the basis of the accounts of flow in pipes and channels (VII and VIII); flow past symmetrical and asymmetrical cylinders and solids of revolution (IX, X, XI); boundary layer control and wakes (XII and XIII). In XIV and XV the problem of heat transfer in laminar and turbulent flow is discussed. The book is to be praised for the numerous excellent physical descriptions, the free use of diagrams, and the beauty of the photographic illustrations of actual flow

patterns. Of these one of the most remarkable is the vortex trail depicted in Plate 1. The writers are always careful to state the speed and length which define the particular Reynolds number quoted, a feature which should be generally imitated.

But reviewers often feel impelled to mix praise with censure, some have even been known *faute de mieux* to attack the footnotes and the index. In the present case no such opportunity leaps to the eye. There are, however, two relevant matters of which some account might have been expected. The first of these is Dubuat's paradox, that the drag coefficient measured when a disc is fixed in a current of speed V is about 30 per cent. greater than the coefficient measured when the disc moves with speed V in the same fluid otherwise at rest. The elucidation of this result, which was considered experimentally and theoretically by Joukowski, is of such importance in connection with the application of wind-tunnel experiments that some mention of it would have been welcome. Again in chapter VI where smoke methods are described there is no account of the recent technique of J. Valensi which leads not only to qualitative but also to quantitative descriptions of flow.

A perusal of this work gives rise to certain reflections on (1) the tentative nature of the mathematical description; (2) the dependence of calculation upon experimental data; (3) the wholesale recourse to approximations. This is of course in no sense the fault of authorship, but it points the moral that we are only on the outskirts of the proper mathematical formulation of the problems here discussed. In sharp contrast with the theory of the motion of an inviscid liquid, the mathematical description of which is in a sense complete, the theory of viscous liquids has yielded but little to purely mathematical attack. One is tempted to look for a more deep-seated cause than mere lack of analytical weapons with which to press the offensive. Thus the determination of the conditions which govern the transition from laminar to turbulent flow, one of the major problems, will probably find its solution only when the continuous medium hypothesis is abandoned and the essentially discrete character of a real fluid is taken into account.

Nevertheless this work renders a great service by placing in the hands of research workers an up-to-date account of the position of boundary layer and turbulence theory. To be satisfactory the ultimate outcome of physical research must find its expression in a consistent mathematical theory. This book should be regarded as a successful first approximation to an attempt to reach that goal. **L. M. M.-T.**

The Theory of Group Representations. By F D. MURNAGHAN. Pp. xi, 369. 22s. 6d. 1938. (The Johns Hopkins Press, Baltimore; Humphrey Milford)

This well-printed work deals with the representations of groups by means of matrices and the determination of the irreducible representations by means of the group characters amongst which exist certain relations of orthogonality. The subject is capable of application to a very wide range of mathematics, including the theories of invariance; of integral equations; of reciprocal functions and of topology. The author has considered it with special reference to possible applications to nuclear physics. It is regrettable that he had to stop short at that point and that a chapter on the applications themselves could not be included owing to lack of space.

Great care has been taken to make this somewhat difficult subject easy to understand, and the reader who wishes to consider other applications of it or to study the more general problems of representation will find this work an excellent introduction. The first half of the book is an explanation of the