REVIEWS

Aerodinamica Transonica. By C. FERRARI and F. G. TRICOMI. Rome: Cremonese, 1962. 632 pp. L. 9000.

The 'sound barrier' has not proved an insurmountable obstacle to technological progress, but it seems as unlikely as ever that exact analytical solutions to general problems in transonic flow will be found. Nevertheless, a very considerable understanding of the physical behaviour of a fluid in this difficult region has been built up from particular solutions and approximations of many kinds. The literature on the subject has expanded rapidly in recent years and there was need of a book bringing together the latest work and illustrating the importance and the interconnexion of the many approximations that have been introduced to make analysis more feasible. This new volume, written in Italian and published in a well-known series of mathematical monographs, sets out to satisfy this need and provides an account, often with considerable detail, of the present state of theoretical research on the basis of inviscid fluid flow.

The first two chapters are introductory in character. Written by Professor Ferrari they lead quite quickly to the transformations from the physical to the hodograph plane that yield a linear equation for steady two-dimensional compressible flow, the Chaplygin equation. The principal approximations to the Chaplygin equation are derived, and the implied equations of state compared with that of a real gas, giving an idea of the range of applicability of the approximations. This chain of equations is the chief study of the book.

The third chapter has been written by Professor Tricomi. It is really a monograph on his famous equation of mixed type, the most simple of the useful approximations to Chaplygin's equation. It deals with questions of existence and uniqueness, solutions of the equation itself and of other approximations to the true equation. Tricomi has also contributed an appendix to the book in which he gives an account of the principal properties of hypergeometric functions.

Problems attacked by way of the hodograph plane fall into two categories; 'inverse' problems involve the determination *a posteriori* of the configuration in the physical plane from the solution in the hodograph plane, while 'direct' problems are those for which the configuration in the physical plane is prescribed and the solution in the hodograph plane has to be found. The remaining three chapters, the work of Professor Ferrari, are concerned in the main with such problems.

'Inverse' problems present the less formidable analytical difficulty and in chapter IV these are discussed in relation to the design of two-dimensional nozzles.

In chapter V the question of flow about a profile is the main topic. This chapter is more than 200 pages long. It includes an account of the method devised independently by Lighthill and Cherry for the generalization to compressible fluid flow of solutions obtained from the theory of incompressible

fluid flow. It goes on to deal with the formation of shock waves attached to a profile and with the properties of shock waves and sonic lines in mixed flows with limited regions of supersonic flow, with special reference to the work of Germain and Nocilla. This leads naturally to a detailed discussion of the possibility of the existence of 'regular' transonic flow past an arbitrarily chosen profile and of the stability of such flows with respect to small variations in the shape of the contour or in the Mach number of the approaching stream. The author shows that there are still open questions in this field. The chapter ends with an account of work on streams with either sonic speed or supersonic speed upstream, the latter, of course, involving a detached shock wave.

The last chapter of 160 pages is concerned with 'direct' problems. Those that lend themselves readily to treatment involve boundaries on which one of the hodograph variables, i.e. either the direction of flow or the resultant velocity, is constant. Mackie's solution of the so-called Roshko problem by means of the Green's function for a generalized hodograph equation is given a prominent place. This is one of the few examples, so far worked out, in which direct comparison has been made of the accuracy of results obtained from the approximate forms of the Chaplygin equation. Next there is a section on the Weinstein–Cole problem of flow past a semi-infinite wedge of finite sloping edge. The results of theoretical calculations are compared with experimental results. Sections are devoted to the notable researches of Guderley and Yoshihara on sonic flow past a diamond-shaped profile and of Vincenti and Wagoner on supersonic flow past a similar body with a detached bow wave, and to the effect of incidence on these flows. The book ends with an account of approximate methods based on the physical plane; these include the 'O.G.S.A.' method, compounded of the work of Oswatitsch, Gullstrand, Spreiter and Alksne, by which a problem is reduced to the iterative solution of an integral equation, and the method of Dorodnizin, devised to make use of electronic computation. There is a brief reference to methods, including generalizations of the above, that have been used in the rather limited research on flows with axial symmetry.

The book makes heavy mathematical demands on the reader and also requires good physical insight into the behaviour of compressible fluids. Theoretical and experimental results are compared when possible. The work is valuable in giving a unified account of mathematical research in this important field and in setting out so clearly the many approximations to the Chaplygin equation, their relation to one another and the nature of their solutions. It is a pleasure to record that the bibliography is truly international.

D. C. Pack