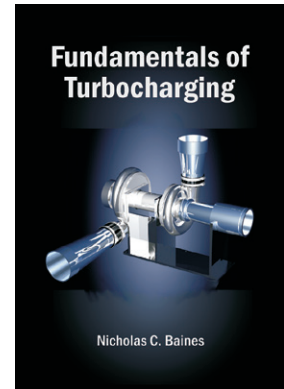


# Fundamentals of Turbocharging

Turbocharging is used more widely than ever in internal combustion engines. Most diesel engines of all types and sizes manufactured today are turbocharged, and gasoline engines are increasingly so. Turbocharger technology and often commercial turbocharger components are being applied in many other fields including fuel cells, miniature gas turbine engines, and air cycle refrigerators.

This book is the first comprehensive treatment of turbochargers and turbocharging to be made widely available in the last twenty years. It is intended to serve as both an introduction to the turbocharger itself, and to the problems of matching a turbocharger with an internal combustion engine. The turbocharger is a highly sophisticated device, which has been described as aerospace gas turbine engineering allied to mass production techniques. Undoubtedly the key to commercial success lies in achieving the correct compromise between performance, life, and cost, and this runs as a continuous thread through the book.

The operation of turbomachines is fundamentally different from that of reciprocating machines, so that the turbocharged engine has many complex characteristics, not all of them desirable. The means by which the advantageous characteristics are exploited to the full, and the technology required to overcome disadvantageous, are fully explained. The latter includes modern developments such as variable geometry, turbocompounding, and electric assist.



## Fundamentals of Turbocharging

Nicholas C. Baines

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## FUNDAMENTALS OF TURBOCHARGING

*Nicholas C. Baines*

### Introduction to Turbochargers and Turbocharging

- Turbocharging the internal combustion engine
- The turbocharger
- Turbocharging requirements
- The principles of operation of turbomachines
- Exhaust gas energy utilization
- Charge air cooling
- Other applications of turbochargers

### The Centrifugal Compressor

- Introduction
- Performance
- Impeller design
- Diffusers
- Volute
- Stability, range, and range extension
- Mechanical design features

### The Turbine

- Axial turbines
- Radial and mixed flow turbines
- Turbine testing

### Mechanical Design of Turbochargers

- Bearings
- Shaft seals
- Bearing or centre housing

### Matching the Engine and the Turbocharger

- Introduction
- Matching an engine and turbocharger at a given operating condition
- Modelling a turbocharged engine
- Turbocharged engine operation

### Turbocharging System Developments

- Exhaust waste gate
- Variable geometry systems
- Turbocompounding
- Waste gate, variable geometry, and compound systems compared
- Exhaust gas recirculation
- Electric drive turbocharger
- Two-stage, or series, turbocharging
- Sequential turbocharging
- Complex, Hyperbar and other systems

### Pulse Flow Performance of Radial Turbines

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- Partial admission

- Pulse flow performance
- Modelling turbine pulse flow performance
- Unsteady performance measurement techniques

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