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Book Review

Shock Wave Engine Design

Edited by Helmut E. Weber, J. Wiley, New York, 1994, 223 pp. $59.95

This book comprises 12 chapters, plus additional data tables etc., on this rather unusual branch of air-breathing propulsion technology. The work is intended, according to the author, to serve as a guide for the designers of wave rotors, also known as dynamic pressure-exchangers. The operation of a wave rotor depends, in large measure, upon moving compression, shock and expansion waves, in addition to fluid-exchange processes, prevailing within substantially axially aligned passages incorporated in the rotor of the device. Wave rotors can, in general, be designed to perform a number of differing cyclic events on compressible fluids involving compressions, expansions, fluid-exchange processes and, in some cases, combustion. The main focus of the author relates to the bene-ficial use of selfdriving wave rotors in thermal power plant, particularly gas turbines.

In a preamble to the main text, following the preface, the author offers a brief, but interesting, review of the 25 year portion of his career associated with wave-rotor R and D. The first five chapters of the book cover essential background material. Chapter 1 contains a brief history of specialized devices employing nonsteady, compressible, flows. The author also cites the main advantages, namely relatively high maximum cycle temperature and pressure ratios plus compactness, of gas turbines incorporating the specific form of wave rotor to which he devotes most of his attention. The second and third chapters contain reviews of background thermodynamics and compressible flow theory, respectively, required as foundations prior to embarking upon an introductory study of the theory of time-dependent compressible flows contained in the fourth chapter. Proof is also included in Chapter 4 demonstrating, correctly, that for static pressure ratios up to about 2.5:1 the isentropic efficiency is very high for compression waves that have coalesced to form a moving shock wave. The application of time-dependent compressible-flow theory to practical nonsteady flow devices such as shock tubes and shock tunnels, including wave rotors, is covered rather briefly in Chapter 5.

A preliminary aerothermodynamic design study of a wave rotor, and the associated scavenge blower and power turbine, is included in Chapter 6. The seventh chapter deals with the selection of suitable materials for wave-rotor components and techniques available for sealing wave rotors in order to minimise internal leakage. The prediction of blade, or cell-wall partition, temperature is also covered in Chapter 7. Various loss mechanisms endemic to wave rotors are discussed in Chapter 8. The compounding of wave rotors with gas turbines and reciprocating internal combustion engines is described in Chapters 9 and 10 respectively.

A treatment of the off-design operation of wave rotors is presented, very briefly, in Chapter 11. Suggestions are made for improving the operational flexibility of wave rotors at part load by incorporating geometrical modifications based on the work of Brown Boveri, now Asea Brown Boveri (ABB), in connection with the development of their successful "Comprex" wave-rotor type turbocharger-counterpart. Chapter 12 contains an example featuring the preliminary design of a basic 373 kW (500 hp) shaft-power engine incorporating a wave rotor, scavenge blower and turbine. Various appendices contain sufficient data to enable readers to conduct their own preliminary, quantitative, design studies. Amongst the 40 or so diagrams illustrating the text is a cross-sectional drawing, appearing in Chapter 9, of a suggested design for an 895 kW (1200 hp) shaft power engine in which a wave rotor is compounded with a gas turbine.

In summary this book, written by an experienced researcher in the field, contains what is probably the only chronological account available of the development, to date, of the particular form of wave rotor the integration of which within small gas turbines offers the potential to permit operation with higher maximum cycle temperatures, and correspondingly higher pressure ratios, than would otherwise be possible. The reader of the book can be excused for wondering whether the protracted development of the wave rotor for small gas-turbine applications is due to the technical difficulties involved or is mainly a consequence of what is obviously a very modest level of funding of the research. This book should prove of interest to most engineers concerned with advanced air-breathing propulsion technology.

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Formulas for Stress, Strain and Structural Matrices

Walter D. Pilkey, J. Wiley, New York, 1994, 1458 pp., $74.95

In general, this book combines the basic concepts of strength of materials with sets of useful formulas and tables which can be extended into stress analysis and design by Aerospace, Civil and Mechanical Engineers. It ranges from beam analysis to plates and shells including static and dynamic concepts. There are many references that touch on several of the included specialties, but this is the first text that is so comprehensive. Because of the broad reach of the book, a summary of the chapter contents is presented as follows:

1. Discusses and lists conversion factors and consistent units.
2. Presents equations and tables for geometric properties of planes areas including torsional constraints and warping functions.
3. Presents the basic definition of Cauchy stress–strain under infinitesimal displacement. It includes unsymmetric bending of beams. Failure theories are introduced.
4. Mechanical properties and testing of engineering materials are discussed including hardness properties and creep. An