Progress in Combustion Science and Technology, Vol. 1. Edited by J. DUCARME, M. GERSTEIN and A. H. LEFEBVRE. Pergamon Press, Oxford, 1960, 350 pp. 70*s*.

THIS is the first in a projected series of annual publications containing review articles "primarily concerned with the aeronautical aspects of combustion and propulsion". Although the title might lead one to expect both science and technology to come in for roughly equal shares in the material covered, there is actually a fairly heavy weighting in favor of the latter over the former—a not uncommon state of affairs in the world. Since this reviewer was not, of course, privy to the processes of selection which the editors employed in planning the contents of the book, he can only state that he has been unable to discern any clear and logical central theme. Except that they all are more or less connected with the large and amorphous field of "combustion", the six review articles comprising the book appear to have little in common. For this reason, it is not feasible to judge the volume as a whole except insofar as it is the sum of its parts, and the parts are quite uneven in quality.

The first is a generally interesting article on "Flow Visualization Techniques" by E. F. Winter. Both direct and inferential (e.g., flow mapping with a Pitot tube) techniques are treated from a fairly elementary and qualitative point of view. Most of the chapter is taken up with direct methods applicable to isothermal models using air or water as the working fluid, and only very brief mention is made of actual combustion systems. Nothing is said about the use of inert gas tracers in combustion studies, for example, nor are particle-track techniques using high-speed photography given due coverage or up-to-date references. The very important direct technique of schlieren photography is given only a sentence or two (although this subject is treated more thoroughly in a subsequent chapter). Thus this reviewer found the article of some interest as a narrative, but by no means a thorough survey of the subject. The whole field of flow visualization has been fairly thoroughly covered elsewhere (e.g., "Physical Measurements in Gas Dynamics and Combustion", Vol. IX of *High Speed Aerodynamics and Jet Propulsion*, Princeton University Press, 1954).

Chapter 2 on "Chemical Analysis in Combustion Chamber Development" by B. Toone is so cursory and elementary as to be quite unsatisfactory, and at times even misleading. The space given to actual analysis techniques is less than a dozen pages, with brief sketches of "wet" and "dry" procedures, continuous flow methods, etc.—the logic of the arrangement of topics is obscure. Infra-red techniques are mentioned, but separately from the six lines on "the spectroscope" under Miscellaneous Methods. Mass spectroscopy and gas chromatography are also relegated to Miscellaneous (!) but fare slightly better at about a dozen lines each. Such slighting of what are perhaps the three most important analysis techniques for combustion (and many other) studies seems astonishing. The remainder of the article deals with applications of gas analysis to various combustion measurements. Thus combustion "efficiency" is discussed with no definition of the term (there are at least three definitions in common usage). The ideas of chemical kinetics are used in a very loose fashion. Thermocouples are stated to have "limited application in combustion studies"—a highly debatable point. Sodium-line reversal is not even mentioned. The author states that the method of preparing standard calibrating mixtures by mixing metered gas streams is "slow and not very accurate". This is certainly not true—calibrated critical orifices are widely used as convenient and accurate (to about 1 per cent) devices for just this purpose. Finally, no discussion is included of one of the biggest problems in the field of gas analysis in combustion systems—namely, that of sampling and quenching a reacting gas so as to obtain a true sample—except to say that the sampling should be done isokinetically, which is probably the worst way to do it. The subject of this chapter has been reviewed far better in several other places.

The material of Chapter 3 on "Aerodynamic Influences on Flame Stability" by M. V. Herbert comprises what seems to this reviewer to be a masterly survey. The state of the art of predicting blowout conditions for both can and baffle stabilizers is discussed thoroughly and in a logical manner. Correlations between aerodynamic and chemical kinetic factors are clearly brought out and all of the major work in this field appears to be included. This should be a very useful review for specialists and students.

This high standard is maintained in the next chapter, which is a discussion of "Geometric-Optical Techniques in Combustion Research" by F. J. Weinberg. The treatment is specifically restricted to ray deflexion techniques, i.e., mainly schlieren and shadowgraph, and excludes interferometry, spectroscopy, etc. Each technique is described as to its theory, apparatus, and application to combustion studies. The author has drawn heavily on his own work to illustrate combustion application and rightly so, since he is a recognized authority in this area. While this reviewer has some reservations about the chemical kinetic interpretation of heat release profiles in laminar flames obtained from temperature distributions measured by these (or any other) methods, this is not unduly emphasized. The author has generally succeeded in giving a concise and precise over-all review of the topic.

The subject of "Flame Quenching" is well-reviewed in Chapter 5 by A. E. Potter, Jr. A feature is an interesting historical sketch of some of the very early work in this field. The various methods of measuring quenching distances are discussed critically, as are various theories. In the latter connexion it is perhaps unfortunate that the theory involving the concept of "excess enthalpy" is given without mentioning that the basic validity of the concept is quite generally doubted. The chapter concludes with a good summary of the effects of various experimental parameters on quenching distances and a useful tabulation of data.

The final chapter is on "Ignition in Liquid Propellant Rocket Engines" by E. A. Fletcher and G. Morrell. The importance of the concept of ignition delay in the starting phase of a rocket engine is emphasized and

illustrated by a simplified, but useful, theoretical model. The difference between homogeneous ignition in a large volume of combustible and flame propagation from a small source (e.g., a spark) is pointed out. Empirical studies of hypergolic propellant ignition delays are surveyed in some detail. Ignition of non-hypergolic propellants by hot surfaces, pilot flames, sparks, etc. is also discussed, there being some duplication in this area with the material of the previous chapter. Most of the theoretical "explanation" offered is based on a simple thermal theory, which is perhaps just as well considering the present impracticality of a thorough fundamental treatment. This reviewer confesses to some confusion at the statement at one point that "when one considers the starting conditions in a liquid propellant rocket engine, it is immediately apparent that these are outside the scope of much of the research discussed in the previous sections", and a later statement that "the theories and data based on laboratory experiments presented in the preceding sections can be applied quite nicely to rocket engine practice". The former statement certainly seems correct, but whether the latter can also be correct seems questionable. Generally, however, the authors seem to have brought out the highlights of a very messy and complex business quite well.

To sum up: here is a book made up of six apparently unrelated review articles ranging from excellent to poor. The excellent parts should be useful for students and others seeking a bird's-eye view of the particular topics covered, and even the specialist may find certain portions of value.

A. A. WESTENBERG